



Systems Operation Troubleshooting Testing and Adjusting

120M, 12M, 140, 140M , 150 , 14M, 160M , 160 , 16M Motor Graders Power Train Electronic Control System

B92 1-UP (Machine)
B54 1-UP (Machine)
B55 1-UP (Machine)
B56 1-UP (Machine)
B57 1-UP (Machine)
B59 1-UP (Machine)
B9H 1-UP (Machine)
R9H 1-UP (Machine)
B9J 1-UP (Machine)
R9J 1-UP (Machine)
B9R 1-UP (Machine)
R9B 1-UP (Machine)
B9F 1-UP (Machine)
B9L 1-UP (Machine)
B9E 1-UP (Machine)
B9M 1-UP (Machine)
B9D 1-UP (Machine)
B9N 1-UP (Machine)
R9A 1-UP (Machine)
B9C 1-UP (Machine)
B9G 1-UP (Machine)
D9G 1-UP (Machine)
B9T 1-UP (Machine)

D9T 1-UP (Machine)
B9W 1-UP (Machine)
R9C 1-UP (Machine)
D9W 1-UP (Machine)

Important Safety Information

Most accidents that involve product operation, maintenance and repair are caused by failure to observe basic safety rules or precautions. An accident can often be avoided by recognizing potentially hazardous situations before an accident occurs. A person must be alert to potential hazards, including human factors that can affect safety. This person should also have the necessary training, skills and tools to perform these functions properly.

Improper operation, lubrication, maintenance or repair of this product can be dangerous and could result in injury or death.

Do not operate or perform any lubrication, maintenance or repair on this product, until you verify that you are authorized to perform this work, and have read and understood the operation, lubrication, maintenance and repair information.

Safety precautions and warnings are provided in this manual and on the product. If these hazard warnings are not heeded, bodily injury or death could occur to you or to other persons.

The hazards are identified by the "Safety Alert Symbol" and followed by a "Signal Word" such as "DANGER", "WARNING" or "CAUTION". The Safety Alert "WARNING" label is shown below.



The meaning of this safety alert symbol is as follows:

Attention! Become Alert! Your Safety is Involved.

The message that appears under the warning explains the hazard and can be either written or pictorially presented.

A non-exhaustive list of operations that may cause product damage are identified by "NOTICE" labels on the product and in this publication.

Caterpillar cannot anticipate every possible circumstance that might involve a potential hazard. The warnings in this publication and on the product are, therefore, not all inclusive. You must not use this product in any manner different from that considered by this manual without first satisfying yourself that you have considered all safety rules and precautions applicable to the operation of the product in the location of use, including site-specific rules and precautions applicable to the worksite. If a tool, procedure, work method or operating technique that is not specifically recommended by Caterpillar is used, you must satisfy yourself that it is safe for you and for others. You should also ensure that you are authorized to perform this work, and that the product will not be damaged or become unsafe by the operation, lubrication, maintenance or repair procedures that you intend to use.

The information, specifications, and illustrations in this publication are on the basis of information that was available at the time that the publication was written. The specifications, torques, pressures, measurements, adjustments, illustrations, and other items can change at any time. These changes can affect the service that is given to the product. Obtain the complete and most current information before you start any job. Cat dealers have the most current information available.



When replacement parts are required for this product Caterpillar recommends using Cat replacement parts.

Failure to follow this warning may lead to premature failures, product damage, personal injury or death.

In the United States, the maintenance, replacement, or repair of the emission control devices and systems may be performed by any repair establishment or individual of the owner's choosing.

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Systems Operation Section

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General Information

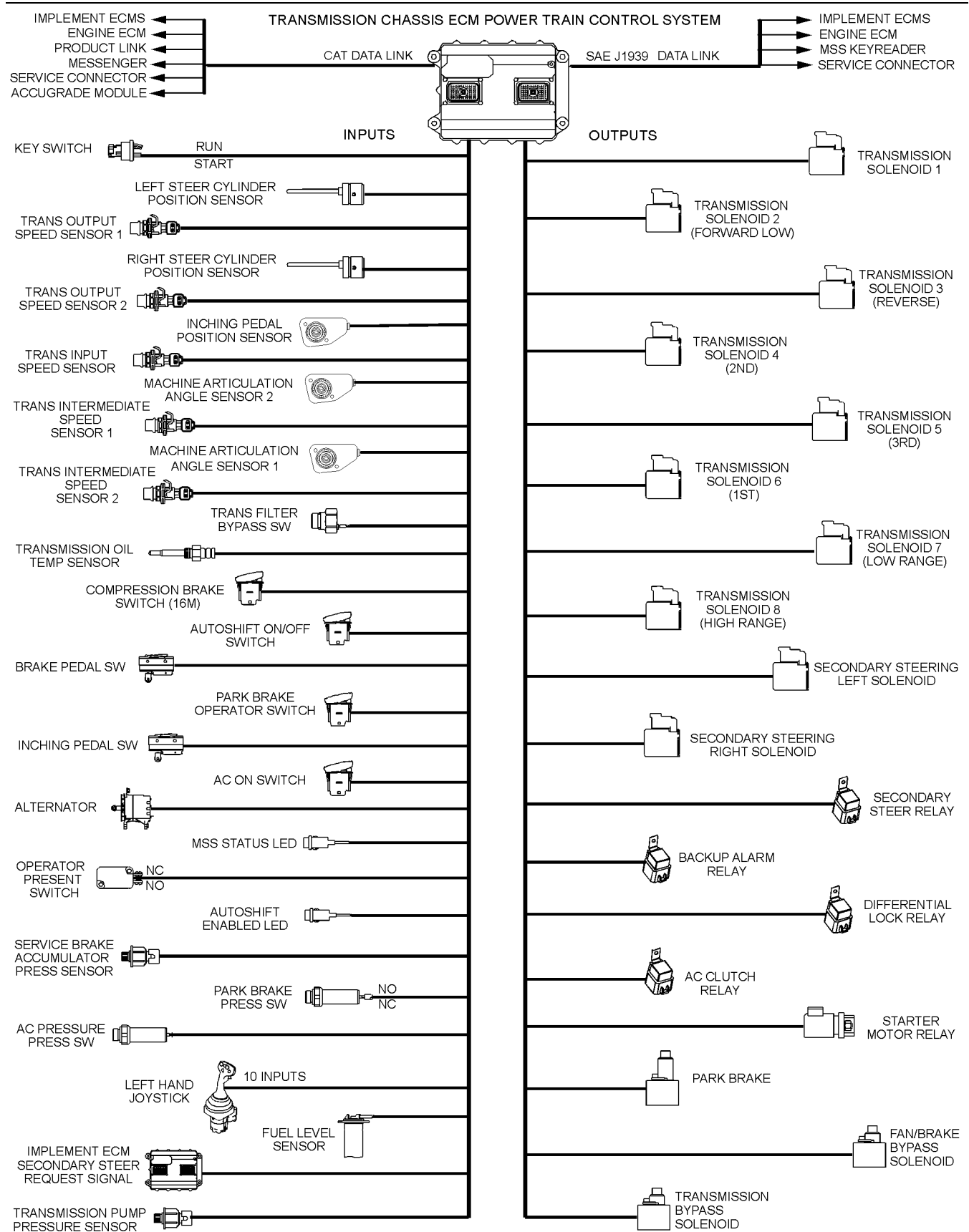
SMCS Code: 1400; 4000; 4800



Illustration 1

M Series Motor Grader

g01315518



Block diagram of the Transmission/Chassis ECM power train control system

The M Series Motor Graders are equipped with a Transmission/Chassis electronic control module (ECM) that will enable full electronic control of the transmission clutch valves. The ECM allows the operator to manually shift the transmission, based on the status of the shift controls that are located on the left joystick. A software enabled attachment "Autoshift" function is available that will enable the ECM to automatically control the operation of the transmission. The electronic control of the transmission by the Transmission/Chassis ECM allows the technician to program specific operating gear ranges to be configured using the Caterpillar Electronic Technician (Cat ET) service tool. The ECM monitors the status of the other machine systems and the operation of the transmission at all times.

In addition to controlling the transmission, the Transmission/Chassis ECM controls the following machine systems:

- The engine starting system that is based on machine conditions and input from the key start switch
- The secondary steering system that is based on machine conditions and communication with the Implement ECM
- Operation of the parking brake that is based on machine conditions and the parking brake switch
- Operation of the inching pedal that is based on position sensor and switch inputs
- Operation of the air conditioning system that is based on the air conditioning switch input
- Differential lock function that is based on selector switch input
- Back up alarm operation that is based on machine conditions

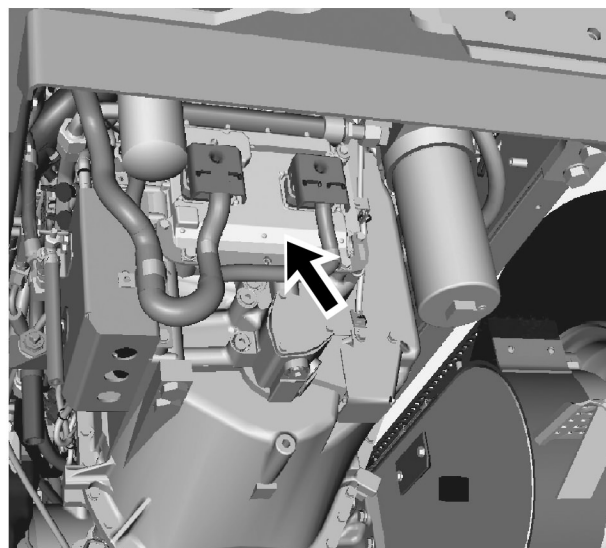


Illustration 3

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Transmission/Chassis ECM located on the rear end of the transmission (arrow)

During machine operation, the Transmission/Chassis ECM receives input data from a variety of components in the power train system. The ECM makes decisions that are based upon the state of these inputs and the operating parameters that are stored in the ECM memory. Input devices in the implement control system include:

- Components in the left joystick
- Other control modules on the machine via the Cat Data Link and the SAE J1939 Data Link
- Various "hard wired" switches that include operator control switches and machine system pressure switches
- Various "hard wired" sensors of the machine system that include position sensors, pressure sensors and temperature sensors
- The Cat ET service tool through the service tool connector

The Transmission/Chassis ECM will activate outputs to energize or de-energize solenoids and relays in order to control the transmission and other machine functions for the power train control system.

i03841033

Features

SMCS Code: 1400; 4000; 4800

S/N: B921–368

S/N: R9A1–Up

S/N: R9B1–Up

S/N: B9C1–Up

S/N: R9C1–Up

S/N: B9D1–4762

S/N: B9E1–1143

S/N: B9F1–Up

S/N: B9G1–Up

S/N: D9G1–1585

S/N: B9H1–Up

S/N: R9H1–Up

S/N: B9J1–Up

S/N: R9J1–Up

S/N: B9L1–Up

S/N: B9M1–Up

S/N: B9N1–Up

S/N: B9R1–Up

S/N: B9T1–Up

S/N: D9T1–1438

S/N: B9W1–Up

S/N: D9W1–Up

Air Conditioning System

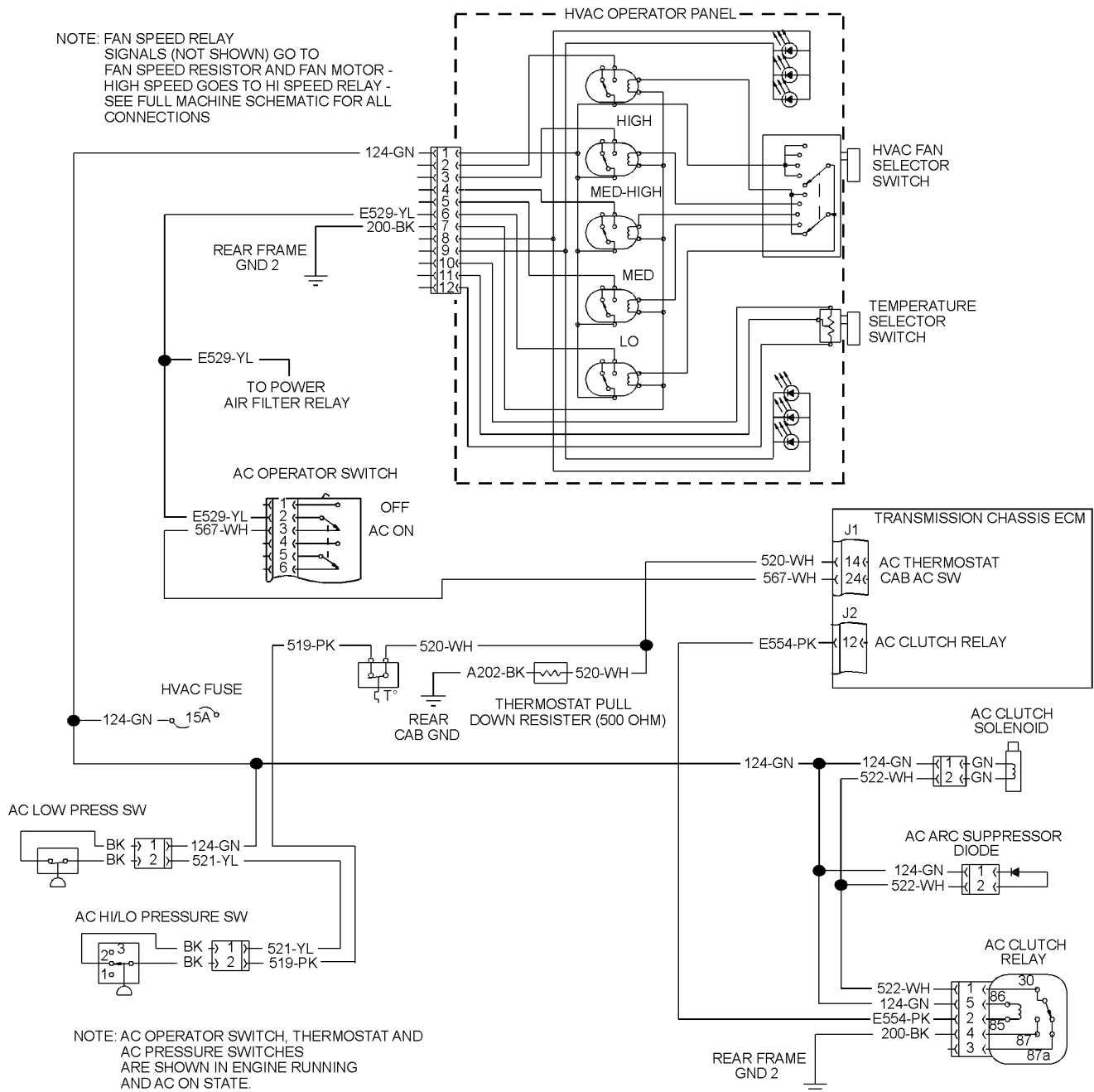


Illustration 4

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Air conditioning control circuit connections

The attachment air conditioning system is controlled by the transmission/chassis ECM.

Power for the air conditioning control components is supplied through the 15 amp HVAC fuse. The power circuit is connected to the HVAC "ON/OFF/FAN" selector switch in the HVAC operator panel.

Power for the high speed blower (not shown) is supplied to the blower motor through a 20 amp circuit breaker and is switched to the blower motor by the high speed relay. Refer to the full machine Electrical Schematic for blower motor control connections.

When the selector switch is switched to the ON position, the system power is directed to the internal AC relay coil in the operator panel which will cause the relay contacts to close. Power is then passed to the AC operator switch through the closed contacts.

When the AC operator switch is moved to the AC ON position, the system power will be directed through the switch contacts to a transmission/chassis ECM switch to +battery type input contact.

During normal operation, the ECM internal pull down voltage will hold the AC operator switch input circuit low until the system power is passed through the switch contacts and pulls the input circuit signal high. When the ECM detects the high +battery signal in the circuit, the ECM will determine that the switch contacts are in the AC ON position.

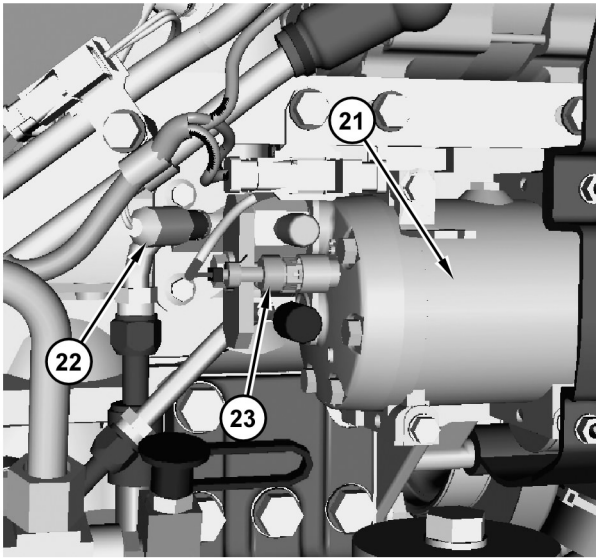


Illustration 5

g01331971

Typical M Series Motor Grader AC Compressor located on the left side of the engine

- (21) AC compressor
- (22) AC low pressure switch
- (23) AC HI/LO pressure switch

Once the ECM has received the signal to activate the AC system from the operator switch, the ECM will monitor the switch to +battery type input circuit that is connected to the thermostat. Power from the fuse must pass through two series connected system pressure switches in order to be present at one side of the thermostat contact. One is a low pressure switch and the other is the HI/LO pressure switch.

The contacts for the low pressure switch will close the system pressure increases to 118 kPa (17.1 psi). The switch contacts will be held closed until the system pressure decreases to 27.5 kPa (4.0 psi).

The switch contacts for the HI/LO pressure switch are closed when the system pressure system pressure is in the range 275 kPa (39.9 psi) to 1750 kPa (253.8 psi).

If the system pressure is not correct and the contacts of one or both of the pressure switches are open, the system power will not reach the thermostat.

A pull-down resistor is connected to the thermostat input circuit in order to hold the input circuit low. When the system power is passed through the contacts of both of the pressure switches and the thermostat contacts are closed, the system power will pull the circuit high.

The ECM will detect the high signal in the thermostat circuit and will then activate the sinking driver output for the AC clutch relay.

Once the ECM turns on the sinking driver for the relay, system power from the HVAC fuse is provided a path to ground through the sinking circuit. This energizes the relay coil which will cause the relay contacts to change states. A path to ground is then provided through the relay contacts for the system power from the fuse to pass through the AC clutch solenoid. The energized clutch solenoid will then engage the AC compressor in order to activate the system.

The transmission/chassis ECM does not monitor the component circuits in the air conditioning system for diagnostics.

Backup Alarm Operation

The backup alarm alerts the surrounding personnel that the machine is backing up. The transmission/chassis ECM activates the back up alarm by use of the backup alarm relay. The relay is controlled by the ECM through an ON/OFF output driver.

Whenever the transmission is shifted to the REVERSE direction, the ECM will turn on the output driver for the relay in order to activate the backup alarm.

Limp Home Mode

A "Limp Home" mode is available in order to provide an override to a transmission disabling diagnostic event. The limp home mode will be activated by the transmission/chassis ECM when a diagnostic code is activated for any of the transmission solenoids. When the limp home mode is activated, the ECM will allow the transmission to shift to gears that are not affected by the active diagnostic code.

Parasitic Load Reduction

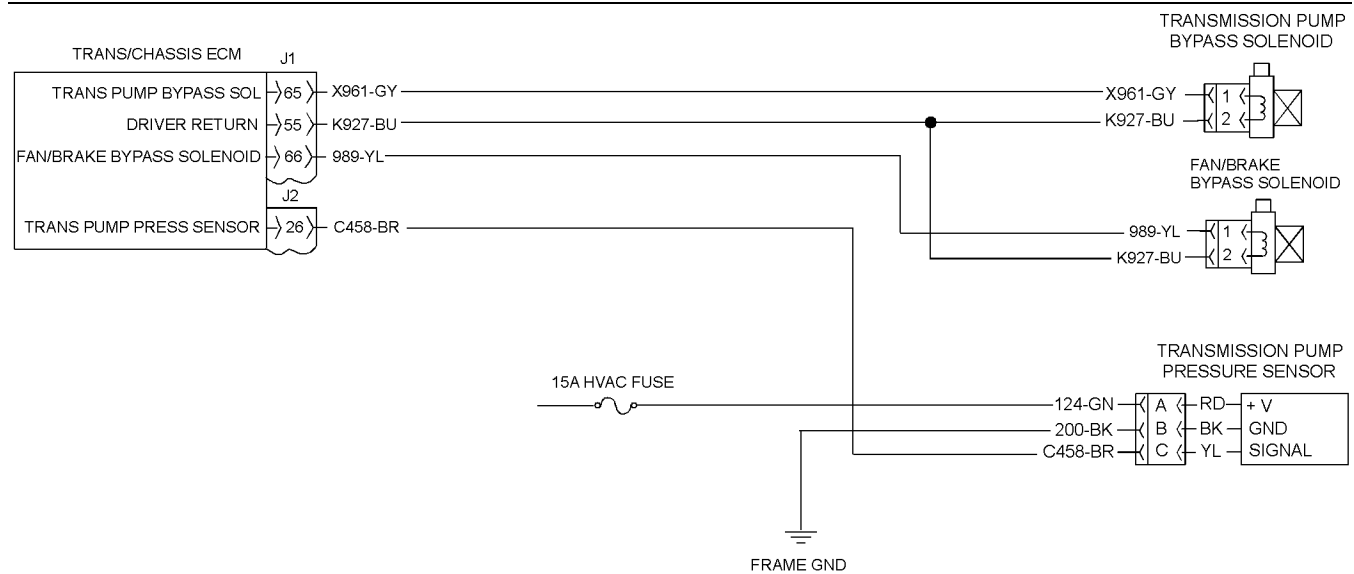


Illustration 6

g01948549

Schematic of the parasitic load reduction circuit

The cold engine parasitic load reduction feature removes non-essential loads during cold weather starts. This feature achieves parasitic load reduction via transmission and fan/brake bypass. This feature is an optional attachment available only on the following models:

- 12M
- 120M
- 140M
- 160M

This feature looks at the transmission oil temperature and hydraulic oil temperature. If either of these temperatures is equal to or less than 0° C (32° F), the cold engine parasitic load reduction feature will activate.

When the cold engine parasitic load reduction feature is activated, the fan/brake pump and transmission pump will bypass to tank, reducing the load on the engine.

Once the engine rpm has stabilized, the transmission pump bypass solenoid will be deactivated first followed by the fan/brake bypass solenoid, increasing the load on the engine.

Parking Brake Test

In order to check for the correct operation of the parking brake, the transmission/chassis ECM will allow a parking brake test to be performed when the transmission is in gear 5F. The following procedure should be performed in order to check the operation of the parking brake.

1. Place the transmission in the NEUTRAL position.
2. Place the parking brake switch in the ENGAGED position.
3. Start the engine.
4. Depress the inching pedal.
The gears 1F and 1R will be displayed on the instrument cluster.
5. Manually upshift the transmission four consecutive times within two seconds.
The instrument cluster will display the gear 5F as the active gear. No reverse gear can be selected.
6. Depress the throttle pedal and release the inching pedal.

Result: For correct operation of the parking brake, depressing the throttle pedal and releasing the inching pedal should force the engine to stall. If the machine moves forward, the parking brake operation is not correct. Investigate the cause of the failed test of the parking brake. Repair the problem before operating the machine.

Parking Brake Emergency Drive Through Function

In the event that the parking brake will not disengage and the machine must be moved for emergency purposes, the machine can be made to “drive through” the engaged park brake.

WARNING: THE FOLLOWING PROCEDURE SHOULD ONLY BE PERFORMED IN AN EMERGENCY SITUATION IN ORDER TO AVOID DANGER TO THE OPERATOR OR TO THE MACHINE. THIS PROCEDURE MAY CAUSE DAMAGE TO THE PARKING BRAKE COMPONENTS.

1. With the transmission in the NEUTRAL position and the parking brake switch in the ENGAGED position, start the engine.
2. Move the parking brake switch to the DISENGAGED position.
3. Depress the inching pedal. The gears 1F and 1R will be displayed on the instrument cluster.
4. Do not upshift or downshift. The active gear must be either gear 1F or 1R.
5. Select a direction and release the inching pedal.
6. Depress the throttle pedal in order to “drive through” the engaged parking brake.

Result: Releasing the inching pedal while depressing the throttle pedal will result in the machine moving in the selected direction and “driving through” the engaged parking brake. Move the machine for the shortest possible distance in order to minimize damage to the parking brake components.

Secondary Steer System

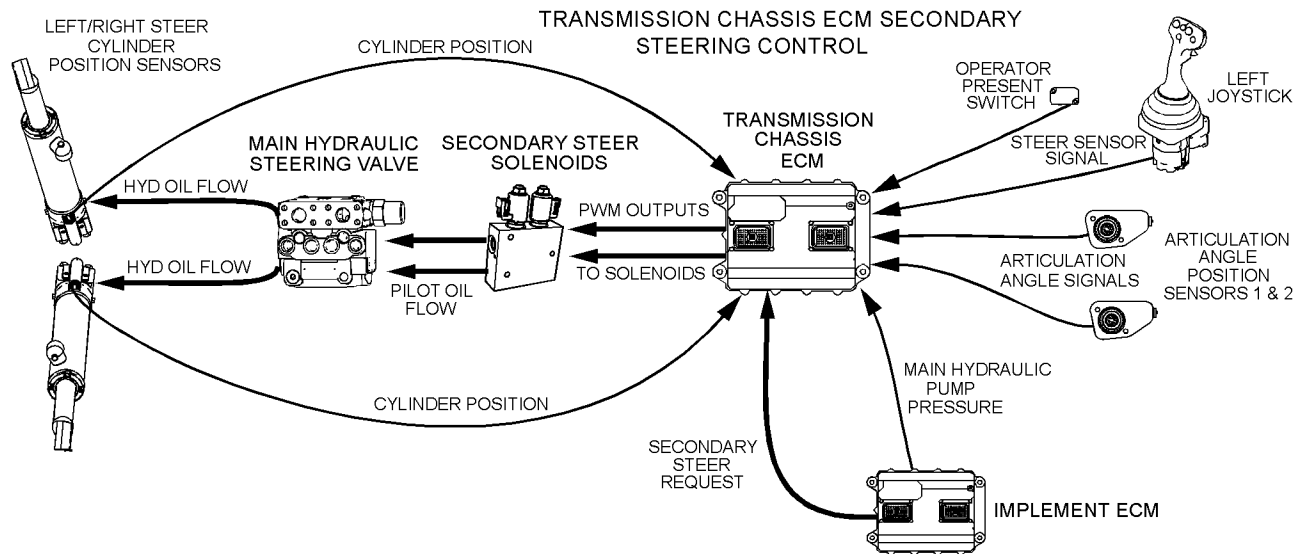


Illustration 7

g01326393

Secondary Steer Control System

Systems Operation Section

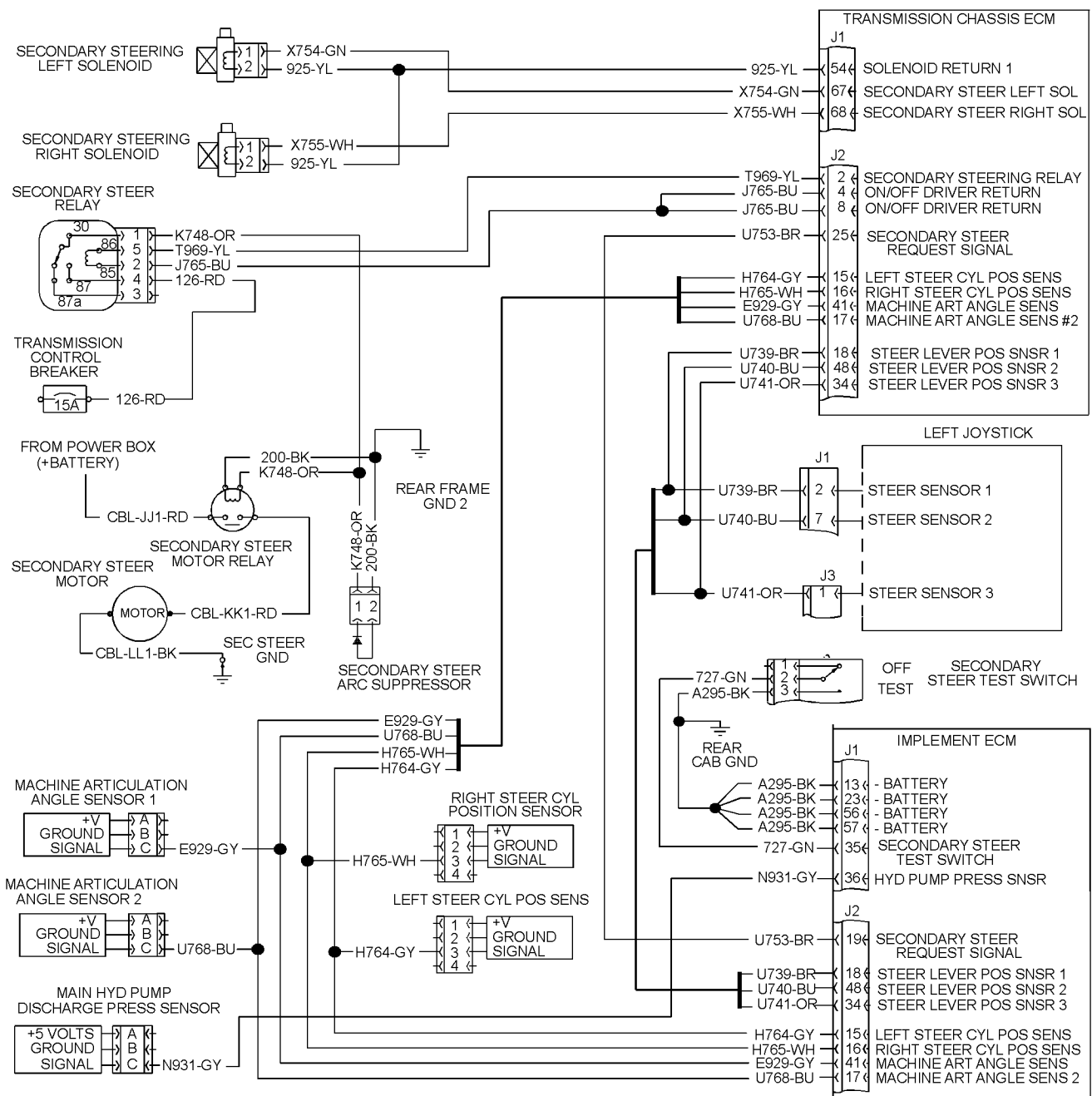


Illustration 8

g01326014

Secondary Steer System connections

The Series M Series motor graders are equipped with a secondary steering system that serves as a backup steering system in the event of a failure of the primary steering system. The transmission/chassis ECM is the main control for the secondary steering system.

Note: When activated, the secondary steering system is designed to be used for a short period of time in order to move the machine to a safe area for shutdown. The steering system loads will cause the secondary steer pump motor to overheat when operated for more than a short period of time.

The transmission/chassis ECM and the implement ECM monitor the position sensor input signals from the following steering system sensors:

- The Left joystick steer sensors 1, 2, and 3.
- The left and the right steer cylinder position sensors.
- The machine articulation position sensors 1 and 2.

The implement ECM monitors the steering system sensor signals in order to control the primary steering system. The transmission/chassis ECM monitors the same steering system sensor signals in order to be able to activate and control the secondary steering system at any time during the operation of the machine.

When the implement ECM detects a problem in the primary steering system, the implement ECM will send a pulse width modulated (PWM) signal to the transmission/chassis ECM on the "Secondary Steer Request" circuit that is connected between the two controls.

The implement ECM will send a request signal to the transmission/chassis ECM in order to activate the secondary steering system when any of the following machine system conditions are detected:

- An active CID 2202 FMI 12 (Steering Valve Control Module Error) diagnostic code.
- A failure of the main hydraulic pump.
- Steering motion is detected when no primary steering command is present.
- Steering motion is not detected when a primary steering command is present.
- Steering motion is detected in the wrong direction.
- A manual secondary steer test has been requested.
- An automatic secondary steering pump test is being performed at initial engine start-up.

The transmission/chassis ECM will activate the secondary steering system without receiving a request signal from the implement ECM when the following condition is present:

- An active CID 2199 (Secondary Steering Request Signal from the implement ECM) diagnostic code.

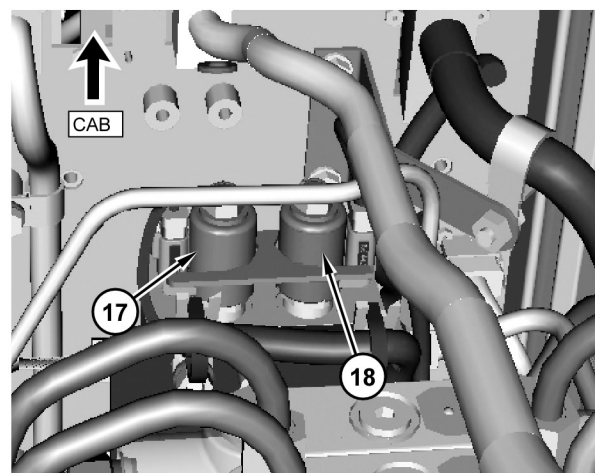


Illustration 9

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Secondary Steer Solenoids located in front of the cab behind the rear valve stack.

- (17) Secondary steer right solenoid
(18) Secondary steer left solenoid

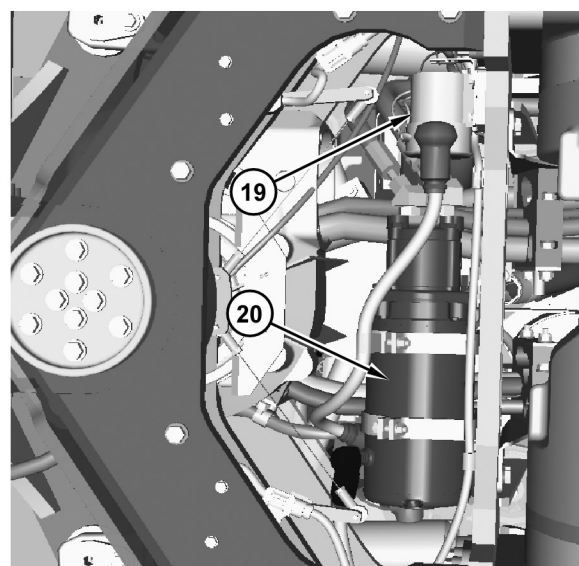


Illustration 10

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Secondary Steer Motor Relay and Pump Motor
(View: Underneath the machine on the rear side of the articulation hitch.)

- (19) Secondary steer motor relay
(20) Secondary steering pump motor

When the implement ECM sends a PWM secondary steer request signal to the transmission/chassis ECM, the duty cycle of the PWM signal will determine which specific secondary steer system components will be activated. During normal operation, the implement ECM maintains a 20 percent duty cycle on the request circuit. When a secondary steer test is requested or when the implement ECM has detected a problem in the primary steering system, the secondary steer request signal will be one of the following duty cycle signals:

20 percent PWM duty cycle – Normal operation, no request to activate.

40 percent PWM duty cycle – Request to activate the secondary steering pump motor only.

60 percent PWM duty cycle – Request to activate the secondary steer pilot solenoid valves only.

80 percent PWM duty cycle – Request to activate the secondary steering pump and the secondary steer pilot solenoid valves.

When a 40 percent duty cycle request is received by the transmission/chassis ECM, the ECM will energize the secondary steer relay. This will allow power to pass through the relay contacts which will energize the secondary steer motor relay. Power from the power control box will then be supplied to the secondary steering pump motor which turns the secondary steering pump. When a pump request only is received, the secondary steering pump will supply hydraulic oil flow to the primary steering system.

Note: When the secondary steering pump motor is activated in order to supply hydraulic oil flow to the primary steering system or the secondary steering system, the secondary steering pump motor will overheat if operated for more than a short period of time.

When a 60 percent duty cycle request is received by the transmission/chassis ECM, the ECM will activate the proportional secondary steer pilot solenoid valves in order to control the hydraulic oil flow to the steer cylinders. The ECM will use a PWM output signal in order to energize the secondary steer solenoids. The transmission/chassis ECM will vary the amount of electrical current that is sent to the solenoids in order to control the angle of the front wheels.

When the secondary steer solenoids are energized, pilot oil is directed to the same main hydraulic valve that is used for the primary steering system. The steering valve control module that is used for operation of the primary steering system is not used when the secondary steer solenoids are active.

When an 80 percent duty cycle request is received by the transmission/chassis ECM, the ECM will energize the secondary steer relay in order to energize the secondary steering pump motor. The ECM will also activate the proportional secondary steer pilot solenoids.

In order to control the secondary steer system, the transmission/chassis ECM will use a “closed loop” command and feedback system similar to the system that the implement ECM uses to control the primary steering system.

The transmission/chassis ECM outputs the PWM output signal to the appropriate solenoid based on the steer sensor input signal from the left joystick. Then, the ECM monitors the position of the steer cylinders in order to adjust the electrical current to the solenoid accordingly. As the steering cylinders approach and reach the commanded position, the ECM will decrease the output current to the solenoid until movement of the cylinders is stopped. The cycle repeats as steering input from the joystick changes.

If one of the steer cylinder position sensor signals is not available, the transmission/chassis ECM will use the signal from the other cylinder position sensor to determine the position of the front wheels. If both of the steer cylinder position sensor signals are not available, the transmission/chassis ECM will use the last known cylinder position sensor data and the commanded hydraulic oil flow in order to estimate the position the steer cylinders and the front wheels. This condition will result in limited steering motion over time.

Once the transmission/chassis ECM has activated the secondary steering system, the system will remain active until the machine is turned OFF. If the condition that caused the activation of the secondary steering system is no longer present, the primary steering system will be active when the machine is restarted.

Secondary Steer System Test

The implement ECM and the transmission/chassis ECM perform an automatic test or a manual test in order to check the system for proper operation.

Automatic Secondary Steering Test

The automatic secondary pump test is performed once each time that the engine is started. If the system does not perform as expected, the implement ECM will activate a level 3 EID 0560 (Secondary Steering Pump No Response) event in order to alert the operator that the system has failed the test.

During the automatic test, the engine must be operating and the machine speed must be zero. During an automatic secondary steering test, all implement and primary steering functions are disabled by the implement ECM for the ten second duration of the test.

Note: If the automatic secondary steer test or the manual test results in an active level 3 EID 0560 (Secondary Steering Pump No Response) event being activated by the implement ECM, the machine must be immediately shutdown in a safe manner. The problem in the secondary steer system must be investigated and repaired before operating the machine.

Manual Secondary Steering Test

The manual test for the secondary steer system should be performed every 100 hours of machine operation or every two weeks.

During a manual secondary steering test, all implement and primary steering functions are disabled by the implement ECM for the ten second duration of the test.

In order to perform the manual secondary steering test, the engine must be running and the machine speed must be zero.

To begin the test, the operator holds the momentary secondary steering test switch in the test position for a period of ten seconds.

When the implement ECM detects that the switch input circuit has been grounded through the switch, the implement ECM will initiate the manual test for the system.

First, the implement ECM disables the primary steering system and the implement system. Then, the implement ECM sends a 40 percent PWM duty cycle signal to the transmission/chassis ECM over the secondary steering request circuit.

A 40 percent duty cycle indicates that the transmission/chassis ECM should activate the secondary steering pump motor only.

While the transmission/chassis ECM energizes the secondary steer relay in order to turn ON the secondary steering pump motor, the implement ECM monitors the main hydraulic discharge pressure sensor.

Two check valves are used in the hydraulic system to enable the main pressure sensor to detect the secondary pump pressure.

If the implement ECM does not detect that the secondary pump pressure is greater than 10,000 kPa (1450.4 psi) in a specified short period of time, the implement ECM will activate an EID 0560 (Secondary Steering Pump No Response) event code.

If the implement ECM detects that the secondary pump pressure is greater than 10,000 kPa (1450.4 psi) within the specified time limit, the implement ECM will send an 80 percent PWM duty cycle signal to the transmission/chassis ECM over the secondary steering request circuit.

An 80 percent duty cycle indicates that the transmission/chassis ECM should activate the secondary steering pump motor and the secondary steer pilot solenoid valves.

When the operator sees that no EID 0560 event code has been activated on the Messenger, the operator should immediately move the left joystick to the steer left and the steer right positions.

If the front wheels follow the steer commands, the secondary steer system is performing correctly.

After the operator holds the momentary secondary steer test switch in the test position for ten seconds, the implement ECM will deactivate the test mode.

Note: If the manual secondary steer test results in no active EID 0560 (Secondary Steering Pump No Response) event code, however, the front wheels do not respond correctly to the steering commands within the ten second time limit, the machine must be immediately shutdown in a safe manner. There is a problem in the secondary steer system that must be investigated and repaired before operating the machine.

Transmission Electronic Clutch Pressure Control (ECPC)

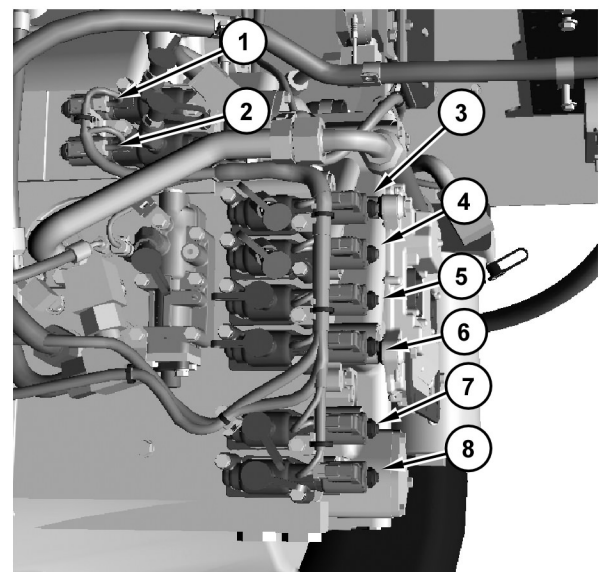


Illustration 11

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Transmission clutch solenoids that are located on the left side of the transmission

- (1) Transmission clutch solenoid 1 (forward high)
- (2) Transmission clutch solenoid 2 (forward low)
- (3) Transmission clutch solenoid 3 (reverse)
- (4) Transmission clutch solenoid 4 (2nd speed)
- (5) Transmission clutch solenoid 5 (3rd speed)
- (6) Transmission clutch solenoid 6 (1st speed)
- (7) Transmission clutch solenoid 7 (low range)
- (8) Transmission clutch solenoid 8 (high range)

The transmission/chassis ECM on the Series M Series Motor Graders enables the operation of Electronic Clutch Pressure Control (ECPC) valves for control of the transmission. The ECM controls the eight proportional solenoid valves of the transmission clutch in order to shift the transmission.

The transmission solenoid valves control the hydraulic circuits that engage the transmission clutch pressures. The ECM supplies electrical current to the appropriate transmission solenoid valves in order to move the machine in one of the two available speed ranges that enable eight speeds in the forward direction and 6 speeds in the reverse direction.

On an ECPC controlled transmission, the clutch pressure is modulated electronically. The ECM controls the modulation of clutch pressure by sending a variable output current to the appropriate proportional clutch solenoids. In order to determine the correct output current to send to the clutch solenoids, the ECM monitors the following data:

- Engine torque data from the Engine ECM
- Input data from the transmission speed sensors
- Temperature data from the transmission sensor

The ECM will output a pulse width modulated(PWM) signal in order to vary the current to the solenoid. The current to the solenoid determines the amount of pilot oil pressure that is applied to the hydraulic valve spool. The travel of the spool is proportional to the electrical current that is supplied to the solenoid.

The position of the valve spool controls the amount of hydraulic oil pressure that is applied to the clutch which determines the amount of clutch engagement. An increase in electrical current will cause an increase in the engagement pressure from the clutch.

The following two modes are available for operation of the transmission:

- The standard mode of operation is the manual mode.
- The attachment autoshift mode.

When in the manual mode, the transmission/chassis ECM selects the transmission clutches that must be engaged according to the inputs from the operator controls on the left joystick.

When the machine is in the attachment autoshift mode, the ECM controls the shifting pattern according to machine operating conditions and the transmission output speed (TOS).

Note: When the transmission oil is changed and the viscosity of the new oil is not the same as the viscosity of the old oil, the new oil viscosity must be configured for the machine.

The parameter for the viscosity of the new oil can be changed by use of the Messenger or by use of the Cat ET service tool in the configuration screen. Once the new oil viscosity is configured, the Transmission Clutch Fill Calibration MUST be performed.

The transmission/chassis ECM will adjust the operation of the transmission according to the viscosity of the new transmission oil. Refer to the Testing and Adjusting, "Machine Control Module (ECM) - Configure" section of this manual for more information.

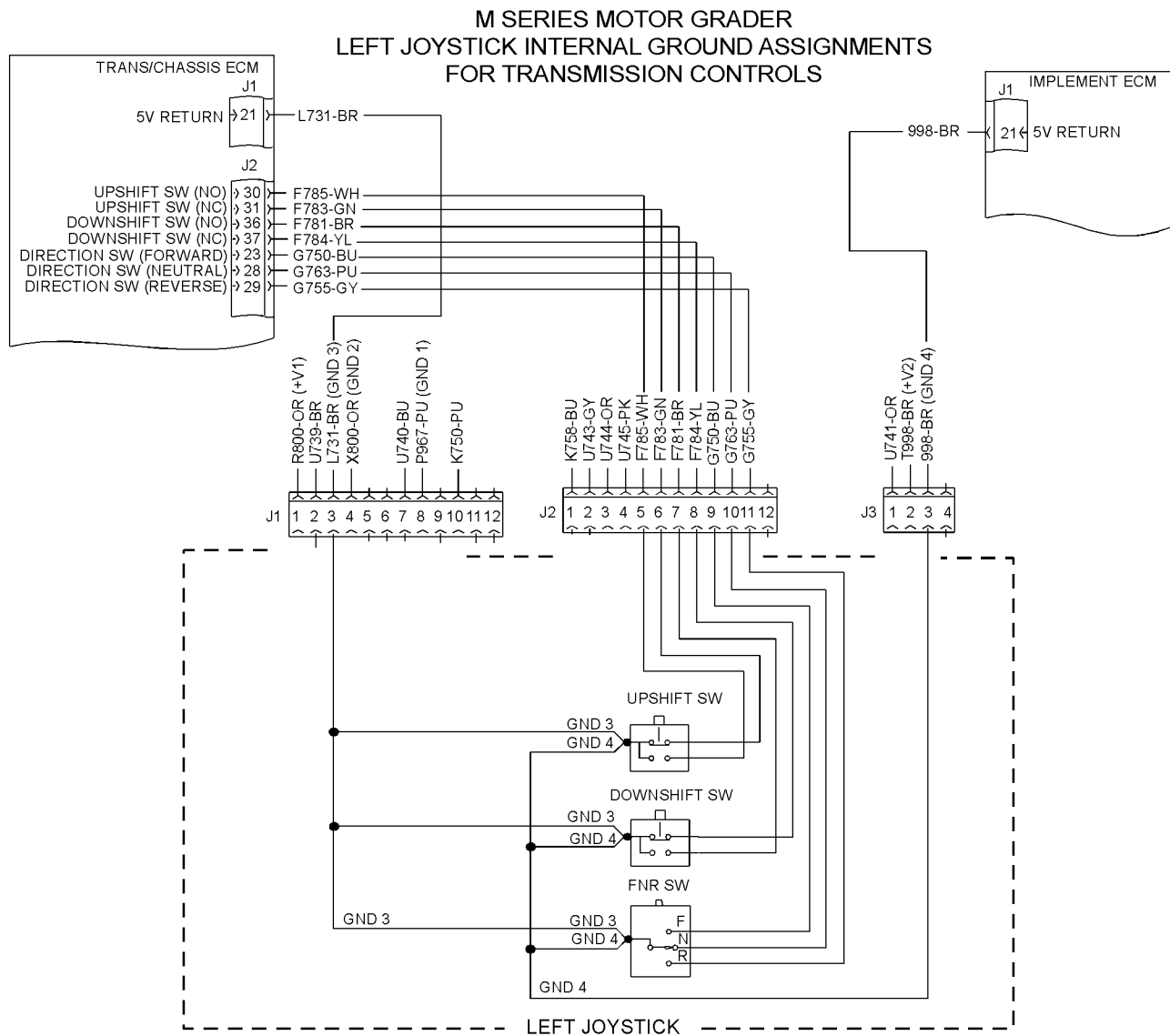


Illustration 12

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Note: Illustration 12 shows the internal push buttons and ground assignments for the transmission controls in the left joystick. The left joystick for the implement and steering components that provide inputs to the implement ECM are not shown here.

The components that are in the left joystick are not serviceable. If a component in the joystick has failed, the complete assembly must be replaced. The illustration is displayed in order to aid in the component and the troubleshooting of the circuit for the transmission controls. For a complete connection diagram for all of the joystick to ECM connections, refer to the System Schematics in the back of this manual.

The following switches provide a switch to ground input to the transmission/chassis ECM in order to indicate the commands of the operator for gear selection:

- The upshift switch
- The downshift switch
- The FORWARD/NEUTRAL/REVERSE (FNR) switch

Each switch is internally connected to two of the four ECM return (ground) circuits that are supplied to the left joystick. One of the return circuits of the ECM for the switches is supplied by the transmission/chassis ECM and the other return circuit of the ECM for the switches is supplied by the implement ECM. Both ground connections must fail either internally or externally in order to interrupt the operation of the switch due to loss of ground connections.

The ECM has an internal “pull up” voltage that is connected to each of the switch input connections. The pull up voltage holds the circuit high until the switch grounds the circuit through the switch contacts. The ECM expects one of the switch inputs to be grounded at all times. If all of the switch inputs are grounded or if none of the switch inputs are grounded, the ECM will activate a diagnostic code for the switch.

The ECM monitors the state of the three inputs of the switch for the FNR trigger selector switch. The switch input that is grounded through the switch contacts will determine the directional mode that the ECM will activate for the transmission.

The ECM monitors the state of the two switch inputs for the upshift switch and the down shift switch. When the ECM detects the transition from the normally closed input being grounded through the switch contacts to the normally open input being grounded through the switch contacts, the ECM will activate the solenoid outputs for the next higher or lower gear in the selected forward or reverse direction.

If the upshift switch or the down shift switch is depressed numerous times, the ECM will detect the number of switch input transitions and activate the solenoids for the requested higher or lower gear provided that the requested shift will not cause damage to transmission components.

Operation of the Transmission Speed Sensor

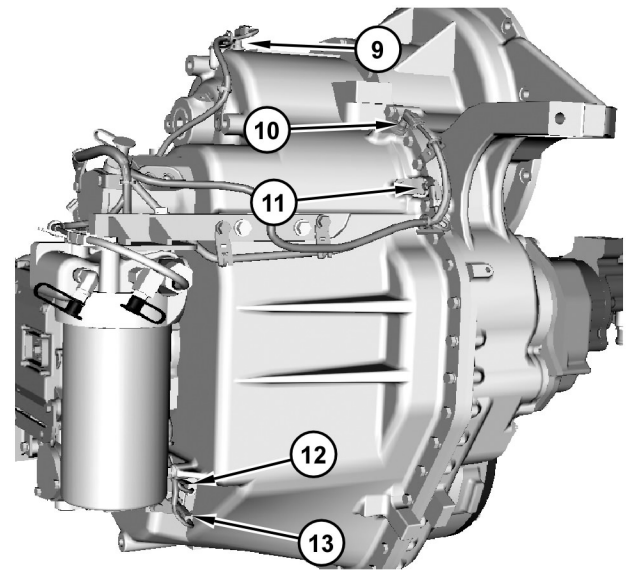


Illustration 13

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Transmission speed sensors that are located on the top side and the right side of the transmission

- (9) Transmission input speed sensor
- (10) Transmission intermediate speed sensor 2
- (11) Transmission intermediate speed sensor 1
- (12) Transmission output speed sensor 2
- (13) Transmission output speed sensor 1

The transmission on the M Series Motor Graders is equipped with five transmission speed sensors. Each speed sensor supplies a frequency input to the transmission/chassis ECM.

The input speed sensor is mounted at a location that will monitor a gear on the input shaft of the transmission. The two intermediate speed sensors are mounted at a location in order to monitor a large intermediate gear in the transmission. The two output speed sensors are mounted at a location in order to monitor a gear that is mounted on the output shaft of the transmission.

Each of the speed sensors is attached to the transmission with a fixed mount. No adjustment of the mount for the speed sensor is necessary.

The speed sensors produce a signal that varies in frequency (Hz) as the tooth of the gear is passed in front of the sensor. As each tooth of the gear passes the sensor one cycle or hertz is detected by the speed sensor. The ECM detects the frequency of the signal. The ECM then determines the speed and the direction of the shaft that is associated with that gear. Each speed sensor has two input connections to the ECM (“+” and “-”). The following applies to all speed sensors:

- Connector contact 2 is the signal (+)

- Connector contact 1 is the return line (-)

When the speed of the transmission output shaft is greater than 150 rpm, the transmission/chassis ECM monitors the two output speed sensors in order to determine the transmission output speed (TOS) and the direction of travel.

If no TOS or direction signals are coming from the two output speed sensors, the ECM will use the signals from intermediate speed sensors in order to calculate the TOS and in order to determine the direction. This enables the ECM to maintain control of the transmission if a failure of the two output speed sensor circuits should occur.

When the speed of the transmission output shaft is less than 150 rpm, the ECM will use the signals from the two intermediate speed sensors to calculate the TOS and the direction of travel. At the lower TOS, the slower speed of the output gear results in a poor signal from the output speed sensors. The larger intermediate gear is rotating faster at the lower output shaft speed which results in a more reliable intermediate speed sensor signal.

Note: In the event that both of the intermediate speed sensors fail, the speed of the transmission output shaft will not be able to be determined at a speed of less than 150 rpm.

The ECM uses the TOS and direction data in order to control the shifting of the transmission when operating in the autoshift mode. The ECM uses the TOS and direction information in order to control the operation of the transmission and to prevent unsafe operating conditions that could be dangerous to the operator or cause damage to the machine.

During normal operation of the transmission, the transmission/chassis ECM is using the signal from the input speed sensor to determine the speed of the engine. In addition, the ECM is receiving data about engine speed from the Engine ECM over the J1939 Data Link. The ECM is comparing the speed data for the engine against the frequency from the input speed sensor. The ECM is continuously comparing the signals that are supplied by the two output speed sensors to each other and the ECM is continuously comparing the signals that are supplied by the two intermediate speed sensors to each other.

If the ECM detects that the two output speed sensor signals differ by more than 50 rpm, the ECM will use the signals from the intermediate speed sensors to determine which output speed sensor signal is correct.

In the unlikely event that the signals from the two intermediate speed sensors differ by more than 50 rpm, the ECM will use the input speed sensor signal and calculate which output speed sensor signal is the correct signal and which intermediate speed sensor signal is the correct signal. The ECM will then activate a diagnostic code for the speed sensor circuits that are determined to be producing the faulty signal.

If the ECM determines that the signals of the two intermediate speed sensors differ by more than 50 rpm, the ECM will use the input speed sensor signal and calculate which intermediate speed sensor signal is the correct signal. The ECM will then activate a diagnostic code for the intermediate speed sensor circuit that is producing the faulty signal.

Operation of Transmission Shifting

In order to control the shifting of the transmission, the transmission/chassis ECM will energize two clutch solenoids when the machine is in PARK or NEUTRAL. The ECM will energize different combinations of three clutch solenoids when the machine is in one of the available gears in the forward or the reverse direction. Table 1 indicates which solenoids are energized in order to activate the corresponding gear arrangement.

Note: During machine operation, the selected gear and direction are displayed on the LCD screen of the instrument cluster. When in NEUTRAL, the selected gear for FORWARD and for REVERSE are displayed.

Systems Operation Section

Table 1

Transmission Gear and Solenoid Valve Logic								
	Solenoid 1 (forward high)	Solenoid 2 (forward low)	Solenoid 3 (reverse)	Solenoid 4 (second speed)	Solenoid 5 (third speed)	Solenoid 6 (first speed)	Solenoid 7 (low range)	Solenoid 8 (high range)
Park					X			X
Neutral					X			X
First Speed Forward	X					X	X	
Second Speed Forward		X		X			X	
Third Speed Forward		X			X		X	
Fourth Speed Forward	X				X		X	
Fifth Speed Forward	X					X		X
Sixth Speed Forward		X		X				X
Seventh Speed Forward	X			X				X
Eighth Speed Forward	X				X			X
First Speed Reverse			X			X	X	
Second Speed Reverse			X	X			X	
Third Speed Reverse			X		X		X	
Fourth Speed Reverse			X			X		X
Fifth Speed Reverse			X	X				X
Sixth Speed Reverse			X		X			X

Operation of Manual Mode

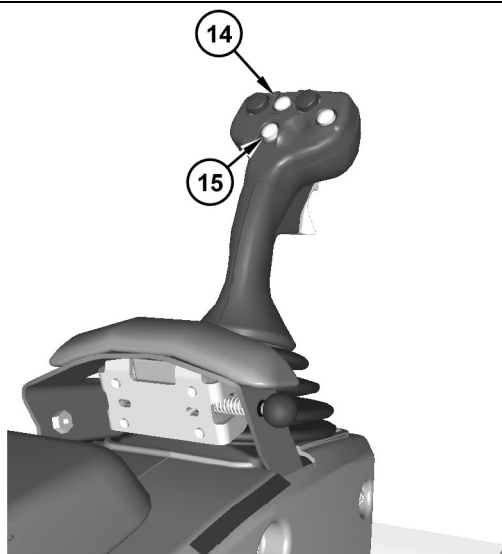


Illustration 14

Transmission Shift Controls on the left joystick

(14) Upshift switch

(15) Downshift switch

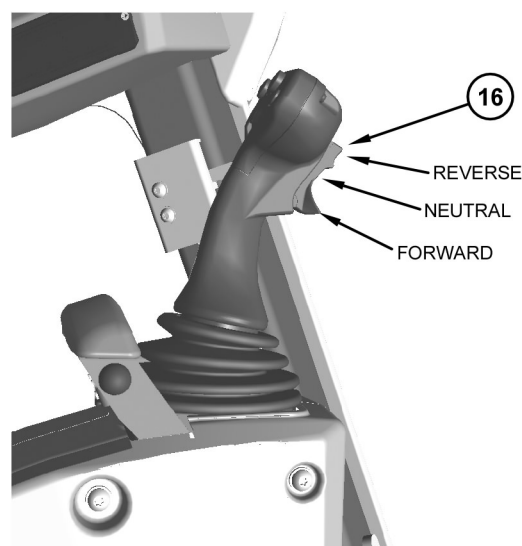
The standard mode of transmission operation is the manual mode. The manual mode is active when the engine is started. If the machine is equipped with the autoshift attachment, the manual mode is active anytime the autoshift function is in the OFF position.

When in manual mode, the operator uses the push button switch controls on the left joystick to send shift commands to the transmission/chassis ECM.

Two gear presets can be configured for use in the standard manual mode or for use in the attachment autoshift mode if it is installed on the machine. The presets are the "Initial" gear and the "Maximum" gear.

Initial Gear

The transmission/chassis ECM allows an "Initial Gear" to be configured for the FORWARD and REVERSE direction by use of the Cat ET service tool or the Messenger. The configuring of the initial gear must be done when the transmission is in NEUTRAL and the transmission output speed is zero (no travel). The configured Initial gear will be recognized in the Manual Mode and the Initial gear will be recognized under some conditions in the Autoshift Mode.



(16) FNR trigger selector switch

The initial gear that is configured in the Cat ET service tool or in Messenger will be the first gear that the ECM will shift to when the machine is shifted to the FORWARD position or to the REVERSE position. For example, the factory default for the Initial gear is set to gear 3F and gear 3R. At start-up of the machine with the transmission in NEUTRAL, both the gear 3F and the gear 3R will be displayed on the instrument cluster. When the transmission is shifted into the FORWARD position and no upshift or no downshift has been requested by the operator, the active gear will be gear 3F. Gear 3R would be active if the machine were shifted to the REVERSE position.

Upshifts or downshifts can be requested while the transmission is in the NEUTRAL position. Upshifts or downshifts can also be requested during travel to activate a gear other than the defined initial gear.

The defined Initial gear is effective at all times during the machine operation. When the "Autoshift" mode is active, the initial gear may be ignored under certain operating conditions that are covered in the "Autoshift" section below.

The ECM will accept gears in the following gear ranges as the configured initial gear. In the FORWARD direction, gear 1F to gear 5F. In the REVERSE direction, gear 1R to gear 4R. The factory defaults for the Initial gears are gear 3F and gear 3R.

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Maximum Gear

The transmission/chassis ECM allows a “Maximum” gear to be configured for the FORWARD and REVERSE directions by use of the Cat ET service tool only. The configuring of the Maximum Gear must be done when the transmission is in NEUTRAL and the transmission output speed is zero (no travel). The configured Maximum gear will be used at all times during machine operation in either the manual mode or the autoshift mode.

The configured maximum gear that is configured in the Cat ET service tool will be the highest gear that the ECM will activate when the machine is in operation in the FORWARD direction or the machine is in operation in the REVERSE direction. The maximum FORWARD gear can be configured as low as 3F and up to 8F and the maximum REVERSE gear can be configured starting at 3R and up to 6R. For example, the factory default for the Maximum gear is set to gear 8F and gear 6R. The maximum gear setting allows for the normal operation of all of the available gears for the operation of the transmission. If the operator wants to limit transmission operation to no higher than gear 4F in the FORWARD direction and 3R in the REVERSE direction, the technician can configure the maximum gears to gear 4F and gear 3R by use of the Cat ET service tool. When this is done, the ECM will not allow a shift to a gear that is higher than gear 4F or gear 3R at any time during machine operation in either transmission mode. The ECM will retain the configured maximum gear parameter in both directions until the parameters are changed using the Cat ET service tool.

Transmission/Chassis ECM Shifting Logic In Manual Mode

The transmission/chassis ECM monitors the input signals from the transmission speed sensors in order to determine the transmission output speed (TOS) and direction of travel. The ECM will use “speed inhibit logic” to prevent hazardous transmission operation. The ECM will allow directional shifts while traveling if the requested change in operation will not result in damage to the machine or in danger to the operator. If a requested gear shift is determined to be improper at a given machine speed, the ECM will shift to a gear that is close to the requested gear in order to allow for safe operation.

The following logic is used by the ECM for normal operation of the transmission and to prevent hazardous transmission operation:

- All shifts must be performed as the engine is running, the operator is in the seat and the parking brake is disengaged.
- If an active gear is not selected after the machine start-up, the default or configured initial gear will be the active gear in both directions.

- **When (TOS) is greater than 150 rpm:** When shifting to NEUTRAL from either the FORWARD or the REVERSE direction, the gear that is active when the shift to NEUTRAL takes place will remain the same. Example: Active gear is 2F. The transmission is shifted to NEUTRAL from 2F. Gear 2F will be active if the transmission is shifted back to FORWARD. Gear 2R will be active if the transmission is shifted to REVERSE. If the active gear is set greater than 3F or 3R then the opposite direction is set to 3F or 3R.
- **When (TOS) is less than 150 rpm:** Shifting to the NEUTRAL position from a gear that is lower than the configured initial gear will result in the same gear being available for the next request of a directional shift. Example: The Initial gear is 3F and 3R. The transmission is shifted to NEUTRAL from active gear 2F. Gear 2F will be active when a shift to FORWARD is requested. Gear 2R will be active if a shift to REVERSE is requested.
- **When (TOS) is less than 150 rpm:** Shifting to the NEUTRAL position from a gear that is higher than the configured initial gear will result in the configured initial gear being active the next time a directional shift is requested. Example: The Initial gear is 3F and 3R. The transmission is shifted to NEUTRAL from active gear 5F. Initial gear 3F will be active when a shift to FORWARD is requested. Gear 3R will be active if a shift to REVERSE is requested.
- If the transmission is operating in an overspeed condition for the active gear, the active gear display on the instrument cluster will flash ON and OFF until the overspeed condition is no longer occurring.

Directional Shifting

The ECM will allow directional shifting in gear 1, gear 2, gear 3, or gear 4 when the machine is in gear and traveling. The following directional shifts are allowed:

- From FORWARD to REVERSE: 1F to 1R, 2F to 2R, 3F to 3R and 4F to 3R.
- From REVERSE to FORWARD: 1R to 1F, 2R to 2F, 3R to 3F.

The following logic is used by the ECM for directional shifting operation of the transmission and to prevent hazardous transmission operation:

- For a directional shift, the FNR switch must pass through NEUTRAL in less than 0.1 seconds.

- Directional shifts may be performed with or without the operation of the inching pedal. If the inching pedal is depressed, during a directional shift request, and is then released, the ECM will shift to the appropriate gear for the current machine speed and execute the requested directional shift.
- A directional shift from gear 4F to gear 3R will not be allowed if the TOS is above a defined speed. The ECM will initiate a down shift to gear 3F before shifting to gear 3R.
- When a directional shift is initiated from a gear higher than gear 3, the ECM will downshift the transmission to gear 3 and will execute the requested directional shift.

Note: If, for example, the directional shift was initiated in 7F and the inching pedal was depressed and the machine was allowed to slow to a 5F speed, releasing the inching pedal would engage 5F and continue to down shift to 3F and execute the directional shift to 3R.

Cold Transmission Oil Mode - Direction Clutch Priming

In order to avoid harsh shifting that can be caused by cold transmission oil, the transmission/chassis ECM will perform an automatic procedure for priming the direction clutch. The ECM will activate the direction clutch priming cycle when the engine is started and the following machine conditions are present.

- The temperature of the transmission oil is equal to or less than 15 °C (59.0 °F).
- The starting sequence of the machine is complete. The engine is running and the speed sensors are active.
- The parking brake is engaged.
- The FNR switch is in the NEUTRAL position.
- The inching pedal is not depressed.

During the priming cycle of the clutch, the ECM will inhibit the calculated transmission output speed. The ECM will change the minimum transmission output speed from 150 rpm to 95 rpm in order to detect any machine movement.

During the priming of the clutch, the ECM will send a pulse of electrical current to the outputs for the transmission clutch solenoid valves. This procedure fills the clutch valves with oil in order to avoid harsh transmission shifts.

The ECM performs the automatic direction clutch priming cycle in less than 10 seconds.

The ECM will deactivate the priming of the clutch when the automatic cycle is completed or if the following machine conditions occur.

- The parking brake is disengaged.
- The “FNR” switch is moved out of the NEUTRAL position.
- The inching pedal is depressed.
- The transmission output speed is greater than 95 rpm.
- A signal is not received from the transmission output speed sensor.
- The engine is turned OFF.

The ECM will also deactivate the priming of the clutch when a diagnostic code is activated for any of the following components.

- Any of the transmission clutch solenoids
- The FNR switch
- Any of the electrical components of the parking brake system
- The position sensor of the inching pedal

Transmission Over Speed Protection Strategy

Overspeed protection is a feature that utilizes transmission shifts to help protect the engine from running at an overspeed condition. In addition, overspeed protection ensures that the transmission will never be shifted into a gear that would cause an overspeed condition.

Overspeed Upshift

The control will upshift the transmission by one gear when the transmission output speed reaches the overspeed up shift point for the current gear. The control does not limit the number of overspeed up shifts. If the transmission output speed continues to increase, the control will upshift, based on overspeed upshift points, until the transmission reaches the top gear.

Overspeed Downshift

The control will downshift the transmission by one gear when the actual gear is higher than the selected gear and the transmission output speed decreases below the overspeed downshift point.

Engine Controlled Downshift

The shift control logic contains downshift inhibit points. These “inhibit” points were established in order to prevent abusive operation of the power train. The “inhibit” points also protect the operator from possible adverse operation of the machine. The Transmission ECM will downshift the transmission by one gear when the actual gear is higher than the desired gear and the transmission output speed is below the overspeed downshift rpm point. The current downshift inhibit strategy is good for protecting the transmission and protecting the engine from damage caused by overspeed. The downshift inhibit strategy does not allow the requested shift to take place as quickly as possible. The engine controlled downshift feature will try to resolve this issue. If the transmission/chassis ECM requests a downshift and the transmission output speed is above the overspeed downshift point, the transmission/chassis ECM will command the minimum engine speed among the gears between the current gear and the minimum downshift gear.

In an example of this process, suppose that the actual gear is 6F. The operator request downshifts to 3F. If the transmission output speed is above the overspeed downshift transmission output speed for 5F, the transmission/chassis ECM will command the minimum engine speed between 6F to 5F, 5F to 4F and 4F to 3F.

Note: The downshift function for engine control will be deactivated if the parking brake is engaged. The downshift function for engine control will also be deactivated if the inching pedal or the switch for the inching pedal is depressed.

Transmission Gear Limiting

The Transmission Output Speed Steering Limit (TOSSL) is evaluated against the transmission speed limiting tables to determine the highest gear that would not exceed TOSSL. All gears above this gear will be inhibited. If the actual gear is an inhibited gear, the gear limiting feature will check to see if shifting to the highest gear would cause an overspeed condition. If no overspeed condition is predicted, the transmission will command a shift to this gear. If an overspeed condition is predicted, a shift command will be prohibited.

Autoshift Operation

The autoshift function allows the operator to set or configure the range of gears that the transmission/chassis ECM will use for automatic shifting of the transmission in the FORWARD direction or the REVERSE direction.

The autoshift function is an attachment function that is software enabled. A factory password is required to enable this function.

The operator turns on the function with the autoshift switch on the right console. When the autoshift mode is active, the ECM will illuminate the autoshift LED that is located below the instrument cluster on the dash. The LED will flash “ON” and “OFF” when the machine is operated in a gear that is lower than the configured minimum autoshift gear or when the transmission is in NEUTRAL position.

The ECM uses the transmission output speed (TOS) data from the transmission output speed sensors to determine the shift points at which the autoshift function is active. If the output speed sensor signals are determined to be faulty, the ECM will use the speed and direction signals from the intermediate speed sensors to determine the autoshift shift points.

In order to set up the operating gear range of the autoshift, the ECM will recognize a configured autoshift minimum gear and a configured autoshift maximum gear. These operating gear limits are configured for the FORWARD and REVERSE direction by use of the Cat ET service tool or Messenger. The configuring of the autoshift minimum gear and autoshift maximum gear must be done when the transmission is in NEUTRAL and the transmission output speed is zero (no travel).

Note: The autoshift maximum gear that can be set up using the Cat ET service tool or the Messenger should not be confused with the maximum gear that is set up in the Cat ET service tool only. The autoshift maximum gear set up using the Cat ET service tool and the maximum gear that is set up in the Messenger are two different parameters. The autoshift maximum gear is only active when the autoshift function is enabled. The maximum gear is active at all times in any mode of transmission operation.

The ECM will accept certain gear ranges for the autoshift maximum gear and the autoshift minimum gear. The following table displays the selectable gears that the ECM will accept for each parameter. The table also displays the factory default settings for the gears.

Table 2

Selectable Range Of Autoshift Gears			
Direction	Allowable “Auto-shift Minimum” Gears	Allowable “Auto-shift Maximum” Gears	Factory Default Settings (Minimum to Maximum)
Forward	1F to 5F	3F to 8F	3F to 8F
Reverse	1R to 4R	3R to 6R	3R to 6R

The following logic is used by the ECM for operation of the transmission in the autoshift mode.

- In order for the ECM to enable the autoshift function, there can be no active diagnostic codes for the transmission solenoids, the FNR switch, the Autoshift switch or the parking brake components. If the ECM detects an abnormal condition the ECM may active a diagnostic code for any of these components. The autoshift function will be turned OFF.
- If the ECM can not determine the TOS speed signal or the direction signal from the output speed sensors or from the intermediate speed sensors, the autoshift mode will not be enabled. If these signals are lost during autoshift operation, the ECM will turn OFF the Autoshift mode.
- When the autoshift mode is active and a shift from NEUTRAL in either direction is performed, the configured initial gear will be ignored if it is within the set autoshift gear range. If the Initial gear is not within the set autoshift range, then the ECM will shift to the Initial gear. A manual shift into the autoshift range is then required to operate in the Autoshift mode.
- A manual shift will be required when operating outside the configured range of the autoshift. Once a manual shift to a gear within the autoshift range takes place, the ECM will continue the automatic transmission operation in the autoshift gear range.
- When operating the machine in the autoshift range, if the ECM detects an operator requested **upshift or downshift** from the push button switches on the left joystick, the ECM will change the autoshift maximum gear to the operator requested gear. This temporary change of the autoshift maximum gear will be in effect until the key switch is turned to the OFF position. When the engine is started again, the ECM will return to the original configured maximum gear of the autoshift. Example: The ECM is automatically shifting in the configured autoshift range of gear 3F to gear 6F in the FORWARD direction and gear 2R to gear 4R in the REVERSE direction. While in gear 6F, the operator depresses the downshift switch once in order to manually downshift into gear 5F. The ECM executes the downshift and this action changes the autoshift maximum gear to gear 5F until the next key start cycle. The same process will occur in the REVERSE direction if a manual **upshift or downshift** is requested.

i06746822

Features

SMCS Code: 1400; 4000; 4800

S/N: B92369–Up

S/N: B541–Up

S/N: B551–Up

S/N: B561–Up

S/N: B571–Up

S/N: B591–Up

S/N: B9D4763–Up

S/N: B9E1144–Up

S/N: D9G1586–Up

S/N: D9T1439–Up

Air Conditioning System

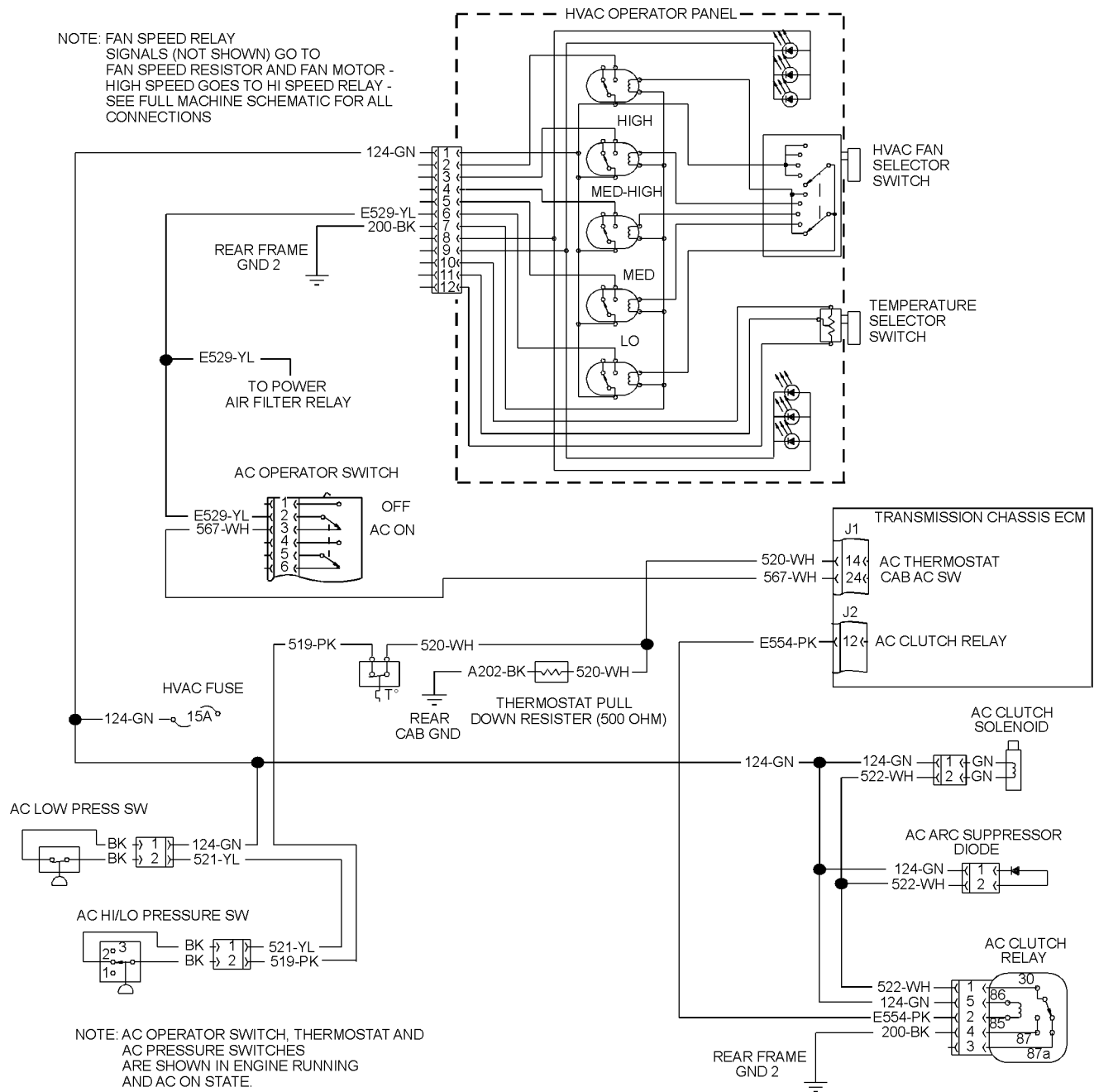


Illustration 15

g02089155

Air conditioning control circuit connections

The attachment air conditioning system is controlled by the transmission/chassis ECM.

Power for the air conditioning control components is supplied through the 15 amp HVAC fuse. The power circuit is connected to the HVAC "ON/OFF/FAN" selector switch in the HVAC operator panel.

Power for the high-speed blower (not shown) is supplied to the blower motor through a 20 amp circuit breaker and is switched to the blower motor by the high-speed relay. Refer to the full machine Electrical Schematic for blower motor control connections.

When the selector switch is switched to the ON position, the system power is directed to the internal AC relay coil in the operator panel which will cause the relay contacts to close. Power is then passed to the AC operator switch through the closed contacts.

When the AC operator switch is moved to the AC ON position, the system power will be directed through the switch contacts to a transmission/chassis ECM switch to +battery type input contact.

During normal operation, the ECM internal pull-down voltage will hold the AC operator switch input circuit low until the system power is passed through the switch contacts and pulls the input circuit signal high. When the ECM detects the high +battery signal in the circuit, the ECM determines that the switch contacts are in the AC ON position.

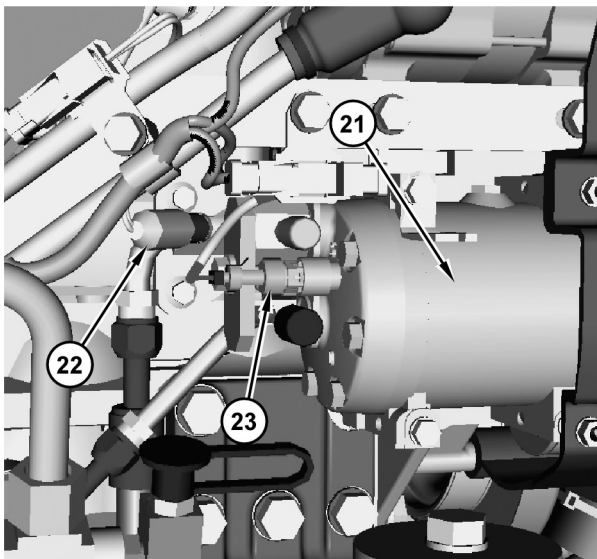


Illustration 16

g01331971

Typical M Series Motor Grader AC Compressor located on the left side of the engine

- (21) AC compressor
- (22) AC low-pressure switch
- (23) AC HI/LO pressure switch

Once the ECM has received the signal to activate the AC system from the operator switch, the ECM will monitor the switch to +battery type input circuit that is connected to the thermostat. Power from the fuse must pass through two series connected system pressure switches to be present at one side of the thermostat contact. One is a low-pressure switch and the other is the HI/LO pressure switch.

The contacts for the low-pressure switch will close the system pressure increases to 118 kPa (17.1 psi). The switch contacts will be held closed until the system pressure decreases to 27.5 kPa (4.0 psi).

The switch contacts for the HI/LO pressure switch are closed when the system pressure is in the range 275 kPa (39.9 psi) to 1750 kPa (253.8 psi).

If the system pressure is not correct and the contacts of one or both of the pressure switches are open, the system power will not reach the thermostat.

A pull-down resistor is connected to the thermostat input circuit to hold the input circuit low. When the system power is passed through the contacts of both of the pressure switches and the thermostat contacts are closed, the system power will pull the circuit high.

The ECM will detect the high signal in the thermostat circuit and will then activate the sinking driver output for the AC clutch relay.

Once the ECM turns on the sinking driver for the relay, system power from the HVAC fuse is provided a path to ground through the sinking circuit. This energizes the relay coil which will cause the relay contacts to change states. A path to ground is then provided through the relay contacts for the system power from the fuse to pass through the AC clutch solenoid. The energized clutch solenoid will then engage the AC compressor to activate the system.

The transmission/chassis ECM does not monitor the component circuits in the air conditioning system for diagnostics.

Backup Alarm Operation

The backup alarm alerts the surrounding personnel that the machine is backing up. The Transmission/Chassis ECM activates the back-up alarm by use of the backup alarm relay. The relay is controlled by the ECM through an ON/OFF output driver.

Whenever the transmission is shifted to the REVERSE direction, the ECM will turn "ON" the output driver for the relay to activate the backup alarm.

Limp Home Mode

A "Limp Home Mode" is available to provide an override to a transmission disabling diagnostic event. The limp home mode will be activated by the Transmission/Chassis ECM when a diagnostic code is activated for any of the transmission solenoids. When the limp home mode is activated, the ECM will allow the transmission to shift to gears that are not affected by the active diagnostic code.

Parasitic Load Reduction

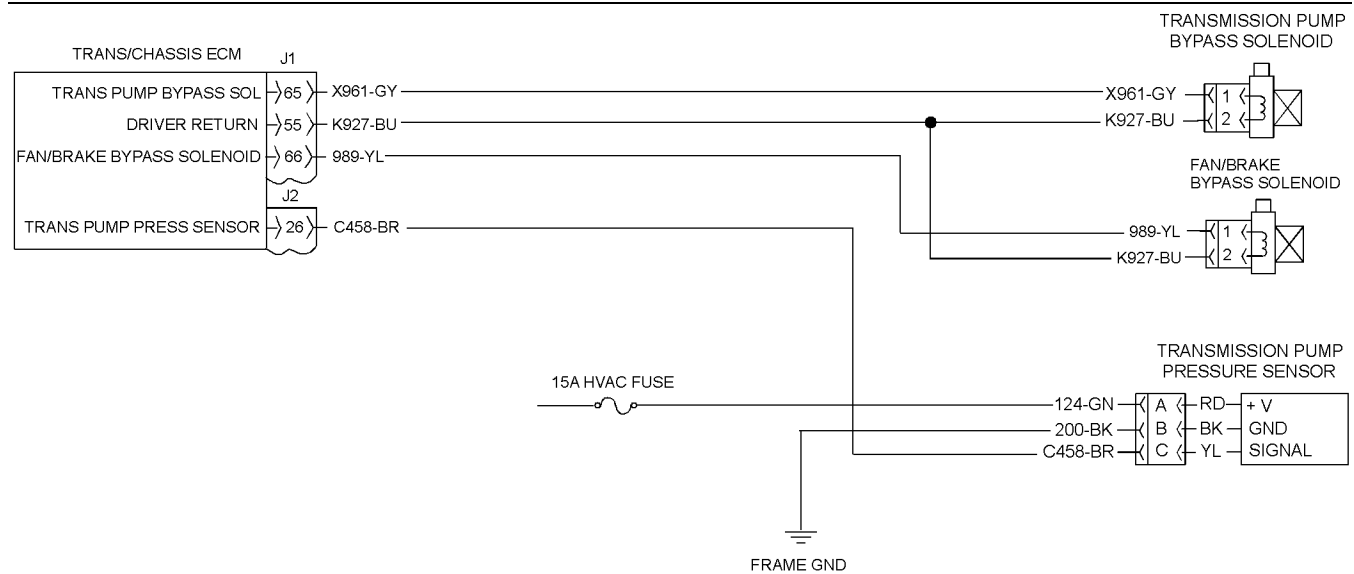


Illustration 17

g01948549

Schematic of the parasitic load reduction circuit

The cold engine parasitic load reduction feature removes non-essential loads during cold weather starts. This feature achieves parasitic load reduction via transmission and fan/brake bypass. This feature is an optional attachment available only on the following models:

- 12M
- 120M
- 140M
- 160M

This feature looks at the transmission oil temperature and hydraulic oil temperature. If either of these temperatures is equal to or less than 0° C (32° F), the cold engine parasitic load reduction feature will activate.

When the cold engine parasitic load reduction feature is activated, the fan/brake pump and transmission pump will bypass to tank, reducing the load on the engine.

Once the engine rpm has stabilized, the transmission pump bypass solenoid will be deactivated first followed by the fan/brake bypass solenoid, increasing the load on the engine.

Parking Brake Test

To check for the correct operation of the parking brake, the transmission/chassis ECM will allow a parking brake test to be performed when the transmission is in gear 5F. The following procedure should be performed to check the operation of the parking brake.

1. Place the transmission in the NEUTRAL position.
2. Place the parking brake switch in the ENGAGED position.
3. Start the engine.
4. Depress the inching pedal.
The gears 1F and 1R will be displayed on the instrument cluster.
5. Manually upshift the transmission four consecutive times within two seconds.
The instrument cluster will display the gear 5F as the active gear. No reverse gear can be selected.
6. Depress the throttle pedal and release the inching pedal.

Result: For correct operation of the parking brake, depressing the throttle pedal and releasing the inching pedal should force the engine to stall. If the machine moves forward, the parking brake operation is not correct. Investigate the cause of the failed test of the parking brake. Repair the problem before operating the machine.

Parking Brake Emergency Drive Through Function

Should the parking brake not disengage and the machine must be moved for emergency purposes, the machine can be made to “drive through” the engaged park brake.

WARNING: THE FOLLOWING PROCEDURE SHOULD ONLY BE PERFORMED IN AN EMERGENCY SITUATION IN ORDER TO AVOID DANGER TO THE OPERATOR OR TO THE MACHINE. THIS PROCEDURE MAY CAUSE DAMAGE TO THE PARKING BRAKE COMPONENTS.

1. With the transmission in the NEUTRAL position and the parking brake switch in the ENGAGED position, start the engine.
2. Move the parking brake switch to the DISENGAGED position.
3. Depress the inching pedal. The gears 1F and 1R will be displayed on the instrument cluster.
4. Do not upshift or downshift. The active gear must be either gear 1F or 1R.
5. Select a direction and release the inching pedal.
6. Depress the throttle pedal to “drive through” the engaged parking brake.

Result: Releasing the inching pedal while depressing the throttle pedal will result in the machine moving in the selected direction and “driving through” the engaged parking brake. Move the machine for the shortest possible distance to minimize damage to the parking brake components.

Secondary Steer System

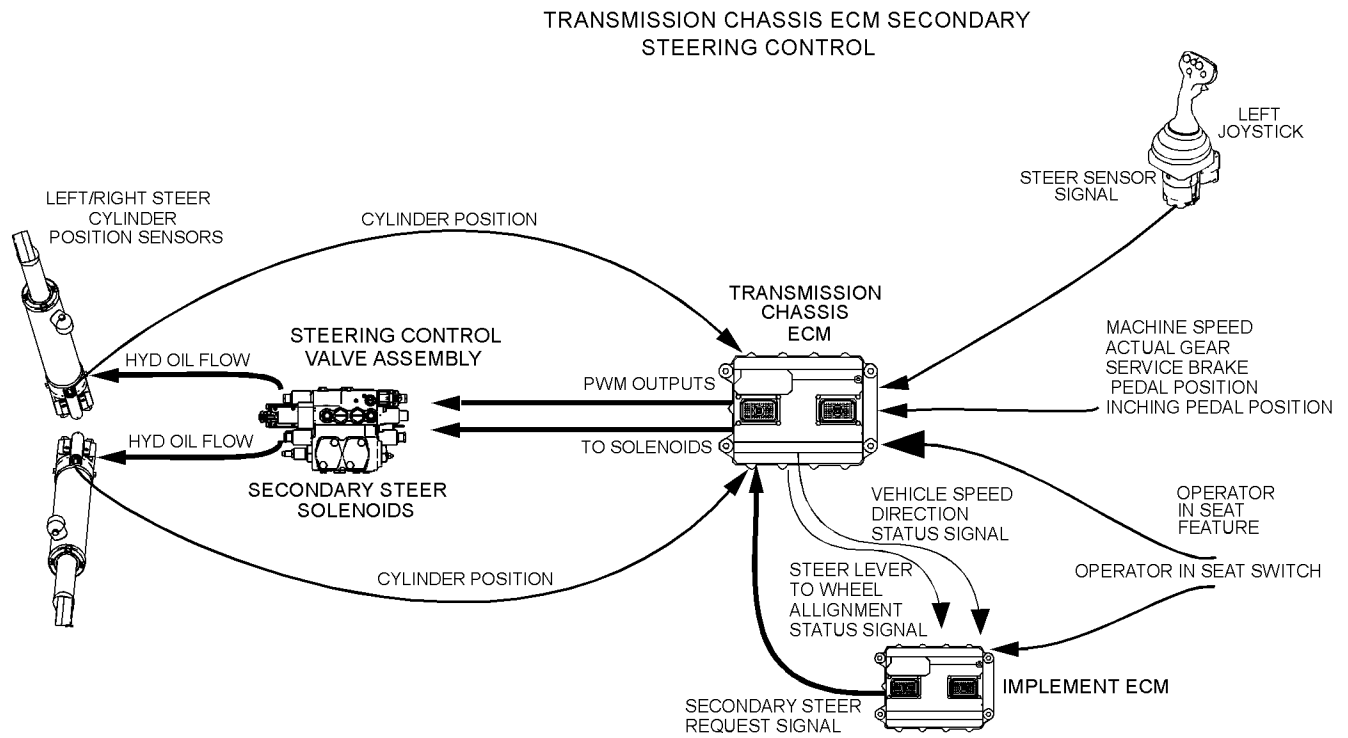


Illustration 18

Secondary Steer Control System

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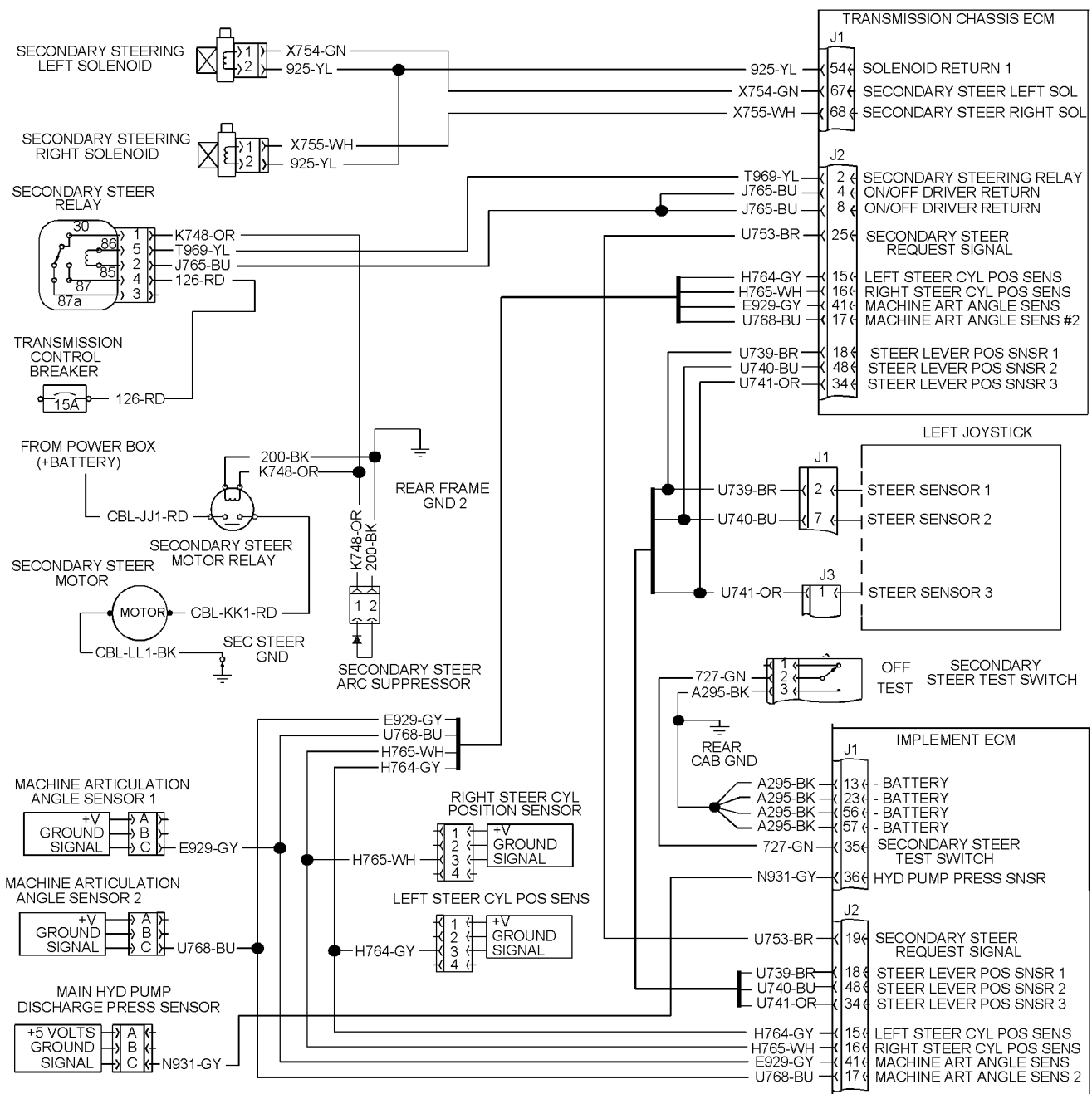


Illustration 19

g06119137

Secondary Steering System connections

The Series M Series motor graders are equipped with a secondary steering system that serves as a backup steering system in the event of a failure of the primary steering system. The transmission/chassis ECM is the main control for the secondary steering system.

Note: When activated, the secondary steering system is to be used for a short time to move the machine to a safe area for shutdown. The steering system loads will cause the secondary steer pump motor to overheat when operated for an extended time.

The transmission/chassis ECM and the implement ECM monitor the position sensor input signals from the following steering system sensors:

- The Left joystick steer sensors 1, 2, and 3.
- The left and the right steer cylinder position sensors.
- The machine articulation position sensors 1 and 2.

The implement ECM monitors the steering system sensor signals to control the primary steering system. The transmission/chassis ECM monitors the same steering system sensor signals to be able to activate and control the secondary steering system at any time during the operation of the machine.

When the implement ECM detects a problem in the primary steering system, the implement ECM will send a pulse width modulated (PWM) signal to the transmission/chassis ECM on the "Secondary Steer Request" circuit that is connected between the two controls.

The implement ECM will send a request signal to the transmission/chassis ECM to activate the secondary steering system when any of the following machine system conditions are detected:

- An active CID 2203 (Primary Steering Valve Spool Displacement Line).
- A failure of the main hydraulic pump.
- All three steering control positions sensors fail.
- Steering spool motion is detected when no primary steering command is present.
- Steering spool motion is not detected when a primary steering command is present.
- Steering spool motion is detected in the wrong direction.
- A manual secondary steer test has been requested.
- An automatic secondary steering pump test is being performed at initial engine start-up.

The Transmission/Chassis ECM will activate the secondary steering system without receiving a request signal from the Implement ECM when the following condition is present:

- An active CID 2199 (Secondary Steering Request Signal from the Implement ECM) diagnostic code.

When the implement ECM sends a PWM secondary steer request signal to the transmission/chassis ECM, the duty cycle of the PWM signal will determine which specific secondary steer system components will be activated. During normal operation, the implement ECM maintains a 20 percent duty cycle on the request circuit. When a secondary steer test is requested or when the implement ECM has detected a problem in the primary steering system, the secondary steer request signal will be one of the following duty cycle signals:

20 percent PWM duty cycle – Normal operation, no request to activate.

40 percent PWM duty cycle – Request to activate the secondary steering pump motor only.

60 percent PWM duty cycle – Request to activate the secondary steer pilot solenoid valves only.

80 percent PWM duty cycle – Request to activate the secondary steering pump and the secondary steer pilot solenoid valves.

When a 40 percent duty cycle request is received by the transmission/chassis ECM, the ECM will energize the secondary steer relay. This will allow power to pass through the relay contacts which will energize the secondary steer motor relay. Power from the power control box will then be supplied to the secondary steering pump motor which turns the secondary steering pump. When a pump request only is received, the secondary steering pump will supply hydraulic oil flow to the primary steering system.

Note: When the secondary steering pump motor is activated to supply hydraulic oil flow to the primary steering system or the secondary steering system, the secondary steering pump motor will overheat if operated for a longer time.

When a 60 percent duty cycle request is received by the transmission/chassis ECM, the ECM will activate the proportional secondary steer pilot solenoid valves to control the hydraulic oil flow to the steer cylinders. The ECM will use a PWM output signal to energize the secondary steer solenoids. The transmission/chassis ECM will vary the amount of electrical current that is sent to the solenoids to control the angle of the front wheels.

When the secondary steer solenoids are energized, pilot oil is directed to the same main hydraulic valve that is used for the primary steering system. The steering valve control module that is used for operation of the primary steering system is not used when the secondary steer solenoids are active.

When an 80 percent duty cycle request is received by the transmission/chassis ECM, the ECM will energize the secondary steer relay to energize the secondary steering pump motor. The ECM will also activate the proportional secondary steer pilot solenoids.

To control the secondary steer system, the transmission/chassis ECM will use a "closed loop" command and feedback system similar to the system that the implement ECM uses to control the primary steering system.

The transmission/chassis ECM outputs the PWM output signal to the appropriate solenoid based on the steer sensor input signal from the left joystick. Then, the ECM monitors the position of the steer cylinders to adjust the electrical current to the solenoid accordingly. As the steering cylinders approach and reach the commanded position, the ECM will decrease the output current to the solenoid until movement of the cylinders is stopped. The cycle repeats as steering input from the joystick changes.

If one of the steer cylinder position sensor signals is not available, the transmission/chassis ECM will use the signal from the other cylinder position sensor to determine the position of the front wheels. If both of the steer cylinder position sensor signals are not available, the transmission/chassis ECM will use the last known cylinder position sensor data and the commanded hydraulic oil flow to estimate the position the steer cylinders and the front wheels. This condition will result in limited steering motion over time.

Once the transmission/chassis ECM has activated the secondary steering system, the system will remain active until the machine is turned OFF. If the condition that caused the activation of the secondary steering system is no longer present, the primary steering system will be active when the machine is restarted.

Secondary Steer System Test

The implement ECM and the transmission/chassis ECM perform an automatic test or a manual test to check the system for proper operation.

Automatic Secondary Steering Test

The automatic secondary pump test is performed once each time that the engine is started. If the system does not perform as expected, the implement ECM will activate a level 3 EID 0560 (Secondary Steering Pump No Response) event to alert the operator that the system has failed the test.

During the automatic test, the engine must be operating and the machine speed must be zero. During an automatic secondary steering test, all implement and primary steering functions are disabled by the implement ECM for the ten second duration of the test.

Note: If the automatic secondary steer test or the manual test results in an active level 3 EID 0560 (Secondary Steering Pump No Response) event being activated by the implement ECM, the machine must be immediately shut down in a safe manner. The problem in the secondary steer system must be investigated and repaired before operating the machine.

Manual Secondary Steering Test

The manual test for the secondary steer system should be performed every 100 hours of machine operation or every two weeks.

During a manual secondary steering test, all implement and primary steering functions are disabled by the implement ECM for the ten second duration of the test.

To perform the manual secondary steering test, the engine must be running and the machine speed must be zero.

To begin the test, the operator holds the momentary secondary steering test switch in the test position for ten seconds.

When the implement ECM detects that the switch input circuit has been grounded through the switch, the implement ECM will initiate the manual test for the system.

First, the implement ECM disables the primary steering system and the implement system. Then, the implement ECM sends a 40 percent PWM duty cycle signal to the transmission/chassis ECM over the secondary steering request circuit. A 40 percent duty cycle indicates that the transmission/chassis ECM should activate the secondary steering pump motor only.

While the transmission/chassis ECM energizes the secondary steer relay to turn "ON" the secondary steering pump motor, the implement ECM monitors the main hydraulic discharge pressure sensor. Two check valves are used in the hydraulic system to enable the main pressure sensor to detect the secondary pump pressure.

If the implement ECM does not detect that the secondary pump pressure is greater than 10,000 kPa (1450.4 psi) in a specified short period of time, the implement ECM will activate an EID 0560 (Secondary Steering Pump No Response) event code.

If the implement ECM detects that the secondary pump pressure is greater than 10,000 kPa (1450.4 psi) within the specified time limit, the implement ECM will send an 80 percent PWM duty cycle signal to the transmission/chassis ECM over the secondary steering request circuit. An 80 percent duty cycle indicates that the transmission/chassis ECM should activate the secondary steering pump motor and the secondary steer pilot solenoid valves.

When the operator sees that no EID 0560 event code has been activated on the Messenger, the operator should immediately move the left joystick to the steer left and the steer right positions. If the front wheels follow the steer commands, the secondary steer system is performing correctly.

After the operator holds the momentary secondary steer test switch in the test position for ten seconds, the implement ECM will deactivate the test mode.

Note: If the manual secondary steer test results in no active EID 0560 (Secondary Steering Pump No Response) event code, however, the front wheels do not respond correctly to the steering commands within the ten second time limit, the machine must be immediately shut down in a safe manner. There is a problem in the secondary steer system that must be investigated and repaired before operating the machine.

Transmission Electronic Clutch Pressure Control (ECPC)

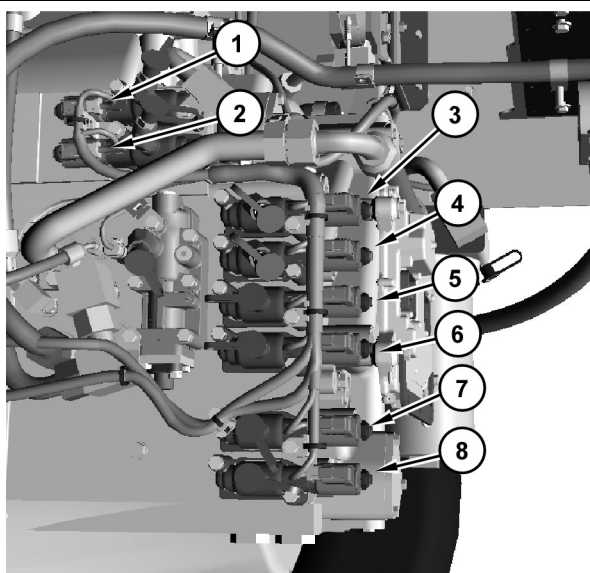


Illustration 20

g01324626

Transmission clutch solenoids that are located on the left side of the transmission

- (1) Transmission clutch solenoid 1 (forward high)
- (2) Transmission clutch solenoid 2 (forward low)
- (3) Transmission clutch solenoid 3 (reverse)
- (4) Transmission clutch solenoid 4 (2nd speed)
- (5) Transmission clutch solenoid 5 (3rd speed)
- (6) Transmission clutch solenoid 6 (1st speed)
- (7) Transmission clutch solenoid 7 (low range)
- (8) Transmission clutch solenoid 8 (high range)

The transmission/chassis ECM on the Series M Series Motor Graders enables the operation of Electronic Clutch Pressure Control (ECPC) valves for control of the transmission. The ECM controls the eight proportional solenoid valves of the transmission clutch to shift the transmission.

The transmission solenoid valves control the hydraulic circuits that engage the transmission clutch pressures. The ECM supplies electrical current to the appropriate transmission solenoid valves to move the machine in one of the two available speed ranges that enable eight speeds in the forward direction and 6 speeds in the reverse direction.

On an ECPC controlled transmission, the clutch pressure is modulated electronically. The ECM controls the modulation of clutch pressure by sending a variable output current to the appropriate proportional clutch solenoids. To determine the correct output current to send to the clutch solenoids, the ECM monitors the following data:

- Engine torque data from the Engine ECM
- Input data from the transmission speed sensors
- Temperature data from the transmission sensor

The ECM will output a pulse width modulated (PWM) signal to vary the current to the solenoid. The current to the solenoid determines the amount of pilot oil pressure that is applied to the hydraulic valve spool. The travel of the spool is proportional to the electrical current that is supplied to the solenoid.

The position of the valve spool controls the amount of hydraulic oil pressure that is applied to the clutch which determines the amount of clutch engagement. An increase in electrical current will cause an increase in the engagement pressure from the clutch.

The following two modes are available for operation of the transmission:

- The standard mode of operation is the manual mode.
- The attachment autoshift mode.

When in the manual mode, the transmission/chassis ECM selects the transmission clutches that must be engaged according to the inputs from the operator controls on the left joystick.

When the machine is in the attachment autoshift mode, the ECM controls the shifting pattern according to machine operating conditions and the transmission output speed (TOS).

Note: When the transmission oil is changed and the viscosity of the new oil is not the same as the viscosity of the old oil, the new oil viscosity must be configured for the machine.

The parameter for the viscosity of the new oil can be changed by use of the Messenger or by use of the Cat ET service tool in the configuration screen. Once the new oil viscosity is configured, the Transmission Clutch Fill Calibration MUST be performed.

The transmission/chassis ECM will adjust the operation of the transmission according to the viscosity of the new transmission oil. Refer to the Testing and Adjusting, "Machine Control Module (ECM) - Configure" section of this manual for more information.

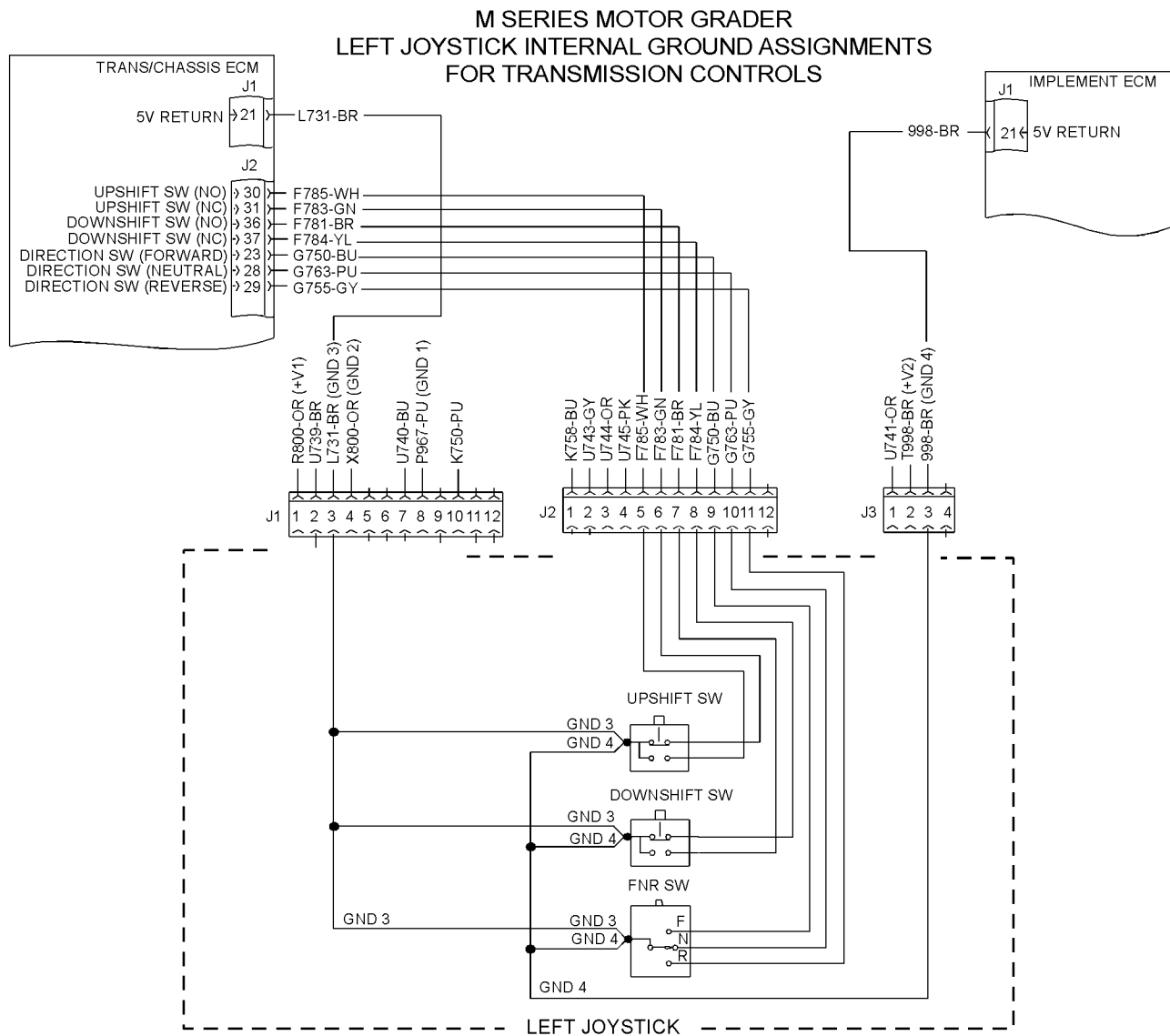


Illustration 21

g01324764

Note: Illustration 21 shows the internal push buttons and ground assignments for the transmission controls in the left joystick. The left joystick for the implement and steering components that provide inputs to the implement ECM are not shown here.

The components that are in the left joystick are not serviceable. If a component in the joystick has failed, the complete assembly must be replaced. The illustration is displayed to aid in the component and the troubleshooting of the circuit for the transmission controls. For a complete connection diagram for all the joystick to ECM connections, refer to the System Schematics in the back of this manual.

The following switches provide a switch to ground input to the transmission/chassis ECM to indicate the commands of the operator for gear selection:

- The upshift switch

- The downshift switch
- The FORWARD/NEUTRAL/REVERSE (FNR) switch

Each switch is internally connected to two of the four ECM return (ground) circuits that are supplied to the left joystick. One of the return circuits of the ECM for the switches is supplied by the transmission/chassis ECM and the other return circuit of the ECM for the switches is supplied by the implement ECM. Both ground connections must fail either internally or externally to interrupt the operation of the switch due to loss of ground connections.

The ECM has an internal “pull up” voltage that is connected to each of the switch input connections. The pull-up voltage holds the circuit high until the switch grounds the circuit through the switch contacts. The ECM expects one of the switch inputs to be grounded always. If all the switch inputs are grounded or if none of the switch inputs are grounded, the ECM will activate a diagnostic code for the switch.

The ECM monitors the state of the three inputs of the switch for the FNR trigger selector switch. The switch input that is grounded through the switch contacts will determine the directional mode that the ECM will activate for the transmission.

The ECM monitors the state of the two switch inputs for the upshift switch and the down shift switch. When the ECM detects the transition from the normally closed input being grounded through the switch contacts to the normally open input being grounded through the switch contacts, the ECM will activate the solenoid outputs for the next higher or lower gear in the selected forward or reverse direction.

If the upshift switch or the down shift switch is depressed numerous times, the ECM will detect the number of switch input transitions and activate the solenoids for the requested higher or lower gear if the requested shift will not cause damage to transmission components.

Operation of the Transmission Speed Sensor

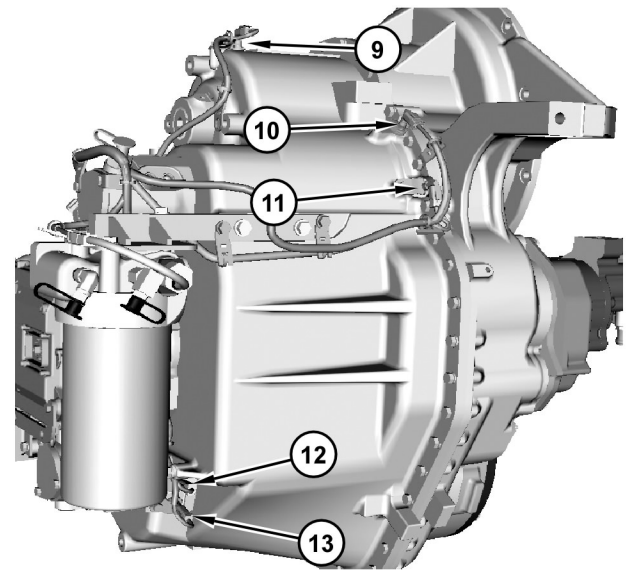


Illustration 22

g01330023

Transmission speed sensors that are located on the top side and the right side of the transmission

- (9) Transmission input speed sensor
- (10) Transmission intermediate speed sensor 2
- (11) Transmission intermediate speed sensor 1
- (12) Transmission output speed sensor 2
- (13) Transmission output speed sensor 1

The transmission on the M Series Motor Graders is equipped with five transmission speed sensors. Each speed sensor supplies a frequency input to the transmission/chassis ECM.

The input speed sensor is mounted at a location that will monitor a gear on the input shaft of the transmission. The two intermediate speed sensors are mounted at a location to monitor a large intermediate gear in the transmission. The two output speed sensors are mounted at a location to monitor a gear that is mounted on the output shaft of the transmission.

Each of the speed sensors is attached to the transmission with a fixed mount. No adjustment of the mount for the speed sensor is necessary.

The speed sensors produce a signal that varies in frequency (Hz) as the tooth of the gear is passed in front of the sensor. As each tooth of the gear passes the sensor one cycle or hertz is detected by the speed sensor. The ECM detects the frequency of the signal. The ECM then determines the speed and the direction of the shaft that is associated with that gear. Each speed sensor has two input connections to the ECM (“+” and “-”). The following applies to all speed sensors:

- Connector contact 2 is the signal (+)

- Connector contact 1 is the return line (-)

When the speed of the transmission output shaft is greater than 150 rpm, the transmission/chassis ECM monitors the two output speed sensors to determine the transmission output speed (TOS) and the direction of travel.

If no TOS or direction signals are coming from the two output speed sensors, the ECM will use the signals from intermediate speed sensors to calculate the TOS and to determine the direction. This enables the ECM to maintain control of the transmission if a failure of the two output speed sensor circuits should occur.

When the speed of the transmission output shaft is less than 150 rpm, the ECM will use the signals from the two intermediate speed sensors to calculate the TOS and the direction of travel. At the lower TOS, the slower speed of the output gear results in a poor signal from the output speed sensors. The larger intermediate gear is rotating faster at the lower output shaft speed which results in a more reliable intermediate speed sensor signal.

Note: If both of the intermediate speed sensors fail, the speed of the transmission output shaft will not be determined at a speed of less than 150 rpm.

The ECM uses the TOS and direction data to control the shifting of the transmission when operating in the autoshift mode. The ECM uses the TOS and direction information to control the operation of the transmission and to prevent unsafe operating conditions that could be dangerous to the operator or cause damage to the machine.

During normal operation of the transmission, the transmission/chassis ECM is using the signal from the input speed sensor to determine the speed of the engine. In addition, the ECM is receiving data about engine speed from the Engine ECM over the J1939 Data Link. The ECM is comparing the speed data for the engine against the frequency from the input speed sensor. The ECM is continuously comparing the signals that are supplied by the two output speed sensors to each other and the ECM is continuously comparing the signals that are supplied by the two intermediate speed sensors to each other.

If the ECM detects that the two output speed sensor signals differ by more than 50 rpm, the ECM will use the signals from the intermediate speed sensors to determine which output speed sensor signal is correct.

In the unlikely event that the signals from the two intermediate speed sensors differ by more than 50 rpm, the ECM will use the input speed sensor signal and calculate which output speed sensor signal is the correct signal and which intermediate speed sensor signal is the correct signal. The ECM will then activate a diagnostic code for the speed sensor circuits that are determined to be producing the faulty signal.

If the ECM determines that the signals of the two intermediate speed sensors differ by more than 50 rpm, the ECM will use the input speed sensor signal and calculate which intermediate speed sensor signal is the correct signal. The ECM will then activate a diagnostic code for the intermediate speed sensor circuit that is producing the faulty signal.

Operation of Transmission Shifting

To control the shifting of the transmission, the transmission/chassis ECM will energize two clutch solenoids when the machine is in PARK or NEUTRAL. The ECM will energize different combinations of three clutch solenoids when the machine is in one of the available gears in the forward or the reverse direction. Table 3 indicates which solenoids are energized to activate the corresponding gear arrangement.

Note: During machine operation, the selected gear and direction are displayed on the LCD screen of the instrument cluster. When in NEUTRAL, the selected gear for FORWARD and for REVERSE are displayed.

Systems Operation Section

Table 3

Transmission Gear and Solenoid Valve Logic								
	Solenoid 1 (forward high)	Solenoid 2 (forward low)	Solenoid 3 (reverse)	Solenoid 4 (second speed)	Solenoid 5 (third speed)	Solenoid 6 (first speed)	Solenoid 7 (low range)	Solenoid 8 (high range)
Park					X			X
Neutral					X			X
First Speed Forward	X					X	X	
Second Speed Forward		X		X			X	
Third Speed Forward		X			X		X	
Fourth Speed Forward	X				X		X	
Fifth Speed Forward	X					X		X
Sixth Speed Forward		X		X				X
Seventh Speed Forward	X			X				X
Eighth Speed Forward	X				X			X
First Speed Reverse			X			X	X	
Second Speed Reverse			X	X			X	
Third Speed Reverse			X		X		X	
Fourth Speed Reverse			X			X		X
Fifth Speed Reverse			X	X				X
Sixth Speed Reverse			X		X			X

Operation of Manual Mode

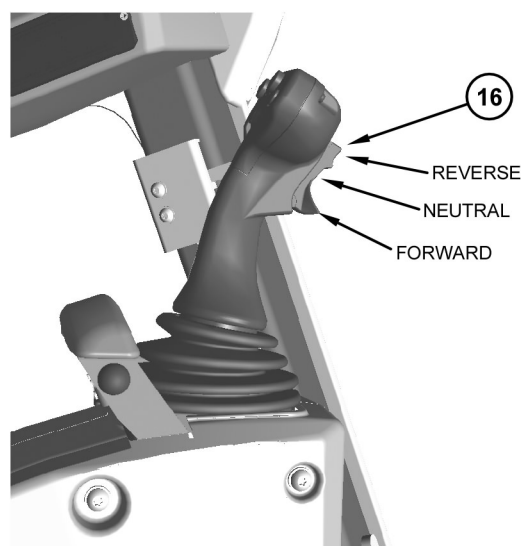
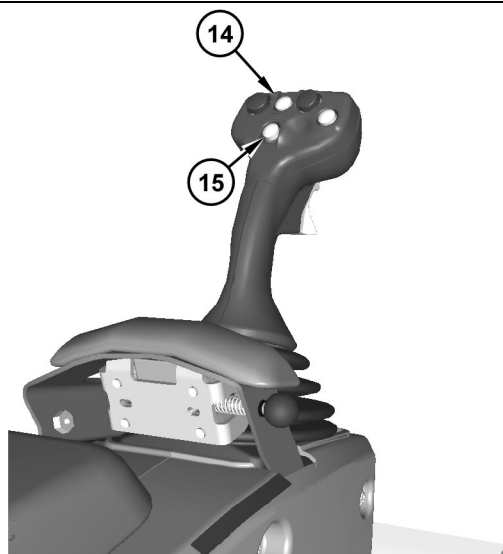


Illustration 23

Transmission Shift Controls on the left joystick

(14) Upshift switch

(15) Downshift switch

g01324667

(16) FNR trigger selector switch

The standard mode of transmission operation is the manual mode. The manual mode is active when the engine is started. If the machine is equipped with the autoshift attachment, the manual mode is active anytime the autoshift function is in the OFF position.

When in manual mode, the operator uses the push-button switch controls on the left joystick to send shift commands to the transmission/chassis ECM.

Two gear presets can be configured for use in the standard manual mode or for use in the attachment autoshift mode if it is installed on the machine. The presets are the "Initial" gear and the "Maximum" gear.

Initial Gear

The transmission/chassis ECM allows an "Initial Gear" to be configured for the FORWARD and REVERSE direction by use of the Cat ET service tool or the Messenger. The configuring of the initial gear must be done when the transmission is in NEUTRAL and the transmission output speed is zero (no travel). The configured Initial gear will be recognized in the Manual Mode and the Initial gear will be recognized under some conditions in the Autoshift Mode.

The initial gear that is configured in the Cat ET service tool or in Messenger will be the first gear that the ECM will shift to when the machine is shifted to the FORWARD position or to the REVERSE position. For example, the factory default for the Initial gear is set to gear 3F and gear 3R. At start-up of the machine with the transmission in NEUTRAL, both the gear 3F and the gear 3R will be displayed on the instrument cluster. When the transmission is shifted into the FORWARD position and no upshift or no downshift has been requested by the operator, the active gear will be gear 3F. Gear 3R would be active if the machine were shifted to the REVERSE position.

Upshifts or downshifts can be requested while the transmission is in the NEUTRAL position. Upshifts or downshifts can also be requested during travel to activate a gear other than the defined initial gear.

The defined Initial gear is effective at all times during the machine operation. When the "Autoshift" mode is active, the initial gear may be ignored under certain operating conditions that are covered in the "Autoshift" section below.

The ECM will accept gears in the following gear ranges as the configured initial gear. In the FORWARD direction, gear 1F to gear 5F. In the REVERSE direction, gear 1R to gear 4R. The factory defaults for the Initial gears are gear 3F and gear 3R.

Maximum Gear

The transmission/chassis ECM allows a “Maximum” gear to be configured for the FORWARD and REVERSE directions by use of the Cat ET service tool only. The configuring of the Maximum Gear must be done when the transmission is in NEUTRAL and the transmission output speed is zero (no travel). The configured Maximum gear will be used at all times during machine operation in either the manual mode or the autoshift mode.

The configured maximum gear that is configured in the Cat ET service tool will be the highest gear that the ECM will activate when the machine is in operation in the FORWARD direction or the machine is in operation in the REVERSE direction. The maximum FORWARD gear can be configured as low as 3F and up to 8F and the maximum REVERSE gear can be configured starting at 3R and up to 6R. For example, the factory default for the Maximum gear is set to gear 8F and gear 6R. The maximum gear setting allows for the normal operation of all of the available gears for the operation of the transmission. If the operator wants to limit transmission operation to no higher than gear 4F in the FORWARD direction and 3R in the REVERSE direction, the technician can configure the maximum gears to gear 4F and gear 3R by use of the Cat ET service tool. When this is done, the ECM will not allow a shift to a gear that is higher than gear 4F or gear 3R at any time during machine operation in either transmission mode. The ECM will retain the configured maximum gear parameter in both directions until the parameters are changed using the Cat ET service tool.

Transmission/Chassis ECM Shifting Logic In Manual Mode

The transmission/chassis ECM monitors the input signals from the transmission speed sensors to determine the transmission output speed (TOS) and direction of travel. The ECM will use “speed inhibit logic” to prevent hazardous transmission operation. The ECM will allow directional shifts while traveling if the requested change in operation will not result in damage to the machine or in danger to the operator. If a requested gear shift is determined to be improper at a given machine speed, the ECM will shift to a gear that is close to the requested gear to allow for safe operation.

The following logic is used by the ECM for normal operation of the transmission and to prevent hazardous transmission operation:

- All shifts must be performed as the engine is running, the operator is in the seat and the parking brake is disengaged.
- If an active gear is not selected after the machine start-up, the default or configured initial gear will be the active gear in both directions.

- **When (TOS) is greater than 150 rpm:** When shifting to NEUTRAL from either the FORWARD or the REVERSE direction, the gear that is active when the shift to NEUTRAL takes place will remain the same. Example: Active gear is 2F. The transmission is shifted to NEUTRAL from 2F. Gear 2F will be active if the transmission is shifted back to FORWARD. Gear 2R will be active if the transmission is shifted to REVERSE. If the active gear is set greater than 3F or 3R then the opposite direction is set to 3F or 3R.
- **When (TOS) is less than 150 rpm:** Shifting to the NEUTRAL position from a gear that is lower than the configured initial gear will result in the same gear being available for the next request of a directional shift. Example: The Initial gear is 3F and 3R. The transmission is shifted to NEUTRAL from active gear 2F. Gear 2F will be active when a shift to FORWARD is requested. Gear 2R will be active if a shift to REVERSE is requested.
- **When (TOS) is less than 150 rpm:** Shifting to the NEUTRAL position from a gear that is higher than the configured initial gear will result in the configured initial gear being active the next time a directional shift is requested. Example: The Initial gear is 3F and 3R. The transmission is shifted to NEUTRAL from active gear 5F. Initial gear 3F will be active when a shift to FORWARD is requested. Gear 3R will be active if a shift to REVERSE is requested.
- If the transmission is operating in an overspeed condition for the active gear, the active gear display on the instrument cluster will flash ON and OFF until the overspeed condition is no longer occurring.

Directional Shifting

The ECM will allow directional shifting in gear 1, gear 2, gear 3, or gear 4 when the machine is in gear and traveling. The following directional shifts are allowed:

- From FORWARD to REVERSE: 1F to 1R, 2F to 2R, 3F to 3R and 4F to 3R.
- From REVERSE to FORWARD: 1R to 1F, 2R to 2F, 3R to 3F.

The following logic is used by the ECM for directional shifting operation of the transmission and to prevent hazardous transmission operation:

- For a directional shift, the FNR switch must pass through NEUTRAL in less than 0.1 seconds.

- Directional shifts may be performed with or without the operation of the inching pedal. If the inching pedal is depressed, during a directional shift request, and is then released, the ECM will shift to the appropriate gear for the current machine speed and execute the requested directional shift.
- A directional shift from gear 4F to gear 3R will not be allowed if the TOS is above a defined speed. The ECM will initiate a down shift to gear 3F before shifting to gear 3R.
- When a directional shift is initiated from a gear higher than gear 3, the ECM will downshift the transmission to gear 3 and will execute the requested directional shift.

Note: If, for example, the directional shift was initiated in 7F and the inching pedal was depressed and the machine was allowed to slow to a 5F speed, releasing the inching pedal would engage 5F and continue to down shift to 3F and execute the directional shift to 3R.

Cold Transmission Oil Mode - Direction Clutch Priming

To avoid harsh shifting that can be caused by cold transmission oil, the transmission/chassis ECM will perform an automatic procedure for priming the direction clutch. The ECM will activate the direction clutch priming cycle when the engine is started and the following machine conditions are present.

- The temperature of the transmission oil is equal to or less than 15 °C (59.0 °F).
- The starting sequence of the machine is complete. The engine is running and the speed sensors are active.
- The parking brake is engaged.
- The FNR switch is in the NEUTRAL position.
- The inching pedal is not depressed.

During the priming cycle of the clutch, the ECM will inhibit the calculated transmission output speed. The ECM will change the minimum transmission output speed from 150 rpm to 95 rpm to detect any machine movement.

During the priming of the clutch, the ECM will send a pulse of electrical current to the outputs for the transmission clutch solenoid valves. This procedure fills the clutch valves with oil to avoid harsh transmission shifts.

The ECM performs the automatic direction clutch priming cycle in less than 10 seconds.

The ECM will deactivate the priming of the clutch when the automatic cycle is completed or if the following machine conditions occur.

- The parking brake is disengaged.
- The “FNR” switch is moved out of the NEUTRAL position.
- The inching pedal is depressed.
- The transmission output speed is greater than 95 rpm.
- A signal is not received from the transmission output speed sensor.
- The engine is turned OFF.

The ECM will also deactivate the priming of the clutch when a diagnostic code is activated for any of the following components.

- Any of the transmission clutch solenoids
- The FNR switch
- Any of the electrical components of the parking brake system
- The position sensor of the inching pedal

Transmission Over Speed Protection Strategy

Overspeed protection is a feature that utilizes transmission shifts to help protect the engine from running at an overspeed condition. In addition, overspeed protection ensures that the transmission will never be shifted into a gear that would cause an overspeed condition.

Overspeed Upshift

The control will upshift the transmission by one gear when the transmission output speed reaches the overspeed up shift point for the current gear. The control does not limit the number of overspeed up shifts. If the transmission output speed continues to increase, the control will upshift, based on overspeed upshift points, until the transmission reaches the top gear.

Overspeed Downshift

The control will downshift the transmission by one gear when the actual gear is higher than the selected gear and the transmission output speed decreases below the overspeed downshift point.

Engine Controlled Downshift

The shift control logic contains downshift inhibit points. These “inhibit” points were established to prevent abusive operation of the power train. The “inhibit” points also protect the operator from possible adverse operation of the machine. The Transmission ECM will downshift the transmission by one gear when the actual gear is higher than the desired gear and the transmission output speed is below the overspeed downshift rpm point. The current downshift inhibit strategy is good for protecting the transmission and protecting the engine from damage caused by overspeed. The downshift inhibit strategy does not allow the requested shift to take place as quickly as possible. The engine controlled downshift feature will try to resolve this issue. If the transmission/chassis ECM requests a downshift and the transmission output speed is above the overspeed downshift point, the transmission/chassis ECM will command the minimum engine speed among the gears between the current gear and the minimum downshift gear.

In an example of this process, suppose that the actual gear is 6F. The operator request downshifts to 3F. If the transmission output speed is above the overspeed downshift transmission output speed for 5F, the transmission/chassis ECM will command the minimum engine speed between 6F to 5F, 5F to 4F and 4F to 3F.

Note: The downshift function for engine control will be deactivated if the parking brake is engaged. The downshift function for engine control will also be deactivated if the inching pedal or the switch for the inching pedal is depressed.

Transmission Gear Limiting

The Transmission Output Speed Steering Limit (TOSSL) is evaluated against the transmission speed limiting tables to determine the highest gear that would not exceed TOSSL. All gears above this gear will be inhibited. If the actual gear is an inhibited gear, the gear limiting feature will check to see if shifting to the highest gear would cause an overspeed condition. If no overspeed condition is predicted, the transmission will command a shift to this gear. If an overspeed condition is predicted, a shift command will be prohibited.

Autoshift Operation

The autoshift function allows the operator to set or configure the range of gears that the transmission/chassis ECM will use for automatic shifting of the transmission in the FORWARD direction or the REVERSE direction.

The autoshift function is an attachment function that is software enabled. A factory password is required to enable this function.

The operator turns on the function with the autoshift switch on the right console. When the autoshift mode is active, the ECM will illuminate the autoshift LED that is located below the instrument cluster on the dash. The LED will flash “ON” and “OFF” when the machine is operated in a gear that is lower than the configured minimum autoshift gear or when the transmission is in NEUTRAL position.

The ECM uses the transmission output speed (TOS) data from the transmission output speed sensors to determine the shift points at which the autoshift function is active. If the output speed sensor signals are determined to be faulty, the ECM will use the speed and direction signals from the intermediate speed sensors to determine the autoshift shift points.

To set up the operating gear range of the autoshift, the ECM will recognize a configured autoshift minimum gear and a configured autoshift maximum gear. These operating gear limits are configured for the FORWARD and REVERSE direction by use of the Cat ET service tool or Messenger. The configuring of the autoshift minimum gear and autoshift maximum gear must be done when the transmission is in NEUTRAL and the transmission output speed is zero (no travel).

Note: The autoshift maximum gear that can be set up using the Cat ET service tool or the Messenger should not be confused with the maximum gear that is set up in the Cat ET service tool only. The autoshift maximum gear set-up using the Cat ET service tool and the maximum gear that is set up in the Messenger are two different parameters. The autoshift maximum gear is only active when the autoshift function is enabled. The maximum gear is active at all times in any mode of transmission operation.

The ECM will accept certain gear ranges for the autoshift maximum gear and the autoshift minimum gear. The following table displays the selectable gears that the ECM will accept for each parameter. The table also displays the factory default settings for the gears.

Table 4

Selectable Range Of Autoshift Gears			
Direction	Allowable “Auto-shift Minimum” Gears	Allowable “Auto-shift Maximum” Gears	Factory Default Settings (Minimum to Maximum)
Forward	1F to 5F	3F to 8F	3F to 8F
Reverse	1R to 4R	3R to 6R	3R to 6R

The following logic is used by the ECM for operation of the transmission in the autoshift mode.

- In order for the ECM to enable the autoshift function, there can be no active diagnostic codes for the transmission solenoids, the FNR switch, the Autoshift switch or the parking brake components. If the ECM detects an abnormal condition, the ECM may active a diagnostic code for any of these components. The autoshift function will be turned OFF.
- If the ECM cannot determine the TOS speed signal or the direction signal from the output speed sensors or from the intermediate speed sensors, the autoshift mode will not be enabled. If these signals are lost during autoshift operation, the ECM will turn OFF the Autoshift mode.
- When the autoshift mode is active and a shift from NEUTRAL in either direction is performed, the configured initial gear will be ignored if it is within the set autoshift gear range. If the Initial gear is not within the set autoshift range, then the ECM will shift to the Initial gear. A manual shift into the autoshift range is then required to operate in the Autoshift mode.
- A manual shift will be required when operating outside the configured range of the autoshift. Once a manual shift to a gear within the autoshift range takes place, the ECM will continue the automatic transmission operation in the autoshift gear range.
- When operating the machine in the autoshift range, if the ECM detects an operator requested **upshift or downshift** from the push-button switches on the left joystick, the ECM will change the autoshift maximum gear to the operator requested gear. This temporary change of the autoshift maximum gear will be in effect until the key switch is turned to the OFF position. When the engine is started again, the ECM will return to the original configured maximum gear of the autoshift. Example: The ECM is automatically shifting in the configured autoshift range of gear 3F to gear 6F in the FORWARD direction and gear 2R to gear 4R in the REVERSE direction. While in gear 6F, the operator depresses the downshift switch once to manually downshift into gear 5F. The ECM executes the downshift and this action changes the autoshift maximum gear to gear 5F until the next key start cycle. The same process will occur in the REVERSE direction if a manual **upshift or downshift** is requested.

i02912116

Location of Electrical Components

SMCS Code: 1400; 4000

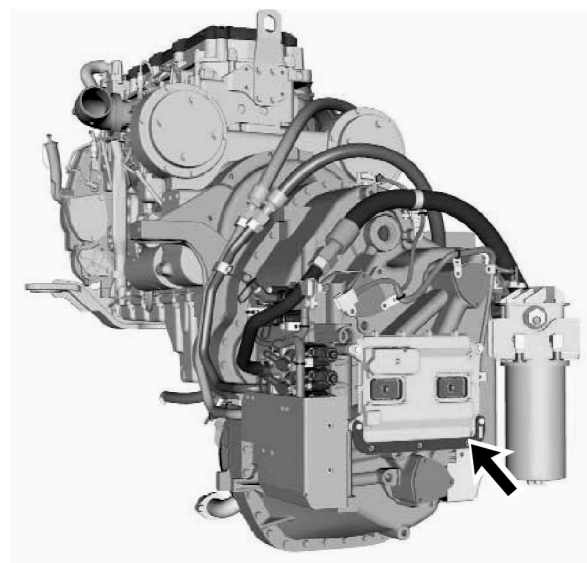


Illustration 24

g01322755

Transmission/Chassis ECM location on the rear of the transmission

The Transmission/Chassis ECM is mounted on the rear of the transmission. Many of the components, that make up the electronic control system of the Power Train, are located at the transmission or near the transmission. For the locations of many of these components, refer to the Systems Operation, "Inputs" and Systems Operation, "Outputs" sections of this manual.

The Electrical System Schematic of the machine that is in the Service Manual will illustrate locations for all of the electrical components and harness connectors that are installed on the machine.

Cab Relay Locations

Note: The following relay locations for cab mounted relays are correct at the time of publication of this manual. The location of the relays on some early model machines may be slightly different. When servicing a particular relay, always refer to the complete Electrical System Schematic of the machine in order to verify the wire numbers of the relay that is being serviced.

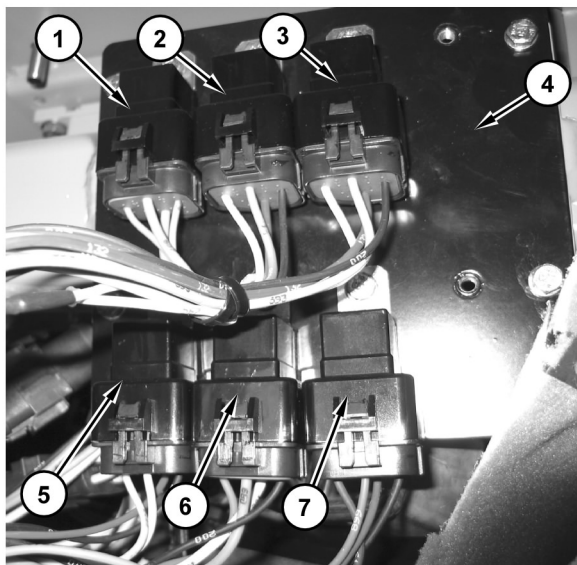


Illustration 25

g01379724

Relays that are located behind the cover on the right side headliner

- (1) Power air cleaner relay
- (2) Cab floodlights relay
- (3) Backlight relay
- (4) Mounting location of attachment heated mirror relay when installed
- (5) Blade flood relay
- (6) Condenser fan relay 2
- (7) Condenser fan relay

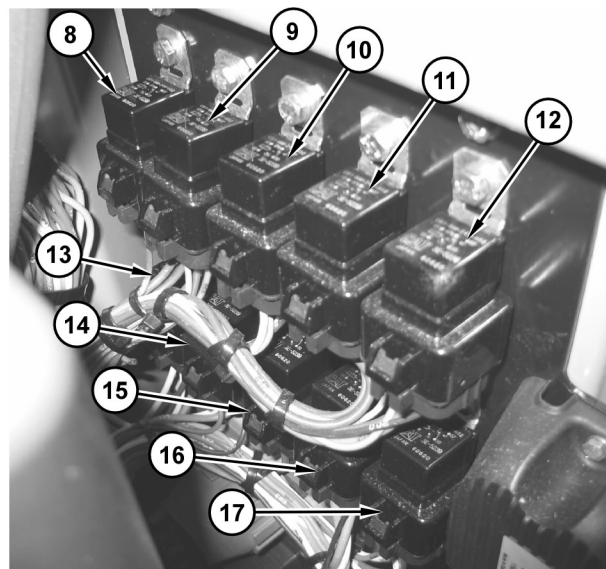


Illustration 26

g01379730

Relays that are located on the rear wall of the cab behind the right hand console

- (8) Horn relay
- (9) L. H. position relay
- (10) Diff lock relay
- (11) Headlamp relay
- (12) Blade flood relay
- (13) Enable relay
- (14) R.H. position relay
- (15) Dimmer relay
- (16) Rear flood relay
- (17) Fast speed relay

i06969972

Electrical Input Components

SMCS Code: 1400; 4000

TRANSMISSION CHASSIS ECM POWER TRAIN CONTROL SYSTEM INPUT COMPONENTS

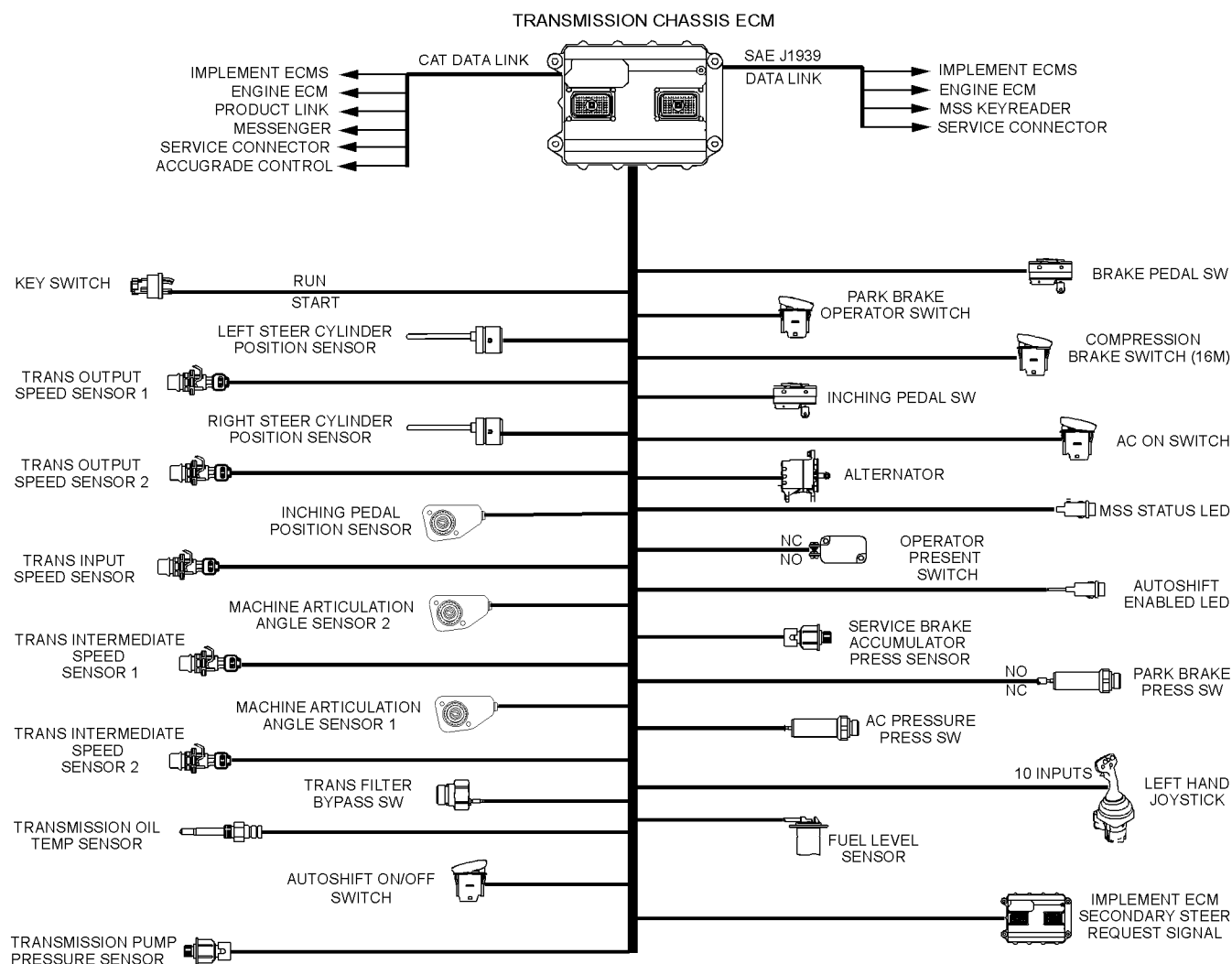


Illustration 27

g01947755

Block diagram of the Transmission/Chassis ECM power train input components

The electronic control system of the power train utilizes various different types of devices that provide input data to the Transmission/Chassis ECM. The ECM receives data about the status of the machine from the input devices. The ECM will use the machine status information to determine the correct output action that is needed to control the power train functions of the machine based on memory and software parameters. All of the power train system components that supply inputs to the ECM fall into one of the following groups: switch-type inputs and sensor type inputs.

Switches provide signals to the switch inputs of the ECM. The possible outputs of a switch are an open signal, a grounded signal, or a voltage signal.

Sensors provide an electrical signal to the ECM that constantly changes. The sensor input to the ECM can be one of several different types of electrical signals such as the following: pulse width modulated (PWM) signals, active analog (voltage) input signals, passive analog (resistance) input signals and frequency input signals.

The Transmission/Chassis ECM monitors most of the circuits of the input components for diagnostics. If the ECM determines that an abnormal condition exists in one of the circuits, the ECM will log a diagnostic code for the involved component.

Sensors

Most input circuits of the sensors have an internal ECM "pull up voltage" that is present at the contacts of the ECM. An above normal voltage is internally connected to the input circuit of the ECM through a resistor. During normal operation, the sensor signal will hold the circuit at a certain amplitude. Circuit conditions such as a loss of power to the component, a disconnection of the circuit or an open circuit will allow the circuit to be pulled high by the pull up voltage of the ECM. This action will result in an above normal voltage at the contact of the ECM. As a result, the ECM will activate an FMI 03 (voltage above normal) diagnostic code for the affected circuit.

The types of ECM input sensor circuits that have pull up voltage present are listed below:

- Pulse Width Modulated (PWM) sensor input circuits
- Active analog (voltage) input signal circuits
- Passive analog (resistance) input signal circuits

Articulation Position Sensors

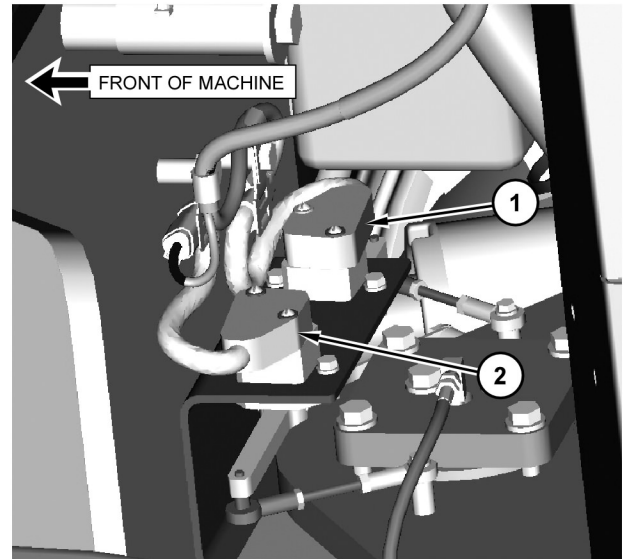


Illustration 28

g01327588

Early M Series Motor Graders were equipped with two angle position sensors for machine articulation. Located on the front half of the machine, in front of the articulation hitch. (View: Looking from the left side of the machine)

Left and right hand are in reference to the front of the machine.

- (1) Machine Articulation Sensor #2 (right side)
- (2) Machine Articulation Sensor #1 (left side)

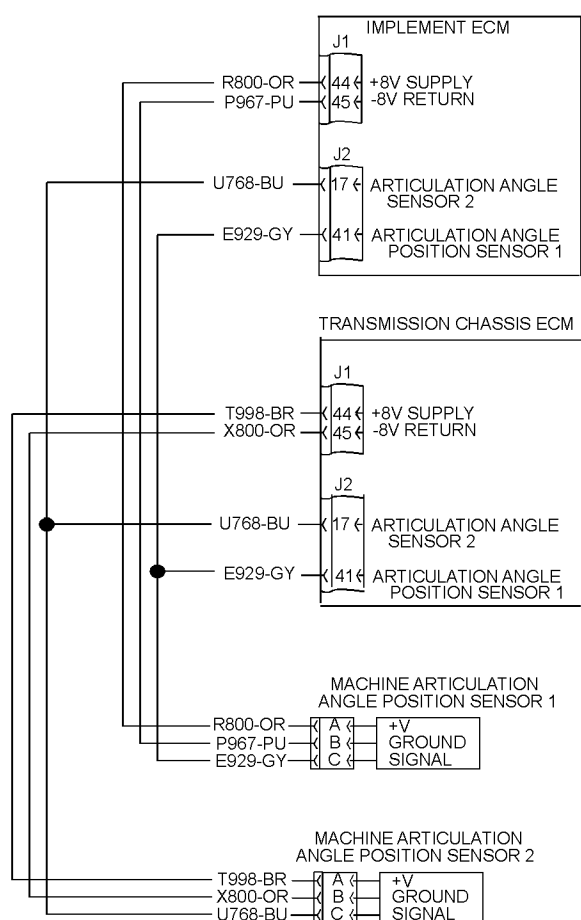


Illustration 29

g01313624

Dual Articulation Position Sensors 1 and 2 Input Circuits

The two machine articulation position sensors for the M Series Motor Graders are mounted on the front half of the machine in front of the articulation hinge. Each position sensor will provide a PWM input to the Implement ECM and to the Transmission/Chassis ECM.

The position sensor for articulation angle (1) is powered by the 8 V sensor power supply of the Implement ECM. The position sensor for articulation angle (2) is powered by the 8 V sensor power supply of the Transmission/Chassis ECM.

The Transmission/Chassis ECM monitors the signals from the sensors in order to be instantly ready to activate and control the secondary steer system.

The Transmission/Chassis ECM monitors the PWM duty cycle from the articulation position sensors in order to determine the articulation angle of the machine. The sensor operates at a frequency of approximately 500 Hz. When the articulation angle of the machine is in the neutral position, the duty cycle from the position sensor to the ECM is approximately 55%. When the machine is articulated to the full left position, the duty cycle will be approximately 33%. When the machine is articulated to the full right position, the duty cycle will be approximately 74%.

When an abnormal condition is detected in one or both of the machine articulation position sensor circuits, the ECM will activate a diagnostic code for the affected circuit.

Single Articulation Position Sensor

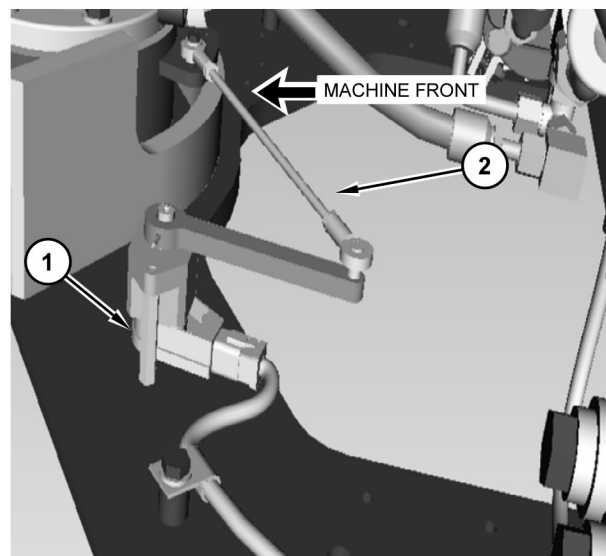


Illustration 30

g03236020

Machine Articulation Angle Position Sensor is located on the left-hand side of the articulation hitch. (View from left side of machine with covers removed)

- (1) Machine Articulation Sensor
- (2) Mechanical linkage

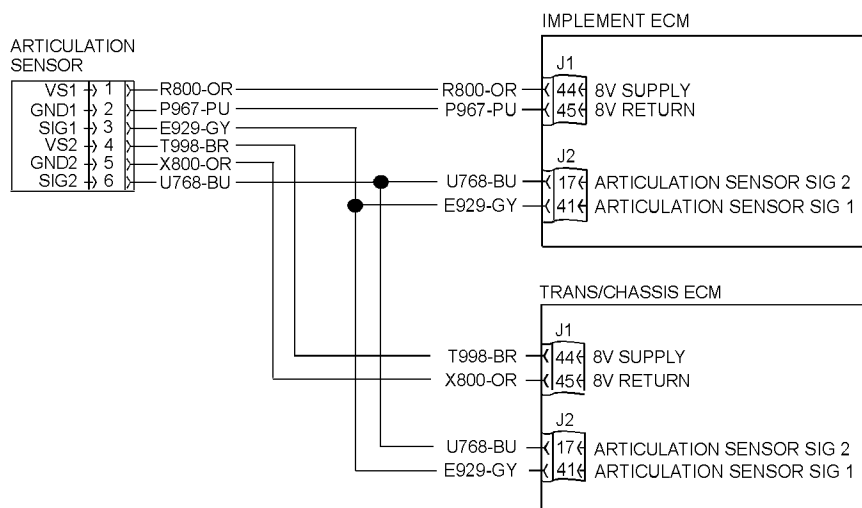


Illustration 31

g03209100

Single Articulation Position Sensor Circuit

Reference: Special Instruction, REHS7330, “Rework Procedure to Accommodate a Single Articulation Angle Position Sensor on Certain M-Series and M-Series 2 Motor Graders.{4806, 7610}”

The single “Dual Output Machine Articulation Position Sensor” is mounted on the front half of the machine at the hinge of the articulation. (Same location mount as the left-hand, articulation angle position sensor # 1, on the earlier 2-sensor configuration.) The position sensor provides a PWM signal input to the Implement ECM and to the Transmission/Chassis ECM.

The “articulation angle position sensor” is powered by the 8 VDC “Sensor Power” supply of the Implement ECM.

The Implement ECM measures the PWM duty cycle from the articulation position sensor in order to determine the articulation angle of the machine. The sensor operates at a frequency of approximately 500 Hz. When the articulation angle of the machine is in the neutral position, the input of the duty cycle from the position sensor to the ECM is approximately 55%. When the machine is articulated to the full left position, the duty cycle will be approximately 33%. When the machine is articulated to the full right position, the duty cycle will be approximately 74%.

The Transmission/Chassis ECM monitors the articulation angle of the machine and the gear selected for the machine. The ECM will limit the selected gear to a value no greater than “6F” or “5R” if the articulation of the machine is greater than 7°. The Transmission/Chassis ECM will limit the articulation angle to less than 7° if the gear selected for the machine is greater than “6F” or “5R”.

The monitoring of the articulation angle of the machine is not inhibited while operating the machine using the secondary steering function.

Fuel Level Sender

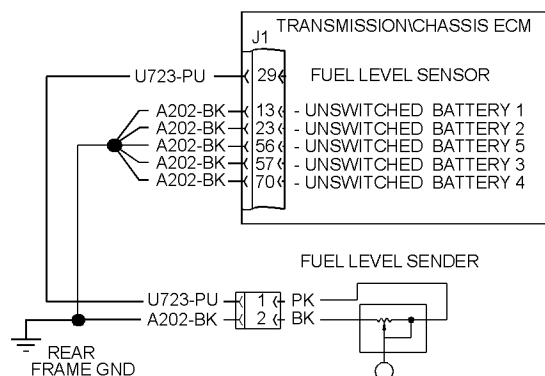


Illustration 32

g01287755

Input circuit of the “Fuel Level Sender”

The fuel level sender is mounted on the top of the fuel tank under the left side of the cab.

The Transmission/Chassis ECM monitors the resistance of the fuel level sender input signal. The ECM associates the resistance value of the sender signal of the circuit with a specific level of fuel in the fuel tank. The ECM sends this information to the Messenger over the data link.

When the fuel tank is nearly empty, the resistance in the sender circuit is approximately 248 ± 8 ohms. When the fuel tank is nearly full, the resistance in the sender circuit is approximately 27 ± 2 ohms.

Inching Pedal Position Sensor

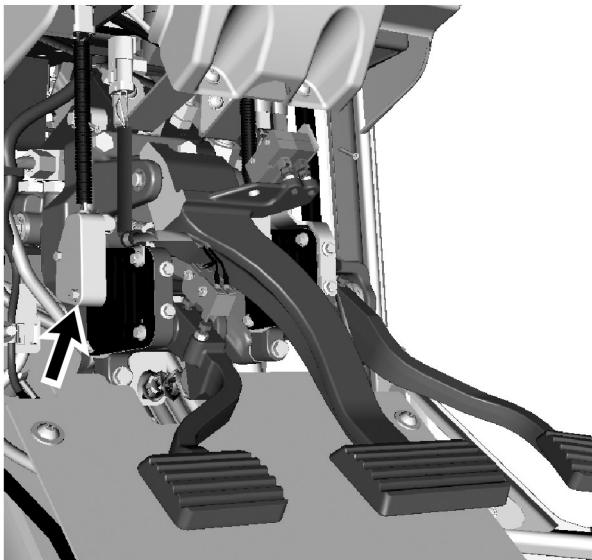


Illustration 33
Inching Pedal Position sensor location (arrow)

The inching pedal position sensor operates in a frequency range of 200 Hz to 600 Hz. The optimal operating frequency is approximately 500 Hz. The Transmission/Chassis ECM will recognize a duty cycle of 4 percent to 96 percent as valid. If the ECM detects a duty cycle that is greater than 96 percent or less than 4 percent, the ECM will activate a diagnostic code for the circuit of the position sensor.

During machine operation, every time the inching pedal is depressed and released, the Transmission/Chassis ECM performs an auto calibration sequence for the position sensor. The ECM defaults to a 30 percent duty cycle when the pedal is not depressed. The ECM defaults to a 70 percent duty cycle when the pedal is fully depressed. During the auto calibration procedure, the ECM will adjust the acceptable pedal position limits from a possible 4 percent duty cycle when the pedal is not depressed to a possible 96 percent duty cycle when the pedal is fully depressed. Duty cycles beyond these limits are not considered acceptable by the ECM.

Pulse Width Modulated (PWM) Position Sensor Operation

When powered up, the position sensors continuously send a Pulse Width Modulated (PWM) square wave signal to the ECM. Any movement on a specific axis is detected by the position sensor for that axis. The duty cycle signal of the PWM sensor changes depending on the direction and the amount of movement on the axis. The duty cycle is the percentage of time that the signal is high as compared to the period of the cycle. The longer the time that the duty cycle is high, the greater the percentage of the duty cycle will be.

The percentage of duty cycle signal from a typical position sensor that the ECM will recognize as valid is 10 ± 5 percent to 90 ± 5 percent at the extreme ends of the axis movement.

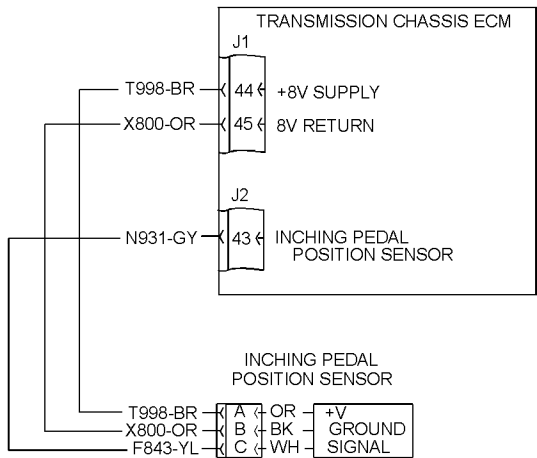


Illustration 34
Inching Pedal Position sensor input circuits

The position of the inching pedal is monitored by the Transmission/Chassis ECM. A position sensor is mounted on the shaft of the pedal. The PWM duty cycle from the sensor is converted by the ECM into a pedal position that represents the position of the inching pedal.

Service Brake Accumulator Pressure Sensor

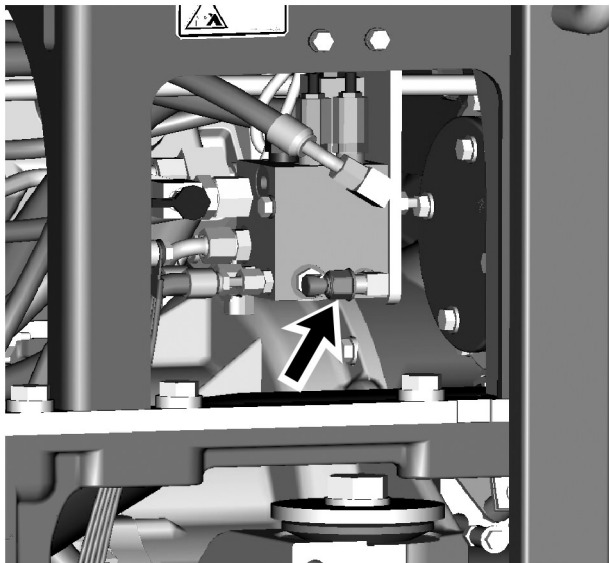


Illustration 35 g01328784
Service Brake Accumulator Pressure Sensor (arrow) located on the brake manifold on the left rear side of the engine compartment

When the ECM detects that the hydraulic pressure for the service brake accumulator is less than 8101.3 kPa (1175.0 psi) for more than one second, the ECM will activate an EID 0284 warning level 3 event code and illuminate the brake subsystem indicator on the Instrument Cluster. The ECM will deactivate the event code, turn OFF the indicator, when the brake accumulator pressure is greater than 9825.0 kPa (1425.0 psi) for one second.

The ECM will not log the level 3 event for 10 seconds after the engine is started in order to give the accumulator pressure time to reach the operating pressure. Ten seconds after the machine is started, if the pressure is not greater than 8101.3 kPa (1175.0 psi), the EID 0284 event code will be logged.

Steer Cylinder Position Sensors

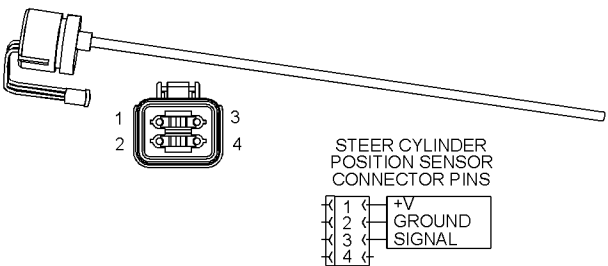


Illustration 37 g01313639
Steer Cylinder Position Sensor

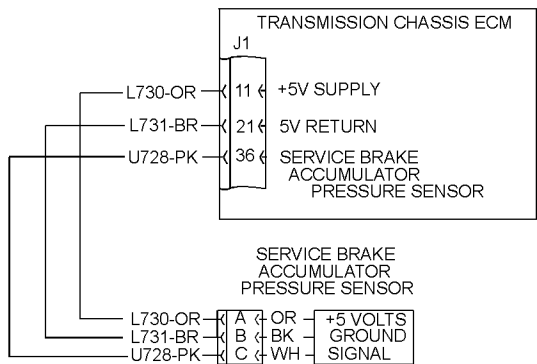


Illustration 36 g01305473
Input circuit of the pressure sensor for the Service Brake Accumulator

The position sensor for the service brake accumulator is an active analog sensor that sends a 0 to 4.5 V signal to the Transmission/Chassis ECM in order to indicate the hydraulic pressure that is in the service brake accumulator.

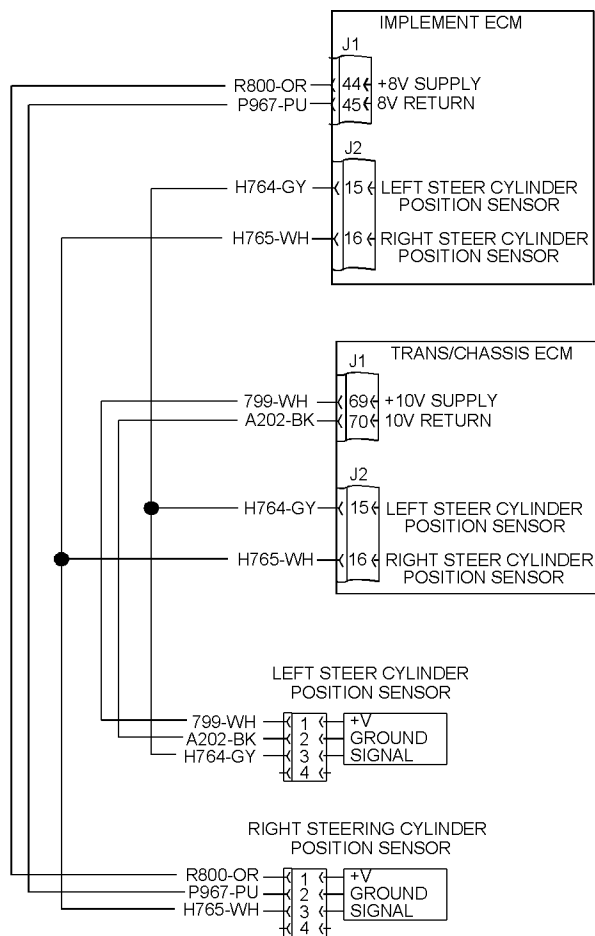


Illustration 38

g01313665

Steer Cylinder Position sensor input circuits

The position sensors for the steering cylinders are mounted on the head end of the front steering cylinders. The position sensors provide a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM.

The position sensor of the left steering cylinder is powered by the 10 V sensor power supply of the Transmission/Chassis ECM. The position sensor of the right steering cylinder is powered by the 8 V sensor power supply of the Implement ECM.

The sensor is a PWM sensor that operates at a frequency of approximately 500 Hz. When the length of the extension of the steering cylinder changes, the duty cycle of the PWM sensor changes. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. This intricate signal makes the measurement of the changes of the duty cycle difficult.

The Transmission/Chassis ECM monitors the signals from the articulation sensors in order to be able to activate the secondary steering system at any time during machine operation. The Transmission/Chassis ECM will use the signals from the position sensors when the secondary steering system is active in order to control the angle of the front wheels. The Transmission/Chassis ECM activates the outputs to the secondary steering solenoids based on the left joystick steering axis position. The ECM monitors the signals from the position sensors of the steering cylinder in order to adjust the output current to the solenoids accordingly.

The Implement ECM will use the signals from the position sensors to control the primary steering system.

Transmission Oil Temperature Sensor

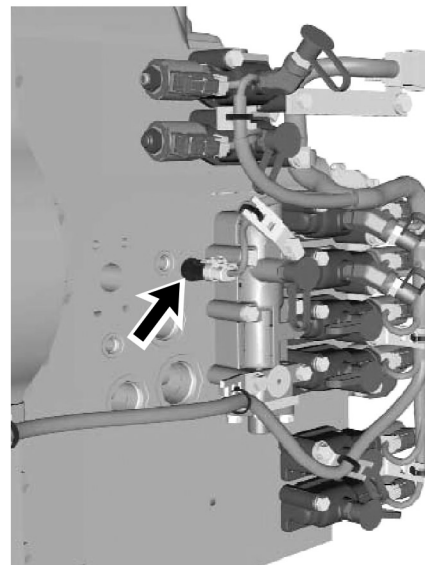


Illustration 39

g01321613

Transmission Oil Temperature sensor location on the left side of the transmission (arrow)

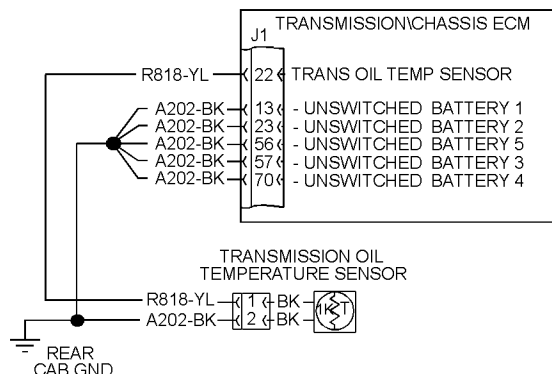


Illustration 40

g01287815

Input circuit of the Transmission Oil Temperature sensor

The transmission oil temperature sensor allows the Transmission/Chassis ECM to monitor the temperature of the transmission oil. The sensor provides a passive analog (resistance) input signal to the ECM.

The ECM associates the resistance value of the sensor signal with a specific temperature of the transmission oil.

The resistance range of the sensor that the ECM will consider valid is 33650 ohms at -40°C (-40.0°F) to 18.6 ohms at 150°C (302.0°F).

If the ECM detects that the resistance of the sensor circuit is 60.6 Ω , which is converted as 104°C (219.2°F) oil temperature, the ECM will activate an EID 0877 event code for high oil temperature. When the circuit resistance of the sensor is 68.0 Ω , which is converted as 104°C (219.2°F) 100°C (212.0°F) oil temperature, the ECM will deactivate the event code.

When the resistance of the sensor circuit is above 33650 ohms or below 18.6 ohms, the Transmission/Chassis ECM will activate a diagnostic code for the circuit.

Transmission Pump Pressure Sensor

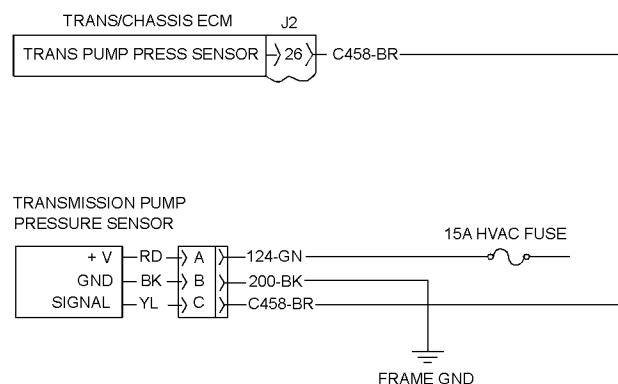


Illustration 41

g01948597

Transmission pump pressure sensor circuit

The transmission pump pressure sensor allows the Transmission/Chassis ECM to determine the transmission pump oil pressure. The ECM reads the pulse width modulated (PWM) signal from the sensor and computes a main hydraulic pump discharge pressure.

Transmission Speed Sensors

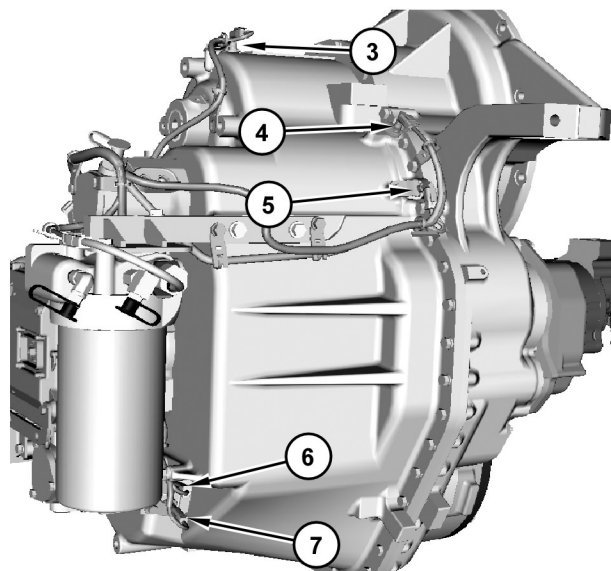


Illustration 42

g01327859

Transmission speed sensors located on the top side and the right side of the transmission.

- (3) Transmission input speed sensor
- (4) Transmission intermediate speed sensor 2
- (5) Transmission intermediate speed sensor 1
- (6) Transmission output speed sensor 2
- (7) Transmission output speed sensor 1

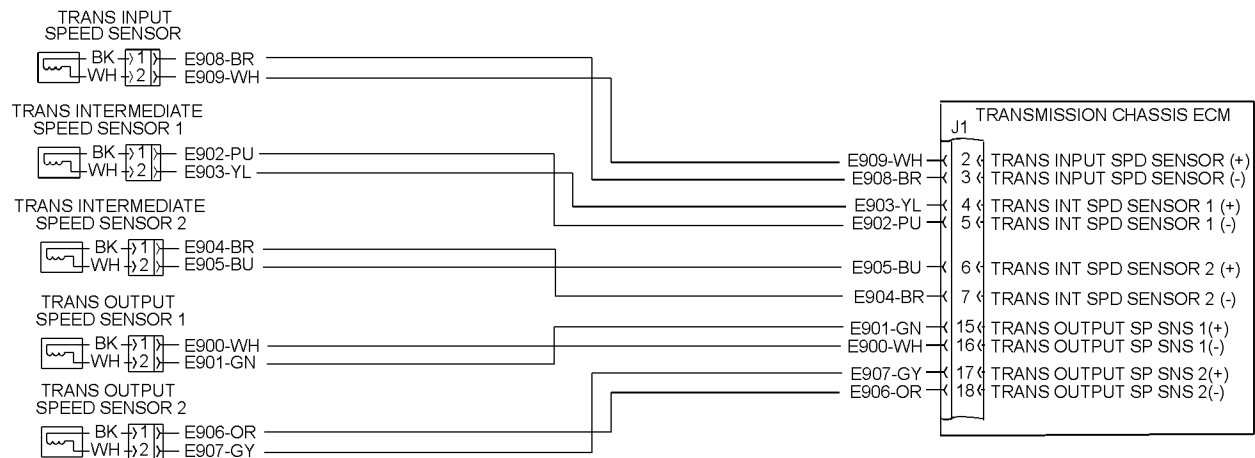


Illustration 43 g01375824

Input circuits of the Transmission speed sensors

The transmission on the M Series Motor Graders is equipped with five speed sensors. Each speed sensor supplies a frequency input to the Transmission/Chassis ECM.

The input speed sensor is mounted at a location that will monitor a gear on the input shaft of the transmission. The two intermediate speed sensors are mounted at a location in order to monitor a large intermediate gear in the transmission. The two output speed sensors are mounted at a location in order to monitor a gear that is mounted on the output shaft of the transmission.

Each of the speed sensors is attached to the transmission with a fixed mount. No adjustment of the mount for the speed sensor is necessary.

The speed sensors produce a signal that varies in frequency (Hz) as the tooth of the gear is passed in front of the sensor. Each tooth that passes the gear will produce one cycle or hertz of the frequency signal. The ECM detects the frequency of the signal. The ECM then determines the speed and the direction of the gear and the shaft that the gear is mounted on. Each speed sensor has two input connections to the ECM ("+" and "-"). On all of the speed sensors, connector contact 2 is the signal (+). Connector contact 1 is the return line (-).

When the speed of the transmission output shaft is greater than 150 rpm, the Transmission/Chassis ECM monitors the two output speed sensors in order to determine the transmission output speed (TOS) and the direction of travel. If no TOS or direction signals are coming from the two output speed sensors, the ECM will use the signals from intermediate speed sensors in order to calculate the TOS and to determine the direction. As a result, the ECM will maintain control of the transmission if failures of the two output speed sensor circuits occur.

When the speed of the transmission output shaft is less than 150 rpm, the ECM will use the signals from the two intermediate speed sensors to calculate the TOS and the direction of travel. At the lower TOS, the slower speed of the output gear results in a poor signal from the output speed sensors. The larger intermediate gear is rotating faster at the lower output shaft speed which results in a more reliable intermediate speed sensor signal.

The ECM uses the TOS and direction data in order to control the shifting of the transmission when operating in the "Autoshift" mode. The ECM will use the TOS and direction information to control the operation of the transmission and to prevent unsafe operating conditions that could be dangerous to the operator or cause damage of the machine.

Both of the intermediate speed sensors are monitoring one intermediate gear in the transmission. Both of the output speed sensors are monitoring an output gear in the transmission. The Transmission/Chassis ECM expects approximately the same signal to be coming from each of the pairs of speed sensors. If the signals differ more than 50 Hz, the ECM will determine the correct signal based on the input signals from the other speed sensors on the transmission. Then, the ECM will activate a diagnostic code for the speed sensor circuit that has the abnormal condition.

Secondary Steer Request Signal

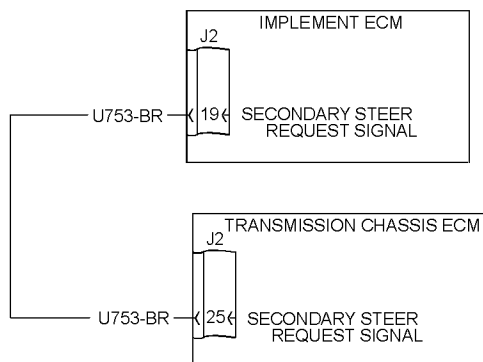


Illustration 44

g01305868

Input circuit connections of the "Secondary Steer Request"

The secondary steer request circuit is a hard wired circuit that is connected between the Implement ECM and the Transmission/Chassis ECM. When the Implement ECM detects a problem in the primary steering circuit, the Implement ECM will send a PWM signal to the Transmission/Chassis ECM through the circuit requesting activation of specific components in the secondary steer system or requesting that the complete secondary steer system be activated.

The Implement ECM will send a signal to the Transmission/Chassis ECM in order to activate the secondary steering system when any of the following conditions of the machine system are detected:

- An active CID 2202 FMI 12 (Steering Valve Control Module Error) diagnostic code.
- A failure of the main hydraulic pump.
- Steering motion is detected when no primary steering command is present.
- Steering motion is not detected when a primary steering command is present.
- Steering motion is detected in the wrong direction.
- A manual secondary steer test has been requested.

- An automatic test of the secondary steering pump is being performed at initial engine start-up.

The Transmission/Chassis ECM will activate the secondary steering system without receiving a request signal from the Implement ECM when the following condition is present:

- An active CID 2199 (Secondary Steering Request Signal from the Implement ECM) diagnostic code.

When the Implement ECM sends a PWM secondary steer request signal to the Transmission/Chassis ECM, the duty cycle of the PWM signal will determine which specific secondary steer system components will be activated. During normal operation, the Implement ECM maintains a 20 percent duty cycle on the request circuit. When a secondary steer test is requested or when the Implement ECM has detected a problem in the primary steering system, the secondary steer request signal will be one of the following duty cycle signals:

20 percent PWM duty cycle – Normal operation, no request to activate.

40 percent PWM duty cycle – Request to activate the secondary steering pump motor only.

60 percent PWM duty cycle – Request to activate the secondary steering pilot solenoid valves only.

80 percent PWM duty cycle – Request to activate the secondary steering pump and the secondary steering pilot solenoid valves.

When a 40 percent duty cycle request is received by the Transmission/Chassis ECM, the ECM will energize the secondary steer relay. This action will allow system power to pass through the relay contacts and will energize the secondary steer motor relay. System power from the power control box will then be supplied to the secondary steering pump motor which turns the secondary steering pump. When a pump request only is received, the secondary steering pump will supply hydraulic pressure and flow to the primary steering system. Under these circumstances, the secondary steering pump motor will overheat if operated for more than a short amount of time.

When a 60 percent duty cycle request is received by the Transmission/Chassis ECM, the ECM will activate the proportional secondary steer pilot solenoid valves in order to control the hydraulic oil flow to the steer cylinders. The ECM will use a PWM output signal in order to energize the secondary steer solenoids. The Transmission/Chassis ECM will vary the amount of electrical current that is sent to the solenoids in order to control the angle of the front wheels.

When the secondary steer solenoids are energized, pilot hydraulic oil pressure is directed to the same main hydraulic valve that is used for the primary steering system. The steering valve control module that is used for operation of the primary steering system is not used when the secondary steer solenoids are active.

When an 80 percent duty cycle request is received by the Transmission/Chassis ECM, the ECM will energize the secondary steer relay in order to energize the secondary steer pump motor. The ECM will also activate the proportional secondary steer pilot solenoids.

Switches

Switches will provide one of the following types of input signals to the ECM:

- An Open signal
- A Ground signal
- A +battery or voltage signal

The contacts of a switch have two states of contact. The switch contacts are open or the switch contacts are closed.

- When switch contacts are open, no signal is provided to the corresponding input of the ECM. A “no signal” condition is also referred to as floating.
- When switch contacts are closed, either a ground signal or the +battery signal is passed through the contacts of the switch and to the corresponding input of the ECM.

Switch to ground type input circuits have an internal ECM pull-up voltage that is present at the contacts of the ECM. An above normal voltage is internally connected to the input circuit of the ECM through a resistor. This internal resistance allows the ECM to detect a problem in the switch circuit. During normal operation, the switch signal will hold the circuit low, however, circuit conditions such as a disconnection or an open circuit will allow the circuit to be pulled high by the ECM pull-up voltage. This action will result in an above normal voltage at the contact of the ECM. If this action occurs when the ECM is expecting the circuit to be low, the ECM will activate a diagnostic code for the circuit.

Switch to +battery type input circuits have an internal ECM pull-down voltage that is present at the ECM contacts. A below normal voltage is internally connected to the input circuit of the ECM through a resistor. This allows the ECM to detect a problem in the switch circuit. The circuit will be held high when the switch contacts are closed to a +battery source. If the circuit is open or has a bad connection, the pull down voltage will pull the circuit low. If this action occurs when the ECM is expecting the circuit to be high, the ECM will activate a diagnostic code for the circuit.

The ECM monitors the switch input circuits for most of the following switches unless otherwise noted. The ECM will activate a diagnostic code for the input circuits of the switch when an abnormal condition is detected.

“Key Start” Switch Inputs

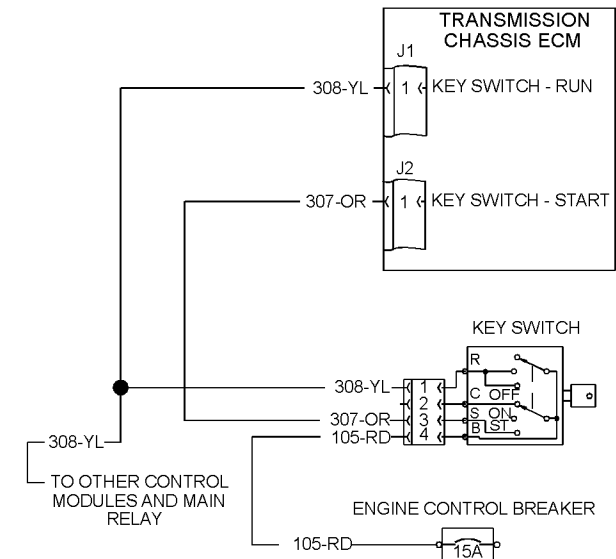


Illustration 45

g01329042

Input circuits of the “Key Start” switch

The Transmission/Chassis ECM monitors the status of the “key start” switch. When the “key start” switch is in the ON position or in the START position, a voltage input is supplied to the ECM through the contacts of the “key start” switch.

When the “key start” switch is in the OFF position, the ECM is in a “sleep” mode. In the sleep mode, system power is still supplied to the ECM, however, the ECM is not functioning. When the “key start” switch is moved to the ON position, the Transmission/Chassis ECM will detect the system voltage at the key ON input. When this action occurs, the ECM will activate an internal start-up initialization procedure in order to activate the operation mode.

When the Transmission/Chassis ECM detects the system voltage at the START input, the ECM will activate the start relay in order to initiate the engine start process provided the following machine conditions are present:

- The parking brake is engaged.
- The transmission is in NEUTRAL.
- The operator is in the seat.

Left Joystick Transmission Control Inputs

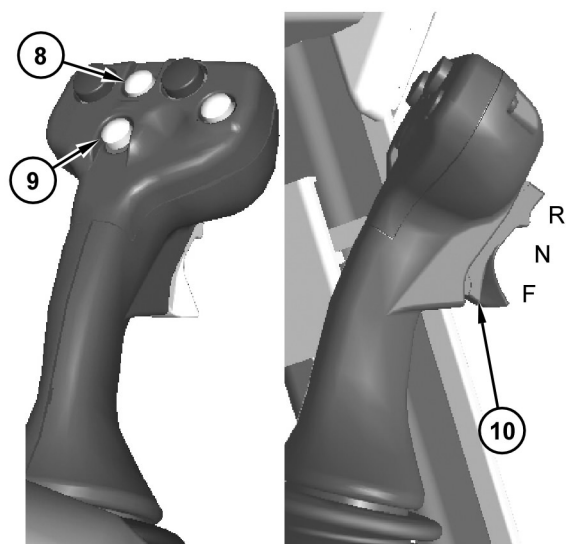


Illustration 46

g01329215

Left Joystick Transmission Controls

- (8) Upshift push-button switch
- (9) Upshift push-button switch
- (10) Forward/neutral/reverse trigger switch

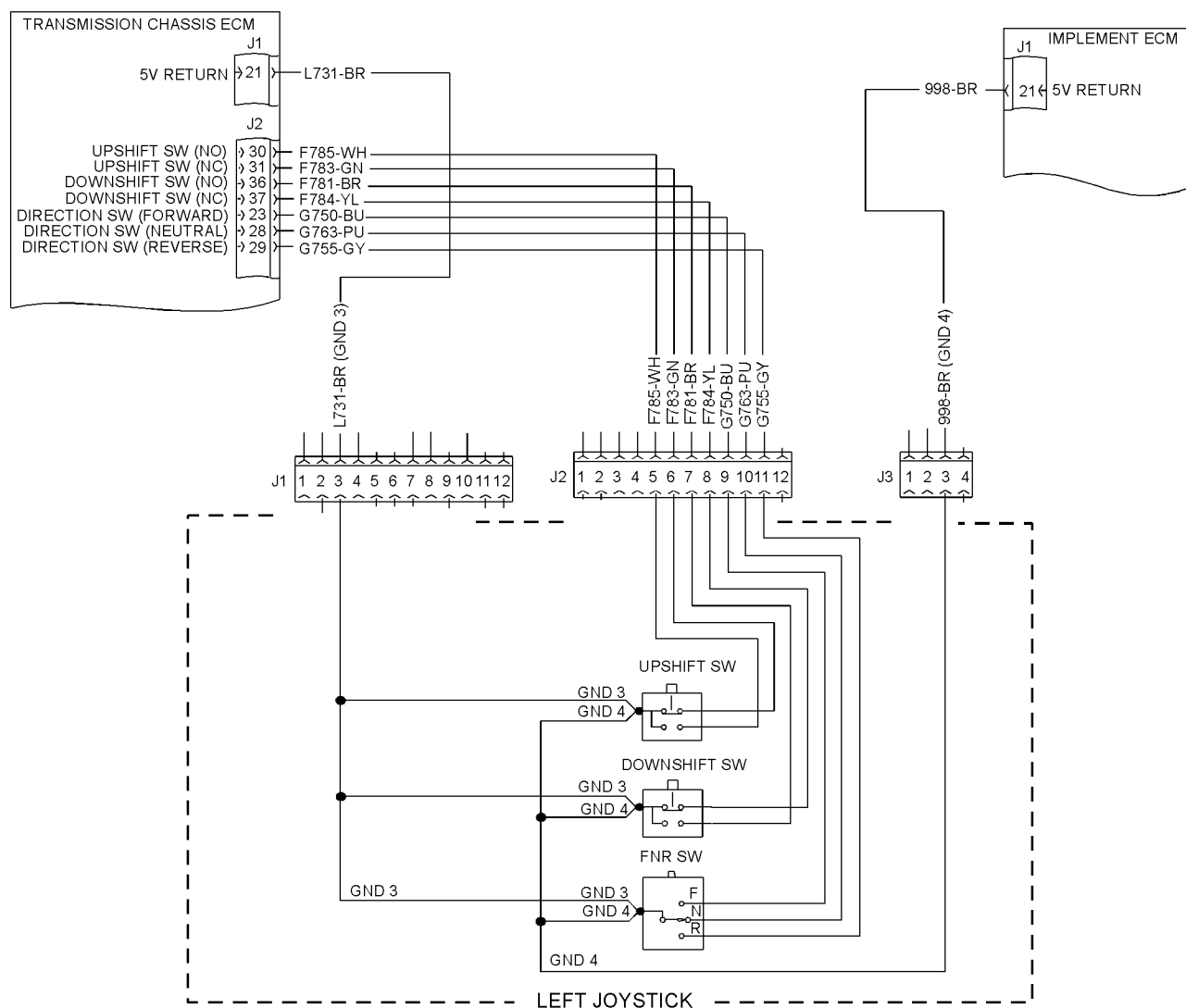


Illustration 47

g01329216

Input circuits of the “Left Joystick Transmission Control”

The illustration above shows the internal push button and ground assignments for the transmission controls in the left joystick. The illustration is displayed in order to aid in component and circuit troubleshooting for the transmission controls. For a complete connection diagram for all of the joystick to ECM connections, refer to the System Schematics in the back of this manual.

The upshift switch, the downshift switch, and the FORWARD/NEUTRAL/REVERSE “(FNR)” switch provide switch to ground inputs to the Transmission/Chassis ECM in order to indicate operator commands for gear selection. Each switch is internally connected to two of the four ECM return (ground) circuits that are supplied to the left joystick. One of the ECM return circuits for the switches is supplied by the Transmission/Chassis ECM and the other ECM return circuit for the switches is supplied by the Implement ECM. Both ground connections must fail either internally or externally in order to interrupt switch operation due to loss of ground connections.

The ECM expects one of the switch inputs to be grounded at all times. If all of the switch inputs are grounded or if none of the switch inputs are grounded, the ECM will activate a diagnostic code for the switch.

Autoshift Switch, Park Brake Switch, Compression Brake Switch

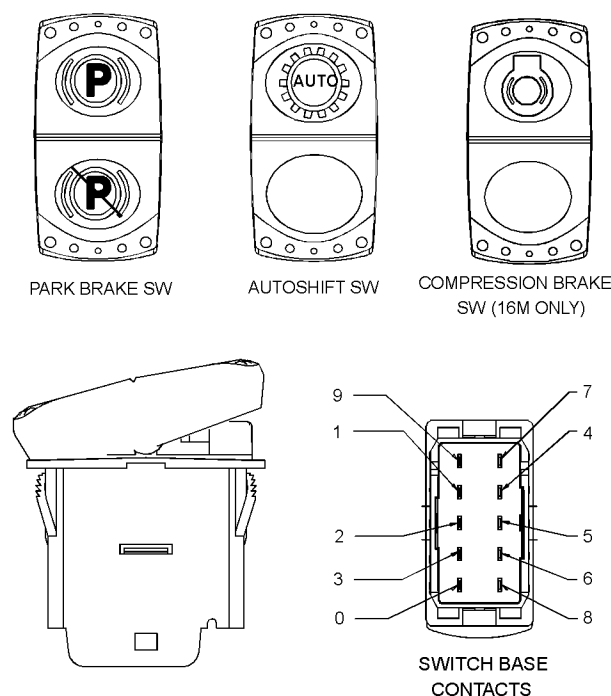


Illustration 48

g01376046

Rocker Switch Contacts

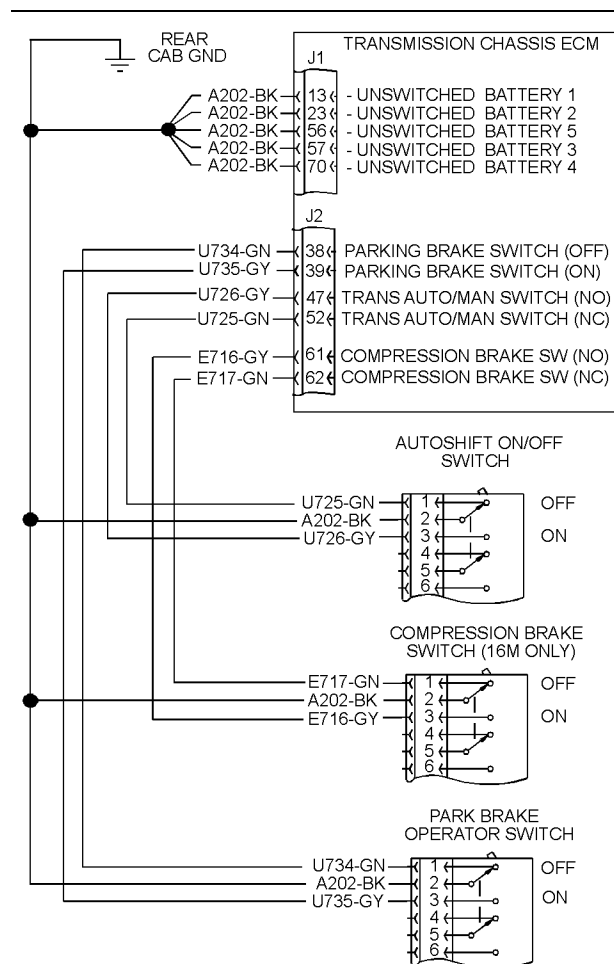


Illustration 49

g01376002

Input circuits of the "Autoshift" switch, "Parking Brake" switch and "Compression Brake" switch (16M)

The autoshift switch, the parking brake switch, and the compression brake switch each provide two switch-to-ground inputs to the Transmission/Chassis ECM. The switches are two-pole, double-throw rocker switches. The switches are located on the right-hand console in the cab.

One pole on each of the switches is used to provide the two inputs to the ECM in order to indicate the switch status. During normal operation, one of the inputs is open and the other input is closed to ground. The other switch pole is either not used or is used for switch backlighting.

If the ECM detects that both of the switch inputs are grounded at the same time or both of the switch inputs are open at the same time, the ECM will activate a diagnostic code for the involved switch.

For the operation of the autoshift switch, when the ECM detects a ground condition in the “ON” switch input circuit, the ECM will activate the autoshift transmission mode when the required machine conditions are correct. When the ECM detects a ground condition in the “OFF” switch input circuit, the ECM will deactivate the autoshift transmission mode.

For the operation of the parking brake switch, when the ECM detects a ground condition in the “ON” input circuit of the switch, the ECM will deactivate the parking brake solenoid in order to engage the parking brake. When the ECM detects a ground condition in the “OFF” input circuit of the switch, the ECM will energize the parking brake solenoid in order to disengage the parking brake.

The compression brake is only equipped on the 16M motor graders.

For the operation of the compression brake switch, when the Transmission/Chassis ECM detects a ground condition in the “ON” input circuit of the switch, the ECM will send this information to the Engine ECM on the J1939 data link. The Engine ECM will activate the output for the appropriate compression brake solenoid if the machine conditions are correct. When the Transmission/Chassis ECM detects a ground condition in the “OFF” input circuit of the switch, the Transmission/Chassis ECM will send this information to the Engine ECM on the J1939 data link. The Engine ECM will turn OFF the output for the “compression brake” solenoid.

Operator Present Switch

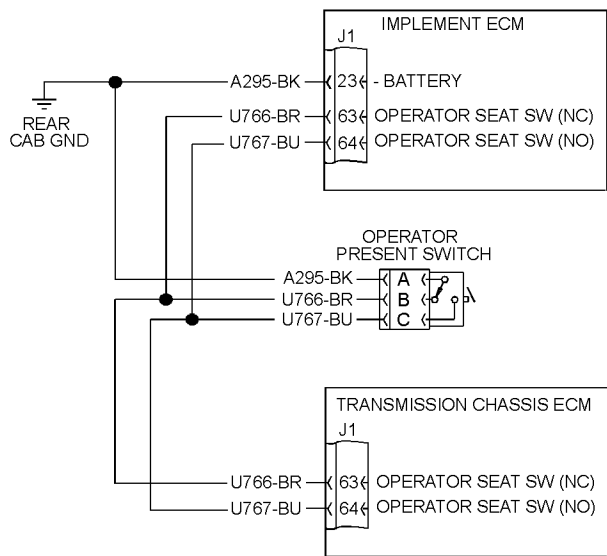


Illustration 50
Input circuits for the “Operator Present” switch

The operator present switch supplies two switch-to-ground type inputs to the Implement ECM and to the Transmission/Chassis ECM. The switch is located under the operator seat.

The Transmission/Chassis ECM will not allow a shift out of NEUTRAL, will not allow the parking brake to be disengaged, or will not permit the engine start sequence to be enabled unless the switch is indicating that an operator is present in the seat.

Inching Pedal Switch, Brake Pedal Switch

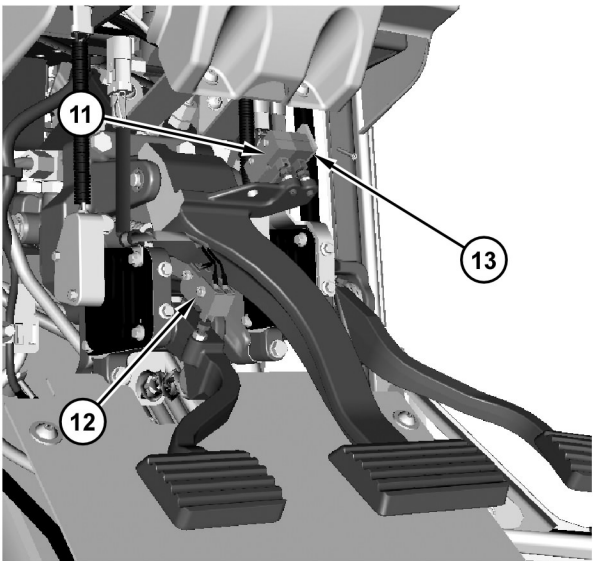


Illustration 51
“Inching pedal” switch and “Brake pedal” switch locations
(11) Brake pedal switch
(12) Inching pedal switch
(13) Brake light switch

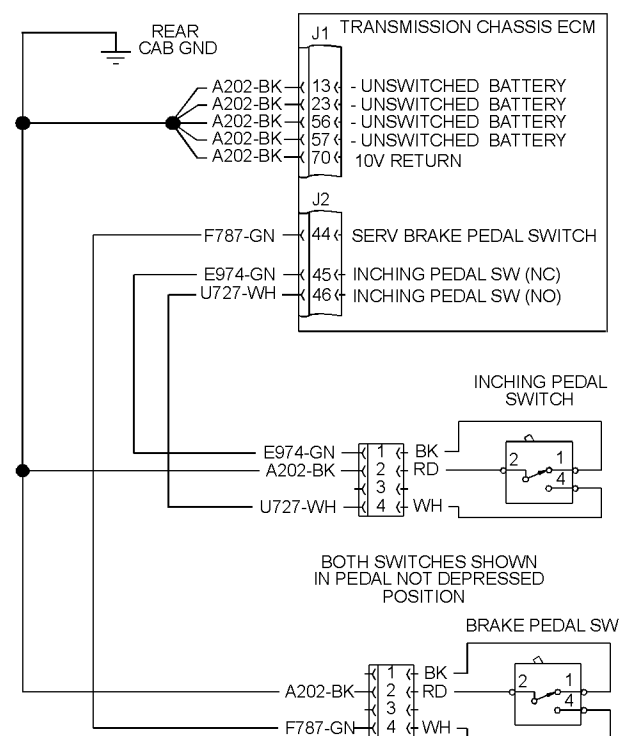


Illustration 52

g01329178

Input circuits of the "Inching pedal" switch and "Brake pedal" switch

The inching pedal limit switch and the brake pedal limit switch each provide switch to ground inputs to the Transmission/Chassis ECM. The inching pedal switch provides two inputs to the ECM. The brake pedal switch provides one input to the ECM.

The ECM monitors the inputs from the inching pedal switch in order to determine when the inching pedal is depressed. This function is used as a backup if the inching pedal position sensor fails.

For the inching pedal switch operation, the ECM expects one of the input circuits to be grounded and the other input circuit to be open at all times. If the ECM detects that both of the switch inputs are grounded at the same time or both of the switch inputs are open at the same time, the ECM will activate a diagnostic code for the switch circuits.

The ECM monitors the input from the brake pedal switch to detect if the brake pedal is depressed or is not depressed.

Park Brake Pressure Switch

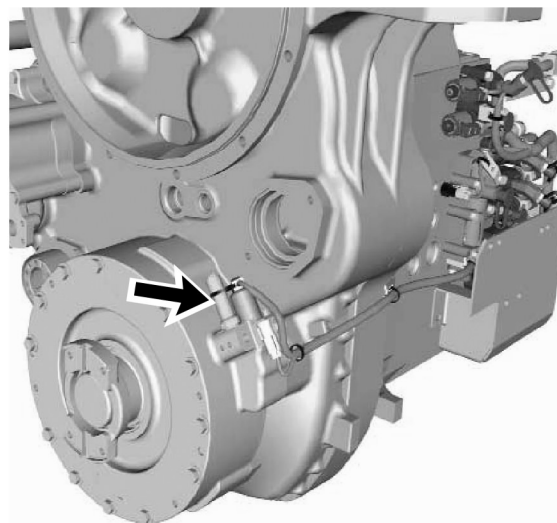


Illustration 53

g01329253

Park Brake pressure switch location on the output shaft side of the transmission (arrow)

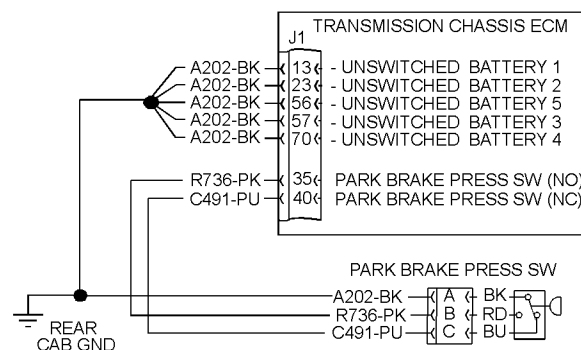


Illustration 54

g01375676

Park Brake pressure switch connections

The pressure switch for the park brake supplies two switch-to-ground inputs to the Transmission/Chassis ECM. The switch allows the ECM to detect if the parking brake is engaged or if the parking brake is disengaged.

The ECM expects the two switch inputs to be connected through the switch contacts when the parking brake is engaged. The ECM expects the normally open (N/O.) contact to be grounded when the park brake is disengaged. When the ECM detects that the switch inputs are not connected, and the N/O contact is not grounded, the ECM will activate a diagnostic code for the switch circuit.

i03631710

Electronic Control Module

SMCS Code: 7610-DTN

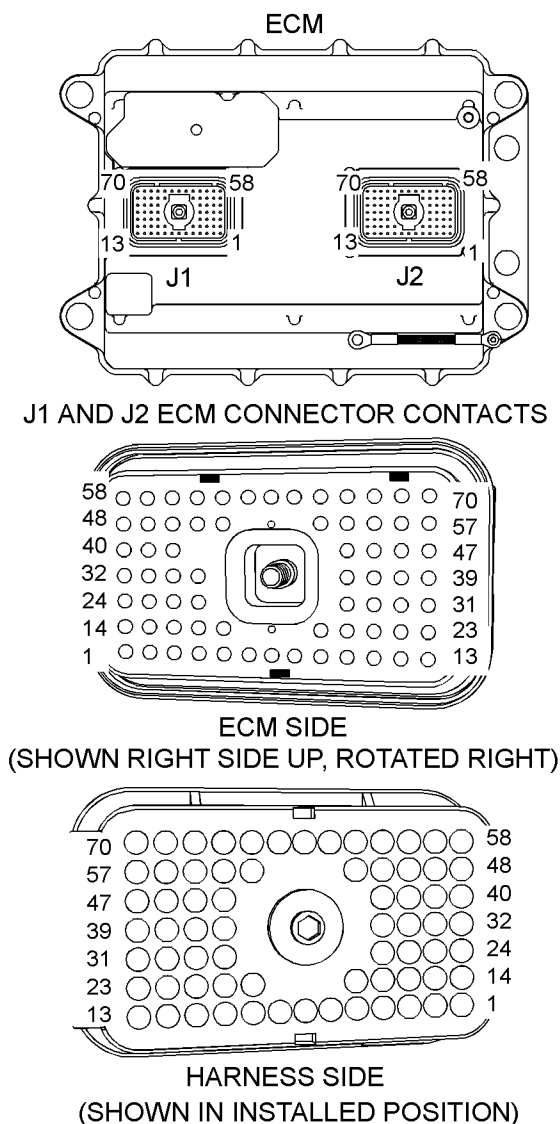


Illustration 55

g01309473

ECM connectors and contacts

The Transmission/Chassis ECM of the Series M Series of Motor Grader is mounted on the rear of the transmission.

The ECM will make decisions that are based on input data information and programming parameters that have been flashed to the ECM memory. After the ECM receives the input information, the ECM determines the correct response. The ECM will send an output signal to the appropriate device. The internal input circuits and the internal output circuits of the ECM are connected to the machine wiring harness by two 70 contact connectors (J1 and J2).

Note: The ECM is not serviceable. If the ECM is damaged, the ECM must be replaced. The rate of failure for the ECM is very low. If a failure of an ECM is suspected, contact the technical communicator at your dealership for possible consultation with Caterpillar before replacing the ECM. Replace the ECM only after all of the other possible causes of a particular problem have been investigated.

ECM Pull Up Voltage

In order to aid in diagnostics of certain types of electrical circuits that are controlled by the ECM, an internal "pull up voltage" is connected to the switch and sensor signal input contacts of the ECM. An above normal voltage is internally connected to the signal input of the ECM through a resistor.

During normal operation, the switch or sensor signal will hold the circuit low or at a certain signal amplitude, however, circuit conditions such as a loss of power to the component, a disconnection or an open circuit will allow the circuit to be pulled high by the ECM pull up voltage. This will result in an above normal voltage reading at the contact of the ECM. As a result, the ECM will activate an FMI 03 (voltage above normal) diagnostic code for the affected circuit.

The types of input circuits of the ECM that have a pull up voltage present are listed below:

- Pulse Width Modulated (PWM) sensor input circuits
- Switch to ground switch input circuits
- Active analog (voltage) input signal circuits
- Passive analog (resistance) input signal circuits

ECM Pull Down Voltage

In order to aid in diagnostics of electrical circuits that are controlled by the ECM, an internal "pull down voltage" is connected to ECM switch to battery type input circuits.

During normal operation, the switch contacts that are allowing the connection to a voltage source will hold the circuit high. When circuit conditions such as a loss of power to the supply voltage of the switch, a disconnection in the switch circuit or an open circuit will allow the circuit to be pulled low by the ECM pull down voltage. This will result in below normal voltage at the contact of the ECM. As a result, the ECM will activate an FMI 04 (voltage below normal) diagnostic code for the affected circuit.

Inputs

The machine has several different types of input devices. The ECM receives status information about the machine from the input devices. The ECM then determines the correct output action that is needed in order to control machine operations. The output action is based on memory and software parameters. The machine utilizes the following types of inputs: switch type and sensor type.

Switches provide signals to the switch inputs of the ECM. The possible outputs of a switch are listed: an open signal, a grounded signal and + battery signal.

Sensors provide an electrical signal to the ECM that constantly changes. The sensor input to the ECM can be one of several different types of electrical signals such as the following: pulse width modulated (PWM) signals, voltage signals and frequency input signals. Each possible input to each of the Transmission/Chassis ECM is listed in the tables for the 70-pin connectors.

Outputs

The ECM sends electrical signals through the outputs. The outputs can create an action or the outputs can provide information to the ECM. The ECM can send output signals to system components in one of the following types of electrical signals: driver outputs, sinking driver outputs, sensor power supply outputs and data link outputs. The possible outputs for each of the transmission/chassis ECM are listed in the tables for the 70-pin connectors.

Input/Output

Communication between the Transmission/Chassis ECM and between the other ECM modules on the machine are conducted over the data link circuits. The data link circuits allow the sharing of information with other electronic control modules. The data link circuits are bidirectional. The data link circuit allows the ECM to send information and the data link allows the ECM to receive information.

The ECM supports two types of data link systems.

- Cat Data Link
- SAE J1939 (CAN) Data Link

The two types of data links are the main structure for communication between all of the control modules on the machine. More than one CAN data link system can be present on a machine. Dedicated CAN data link circuits can be used for communication between specific controls on the machine.

Communication between the Transmission/Chassis ECM and between the other control modules on the machine are conducted over the SAE J1939 data link circuit that is connected to each control module. The ECM uses the Cat Data Link to send and to receive information from the Caterpillar Electronic Technician (ET).

A module identifier (MID) is assigned to the Transmission/Chassis ECM. The MID for the Transmission/Chassis ECM is:

Transmission/Chassis ECM – MID 027

Note: The following tables list the circuit connections for the Transmission/Chassis ECM.

Table 5

Transmission/Chassis ECM Connector J1 Contact Descriptions ⁽¹⁾		
No.	Function	Type
1	Key Switch Run	Input
2	Transmission Input Speed Sensor (+)	Speed Sensor
3	Transmission Input Speed Sensor (-)	Speed Sensor
4	Transmission Intermediate Speed Sensor 1 (+)	Speed Sensor
5	Transmission Intermediate Speed Sensor 1 (-)	Speed Sensor
6	Transmission Intermediate Speed Sensor 2(+)	Speed Sensor
7	Transmission Intermediate Speed Sensor 2 (-)	Speed Sensor
10	Cat Data Link (+)	Input/Output
11	+5 Volt Supply	Power Supply
13	Unswitched Battery 1 (-)	System Ground
15	Transmission Output Speed Sensor 1 (+)	Speed Sensor
16	Transmission Output Speed Sensor 1 (-)	Speed Sensor
17	Transmission Output Speed Sensor 2(+)	Speed Sensor
18	Transmission Output Speed Sensor 2 (-)	Speed Sensor

(continued)

(Table 5, contd)

Transmission/Chassis ECM Connector J1 Contact Descriptions⁽¹⁾		
No.	Function	Type
20	Cat Data Link (-)	Input/Output
21	5 Volt Return	ECM Ground
22	Transmission Oil Temperature Sensor	Active Analog Input
23	Unswitched Battery 2 (-)	System Ground
24	Cab AC Switch	Switch to Battery
26	ECM Location 0 (Ground)	Ground
27	ECM Location 1 (Open)	Open
28	ECM Location 2 (Open)	Open
29	Fuel Level Sensor	Active Analog Input
31	Unswitched Battery 1 (-)	System Ground
32	ECM Location Enable (Ground)	Ground
33	Transmission Filter Bypass Switch	STG ⁽²⁾ Input
34	Differential Lock (Normally Open)	STG Input
35	Parking Brake Pressure Switch (Normally Open)	STG Input
36	Service Brake Accum Pressure Sensor	Active Analog Input
37	Steering Valve Signal	Active Analog Input
38	Unswitched Battery 4 (+)	System Power
39	Unswitched Battery 2 (+)	System Power
40	Parking Brake Pressure Switch (Normally Closed)	STG Input
44	+ 8 Volt Supply	Power Supply
45	8 Volt Return	ECM Ground
46	Unswitched Battery 5 (+)	System Power
47	Unswitched Battery 3 (+)	System Power
48	Transmission Solenoid 7	PWM Driver Output
49	Transmission Solenoid 2	PWM Driver Output
50	PWM Driver Return	Solenoid Return
51	Transmission Solenoid 3	PWM Driver Output
52	Transmission Solenoid 4	PWM Driver Output
54	Solenoid Return 1	Solenoid Return
55	Driver Return	Solenoid Return

(Table 5, contd)

Transmission/Chassis ECM Connector J1 Contact Descriptions⁽¹⁾		
No.	Function	Type
56	Unswitched Battery 5 (-)	System Ground
57	Unswitched Battery 3 (-)	System Ground
58	Transmission Solenoid 5	PWM Driver Output
59	Transmission Solenoid 6	PWM Output
60	PWM Driver Return	Solenoid Return
61	Transmission Solenoid 1	PWM Driver Output
62	Transmission Solenoid 8	PWM Driver Output
63	Operator in Seat Switch (Normally Closed)	STG Input
64	Operator in Seat Switch (Normally Open)	STG Input
65	Transmission Pump Bypass Solenoid	PWM Driver Output
66	Fan/Brake Solenoid	PWM Driver Output
67	Secondary Steer Left Solenoid	PWM Driver Output
68	Secondary Steer Right Solenoid	PWM Driver Output
69	+10 Volt Supply	Power Supply
70	Unswitched Battery 4 (-)	System Ground

(1) Contacts that are not listed are not used.

(2) Switch to ground.

Table 6

Transmission/Chassis ECM Connector J2 Contact Descriptions⁽¹⁾		
No.	Function	Type
1	Key Switch - Start	STB ⁽²⁾ Input
2	Secondary Steering Relay	On/Off Output
3	Differential Lock Relay	On/Off Output
4	On/Off Driver Return	ECM Ground
5	Backup Alarm Relay	On/Off Output
6	Parking Brake Solenoid	On/Off Output
7	Starter Motor Relay	On/Off Output
8	On/Off Driver Return	ECM Ground
9	MSS Status LED	Sinking Output
11	Autoshift Enabled Indicator	Sinking Output
14	R - Terminal	R - Terminal

(continued)

(continued)

(Table 6, contd)

Transmission/Chassis ECM Connector J2 Contact Descriptions⁽¹⁾		
No.	Function	Type
15	Left Steer Cylinder Position Sensor	PWM Input
16	Right Steer Cylinder Position Sensor	PWM Input
17	Machine Articulation Angle Sensor 2	PWM Input
18	Steer Control Position Sensor 1	PWM Input
20	AC Clutch Relay	Sinking Output
23	Direction Switch (Forward)	STG ⁽³⁾ Input
25	Secondary Steer Request Signal	PWM Input
26	Transmission Pump Pressure Sensor	PWM Input
28	Direction Switch (Neutral)	STG Input
29	Direction Switch (Reverse)	STG Input
30	Upshift Switch (Normally Open)	STG Input
31	Upshift Switch (Normally Closed)	STG Input
34	Steer Control Position Sensor 3	PWM Input
36	Downshift Switch (Normally Open)	STG Input
37	Downshift Switch (Normally Closed)	STG Input
38	Parking Brake Switch (Off)	STG Input

(Table 6, contd)

Transmission/Chassis ECM Connector J2 Contact Descriptions⁽¹⁾		
No.	Function	Type
39	Parking Brake Switch (On)	STG Input
41	Machine Articulation Angle Sensor	PWM Input
43	Inching Pedal Position Sensor	PWM Input
44	Service Brake Pedal Switch	STG Input
45	Inching Pedal Switch (Normally Closed)	STG Input
46	Inching Pedal Switch (Normally Open)	STG Input
47	Transmission Auto/Manual Switch (Normally Open)	STG Input
48	Steer Control Position Sensor 2	PWM Input
52	Transmission Auto/Manual Switch (Normally Closed)	STG Input
61	Compression Brake Switch (Normally Open)	STG Input
62	Compression Brake Switch (Normally Closed)	STG Input
67	J1939 High	Input/Output
68	J1939 Low	Input/Output
69	J1939 Shield	Input/Output

(1) Contacts that are not listed are not used.

(2) Switch to + battery.

(continued)

(continued)

(Table 6, contd)

(3) Switch to ground.

i06747143

Electrical Output Components

SMCS Code: 1400; 4000

Outputs

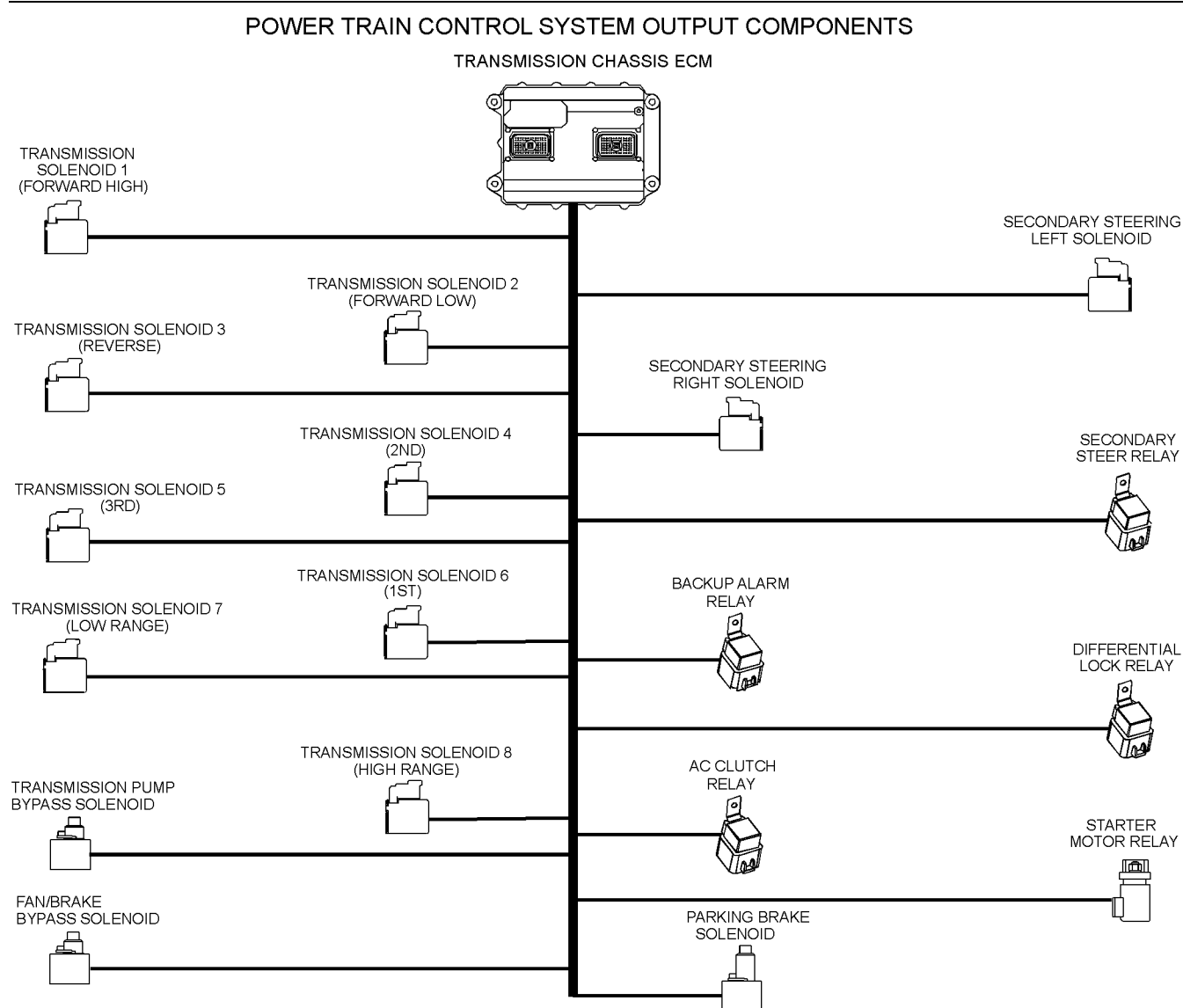


Illustration 56

g01948197

Block diagram of the output components

The Transmission/Chassis ECM will use output circuits to send electrical control signals to the output components. The output signals can create an action or the output signals can provide information to the ECM. The ECM will use different types of output signals to control the system components. Following are the types output signals:

- PWM proportional driver
- ON/OFF driver
- Sinking driver
- Sensor power supply

- Data link

The ECM monitors the circuits of the output components. If the ECM determines that an abnormal condition exists in one of the circuits, the ECM will log a diagnostic code for the involved component.

Backup Alarm Relay

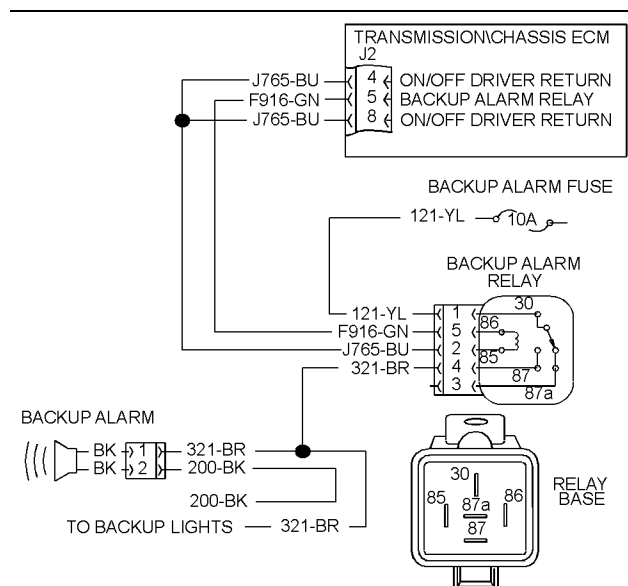


Illustration 57

g01287438

Backup alarm relay output connections

The backup alarm relay is controlled by the Transmission/Chassis ECM through an ON/OFF output driver.

The backup alarm alerts the surrounding personnel that the machine is backing up. Whenever the transmission is shifted to the reverse direction, the ECM will turn on the output driver for the relay to activate the backup alarm.

Differential Lock Relay

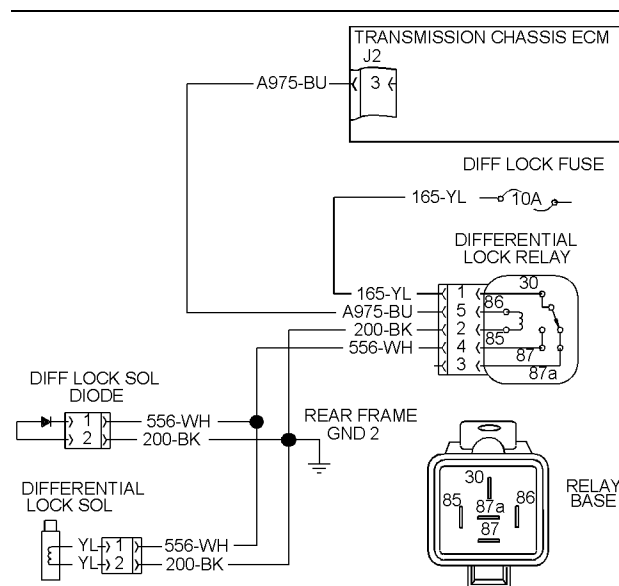


Illustration 58

g01322415

Differential lock relay output connections

The differential lock relay is controlled by the Transmission/Chassis ECM through an ON/OFF output driver. The ECM will activate or deactivate the output when the differential lock operator switch in the cab changes states. This will result in the differential axle being mechanically locked.

When the differential lock switch is pressed by the operator, the ECM will turn ON the ON/OFF output driver for the relay. This allows system power to be directed to the differential lock solenoid through the relay contacts. When the operator presses the differential lock switch again, the ECM will turn off the output for the relay to deactivate the differential lock function.

ECPC Transmission Proportional Solenoid Valves

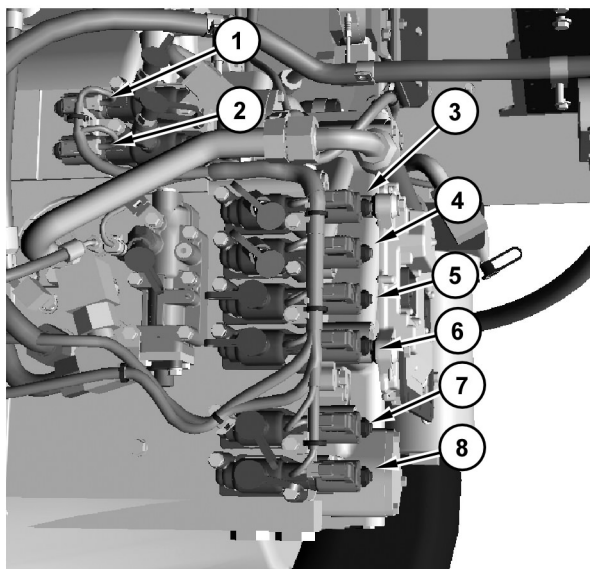


Illustration 59

g01324626

Transmission clutch solenoid valves are on the left side of the transmission.

- (1) Transmission clutch solenoid valve 1 (forward high)
- (2) Transmission clutch solenoid valve 2 (forward low)
- (3) Transmission clutch solenoid valve 3 (reverse)
- (4) Transmission clutch solenoid valve 4 (2nd speed)
- (5) Transmission clutch solenoid valve 5 (3rd speed)
- (6) Transmission clutch solenoid valve 6 (1st speed)
- (7) Transmission clutch solenoid valve 7 (low range)
- (8) Transmission clutch solenoid valve 8 (high range)

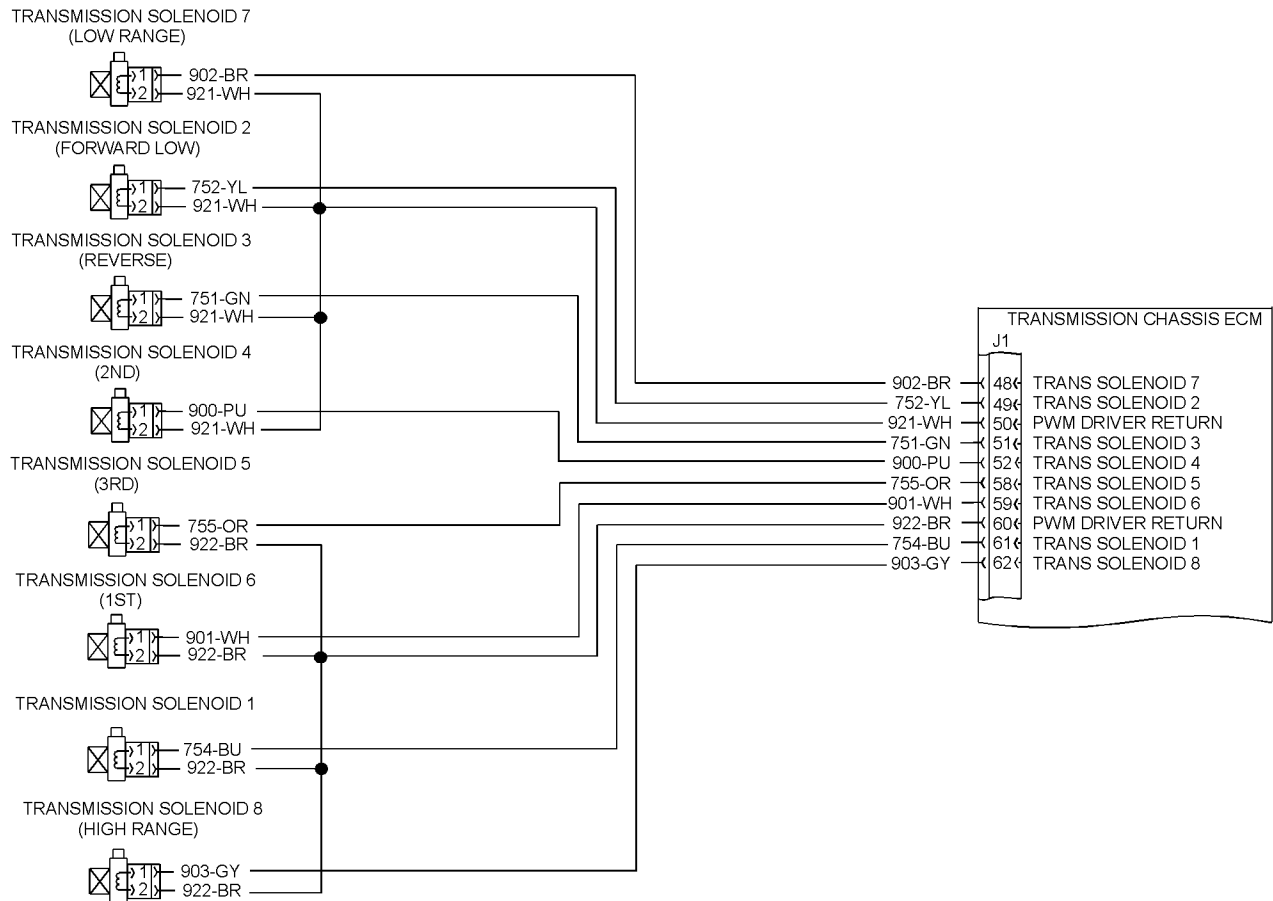


Illustration 60

g01329409

Transmission solenoid output connections

The Transmission/Chassis ECM controls the operation of the “Electronic Clutch Pressure Control” (ECPC) solenoid valves for control of the transmission. The ECM uses eight transmission clutch proportional solenoid valves to shift the transmission. The transmission solenoid valves control the hydraulic circuits that engage the transmission clutch pressures. The ECM supplies electrical current to the appropriate transmission solenoid valves to move the machine in one of the two available speed ranges that enable eight gears in the forward direction and 6 gears in the reverse direction.

On an ECPC controlled transmission, the clutch pressure is modulated electronically. The ECM controls the modulation of clutch pressure by sending a variable output current to the appropriate proportional clutch solenoids. The ECM uses input information from the operator controls, the transmission speed sensors, and the transmission temperature sensor to determine the correct output current to the solenoid valves.

The ECM will output a pulse width modulated (PWM) signal to vary the current to the solenoid. The current to the solenoid determines the amount of pilot oil pressure that is applied to the hydraulic valve spool. The travel of the spool is proportional to the electrical current that is supplied to the solenoid. The position of the valve spool controls the amount of hydraulic oil pressure that is applied to the clutch which will determine the amount of clutch engagement. An increase in the electrical output current of the ECM will result in an increase of the engagement pressure of the clutch.

To control the shifting of the transmission, the Transmission/Chassis ECM will energize two clutch solenoids when the machine is in PARK or NEUTRAL. The ECM will energize different combinations of three clutch solenoids when the machine is in one of the available gears in the forward or the reverse direction. The table below indicates the solenoids that are energized to activate each gear arrangement.

Table 7

Transmission Gear and Solenoid Valve Logic								
	Solenoid 1 (forward high)	Solenoid 2 (forward low)	Solenoid 3 (reverse)	Solenoid 4 (second speed)	Solenoid 5 (third speed)	Solenoid 6 (first speed)	Solenoid 7 (low range)	Solenoid 8 (high range)
Park					X			X
Neutral					X			X
First Speed Forward	X					X	X	
Second Speed Forward		X		X			X	
Third Speed Forward		X			X		X	
Fourth Speed Forward	X				X		X	
Fifth Speed Forward	X					X		X
Sixth Speed Forward		X		X				X
Seventh Speed Forward	X			X				X
Eighth Speed Forward	X				X			X
First Speed Reverse			X			X	X	
Second Speed Reverse			X	X			X	
Third Speed Reverse			X		X		X	
Fourth Speed Reverse			X			X		X
Fifth Speed Reverse			X	X				X
Sixth Speed Reverse			X		X			X

Fan/Brake Bypass Solenoid

The fan/brake pump load sense bypass solenoid allows the Transmission/Chassis ECM to bypass the fan/brake pump load signal straight to the tank.

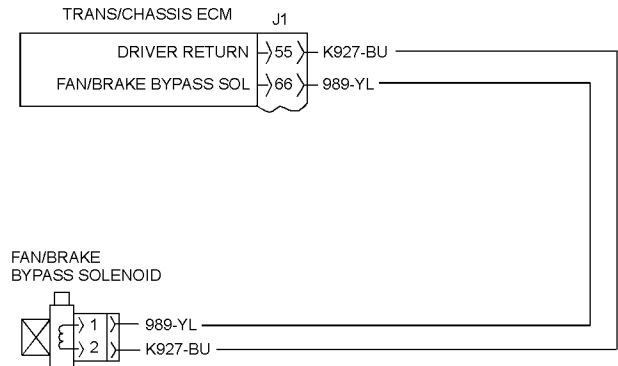


Illustration 61

g01948555

Fan/brake bypass solenoid circuit

Park Brake Solenoid

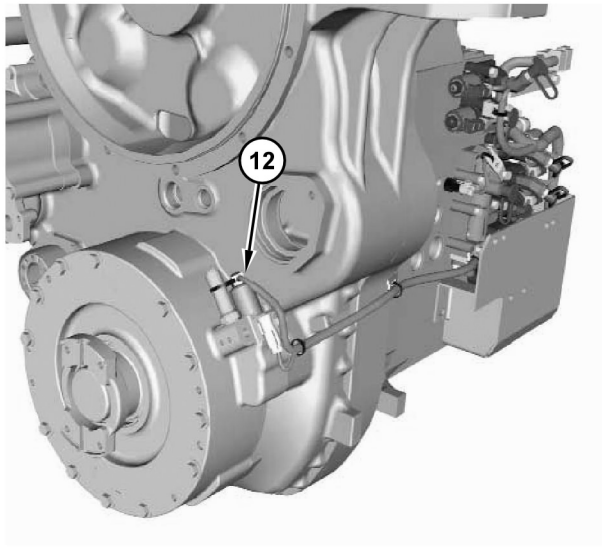


Illustration 62

g01329544

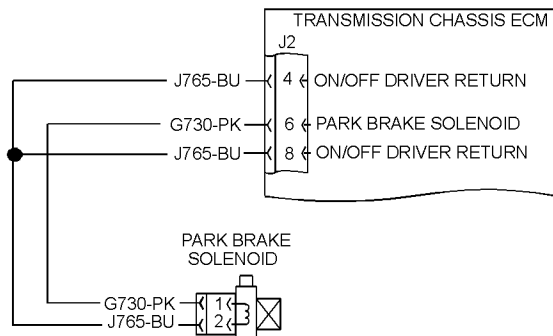


Illustration 63

g01301698

Park brake solenoid connections

The park brake solenoid is controlled by the Transmission/Chassis ECM through an ON/OFF output driver.

The parking brake on the motor graders is spring applied and hydraulically released. When the park brake solenoid is not activated, the parking brake is engaged.

When the Transmission/Chassis ECM receives a disengage input from the park brake switch, the ECM will turn on the ON/OFF output driver to energize the park brake solenoid. This will allow hydraulic oil pressure to disengage the parking brake.

The ECM will not disengage the parking brake unless the following conditions are satisfied:

- The transmission is in the NEUTRAL position.

- The operator is in the seat.

Secondary Steer Proportional Solenoid Valves

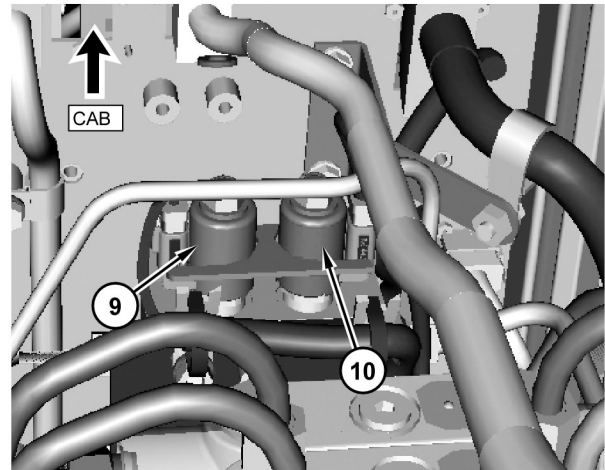


Illustration 64

g01329510

For these machines:

S/N: B921-368; B9H1-UP; R9H1-UP; B9J1-UP; R9J1-UP; B9R1-UP; R9B1-UP; B9F1-UP; B9L1-UP; B9E1-1143; B9M1-UP; B9D1-4762; B9N1-UP; R9A1-UP; B9C1-UP; B9G1-UP; D9G1-1585; B9T1-UP; D9T1-1438; B9W1-UP; R9C1-UP; D9W1-UP

Secondary steer solenoids are located in front of the cab behind the rear valve stack.

- (9) Secondary steer right solenoid
- (10) Secondary steer left solenoid

Secondary Steer Solenoids are on the Steering Valve for these machines:

S/N: B92369-UP; B9E1144-UP; B9D4763-UP; D9G1586-UP; D9T1439-UP

Secondary Steer Relay

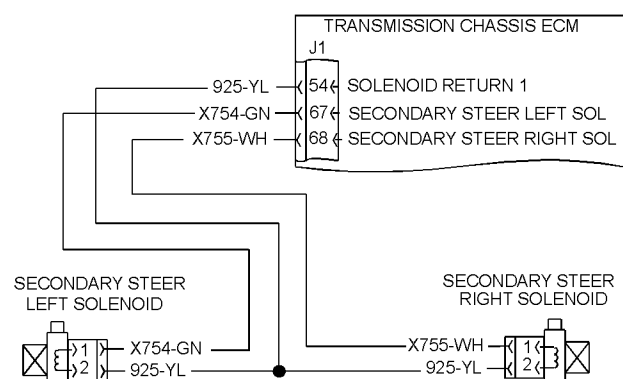


Illustration 65

g01329463

Secondary steer solenoid output connections

When the Transmission/Chassis ECM has activated the secondary steering system and the secondary steering pump is supplying the hydraulic pressure to the system, the Transmission/Chassis ECM will use the proportional secondary steer solenoids to send hydraulic pressure to the steer cylinders. The ECM will output a PWM output signal to energize the secondary steer solenoids. The Transmission/Chassis ECM will vary the amount of electrical current that is sent to the solenoids to control the angle of the front wheels.

When the secondary steer solenoids are energized, pilot hydraulic oil pressure is directed to the same main hydraulic valve that is used for the primary steering system.

The Transmission/Chassis ECM outputs the PWM output signal to the appropriate solenoid based on the steer sensor input signal from the left joystick. Then, the ECM monitors the position of the front steer cylinders to adjust the electrical current to the solenoid accordingly. As the steering cylinders approach and reach the commanded position, the ECM will decrease the output current to the solenoid until movement of the cylinders is stopped. The cycle repeats as steering input from the joystick changes.

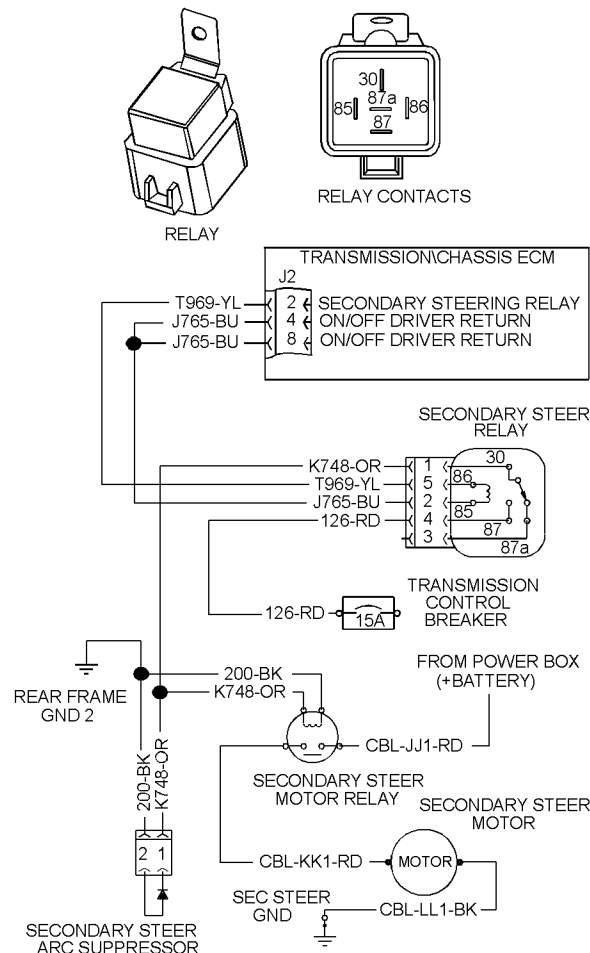


Illustration 66

g01329477

Secondary steer relay output connections

When the Transmission/Chassis ECM receives a secondary steer request from the Implement ECM, the Transmission/Chassis ECM will immediately energize the secondary steer relay. This will allow system power to pass through the relay contacts which will energize the secondary steer motor relay. System power from the power control box will then be supplied to the secondary steering pump motor which turns the secondary steering hydraulic pump. The pump will supply hydraulic pressure and flow to the secondary steering system.

Starter Motor Relay

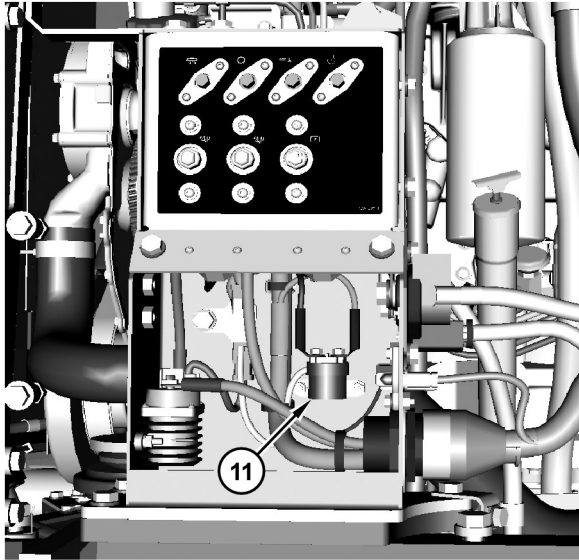


Illustration 67

g01329531

The circuit breaker box is on left side of machine behind the cab.

(11) Start Relay

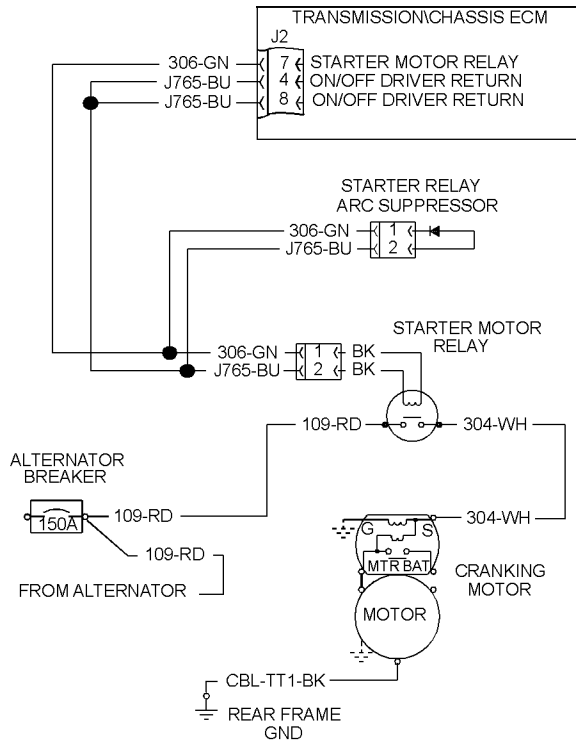


Illustration 68

g01288379

Starter motor relay output connections

The starter motor relay is controlled by the Transmission/Chassis ECM through an ON/OFF output driver.

When the Transmission/Chassis ECM receives a START input from the key start switch, the ECM will turn ON the ON/OFF output driver to activate the starter motor relay provided the following machine conditions are present:

- The parking brake is engaged.
- The transmission is in NEUTRAL.
- The operator is in the seat.

When the ECM activates the starter motor relay, system power is directed to the starter motor through the relay contacts.

Transmission Pump Bypass Solenoid

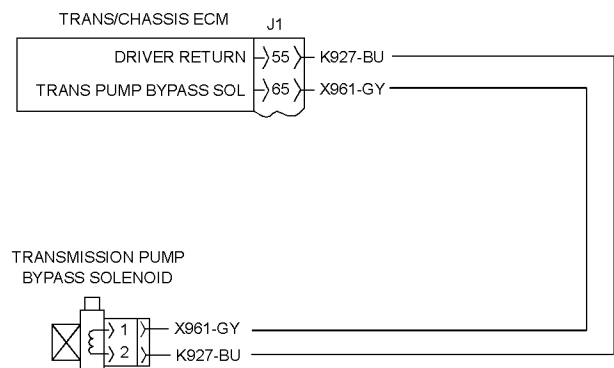


Illustration 69

g01948590

Transmission pump bypass solenoid circuit

The transmission pump bypass solenoid allows the ECM to bypass the transmission pump straight to the tank.

i02913081

Data Link

SMCS Code: 7610-DTN

M SERIES DATA LINK COMMUNICATION SYSTEM

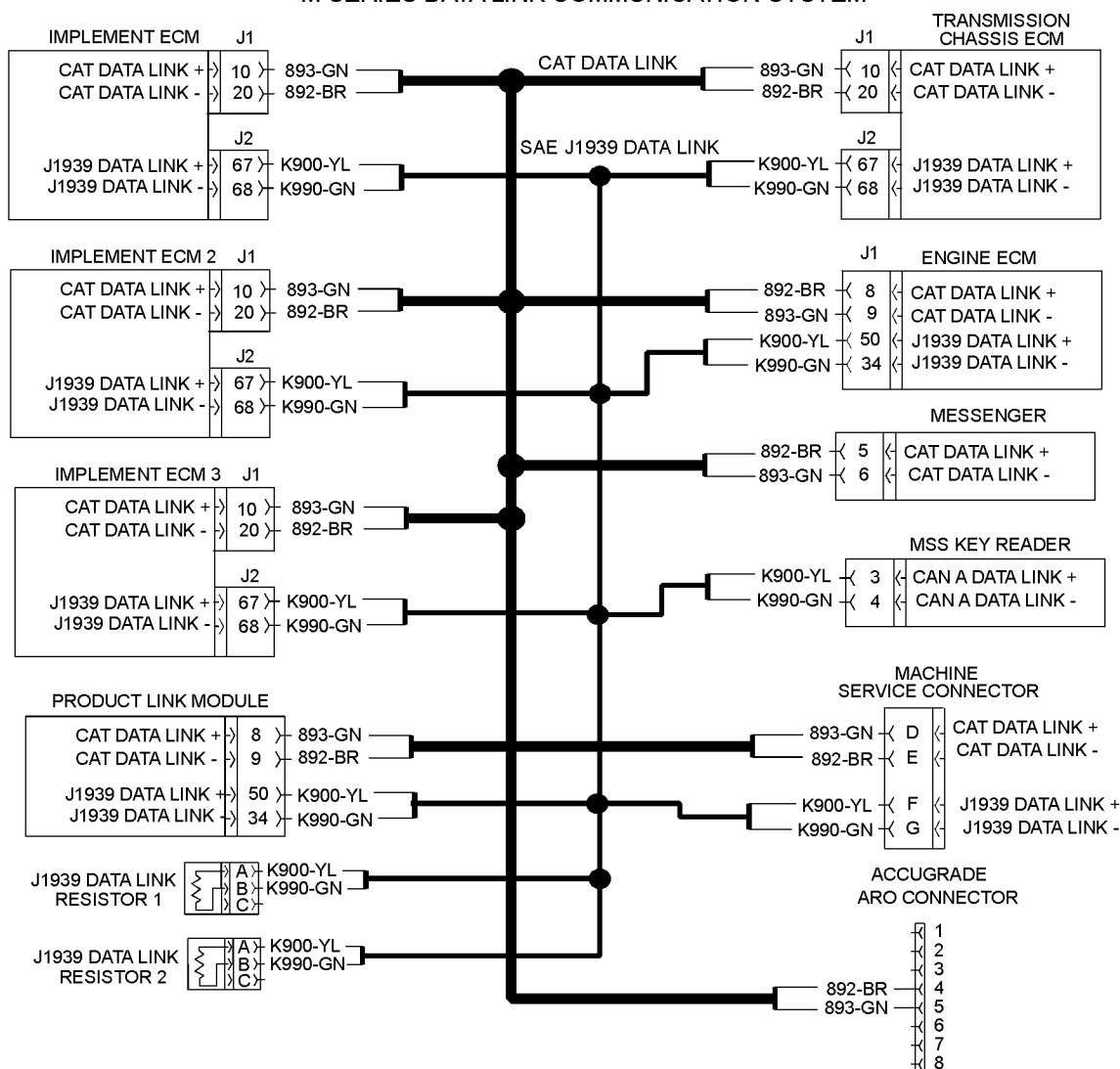


Illustration 70

g01315688

Series M Series Data Link Communication System

The Transmission/Chassis ECM will use two data link systems for communication between the other electronic control modules that are on the machine. The data link systems also allows communication with service tools.

The data link is bidirectional. The Transmission/Chassis ECM can send information and the Transmission/Chassis ECM can receive information. The data link is not a visible component. The data link consists of internal ECM circuits, the related harness wiring, and the harness connectors.

The Transmission/Chassis ECM communicates over the two data link communication systems that are present on the machine. The two types of systems are listed below.

Cat Data Link – The Cat Data Link is used to send system status information between control modules and the Caterpillar Electronic Technician (ET). All implement system diagnostic codes are activated using the Cat Data Link.

SAE J1939 Data Link – The SAE J1939 Data Link is a high speed data link system. The J1939 Data Link

is used for high speed system operation communication between the controls of the ECM and the control modules of other machine systems.

In the event of a failure of the SAE J1939 Data Link system, the Cat Data Link is used as a backup system for operational communication.

Data Link Diagnostics

Both of the data link systems on the machine are monitored by the Transmission/Chassis ECM for abnormal internal or external circuit conditions. The ECM will activate diagnostic codes for a specific control module and the data link circuit when an abnormal condition is detected.

When the Transmission/Chassis ECM detects an abnormal condition in a data link circuit, the ECM will activate a “companion” diagnostic code along with the diagnostic code for the involved control module in order to alert the technician to which data link system is involved. The companion diagnostic codes for the implement system are listed below:

CID 0247 - FMI 09 or FMI 14 – SAE J1939 Data Link

CID 0248 - FMI 09 or FMI 14 – Cat Data Link

An example of how the companion diagnostic codes are used by the Transmission/Chassis ECM for the data link circuits:

The Transmission/Chassis ECM is communicating with the Implement ECM over the SAE J1939 Data Link circuit, however, some expected data is not being communicated. The Transmission/Chassis ECM will activate the CID 0596 FMI 14 diagnostic code (Special Instruction - not receiving expected information) for the Implement ECM. The Transmission/Chassis ECM will also activate the CID 0247 - FMI 14 companion diagnostic code (SAE J1939 Data Link) in order to indicate the data link circuit that is involved. The companion diagnostic code will clear after the primary diagnostic code is cleared.

A CID 0247 or a CID 0248 companion diagnostic code will always be activated when any of the following module communication codes is activated by the Transmission/Chassis ECM.

CID 0588 FMI 09 – Monitoring System

CID 0596 FMI 09 – Implement ECM

CID 0590 – Engine ECM

Troubleshooting Section

Introduction

i02913110

General Information

SMCS Code: 4800

The diagnostics for the Transmission/Chassis ECM Electronic Power Train Control System can be accessed through the Messenger or through the Caterpillar Electronic Technician (Cat ET). Troubleshooting the system requires additional information from the Service Manual for the machine. The following list of references should be used to troubleshoot the systems of the machine:

Table 8

Related Service Manuals	
Title	Form Number
Series M Series Motor Grader Service Manual	REN9030
14M Implement Electronic Control System	REN9013
14M Implement and Steering Hydraulic System	REN8484
Motor Graders Monitoring System	REN9034
Additional References	
14M Electrical System Schematic	REN9023
14M Hydraulic System Schematic	REN9028
Accugrade GPS System For Motor Graders	SEBU8003
Accugrade Laser System For Motor Graders	SEBU8276

As a reference, a simplified Transmission/Chassis ECM electrical system schematic is included at the end of this manual. For a complete representation of the machine that is being diagnosed, refer to the Electrical System Schematic in the Service Manual of the machine.

When the troubleshooting procedure instructs you to "REPAIR THE HARNESS OR REPLACE THE HARNESS", use the Electrical System Schematic in the Service Manual of the machine to trace the circuit. Perform resistance checks at the harness connectors in order to locate harness failures. Always check the ground circuit at the machine harness connector for the components. Less than five ohms of resistance is required between the ground contacts of the connector and the frame ground. Excessive ground resistance that is greater than five ohms can cause an incorrect diagnosis of the system.

During troubleshooting, inspect all harness connections before any component is replaced. If these connections are not clean and tight, permanent electrical problems or intermittent electrical problems can result. Check that the wires are pushed into the connectors completely. Make sure that the connections are tight before other tests are made.

Failure of an electrical component can cause the failure of other components. Always attempt to correct the cause of an electrical system failure before you replace a component. If wire insulation is punctured during troubleshooting, repair the damage. Seal the damaged wires with 8T-0065 RTV Silicone Sealant. Cover the sealant with two layers of 1P-0810 Electrical Tape.

ECM Pull Up Voltage

In order to aid in the diagnostics of certain types of electrical circuits, that are controlled by the ECM, an internal "pullup voltage" is connected to the switch of the ECM and the sensor signal input contacts. An above normal voltage is internally connected to the signal input of the ECM through a resistor.

During normal operation, the switch or sensor signal will hold the circuit low or at a certain signal amplitude, however, circuit conditions such as a loss of power to the component, a disconnection or an open circuit will allow the circuit to be pulled high by the ECM pull up voltage. This will result in an above normal voltage reading at the contact of the ECM. As a result, the ECM will activate an FMI 03 (voltage above normal) diagnostic code for the affected circuit.

The types of input circuits of the ECM that have a pull up voltage present are listed below:

- Pulse Width Modulated (PWM) sensor input circuits
- Switch to ground switch input circuits
- Active analog (voltage) input signal circuits
- Passive analog (resistance) input signal circuits

The ECM pull up voltage should always be considered when troubleshooting one of the circuit types that are listed.

ECM Pull Down Voltage

In order to aid in the diagnostics of electrical circuits that are controlled by the ECM, an internal "pull down voltage" is connected to the ECM switch-to-battery type input circuits.

During normal operation, the switch contacts that are allowing the connection to a voltage source will hold the circuit high. The circuit will be pulled low by the pull down voltage of the ECM when there is a loss of power to the supply voltage of the switch, a disconnection in the switch circuit or an open circuit. This will result in a below normal voltage reading at the contact of the ECM. As a result, the ECM will activate an FMI 04 (voltage below normal) diagnostic code for the affected circuit.

The pull down voltage of the ECM should always be considered when troubleshooting a switch-to-battery type of input circuit.

Cab Relay Locations

Note: The following relay locations for cab mounted relays are correct at the time of publication of this manual. The location of the relays on some early model machines may be slightly different. When servicing a particular relay, always refer to the complete Electrical System Schematic of the machine in order to verify the wire numbers of the relay that is being serviced.

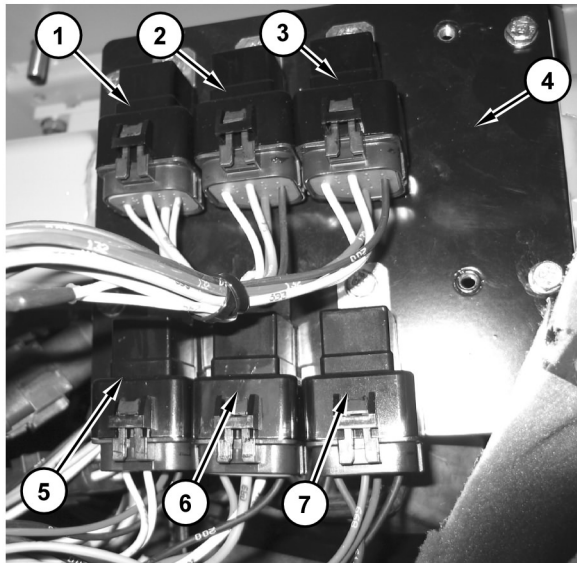


Illustration 71 g01379724

Relays that are located behind the cover on the right side headliner

- (1) Power air cleaner relay
- (2) Cab floodlights relay
- (3) Backlight relay
- (4) Mounting location of attachment heated mirror relay when installed
- (5) Blade flood relay
- (6) Condenser fan relay 2
- (7) Condenser fan relay

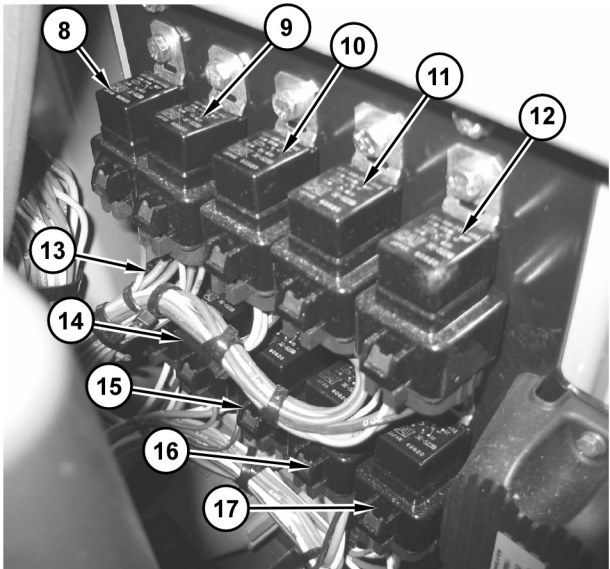


Illustration 72 g01379730

Relays that are located on the rear wall of the cab behind the right hand console

- (8) Horn relay
- (9) L. H. position relay
- (10) Diff lock relay
- (11) Headlamp relay
- (12) Blade flood relay
- (13) Enable relay
- (14) R.H. position relay
- (15) Dimmer relay
- (16) Rear flood relay
- (17) Fast speed relay

i02627448

Service Tools

SMCS Code: 0785

The following service tools can be used to aid in troubleshooting the electrical system.

Table 9

Service Tools	
Part Number	Part
	Caterpillar Electronic Technician (Cat ET)
6V - 7070 9U - 7330	Digital Multimeter
8T - 3224	Needle Tip Group
7X - 1710	Multimeter Probe Group
8T - 8726	Adapter Cable Assembly
151 - 6320	Removal Tool
9U - 7246	Connector Repair Kit DT
4C - 3406	Connector Repair Kit
4C - 8195	Control Service Tool (Switch Box)

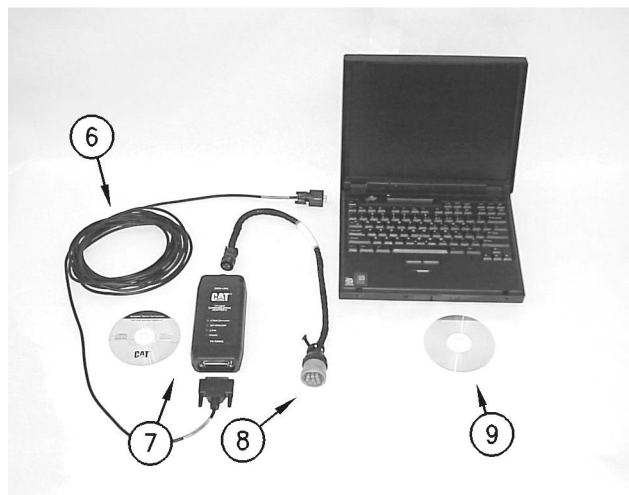


Illustration 73

g00774942

Connections for the Communication Adapter II and the Caterpillar Electronic Technician (ET)

The components that are needed in order to use the Communication Adapter II and the Caterpillar Electronic Technician (ET) in order to determine diagnostic codes are listed:

- (6) Cable
- (7) 171-4400 Communication Adapter II
- (8) Service diagnostic cable.
- (9) Current version of Cat ET software and an IBM-COMPATIBLE personal computer

Reference: See Special Publication, NEHS0758, "Communications Adapter II User's Manual Contains Software".

Note: Caterpillar Electronic Technician (ET) is a software program that can be used on an IBM compatible personal computer.

In order to use the Cat ET, order the following materials: Special Publication, JERD2124, "ET Single Use Program License", Special Publication, JEHP1026, "Information and Requirements Sheet", 7X-1425 Data Link Cable and the Data Subscription and Special Publication, JERD2142, "Data Subscription". The Special Publication, JEHP1026, "Information and Requirements Sheet" lists the required hardware and the features of the Cat ET.

The Cat ET is not required in order to determine the diagnostic codes and the Cat ET is not required in order to clear the diagnostic codes. However, the process of determining the diagnostic codes is easier and faster by using the Cat ET. The Cat ET can also display information on the history of a diagnostic code and the parameter status of diagnostic codes. These features allow the Cat ET to be a useful tool for troubleshooting.

The Cat ET is used to communicate to the electronic control module over the data link by connecting to the machine diagnostic connector. For more information and the locations of the connectors, see Troubleshooting, "Electrical Components and Connector Locations" and the Electrical System Schematic in your machine's Service Manual.

For instructions on servicing Sure Seal connectors, see Special Instruction, SMHS7531. For instructions on servicing Deutsch connectors, see Special Instruction, SEHS9615.

Use the digital multimeter for measuring resistance or for measuring voltage. For instructions about the use of the 6V-7070 Digital Multimeter, see Special Instruction, SEHS7734. The 7X-1710 Multimeter Probes are used to measure the voltage at the connectors without disconnecting the connectors. The probe ends are pushed into the back of the connector along the wire. The 151-6320 Removal Tool is used to remove a wire and socket or pin from the connector body. The 8T-8726 Adapter Cable has a breakout with 3 pins. The adapter cable is used for measurements in the sensor circuits.

Note: Except for harness tests, using continuity testers such as the 8T-0500 Continuity Tester or voltage testers such as the 5P-7277 Voltage Tester is not recommended for today's Caterpillar electrical circuits.

i02913154

Connector Locations

SMCS Code: 7553-546-WW

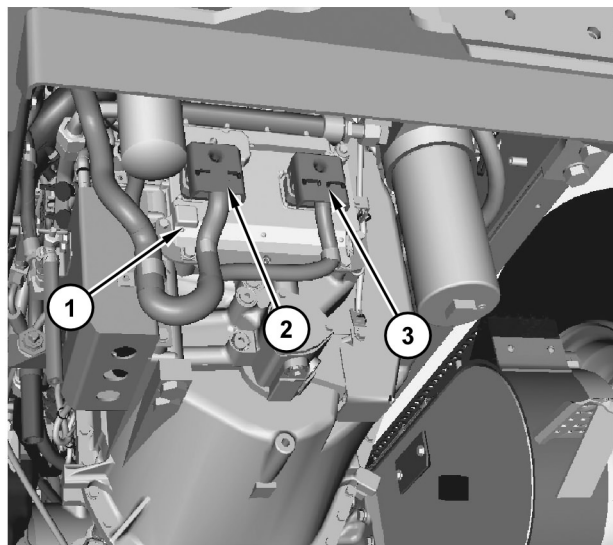


Illustration 74

g01324226

Transmission/Chassis ECM located on the rear of the transmission

- (1) Transmission/Chassis ECM
- (2) J1 Connector
- (3) J2 Connector

The Transmission/Chassis ECM is mounted on the rear of the transmission. The machine service connector for the Cat ET connection is located in the cab on the left side of the operators seat.

When a procedure requires that the machine's electrical system should be turned OFF, move the key start keyswitch to the OFF position and move the electrical disconnect switch to the OFF position.

In order to locate machine wiring harness connectors on the machine, the Electrical System Schematic, Parts Manual and Operation and Maintenance Manual for the machine that is being serviced should be used.

The following information is a guide to reading the tables for the component location on the back of the Electrical System Schematic.

- The "Component Location" table uses white circles or light gray circles in order to mark the locations in the profile of the machine and in the area views. Alphabetical letters in the "Machine Location" column indicate a general area of the machine. Refer to the corresponding footnote at the end of the table for a description of the location.
- The "Harness Connector Location" table uses white circles or light gray circles in order to mark the locations in the general view and in the area views. Alphabetical letters in the "Machine Location" column indicate a general area of the machine. Refer to the corresponding footnote at the end of the table for a description of the location.

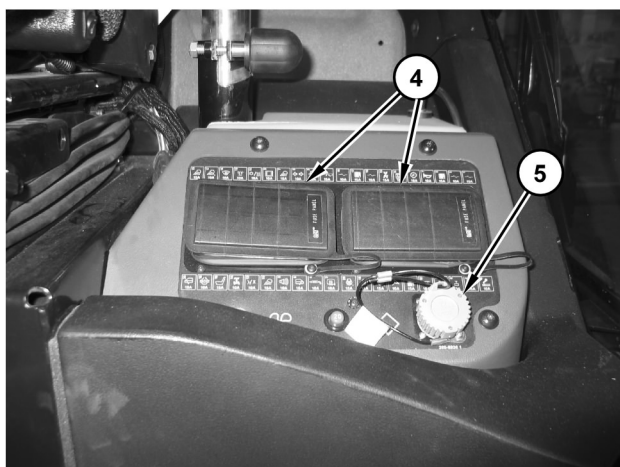


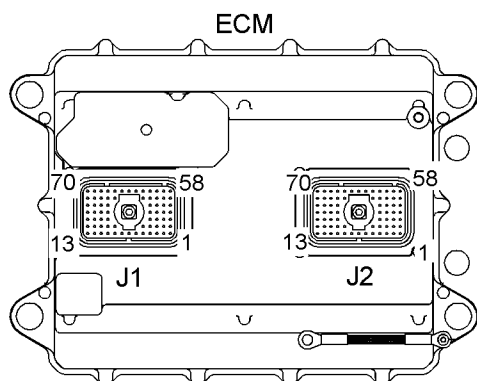
Illustration 75

g01317147

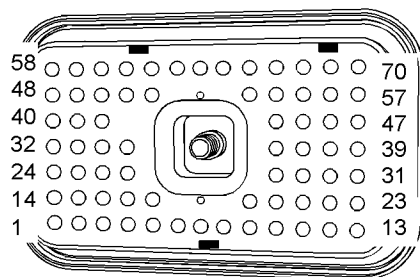
Fuse Panels and Service Connector on the left side of the operator seat

- (4) Fuse panels
- (5) Service Connector

ECM Connector Contact Numbers

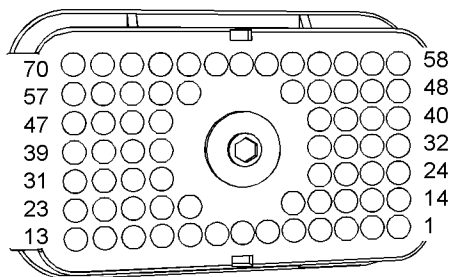


J1 AND J2 ECM CONNECTOR CONTACTS



ECM SIDE

(SHOWN RIGHT SIDE UP, ROTATED RIGHT)



HARNESS SIDE

(SHOWN IN INSTALLED POSITION)

Illustration 76

g01309473

ECM Connectors and Contacts

The J1 and the J2 connectors on the ECM are 70 pin connectors. The two connectors contacts are numbered identically.

i04282649

Diagnostic Capabilities

SMCS Code: 4800

The diagnostic information for the Power Train Electronic Control System can be accessed by the technician using the Caterpillar Electronic Technician Service Tool or by using the Messenger display.

The Cat Electronic Technician (Cat ET)



Illustration 77

g01277712

Connections for the Cat Electronic Technician (Cat ET)

Cat Electronic Technician is software that is used to access, monitor and sometimes change the data that an ECM uses to control a machine system. The service technician can use the Cat ET in order to perform maintenance on the machine. Some of the options that are available with the Caterpillar Electronic Technician are listed below:

- View the active diagnostic codes and logged diagnostic codes. See Troubleshooting, "Using the Caterpillar Electronic Technician to Determine Diagnostic Codes".
- Viewing the active event codes and logged event codes
- View the status of parameters.
- Clear active diagnostic codes and clear logged diagnostic codes
- Perform calibrations of machine systems.
- Program the ECM (Flash) using the "WINflash" program. See Testing and Adjusting, "Electronic Control Module (ECM) - Flash Program".
- Print reports.

The following list contains some of the diagnostic functions and programming functions that are performed by the service tools.

- The failures of the ECM system are displayed.
- The status of most of the inputs and the outputs are displayed.
- The settings for the ECM are displayed.
- Display the status of the input and output parameters in real time.

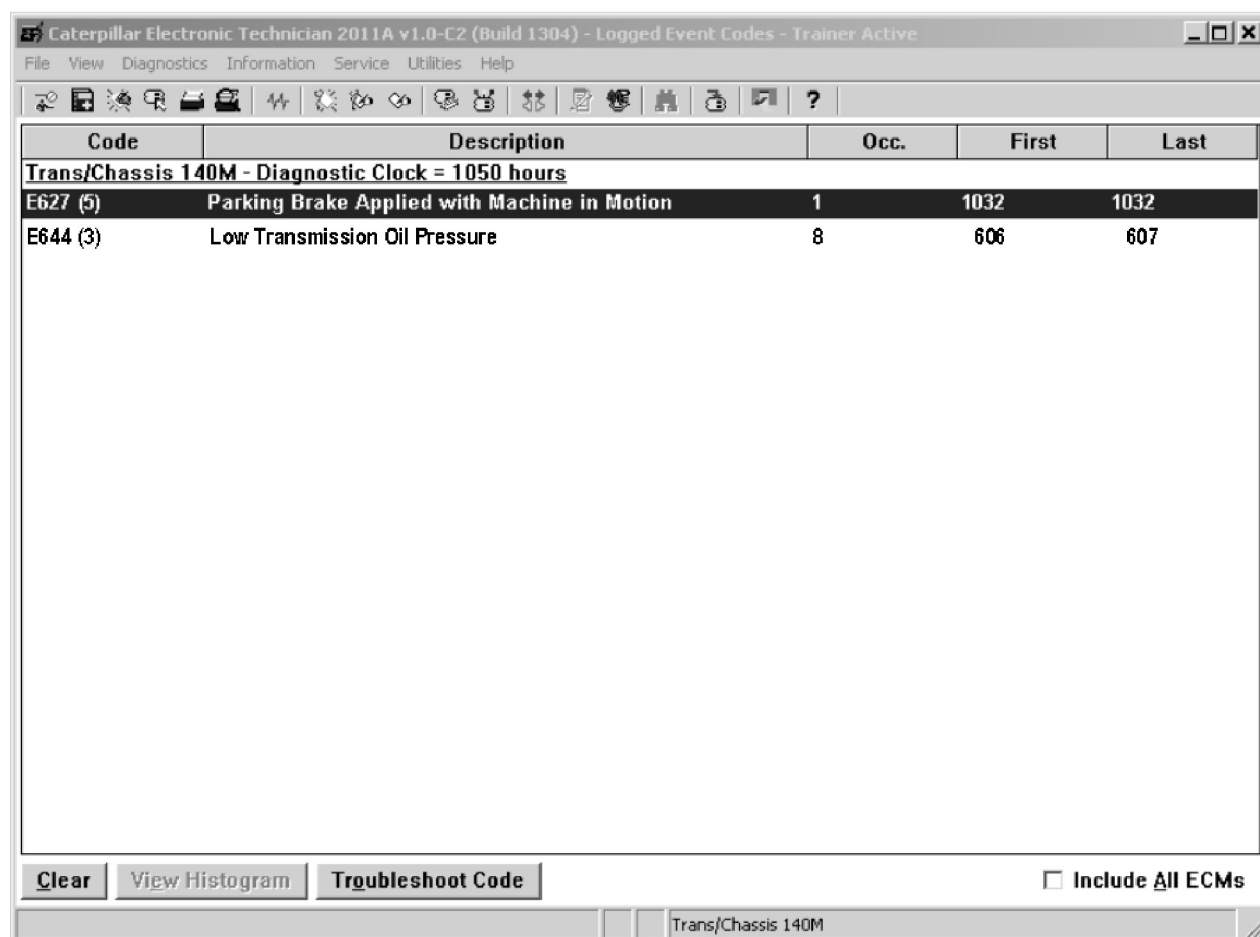
- Display the clock hour of the internal diagnostic clock.
- The number of occurrences and the clock hour of the first occurrence and the last occurrence is displayed for each logged diagnostic code.
- The definition for each logged diagnostic code and each event is displayed.
- Load new FLASH software.

See Troubleshooting, “Diagnostic Code List” for the list of diagnostic codes for the ECM.

- Active diagnostic codes
- Logged diagnostic codes

Event Codes

Logged Event Codes



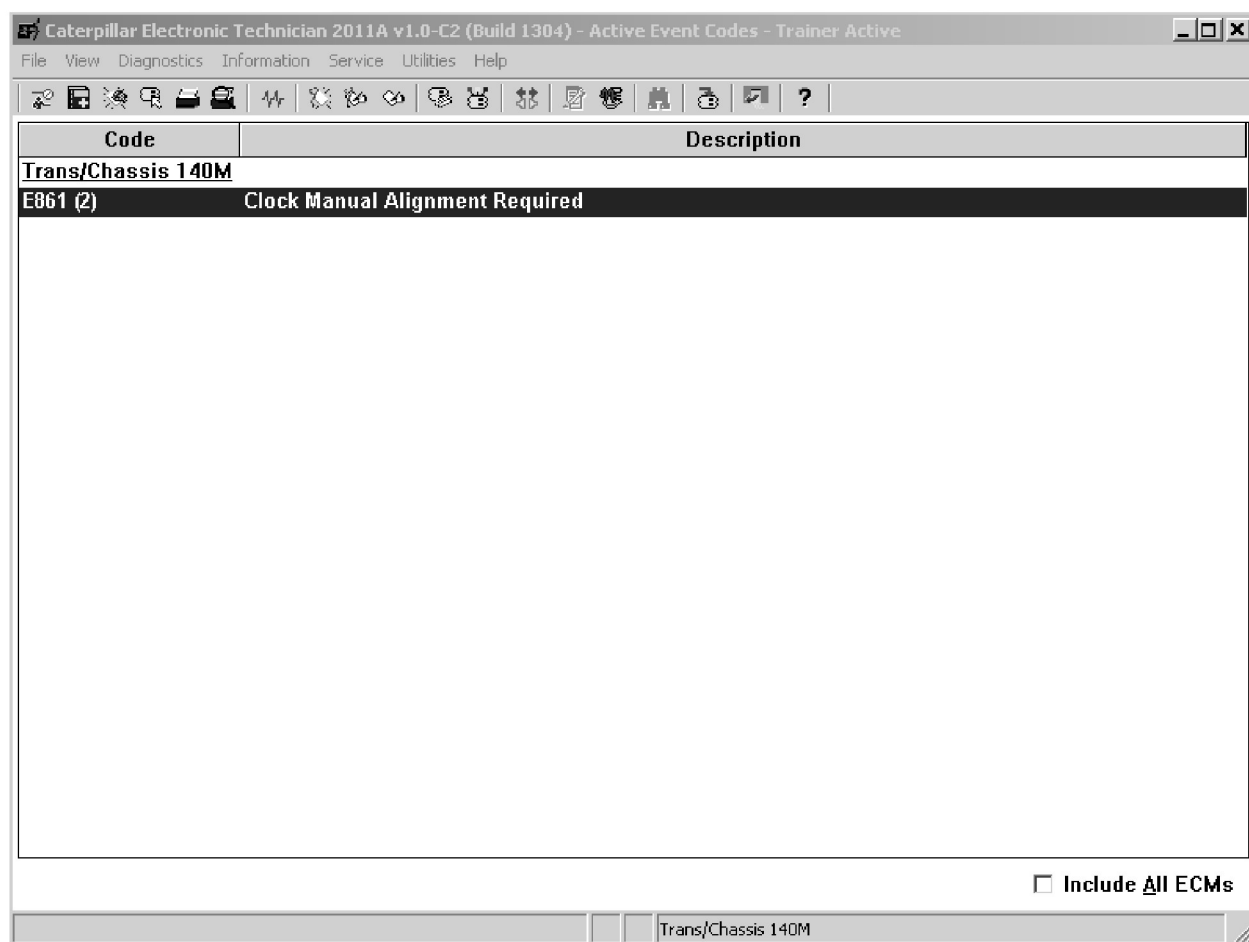


Illustration 79

g02449637

Typical Cat ET screen for active event codes

An indicator for logged events is provided. The indicator allows the service technician to track event codes that are intermittent. The data for the logged event will include the following information:

- An event identifier (EID)
- A text description of the problem
- The number of occurrences of the problem
- A time stamp will display the first occurrence of the problem.
- A time stamp will display the last occurrence of the problem.

Status Groups For The Electronic Technician

The Status groups are lists of machine parameters. The status of the parameters is shown in real time.

Caterpillar Electronic Technician 2010B v1.0-B4 (Build 1210) - Status

File View Diagnostics Information Service Utilities Help

Monitor 140M2

- Charge System
- Float Indicators
- Status Group #3
- Engine Information
- Implement System
- Primary Steering
- Parking Brake
- Transmission Information
- Brake System
- Secondary Steering
- Operator
- System Warnings
- Gauges
- Display Indicators

C9 140M2 (MME00074)

- General Data
- Fuel Delivery
- Engine Temperatures
- Engine Pressures
- Engine Starting
- Engine Starting - II
- Air Filter Restrictions

Description	Value	Unit	Min	Max	ECM
Charging System Warning Indicator Status	Off				Monitor 140M2
System Voltage	26.1	Volts	26.1	26.1	Monitor 140M2
System Voltage Status	OK				Monitor 140M2
Action Lamp	Off				Monitor 140M2
Action Alarm	Off				Monitor 140M2
Engine Speed (J)	0	RPM	0	0	C9 140M2 (MME00074)
Alternator Status	OK				Trans/Chas: 140M2

Groups... Full Screen Zoom In Hold

Active Codes [4] Active Events [0] Status Flags [2]

Charge System Monitor 140M2

Illustration 80

g02138890

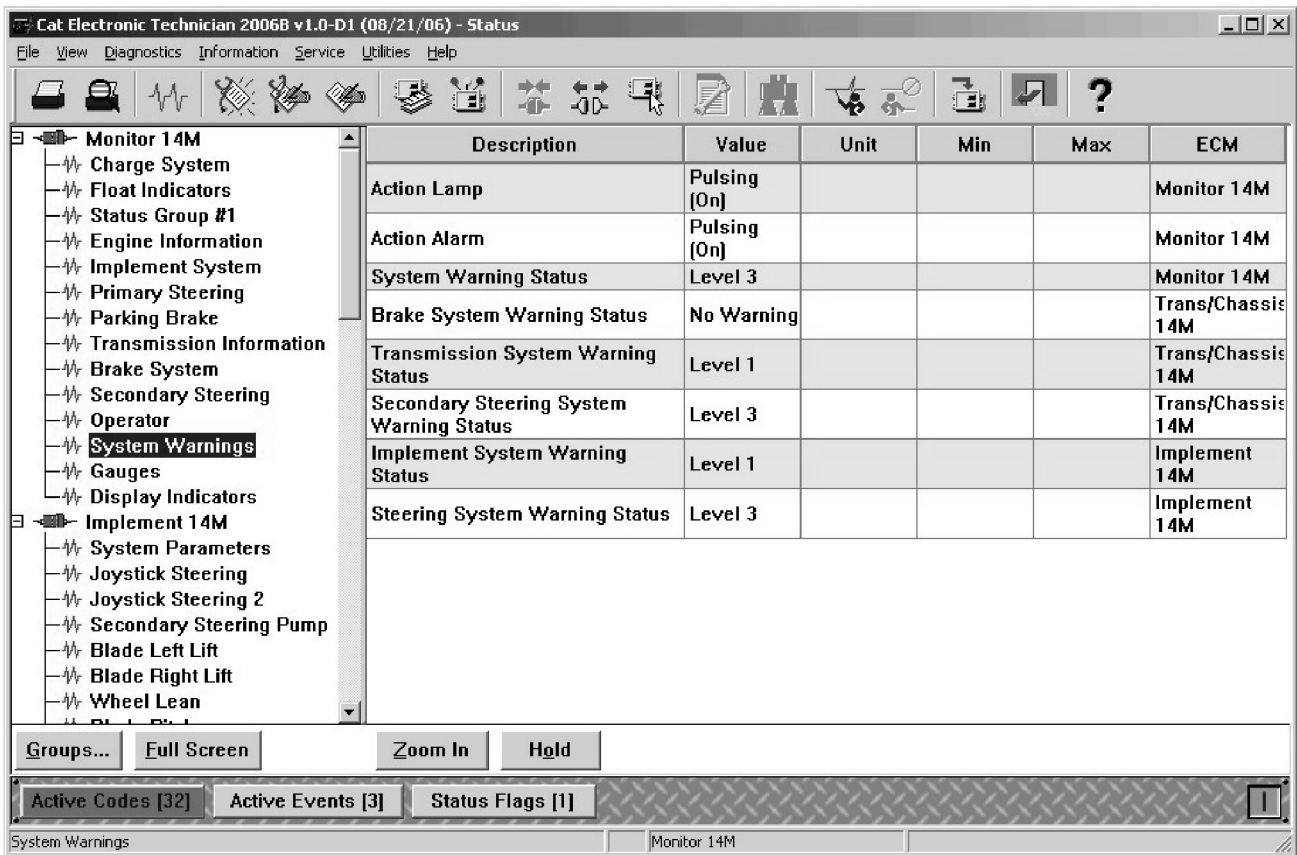


Illustration 81

g01308958

Typical ET Status Screen

Messenger

The Messenger display is located on the right console of the cab. The Messenger monitors the operation of the machine.

The Messenger allows the technician to access the following diagnostic information:

- View Logged Events and Diagnostic Codes.
- View Active Events and Diagnostic Codes.
- View the status of system components.
- View the system parameters.

Some warnings will generate a detailed message that will appear on the Messenger display.

Accessing Diagnostic Codes With The Messenger

Perform the following steps in order to view the active diagnostic codes and the logged diagnostic codes:

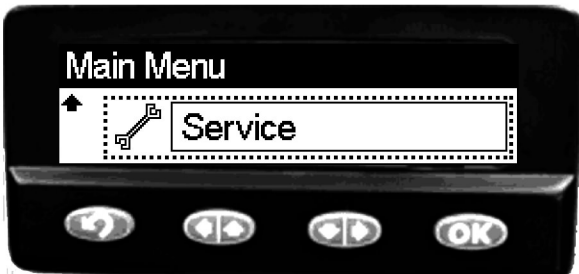


Illustration 82

g02352535

Messenger Main Menu

1. From the Messenger Main Menu page, scroll to "Service" menu and press the "OK" button.



Illustration 83 g02352538

Messenger Service Menu

- From the Messenger Service Menu page, the first option in the service menu will be "Diagnostics/Events". Press "OK" in order to view the list of Active codes and Logged codes.

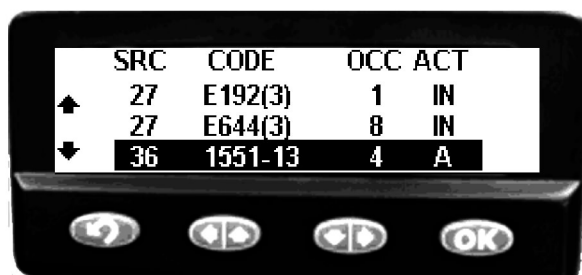


Illustration 84 g02352533

The Messenger Diagnostics/Events List screen

- The Messenger Diagnostics/Events List screen shows the following:

SRC – Source

CODE – MID, CID, FMI, EID and WCI

OCC – The number of occurrences of the codes

ACT – The fact that the code is active

Pressing "OK" on any of these codes will display the Diagnostic/Event screen.

Note: If the code is Active, there will be an "A" in the "ACT" column.



Illustration 85 g02352539

The Messenger Diagnostic/Event Detail screen

The Messenger Diagnostic/Event Detail screen will display the following:

- Source of the failure
- Code CID, FMI, EID and WCI
- Text description of failed component
- Text description of the type of failure

Symptom Troubleshooting

i07793150

Symptom Troubleshooting

SMCS Code: 3000-035; 7000-035

Use the following guidelines when troubleshooting a symptom.

Know the Machine

Understand the operation of the machine. Know if the symptom is a characteristic of normal operation or if the symptom is a failure.

Read the Systems Operation information to understand the systems of the machine. Understand the interaction of the machine systems.

Understand the Symptom

Speak with the operator about the symptom. Inspect the machine and look for problems. Notice any unusual odors in the air. Listen for unusual noises. Acquire the following Information:

- The performance of the machine prior to the failure.
- First occurrence of the symptom.
- The operating conditions at the time of the failure.
- The sequence of events prior to the failure (order of the occurrences).
- The troubleshooting steps that have been taken.
- The history of repairs of the machine.
- The preventive maintenance of the machine.
- Related service information about current problems that affect the serial number of the machine.

Perform the "Visual Inspection" steps.

Verify the Symptom

When possible, attempt to duplicate the symptom. Operate the machine and repeat the conditions that caused the failure. Check the gauges inside the cab. Notice any unusual odors in the air. Listen for unusual noises.

Determine if the ECM has detected any faults. A diagnostic code is used to specify each detected fault.

Determine Possible Causes

Use the information from the operator and your inspection. Attempt to identify a common cause if there is more than one symptom.

If the problem is not resolved after troubleshooting the diagnostic codes, continue troubleshooting using the "Symptom Troubleshooting" section of this manual. Identify the component that is the most probable cause of the symptom.

Test and Repair the System

Use the tests and procedures in this manual to verify the cause of the symptom. Once the cause has been identified, repair the failure. Test the system again to verify that the symptom is resolved.

Provide Feedback to Caterpillar

Share your troubleshooting information with Caterpillar. Use the form in "SIS" or "CBT" feedback to write a brief description about the symptom, testing, and repair. Include your phone number or e-mail address so that you can be contacted. This feedback information helps Caterpillar improve service information.

i03699320

Emerging Symptom Information

SMCS Code: 3000-035; 7000-035

This space is for new symptom information for this product.

Note: Use the Service Information System on the web in order to find the most up-to-date information.

Share your troubleshooting knowledge of symptoms. Please use the feedback form in "SIS" or "CBT" to write a brief description about the symptom, testing and repair of the machine. Your feedback information will help Caterpillar improve the symptom information for this product.

i02651913

Indicator Lamp Does Not Illuminate

SMCS Code: 7400-035-IND

System Operation Description:

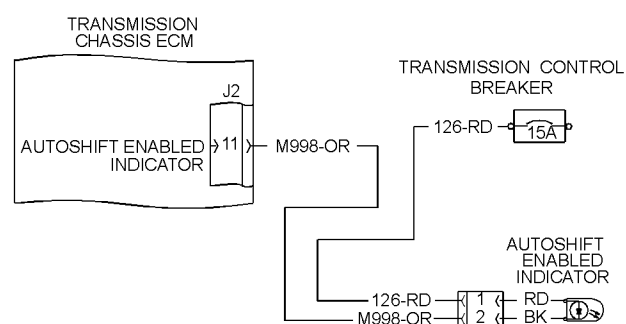


Illustration 86

g01331347

Autoshift Enabled LED Indicator connections

The autoshift enabled LED indicator is controlled by the Transmission Chassis ECM. The LED circuit is not monitored by the ECM for diagnostics.

System power for the LED is supplied by the 15 amp transmission control breaker. The indicator circuit is connected to an ECM sinking output. When the ECM activates the transmission autoshift mode, the ECM will turn ON the sinking output. This allows a path to ground for the power circuit through the LED which will cause the LED to illuminate.

Conditions that could cause an LED indicator to be OFF when the autoshift mode is activated are listed:

- The transmission control breaker is open.
- The power supply circuit is open or has a poor connection
- The sinking LED circuit is open or has a poor connection
- The LED has failed.
- The ECM has failed. This is not likely

When the transmission autoshift mode is active and the LED indicator is OFF, perform the following troubleshooting procedure.

Note: Verify that the autoshift mode is active and the LED should be ON before performing this procedure.

Test Step 1. CHECK THE POWER BREAKER CIRCUIT FOR AN OPEN

Note: Verify that the transmission control breaker is not open, however, it is unlikely that the transmission control breaker would be open. If the transmission control breaker is open, the Transmission Chassis ECM will not function. The transmission control breaker also supplies system power to the Implement ECM.

- Turn the disconnect switch and the key start switch to the ON position.
- Check the transmission control breaker at the power box. If the breaker is open, reset the breaker. If the breaker is not open, proceed to the next step.
- At the machine harness connector for the LED, measure the voltage between contact 1 (wire 126-RD(Red)) and a good frame ground contact.

Expected Result:

The voltage measurement is between 18.0 VDC and 32.0 VDC.

Results:

- OK – The voltage measurement is between 18.0 VDC and 32.0 VDC. The voltage at the LED is correct. Proceed to Test Step 2.
- NOT OK – The voltage measurement is less than 18.0 VDC. The voltage measurement indicates that there is an open or a bad connection in the power circuit in the machine harness.

Repair: There is an open or a bad connection in the LED power supply circuit in the machine harness.

Refer to the complete machine Electrical System Schematic. Check all of the connectors that are in power supply circuit. Ensure that all connections are clean, secure and in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE LED, THE ECM AND THE CIRCUIT

Turn the disconnect switch and the key start switch to the OFF position.

- A.** At the machine harness connector J2 for the ECM, use a 151 - 6320 Removal Tool to remove the autoshift enabled LED indicator circuit (wire M998-OR(Orange)) and socket at contact J2-11 from the ECM connector. The J2 connector remains connected to the ECM.
- B.** Connect one end of a jumper wire to the disconnected LED circuit wire M998-OR(Orange). Connect the other end of the jumper wire to a good frame ground contact.
- C.** Turn the disconnect switch and the key start switch to the ON position.

Expected Result:

The LED indicator is illuminated when the jumper wire was connected to frame ground.

Results:

- YES – The LED indicator is illuminated when the jumper wire was connected to frame ground. The LED and the circuit wire are operating correctly. The ECM could be causing the problem.

Repair: Verify that the LED indicator is supposed to be ON. Ensure that the autoshift mode switch is in the ON position and that the autoshift mode is active.

Exit this procedure and perform this procedure again. If the indication is that the ECM is causing the problem, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The LED indicator is still not illuminated when the jumper wire was connected to frame ground. The ECM is not causing the problem. Reinstall the LED circuit wire and socket that was removed from the ECM J2 connector. Proceed to Test Step 3

Test Step 3. CHECK THE CIRCUIT FOR AN OPEN

- A.** Turn the disconnect switch and the key start switch to the OFF position.
- B.** Disconnect the machine harness connector from the autoshift enabled LED indicator.

- C.** At the machine harness connector for the LED, connect a jumper wire between contact 2 (wire M998-OR(Orange)) and a good frame ground contact.
- D.** Disconnect the machine harness connector J2 from the Transmission Chassis ECM.
- E.** At the machine harness connector J2 for the ECM, measure the resistance between contact J2-11 (wire M998-OR(Orange)) and a good frame ground contact.

Expected Result:

The resistance measurement is less than 5.0 ohms.

Results:

- OK – The resistance measurement is less than 5.0 ohms. The resistance measurement does not indicate an open or a bad connection in the LED circuit in the machine harness.

Repair: The LED may have failed.

Exit this procedure and perform this procedure again. If the indication is that the LED has failed, replace the autoshift enabled LED indicator.

STOP.

- NOT OK – The resistance measurement is greater than 5.0 ohms. The resistance measurement does indicate an open or a bad connection in the LED circuit in the machine harness.

Repair: There is an open or a bad connection in the LED circuit in the machine harness. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not open but is not a good connection.

Refer to the complete machine Electrical System Schematic. Check all of the connectors that are in LED circuit. Ensure that all connections are clean, secure and in good condition. Repair the machine harness or replace the machine harness.

STOP.

i02443772

Indicator Lamp Is On Continuously

SMCS Code: 7400-035-IND

System Operation Description:

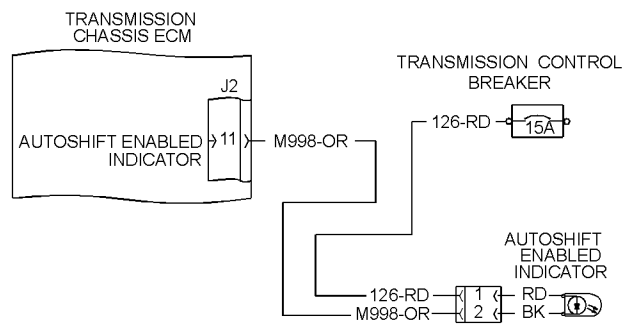


Illustration 87

g01331347

Autoshift Enabled LED Indicator connections

The autoshift enabled LED indicator is controlled by the Transmission Chassis ECM. The LED circuit is not monitored by the ECM for diagnostics.

System power for the LED is supplied by the 15 amp transmission control breaker. The indicator circuit is connected to an ECM sinking output. When the ECM activates the transmission autoshift mode, the ECM will turn ON the sinking output. This allows a path to ground for the power circuit through the LED which will cause the LED to illuminate.

Conditions that could cause an LED indicator to be ON when the autoshift mode is not activated are listed:

- The LED sinking output circuit is shorted to a ground source in the machine harness.
- The ECM has failed. This is not likely

When the transmission autoshift mode is not active and the LED indicator is ON, perform the following troubleshooting procedure.

Note: Verify that the autoshift mode switch is in the OFF position and the LED should be OFF before performing this procedure.

Test Step 1. CHECK THE CIRCUIT FOR A SHORT TO GROUND

- Turn the disconnect switch and the key start switch to the OFF position.
- Disconnect the machine harness connector from the autoshift enabled LED indicator.

- Disconnect the machine harness ECM connectors J1 and J2 from the Transmission Chassis ECM.
- At the machine harness ECM connectors, measure the resistance from the LED circuit contact J2-11 (wire M998-OR(Orange)) to frame ground. Measure the resistance from the contact J2-11 (wire M998-OR(Orange)) to all of the other contacts that are used in the J1 and J2 ECM connectors.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The resistance measurement does not indicate a short to frame ground or to another circuit in the machine harness. Proceed to Test Step 2.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short to frame ground or to another ground circuit in the machine harness.

Repair: Refer to the complete machine Electrical System Schematic. Check all of the connectors that are in the autoshift enabled LED indicator circuit. Ensure that all connections are clean, secure and in good condition. Check the machine harness for areas where there is contact with the machine frame. Look for worn or missing insulation on the wire. Repair the machine harness or replace the machine harness.

Refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test" for more information on finding and correcting a short circuit.

STOP.

Test Step 2. CHECK THE ECM OPERATION

- Reconnect the ECM connectors to the ECM and reconnect the harness connector to the autoshift enabled LED indicator.
- Turn the disconnect switch and the key start switch to the ON position.
- With the autoshift enabled LED indicator ON, use a 151 - 6320 Removal Tool to remove the autoshift enabled LED indicator circuit (wire M998-OR(Orange)) and socket at contact J2-11 from the ECM connector. The J2 connector remains connected to the ECM.

Expected Result:

The LED indicator is still illuminated.

Results:

- YES – The LED indicator is still illuminated. Disconnecting the circuit wire from the ECM connector did not cause the LED to turn OFF. The ECM is not causing the problem.

Repair: The LED circuit wire is grounded to another source in the machine harness or to frame ground.

Refer to the complete machine Electrical System Schematic. Check all of the connectors that are in the autoshift enabled LED indicator circuit. Ensure that all connections are clean, secure and in good condition. Check the machine harness for areas where there is contact with the machine frame. Look for worn or missing insulation on the wire. Repair the machine harness or replace the machine harness.

Refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test" for more information on finding and correcting a short circuit. Repair the machine harness or replace the machine harness.

STOP.

- NO – The LED indicator is no longer illuminated when the circuit wire is disconnected from the ECM connector. Disconnecting the circuit wire from the ECM connector caused the LED to turn OFF. The ECM is could be causing the problem.

Repair: Verify that the autoshift enabled LED indicator should not be ON.

Exit this procedure and perform this procedure again. If the indication is that the ECM is causing the problem, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i07879050

Parking Brake System

SMCS Code: 4267-035

Parking Brake Symptoms

A malfunction in the parking brake system could result in the following symptoms:

- The parking brake does not engage when the parking brake switch is set to the ON position.
- The parking brake slowly engages when the parking brake switch is set to the ON position.
- The parking brake intermittently engages when the parking brake switch is set to the ON position.
- The parking brake intermittently disengages when the parking brake switch is set to the OFF position.
- The parking brake does not release when the parking brake switch is set to the OFF position.
- Event code "E627 - Parking Brake Applied With Machine in Motion" occurs.

Recommended Actions

Use the procedures in this section in order to identify the parking brake symptoms. After the symptom(s) is identified, follow the troubleshooting that is directed for the parking brake system.

Machine Safety

Ensure that all safety information, warnings, and instructions are read and understood before any operation or any procedures are performed. Perform the following safety measures before you begin troubleshooting the machine:

1. Stop the machine on a surface that is hard and level.
2. Lower all of the implements to the ground.
3. Toggle the parking brake switch to the ON position. This action engages the parking brake.
4. Place chocks in front of the wheels and behind the wheels.
5. Shut off the engine.

Diagnostic Code Retrieval

Several of the parking brake symptoms list CID diagnostic codes. These CID codes can be viewed by using either of the following methods:

- Cat® Electronic Technician (Cat ET) Service Tool

- Operator display on the machine

**Symptoms that occur when the parking brake switch is set to the ON position:
Parking Brake Does Not Engage Parking Brake Slowly Engages Parking Brake Intermittently Engages**

1. Check for active diagnostic codes that are related to the parking brake system. Troubleshoot any of the following active CID diagnostic codes:

CID 70 – “Parking Brake Operator Switch”

CID 627 – “Parking Brake Pressure Switch”

CID 681 – “Parking Brake Solenoid”

Reference: Refer to the CID diagnostic code procedures in this manual.

2. If all of the listed diagnostic codes are resolved, proceed to “Troubleshooting the Parking Brake System”.

**Symptoms that occur when the parking brake switch is set to the OFF position:
Parking Brake Does Not Disengage Parking Brake Intermittently Does Not Disengage**

1. Check for active diagnostic codes that are related to the parking brake system. Troubleshoot any of the following active CID diagnostic codes:

CID 70 – “Parking Brake Operator Switch”

CID 623 – “Transmission Control Switch”

CID 627 – “Parking Brake Pressure Switch”

CID 681 – “Parking Brake Solenoid”

CID 2113 – “Operator Present Switch”

Reference: Refer to the CID diagnostic code procedures in this manual.

2. The following conditions must be met in order for the parking brake to release when the parking brake switch is toggled to the OFF position:
 - a. The parking brake switch must be in the ON position.
 - b. The operator is present in the seat.
 - c. The transmission control switch “(Direction Switch)” is in the NEUTRAL position.

- d. The left joystick is aligned with the front wheels. Refer to the “Safety Section” of the Operation and Maintenance Manual, “Operation” for your specific machine.

3. Use Cat ET to verify the input/output states. Troubleshoot the state if any of the conditions cannot be met.
 - a. Select “Trans/Chassis” for your machine.
 - b. Select “Operator Present” .

Symptom Troubleshooting

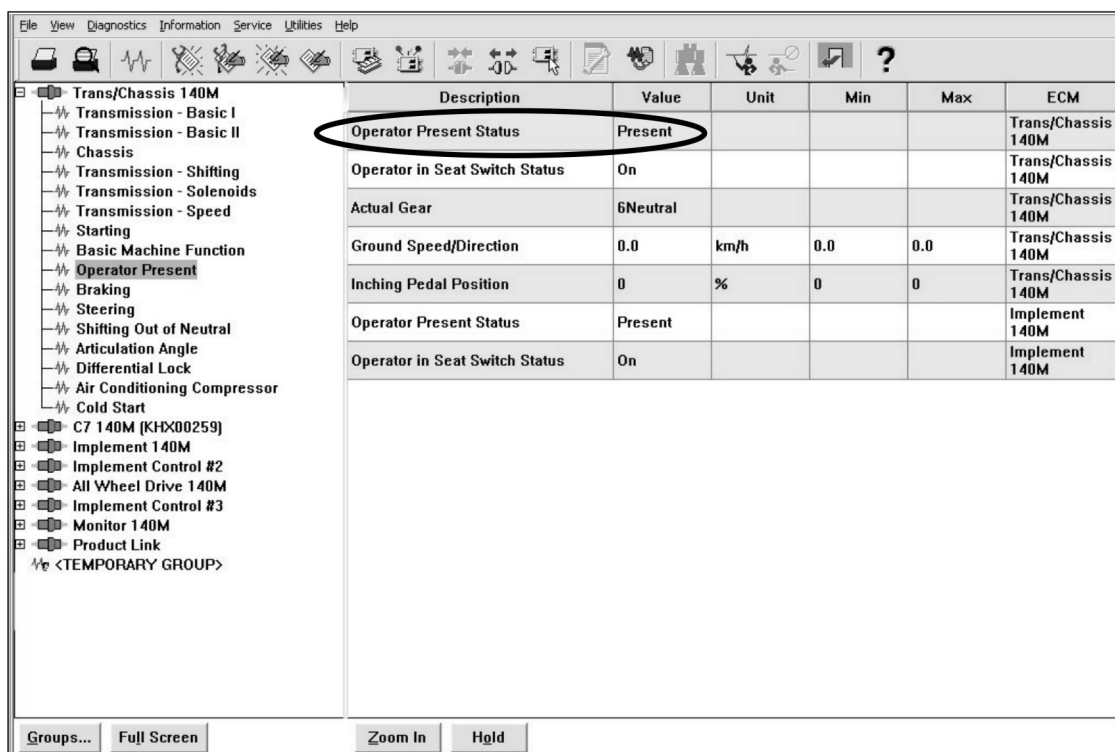


Illustration 88

g01978334

- c. Verify that the "Value" of the "Operator Present Status" indicates "Present".
- d. Select "Transmission - Shifting".

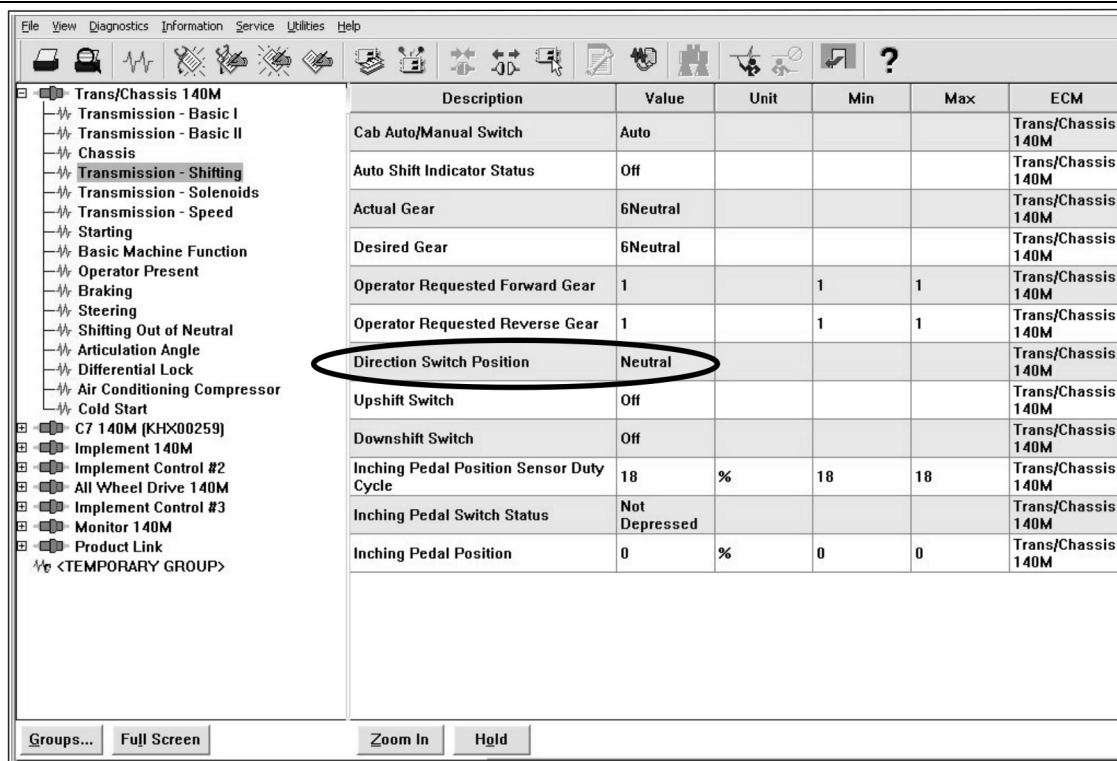


Illustration 89

g01978573

“Transmission - Shifting” values

- e. Verify that the “Value” of the “Direction Switch Position” indicates “Neutral”.
 - f. Start the engine.
 - g. Align the left joystick with the front wheels.
4. Toggle the parking brake switch to the OFF position. If the parking brake does not disengage, proceed to “Troubleshooting the Parking Brake System”.

Note: Event code “EID 562 - Steering lever has not been aligned to wheel steering angle” will be active if the left joystick is not properly aligned with the front wheels.

Event code E627 - Parking Brake Applied With Machine in Motion occurs

Reference: Refer to the “Event Code List” in this manual.

E627 will occur if both of the following conditions are true:

- The machine is traveling at a speed that is greater than 8 km/h (5.0 mph).
- The parking brake switch is toggled to the ON position.

This event is logged in order to identify parking brake abuse. The parking brake should be engaged only after the machine has come to a complete stop. The use of the parking brake as a service brake in regular operation will cause severe damage to the parking brake.

No repair is required if this event occurs. Perform the “Parking Brake - Test” in order to confirm that the parking brake is functional.

Refer to Testing and Adjusting, “Parking Brake - Test”. Refer to Table 10 in order to determine the manual for your specific machine.

Table 10

Manuals for the “Parking Brake - Test”	
Ma- chine Model	Reference
12M 140 120M 140M 150 160M 160	Systems Operation, Testing and Adjusting, RENR8454
14M 16M	Systems Operation, Testing and Adjusting, RENR8482, “14M and 16M Motor Graders Power Train”

Troubleshooting the Parking Brake System

 WARNING

When testing and adjusting the transmission and power train, move the machine to an area clear of obstructions, with safe exhaust ventilation for the exhausts. Sudden movement of the machine or release of oil under pressure can cause injury to persons on or near the machine. To prevent possible injury, do the procedure that follows before testing and adjusting the transmission and power train.

 WARNING

Personal injury can result from spring force released when removing cap screws.

Internal spring force will be released when cylinder assembly cap screws are removed causing injury.

Always restrain cover as cap screws are loosened.

Follow the established procedure in the Service Manual to service these parts.

NOTICE

Care must be taken to ensure that fluids are contained during performance of inspection, maintenance, testing, adjusting, and repair of the machine. Be prepared to collect the fluid with suitable containers before opening any compartment or disassembling any component containing fluids.

Dispose of all fluids according to local regulations and mandates.

- 1. Verify the main relief valve setting for the transmission. Refer to Testing and Adjusting, "Power Train Charge System Pressure - Test and Adjust".

Refer to the information in Table 11 for the correct setting for your machine.

Table 11

Manuals for the "Power Train Charge System Pressure - Test and Adjust"	
Machine Model	Reference
12M 140 120M 140M 150 160M 160	Systems Operation, Testing and Adjusting, RENR8454 ⁽¹⁾
14M 16M	Systems Operation, Testing and Adjusting, RENR8482, "14M and 16M Motor Graders Power Train" ⁽¹⁾

⁽¹⁾ Use this manual to test and adjust the pressure of the main relief valve.

- 2. Use Cat ET to verify the electrical components of the parking brake system.
 - a. Select "Trans/Chassis" for your machine.
 - b. Select "Braking" .

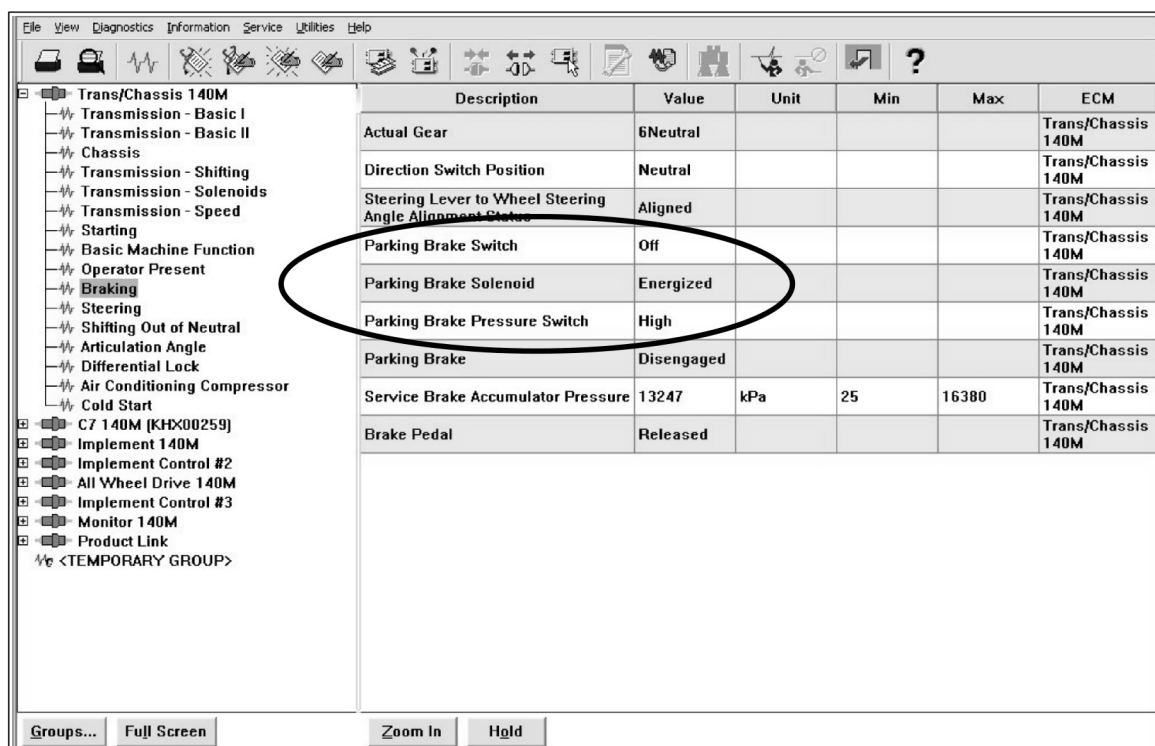


Illustration 90

g01978664

"Braking" values

c. Verify the parking brake switch.

Toggle the parking brake switch and observe the value of the "Parking Brake Switch" on Cat ET.

Expected Results:

The value changes when the switch is toggled.

Results:

- **YES** - The value changes when the switch is toggled. The switch is functional. Proceed to Step 2d.
- **NO** - The value does not change when the switch is toggled.

Repair: Check the continuity of the wiring. If no fault is found in the wiring, then replace the parking brake switch.

d. Verify the parking brake command.

Toggle the parking brake switch. Verify that the "Value" of the "Parking Brake Switch" correlates to the following command to the "Parking Brake Solenoid".

"On" – "Not Energized"

"Off" – "Energized"

Expected Results:

The value changes to the correct state when the parking brake switch is toggled.

Results:

- **YES** - The value changes to the correct state when the switch is toggled. The parking brake command is functional. Proceed to Step 2e.
- **NO** - The value does not change.

Refer to "Symptoms that occur when the parking brake switch is set to the OFF position: Parking Brake Does Not Disengage Parking Brake Intermittently Does Not Disengage".

e. Verify the parking brake pressure switch.

Toggle the parking brake switch. Verify that the "Value" of the "Parking Brake Solenoid" correlates to the following state of the "Parking Brake Pressure Switch".

View the parking brake indicator on the dashboard and verify the following:

Symptom Troubleshooting

- The parking brake indicator is on when the parking brake pressure switch is low.
- The parking brake indicator is off when the parking brake pressure switch is high.

“Not Energized” – “LOW - Indicator ON”

“Energized” – “HIGH - Indicator Off”

Note: The parking brake pressure switch only indicates whether the parking brake is ENGAGED or DISENGAGED. This switch does not control the parking brake.

Expected Results:

The values correlate.

Results:

- **YES** - The values correlate. The parking brake indicator on the dashboard changes. The switch and the parking brake indicator are functional.
- **NO** - The values do not correlate or the parking brake indicator does not change.

Repair: If the state of the parking brake pressure switch changes and the parking brake indicator does not change on the dashboard, perform the following actions: Check for a CDL communication problem between the Trans/ Chassis ECM, the monitor, and the cluster in the dash.

If the state of the parking brake pressure switch does not change, proceed to “Troubleshooting the Parking Brake Solenoid”.

Troubleshooting the Parking Brake Solenoid

Cat ET can be used to test the parking brake system. By using Cat ET, a technician can override the parking brake solenoid. The technician can energize or de-energize the solenoid, as required.

Specific voltage and pressure values are recorded. The values are then compared with the expected values. This comparison is used in order to determine if either the solenoid or the pressure switch for the parking brake should be replaced.

Required Tools

Table 12 lists the tools that are required for Motor Graders with the following range of transmission serial numbers:

- **S/N:** CZM1–03319

Table 12

Required Tools For Troubleshooting			
Tooling	Part Number	Description	Qty
A	198 - 4240	Digital Pressure Indicator Gp	2
B		Parking Brake Adapter	
B1	6V - 3965	Fitting	1
B2	3J - 1907	O-Ring Seal	1
B3	1U - 3176	Connector	
B4	3K - 0360	O-Ring Seal	
C		Digital Voltage Meter	1

Table 13 lists the tools that are required for Motor Graders with the following range of transmission serial numbers:

- **S/N:** DZM1–Up
- **S/N:** CZM03320–Up

Table 13

Required Tools For Troubleshooting			
Tooling	Part Number	Description	Qty
A	198 - 4240	Digital Pressure Indicator Gp	2
B		Parking Brake Adapter	
B1	6V - 3965	Fitting	1
B2	3J - 1907	O-Ring Seal	1
C		Digital Voltage Meter	1

Test Procedures

Preliminary Steps

1. Operate the machine until the transmission oil is at an operating temperature of $80^{\circ} \pm 10^{\circ}\text{C}$ ($176^{\circ} \pm 18^{\circ}\text{F}$).
2. Stop the machine on a surface that is hard and level.
3. Move the transmission control lever to the NEUTRAL position.
4. Lower all of the implements to the ground.
5. Toggle the parking brake switch to the ON position.

6. Shut down the engine.
7. Place chocks in front of the wheels and behind the wheels.

Overriding the Parking Brake Solenoid

The following steps provide general instructions for using Cat ET in order to override the parking brake solenoid:

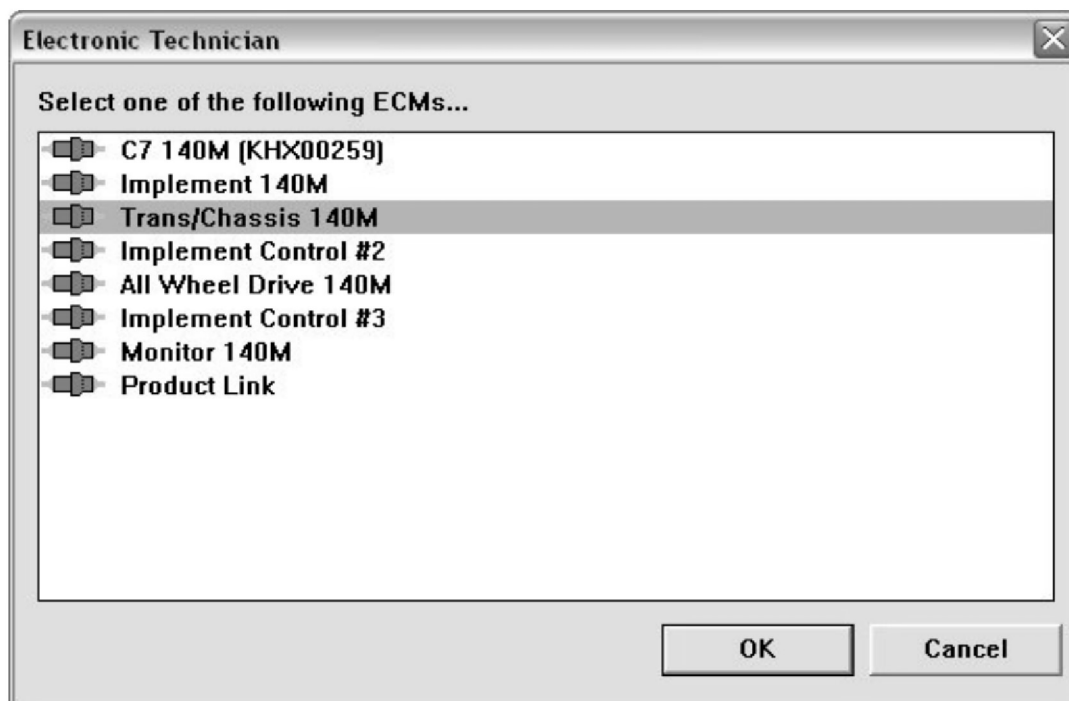


Illustration 91

g01978596

Selecting the "Trans/Chassis" ECM

1. Connect Cat ET to the data link connector and select the "Trans/Chassis" ECM for your machine.

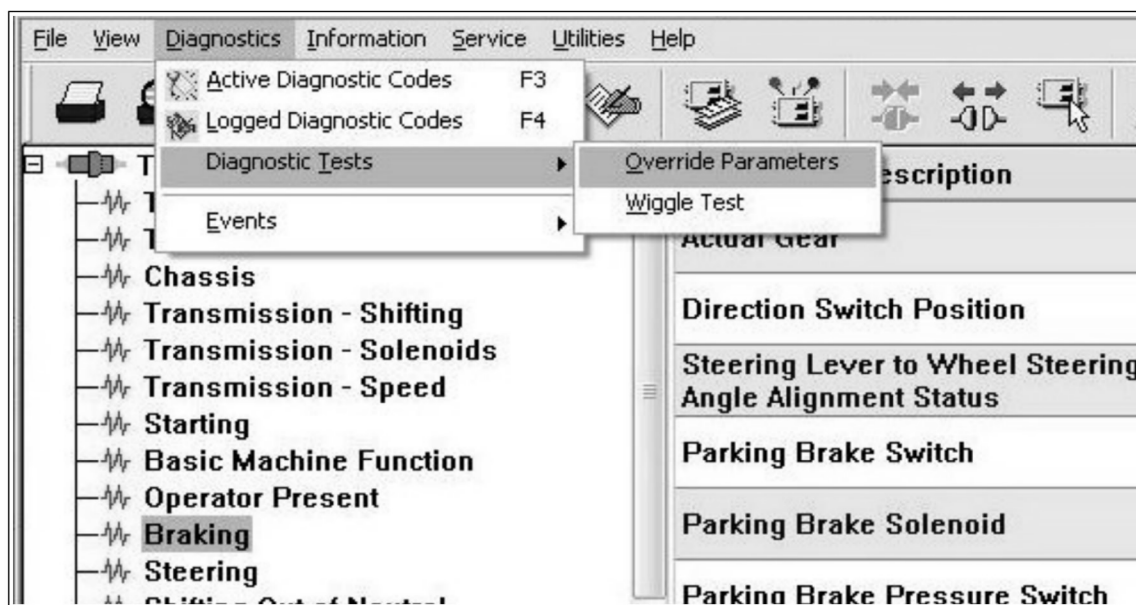


Illustration 92

g01978613

Selecting "Override Parameters" from "Diagnostic Tools"

2. Select "Diagnostic Tools" .
3. Select "Override Parameters" .

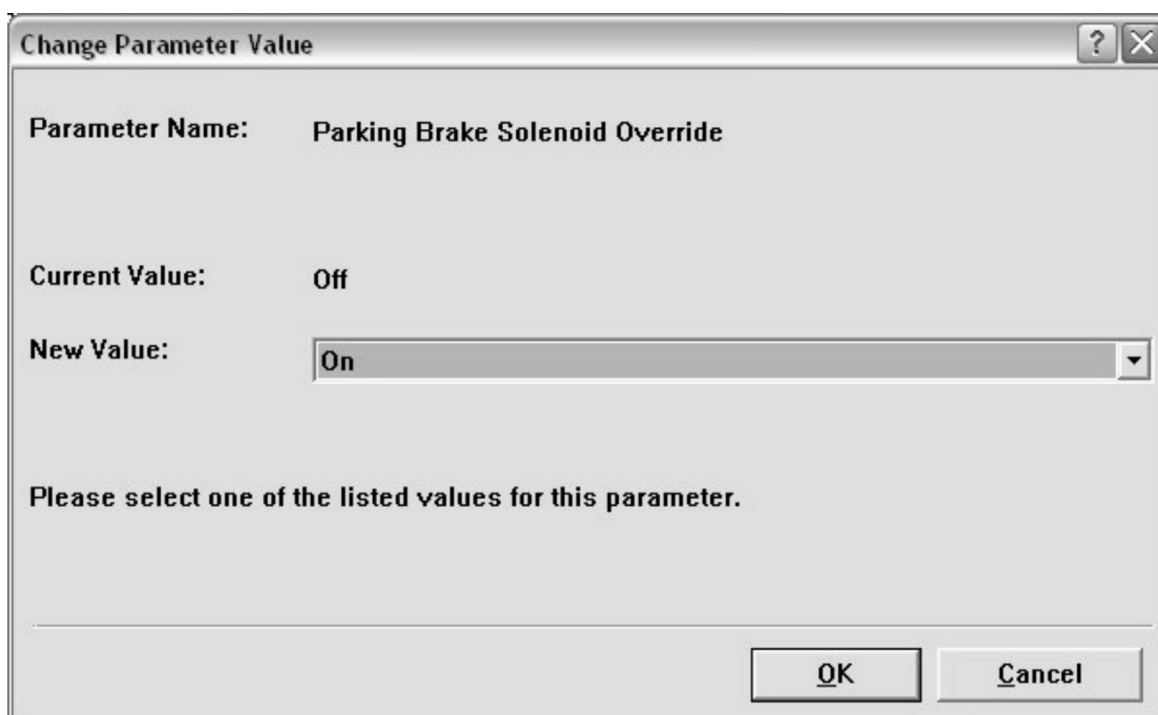


Illustration 93

g01978637

"Change Parameter Value" screen

4. Select "Parking Brake Solenoid Override". The "Change Parameter Value" screen opens. The "Current Value:" is shown.
5. By using the drop-down arrow in the "New Value:" field, select the desired state for the solenoid.
6. Select the "OK" button.

Running the Test

Refer to the "Required Tools" section for the tooling for your machine.

Record all of the values that are requested in Table 14 below. These values will be used in order to troubleshoot the parking brake system.

Table 14

Recorded Values for Troubleshooting			
Override State	Main Relief Valve	Hydraulic Circuit	Solenoid Voltage
Off ⁽¹⁾		P1 = ____	V1 = ____
On ⁽²⁾	P2 = ____	P3 = ____	V2 = ____

⁽¹⁾ The parking brake solenoid is de-energized.

⁽²⁾ The parking brake solenoid is energized.

1. Connect Tooling (C) across the parking brake solenoid.

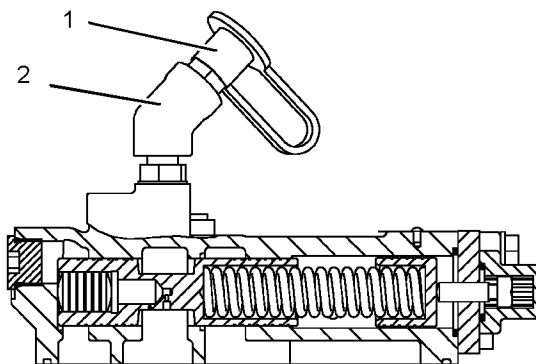


Illustration 94

g01935458

Main Relief Valve (MRV)

- (1) Dust Cap
- (2) Main Relief Valve Fitting

2. Remove the dust cap (1).
3. Attach Tooling (A) to the main relief valve fitting (2) of the parking brake housing.

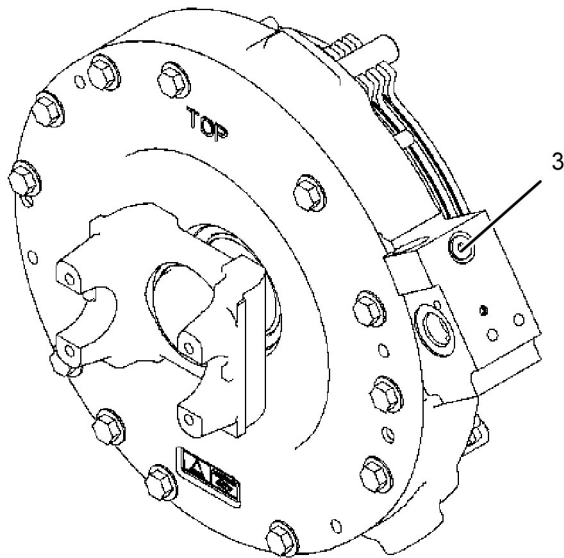


Illustration 95

g01935459

253-8424 Parking Brake Gp

(3) Parking brake hydraulic circuit port

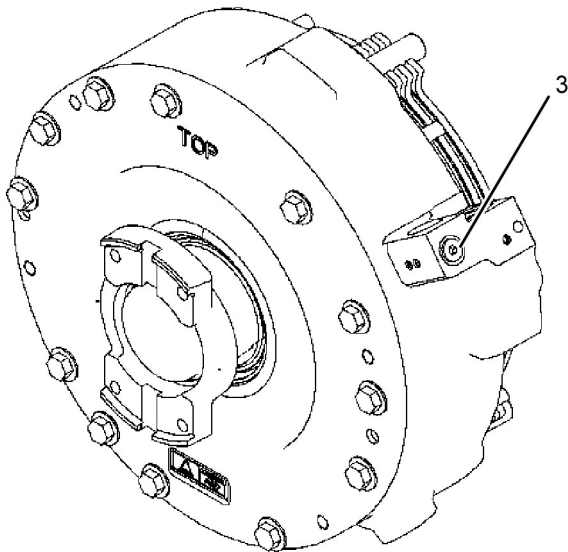


Illustration 96

g01944242

253-8427 Parking Brake Gp

(3) Parking brake hydraulic circuit port

4. Remove the plug assembly from the parking brake hydraulic circuit port (3).
5. Attach Tooling (B) between Tooling (A) and the parking brake hydraulic circuit port.
6. Ensure that the transmission control lever is in the NEUTRAL position.
7. Start the engine and run the engine at high idle.

8. By using Cat ET, change the "Parking Brake Solenoid Override" to "Off". This action de-energizes the solenoid.
9. Observe the pressure of the "Parking Brake Hydraulic Circuit Pressure". Record this value as "P1".
10. Measure the voltage across the parking brake solenoid. Record this value as "V1".
11. Use Cat ET to change the "Parking Brake Solenoid Override" to "On". This action energizes the solenoid.
12. Observe the pressure of the "Main Relief Valve". Record this value as "P2".
13. Observe the pressure of the "Parking Brake Hydraulic Circuit Pressure". Record this value as "P3".
14. Measure the voltage across the parking brake solenoid. Record this value as "V2".
15. Exit the "Override" mode by performing one of the following actions:
 - Close Cat ET.
 - Select a different screen on Cat ET.
16. Turn off the engine.
17. Refer to Table 15 in order to determine the problem with the system. If the Parking Brake Solenoid is replaced, repeat Step 6 through Step 16 in order to verify that the solenoid was the problem. If the pressures do not improve, check for hydraulic contamination or for a parking brake piston that is leaking.
18. Remove Tooling (A) from the main relief valve fitting.
19. Remove Tooling (B) from the parking brake hydraulic circuit port.
20. Attach the plug assembly onto the parking brake hydraulic circuit port.
21. Install the dust cap.

Expected Values

Refer to Table 15 and the values that were recorded in Table 14 in order to troubleshoot the parking brake system.

Table 15

Expected Values for Troubleshooting			
Step	Value	Recorded	Action
1	V1	0 VDC $\pm$ 0.5	OK. Proceed to Step 2.
		> 0.5 VDC	Troubleshoot for CID 681 in REN9004.
2	P1	0 PSI ⁽¹⁾	OK. Proceed to Step 3.
		> 1 PSI	Replace the parking brake solenoid. ⁽²⁾
3	V2	24 VDC $\pm$ 3 VDC	OK. Proceed to Step 4.
		< 21 VDC	Troubleshoot for CID 681 in REN9004.
4	P3	P3 = P2 $\pm$ 10 PSI ⁽³⁾	Replace the parking brake pressure switch.
		P3 < P2 - 10 PSI	Replace the parking brake solenoid. ⁽²⁾

(1) This is the "Hydraulic Circuit Pressure" when the parking brake solenoid is de-energized.

(2) Refer to "Removing and Installing the Parking Brake Solenoid". Verify that the pressure has improved. If the pressure does not improve, check for hydraulic contamination or for a parking brake piston that is leaking.

(3) The "Parking Brake Hydraulic Circuit Pressure" and the "Main Relief Valve Pressure" vary by no more than 10 PSI of each other when the parking brake solenoid is de-energized.

Removing and Installing the Parking Brake Solenoid

Use the correct removal and installation procedures for the parking brake solenoid and other associated components.

Reference: Refer to Table 16 in order to determine the Disassembly and Assembly manual for your specific machine.

Table 16

Manuals for Removal and Installation of the Parking Brake	
Machine Model	Reference
12M 120M	Disassembly and Assembly KENR6419 "120M and 12M Motor Graders Power Train"
14M	Disassembly and Assembly KENR8639 "14M Motor Grader Power Train"
140M 150	Disassembly and Assembly KENR6425 "140M Motor Grader Power Train"
16M	Disassembly and Assembly KENR6019 "16M Motor Grader Power Train"
160M 160	Disassembly and Assembly, RENR9726, "160M Motor Grader Power Train"

i05980047

Steering Direction Is Opposite of Expected Direction

SMCS Code: 4300-035

Immediate safe shutdown required

The E256 (3) event is activated when the steering cylinder position sensor or spool position sensor indicates movement in the opposite direction from commanded flow.

Potential causes of the E256 Event Code are as follows:

- Mechanical problem with the steering valve
- Electrical problem with the steering valve
- Mechanical problem with the front axle linkage
- External forces applied to the front wheels
- Hydraulic hose connections are reversed
- Secondary solenoids electrical connections are reversed

Preliminary checks before troubleshooting:

1. Overview of the machine.

- Troubleshoot all other steering diagnostics codes prior to using this troubleshooting.
- Ensure all the latest steering Product Improvements have been performed prior to using this troubleshooting.

- Determine if the codes or the most recent codes are occurring only on the primary steering ECM. (Implement ECM for M-Series or Implement 2 for M-Series 2). This quick check will verify if the problem is with components that are in only the primary steer system (actuator, wiring, resistor) or with components shared with both primary and secondary steer system (pump, steering valve, steer cylinders).
- Check to make sure oil viscosity setting in ET matches the oil that is in the machine.

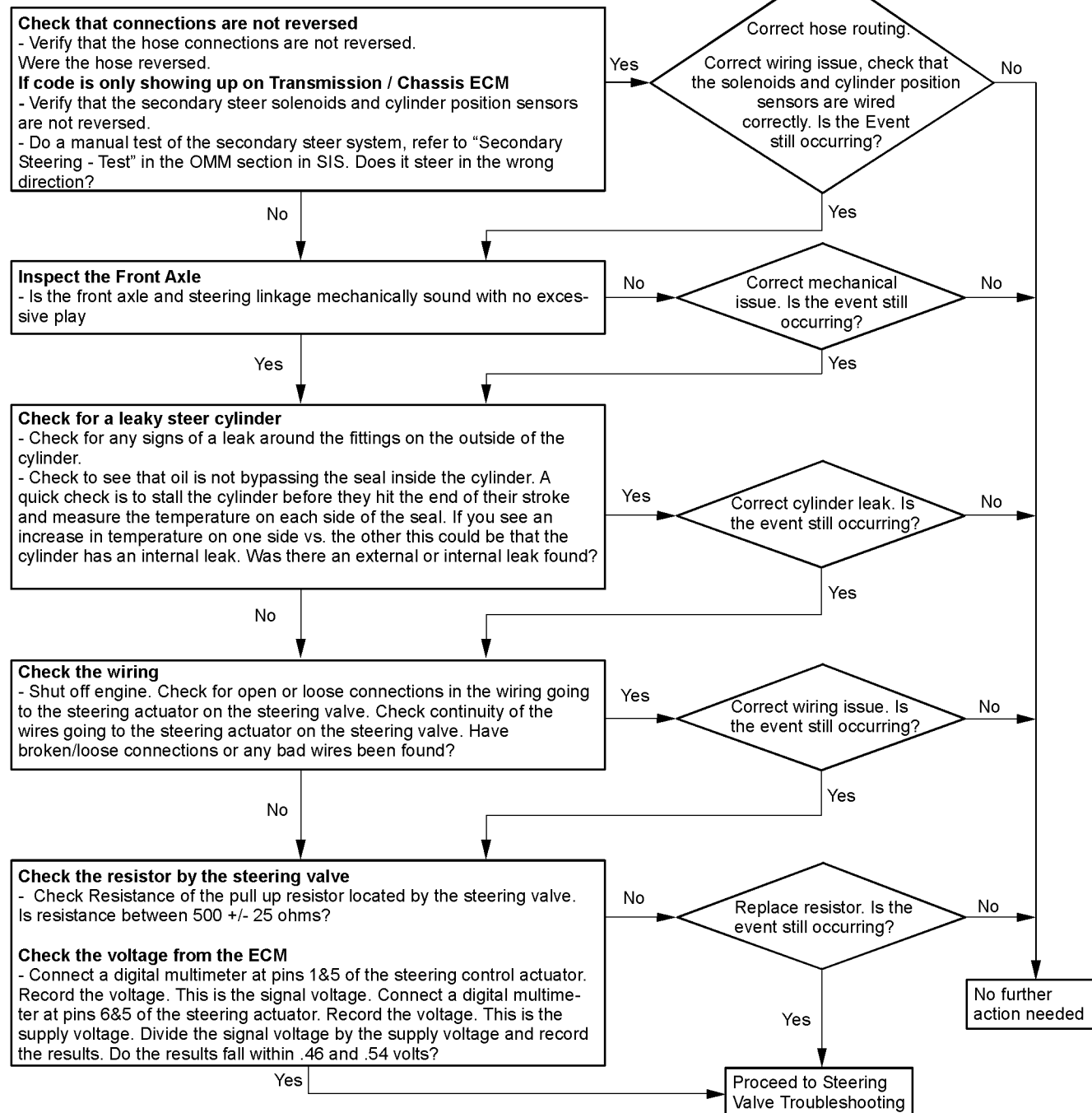
2. Obtain information from the operator.

- Did the front wheels of the machine come into contact with an immovable object or in a heavy, high load underfoot condition at the time the event was activated with no other diagnostics. If so the steering system could be performing as designed. Linkage movement was intended to prevent structural damage.
- Find out if ground conditions could be causing the code. Refer to SEPD1354 for conditions that can cause the code.
- Find out what the machine was doing when the code occurred, Example roading, fine blading, heavy blading, and so on.
- What was the machine speed when the code occurred. This information can help determine if the code is being generated due to lack of spool movement vs lack of wheel movement. For 120 - 14 size machines the software looks at spool position below 9 kph and steering cylinder position above 9 kph. For 16 and 24 size machines the software looks at spool position below 15 kph and steering cylinder position above 15 kph.
- Find out what the hydraulic oil temperature was when the code occurred.

Note: Use the following flowchart to troubleshoot this event:

E256 - Steering Output Detected in Wrong Direction

Note: With February 2014 and later software steering alignment and operator presence will need to be detected for the steering actuator to be turned ON



E256 - Steering Output Detected in Wrong Direction

Note: With February 2014 and later software steering alignment and operator presence will need to be detected for the steering actuator to be turned ON

Steering Valve Troubleshooting

- Shut off engine. Connect a digital multimeter at pins 4&5 of the Steering Valve Control Module. Start the engine and check the voltage. Is the voltage between 2.36 and 2.64 volts?

No

The voltage was out of range with wheel movement.

Possible causes:

- Main spool in steering valve is stuck.
- Contamination in the steering valve.
- Steering actuator has malfunctioned.

Replace the steering actuator.
Is the event still occurring?

Yes

Replace the complete steering valve.
Is the event still occurring?

Yes

The voltage was out of range with no wheel movement.

Possible causes:

- Steering actuator has malfunctioned.

Replace the steering actuator.
Is the event still occurring?

No

No further action needed

The voltages are in range.

Start Engine.

Steer left, ensure the spool voltage reading goes above 3.3 V with a full steering command.

Steer right, ensure the spool voltage reading goes below 1.7 V with a full steering command.

Does the steering valve meet these checks?

Yes

No

Replace the steering actuator.
Is the event still occurring?

Yes

No

No further action needed

Submit a DSN. Provide the following information:

- ET product status report.
- Steering event file, refer to REHS7326.
- Ambient and Hydraulic oil temperatures at time of event
- Voltages when doing the above troubleshooting.
- Information from the operator.

i05745449

Steering Does Not Function

SMCS Code: 4300-035

S/N: B921–368

S/N: R9A1–Up

S/N: R9B1–Up

S/N: B9C1–Up

S/N: R9C1–Up

S/N: B9D1–4762

S/N: B9E1–1143

S/N: B9F1–Up

S/N: B9G1–Up

S/N: D9G1–1585

S/N: B9H1–Up

S/N: R9H1–Up

S/N: B9J1–Up

S/N: R9J1–Up

S/N: B9L1–Up

S/N: B9M1–Up

S/N: B9N1–Up

S/N: B9R1–Up

S/N: B9T1–Up

S/N: D9T1–1438

S/N: B9W1–Up

S/N: D9W1–Up

Immediate safe shutdown required

The E258 (3) Event is activated when steering is commanded and the front wheels are not moving.

Potential causes of the E258 Event Code are as follows:

- Mechanical problem with the steering valve
- Electrical problem with the steering valve
- Mechanical problem with the front axle linkage
- Front wheels are physically blocked and will not respond to command
- Loss of load signal

Preliminary checks before troubleshooting:

1. Overview of the machine.

- Troubleshoot all other steering diagnostics codes prior to using this troubleshooting.
- Ensure all the latest steering Product Improvements have been performed prior to using this troubleshooting.
- Determine if the majority of the codes or the most recent codes are occurring only on the primary steering ECM (Implement ECM for M-Series or Implement 2 for M-Series 2). This is a quick check to verify if the problem is with components that are in only the primary steer system (actuator, wiring, resistor) or components shared with both primary and secondary steer system (pump, steering valve, steer cylinders).
- Check to make sure oil viscosity setting in ET matches the oil that is in the machine.

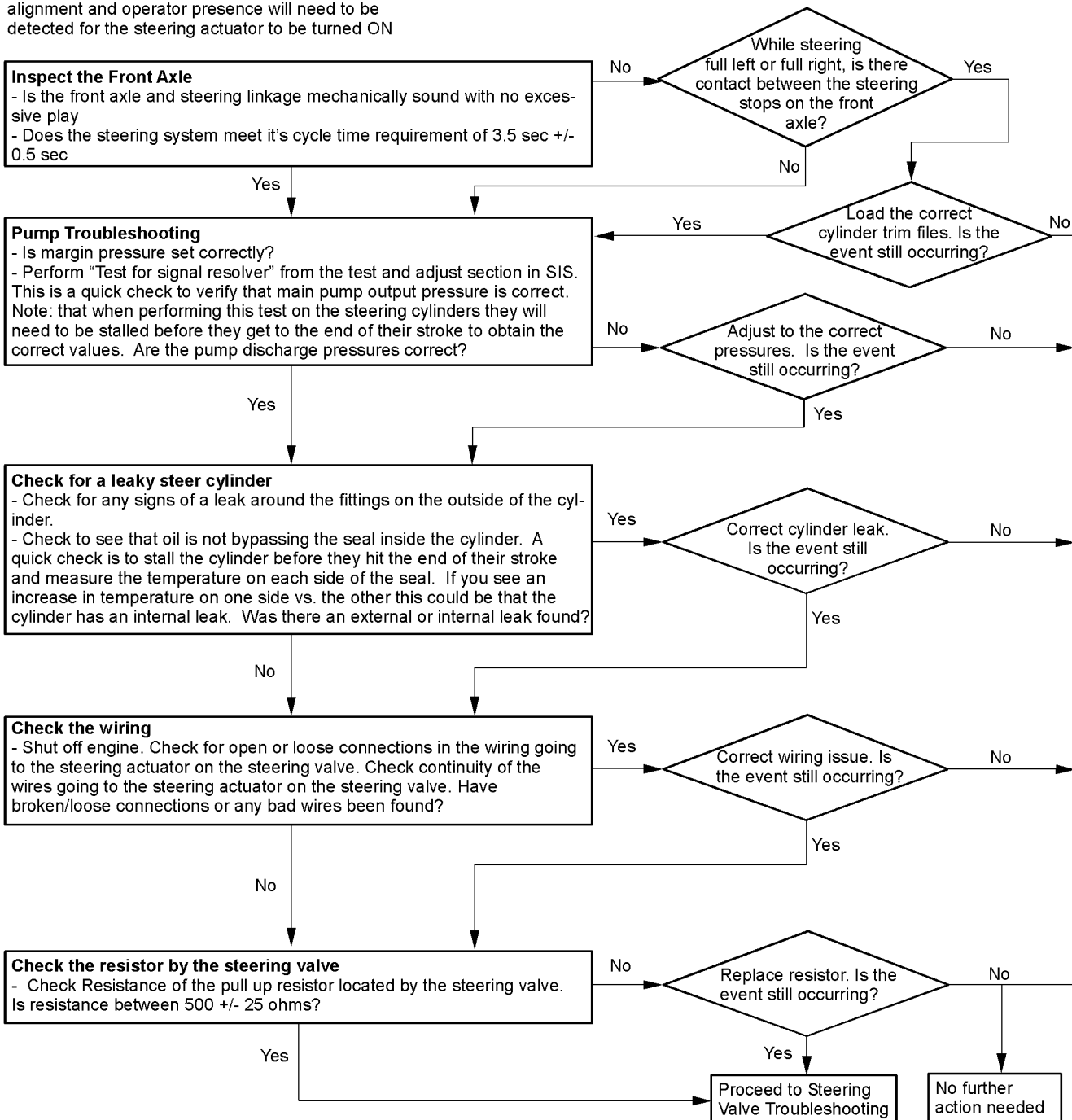
2. Obtain information from the operator.

- Did the front wheels of the machine come into contact with an immovable object or in a heavy, high load underfoot condition at the time the event was activated with no other diagnostics. If so the steering system could be performing as designed. Linkage movement was intended to prevent structural damage.
- Find out if ground conditions could be causing the code. Refer to SEPD1354 for conditions that can cause the code.
- Find out what the machine was doing when the code occurred, Example roading, fine blading, heavy blading, and so on.
- What was the machine speed when the code occurred. This can help determine if the code is being generated due to lack of spool movement vs lack of wheel movement. For 120 - 14 size machines the software looks at spool position below 9 kph and steering cylinder position above 9 kph. For 16 and 24 size machines the software looks at spool position below 15 kph and steering cylinder position above 15 kph.
- Find out what the hydraulic oil temperature was when the code occurred.

Note: Use the following flowchart to troubleshoot this event:

E258 - No Steering Detected With Command Given

Note: With February 2014 and later software steering alignment and operator presence will need to be detected for the steering actuator to be turned ON



E258- No Steering Detected With Command Given

Note: With February 2014 and later software steering alignment and operator presence will need to be detected for the steering actuator to be turned ON

Steering Valve Troubleshooting

- Shut off engine. Connect a digital multimeter at pins 4&5 of the Steering Valve Control Module. Start the engine and check the voltage. Is the voltage between 2.36 and 2.64 volts?

No

The voltage was out of range with wheel movement.

Possible causes:

- Main spool in steering valve is stuck.
- Contamination in the steering valve.
- Steering actuator has malfunctioned.

Replace the steering actuator.
Is the event still occurring?

Yes

Replace the complete steering valve.
Is the event still occurring?

Yes

No further action needed

No

No

No further action needed

The voltages are in range.

Start Engine.

Steer left, ensure the spool voltage reading goes above 3.3 V with a full steering command.

Steer right, ensure the spool voltage reading goes below 1.7 V with a full steering command.

Does the steering valve meet these checks?

Yes

No

Replace the steering actuator.
Is the event still occurring?

Yes

No

The voltage was out of range with no wheel movement.

Possible causes:

- Steering actuator has malfunctioned.

Replace the steering actuator.
Is the event still occurring?

Yes

No

Submit a DSN. Provide the following information:

- ET product status report.
- Steering event file, refer to REHS7326.
- Ambient and Hydraulic oil temperatures at time of event.
- Pressures and Voltages when doing the above troubleshooting.
- Information from the operator.

S/N: B551–Up

S/N: B561–Up

S/N: B571–Up

S/N: B591–Up

S/N: B9D4763–Up

S/N: B9E1144–Up

S/N: D9G1586–Up

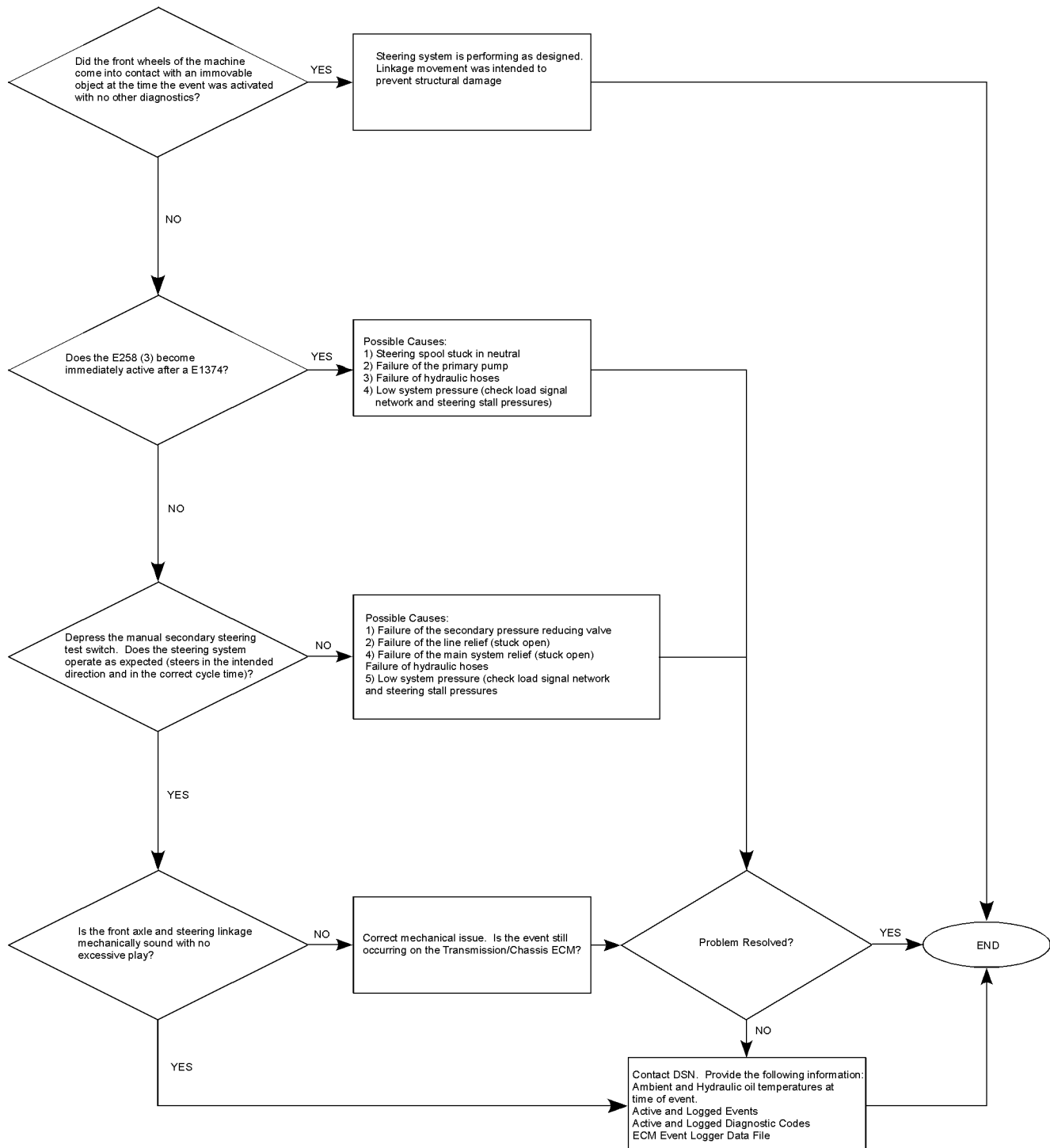
S/N: D9T1439–Up

Immediate safe shutdown required

The E258 (3) Event is activated when steering is commanded and the front wheels are not moving.

Note: Use the following flowchart to troubleshoot this event:

E258 (3) – No Steering Detected with Command Given
Troubleshoot all primary steering system events and any steering diagnostics prior to using this chart.



i05745303

Steering Movement Without Request

SMCS Code: 4300-035

S/N: B921–368

S/N: R9A1–Up

S/N: R9B1–Up

S/N: B9C1–Up

S/N: R9C1–Up

S/N: B9D1–4762

S/N: B9E1–1143

S/N: B9F1–Up

S/N: B9G1–Up

S/N: D9G1–1585

S/N: B9H1–Up

S/N: R9H1–Up

S/N: B9J1–Up

S/N: R9J1–Up

S/N: B9L1–Up

S/N: B9M1–Up

S/N: B9N1–Up

S/N: B9R1–Up

S/N: B9T1–Up

S/N: D9T1–1438

S/N: B9W1–Up

S/N: D9W1–Up

Immediate safe shutdown required

The E257 (3) event is activated when the steering cylinder position sensor or spool position sensor indicates movement without a command.

Potential causes of the E257 Event Code are as follows:

- Mechanical problem with the steering valve
- Electrical problem with the steering valve
- Mechanical problem with the front axle linkage
- External forces applied to the front wheels

Preliminary checks before troubleshooting:

1. Overview of the machine.

- Troubleshoot all other steering diagnostics codes prior to using this troubleshooting.
- Ensure all the latest steering Product Improvements have been performed prior to using this troubleshooting.
- Determine if the majority of the codes or the most recent codes are occurring only on the primary steering ECM (Implement ECM for M-Series or Implement 2 for M-Series 2). This is a quick check to verify if the problem is with components that are in only the primary steer system (actuator, wiring, resistor) or components shared with both primary and secondary steer system (pump, steering valve, steer cylinders).
- Check to make sure oil viscosity setting in ET matches the oil that is in the machine.

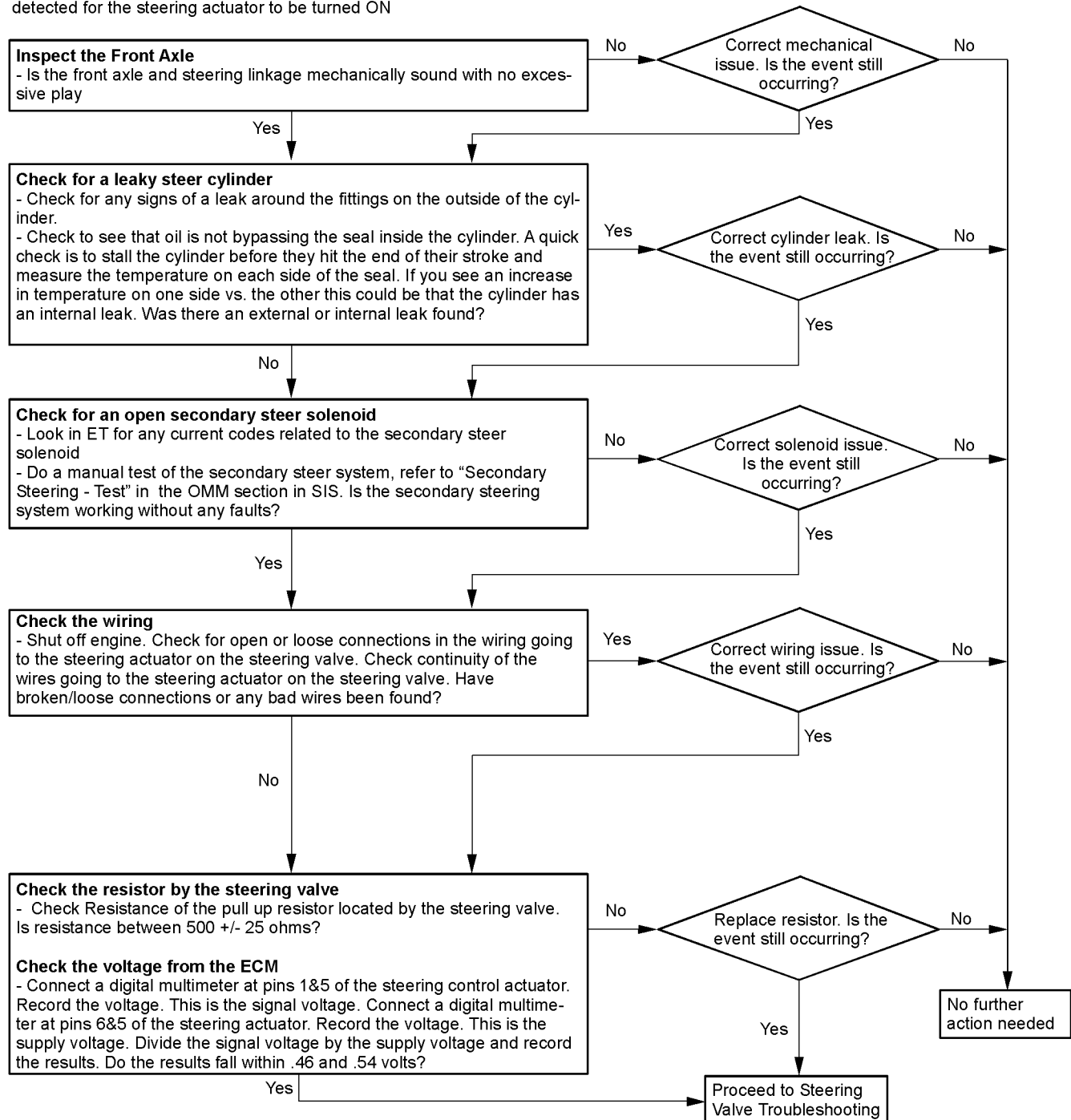
2. Obtain information from the operator.

- Did the front wheels of the machine come into contact with an immovable object or in a heavy, high load underfoot condition at the time the event was activated with no other diagnostics. If so the steering system could be performing as designed. Linkage movement was intended to prevent structural damage.
- Find out if ground conditions could be causing the code. Refer to SEPD1354 for conditions that can cause the code.
- Find out what the machine was doing when the code occurred, Example roading, fine blading, heavy blading, and so on.
- What was the machine speed when the code occurred. This can help determine if the code is being generated due to lack of spool movement vs lack of wheel movement. For 120 - 14 size machines the software looks at spool position below 9 kph and steering cylinder position above 9 kph. For 16 and 24 size machines the software looks at spool position below 15 kph and steering cylinder position above 15 kph.
- Find out what the hydraulic oil temperature was when the code occurred.

Note: Use the following flowchart to troubleshoot this event:

E257 - Steering Detected With No Command Given

Note: With February 2014 and later software steering alignment and operator presence will need to be detected for the steering actuator to be turned ON

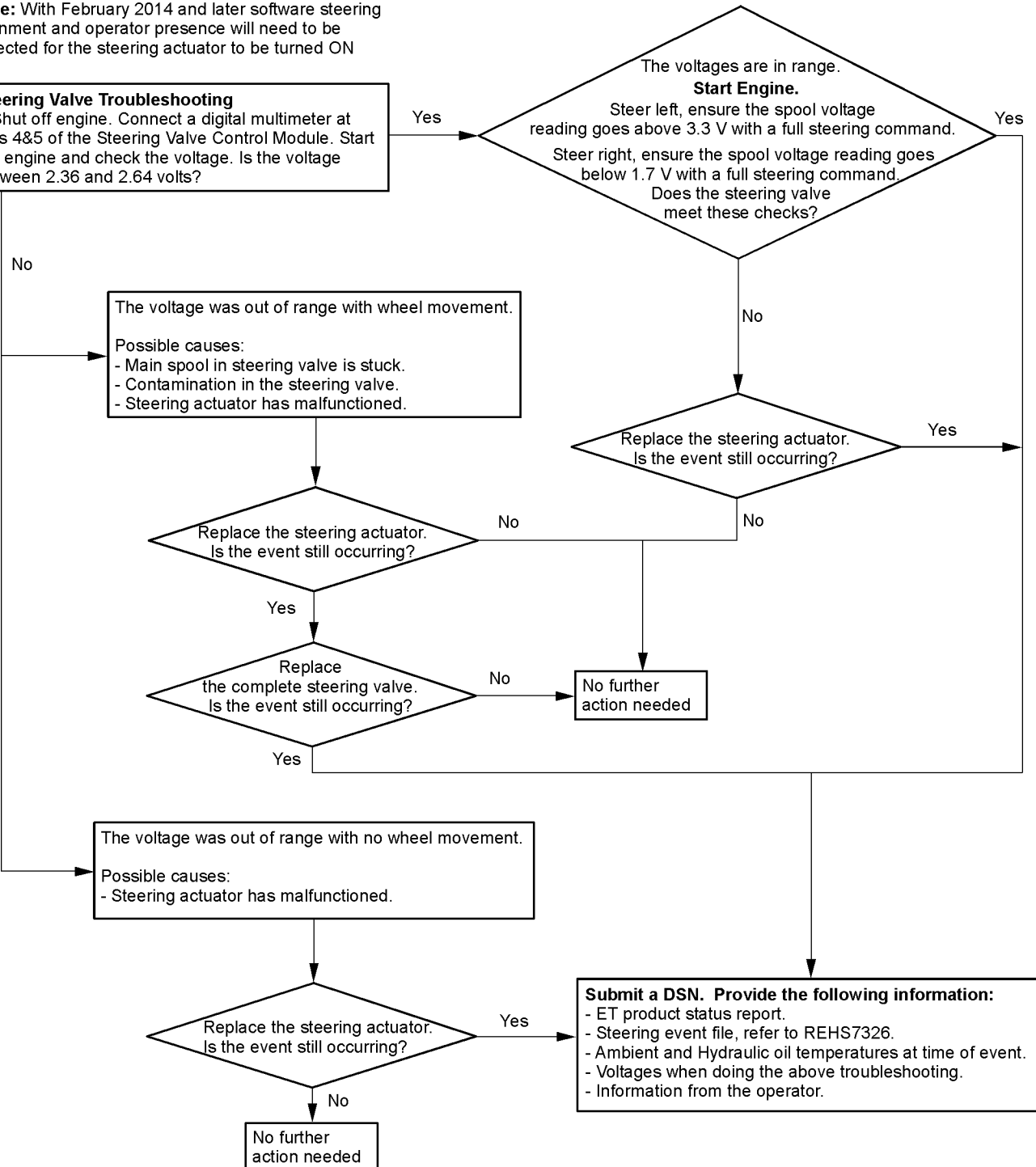


E257- Steering Detected With No Command Given

Note: With February 2014 and later software steering alignment and operator presence will need to be detected for the steering actuator to be turned ON

Steering Valve Troubleshooting

- Shut off engine. Connect a digital multimeter at pins 4&5 of the Steering Valve Control Module. Start the engine and check the voltage. Is the voltage between 2.36 and 2.64 volts?



i06678011

Steering Movement Without Request

SMCS Code: 4300-035

S/N: B92369–Up

S/N: B541–Up

S/N: B551–Up

S/N: B561–Up

S/N: B571–Up

S/N: B591–Up

S/N: B9D4763–Up

S/N: B9E1144–Up

S/N: D9G1586–Up

S/N: D9T1439–Up

Immediate safe shutdown required.

E257 (3) Event is activated when the steering cylinder position sensor is indicating cylinder movement without a command.

Note: Use the following flowchart to troubleshoot this event:

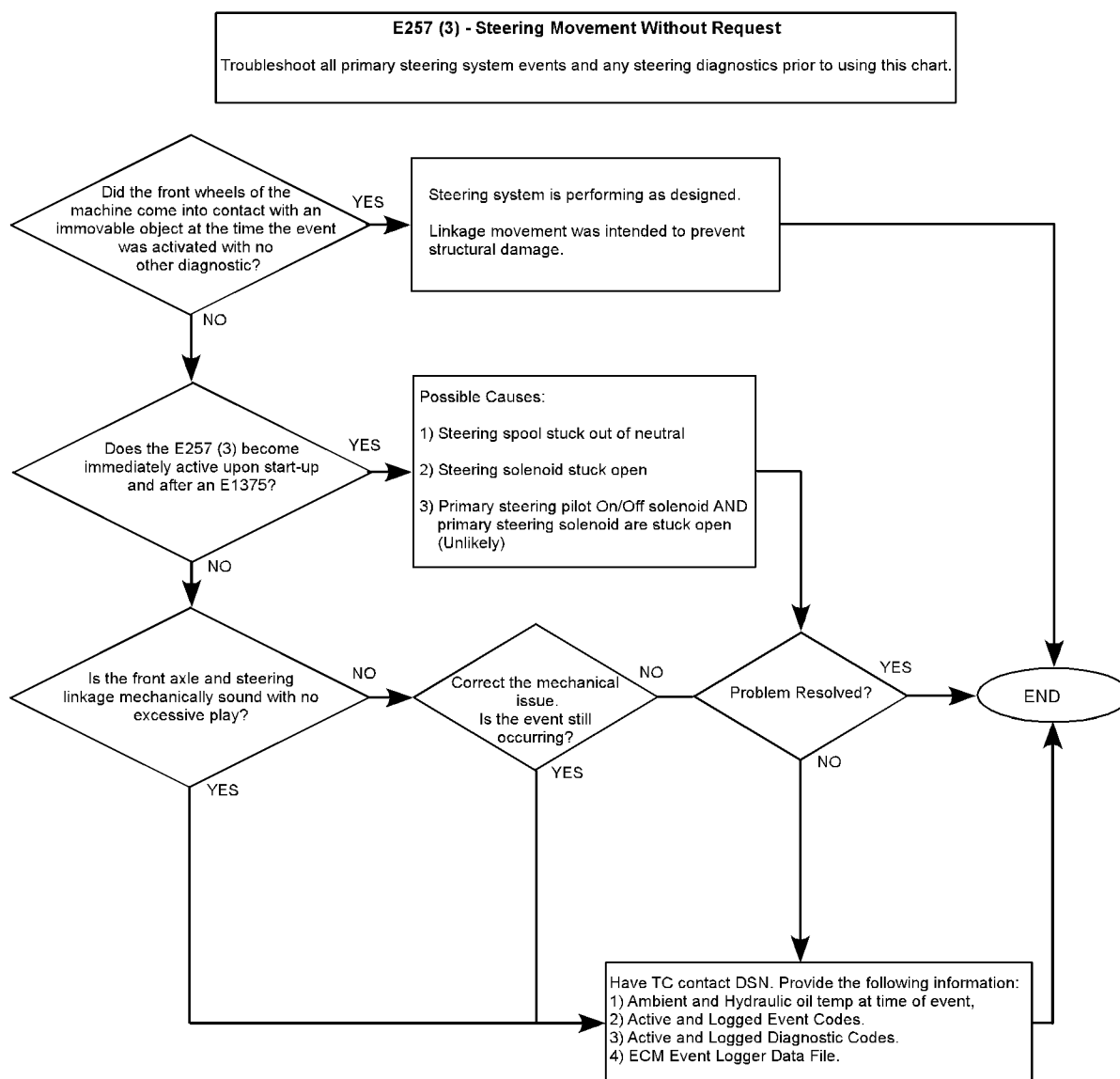


Illustration 104

g03480079

i07246920

Event Code List

SMCS Code: 7569

Event codes identify significant events that occur to machine systems. electronic control modules (ECMs) store the data from the events. This function allows tracking of the machine history and is an aid in troubleshooting.

When the transmission/chassis ECM activates an event code, the operator or the technician will be alerted by the Messenger. Most active events will be logged by the ECM, however some events are active only. Active only events are not logged. Event codes are referred to by an event identifier number (EID). The events that are active and the events that are logged can be viewed with the following equipment:

- Messenger
- Cat® Electronic Technician (Cat ET) Service Tool

Warning Levels

The ECM will assign a warning level to an active event code. Event codes are one of three levels, according to the severity of the abnormal condition. Each warning level requires a specific response from the operator. The warning levels and required operator response are listed below.

Level 1

Warning level 1 alerts the operator that a system requires attention. The operator should check the involved system or perform maintenance on the involved system at the earliest possible time.

Level 2

Warning level 2 requires changing the operation of the machine or performing a maintenance procedure. Failure to correct a level 2 warning may result in component damage.

Level 2S

Warning level 2S requires an immediate change in machine operation to avoid possible system damage.

Level 3

Warning level 3 requires an immediate safe machine shutdown to avoid damage to the machine or injury to personnel around the machine. The problem that caused the event must be corrected before machine operation can resume.

Indications and System Response

Messenger

Messenger alerts the operator when an event code is active.

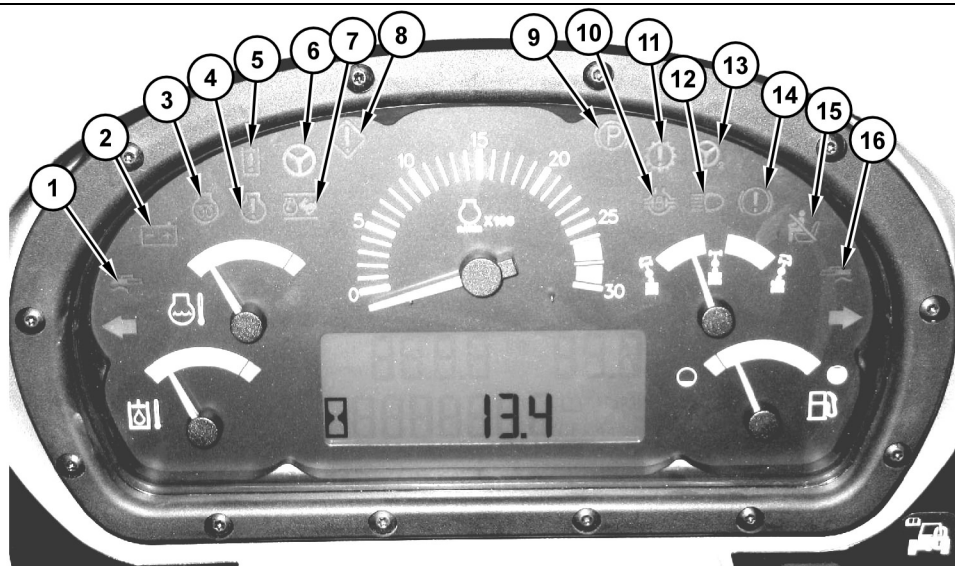


Illustration 105

g01318378

Indicators that are on the Instrument Cluster

(1) Blade left float	(7) Throttle lock (engaged)	(13) Secondary steering system
(2) Charging system	(8) Action Lamp	(14) Braking system
(3) Air inlet heater (active)	(9) Park brake (engaged)	(15) Operator not present
(4) Engine system	(10) Differential lock	(16) Blade right float
(5) Implement system	(11) Transmission system	
(6) Primary steering system	(12) High beam	

The warning indicators for the subsystem on the Instrument Cluster will illuminate when an event code is activated for a particular subsystem. When level 1 events are active, the warning indicator for the subsystem will be the only type of indicator that will illuminate.

The action Indicator will flash red when a level 2 warning or level 3 warning is active. If communication between Messenger and the Instrument Cluster fails, the action lamp will flash yellow.

The action alarm is driven as an output directly from the Instrument Cluster. If a level 3 warning is active, the action alarm will sound a tone that is pulsing. The action alarm will sound these tones to alert the operator that immediate action is required.

If two warnings of a different level are active at the same time, the highest level warning will be displayed.

Table 17 shows the Messenger response to these warning levels.

Table 17

WARNING OPERATION					
Warning Level	Warning Indications			Action That Is Required By The Operator	Possible Result ⁽¹⁾
	Warning Indicators	Action Indicator	Sounds Of The Action Alarm		
1	ON	OFF	OFF	No immediate action is required. The system needs attention soon.	No harmful effects or damaging effects
2	ON	Flash ON and OFF.	OFF	Change machine operation or perform maintenance to the system.	Damage to system components
2S	ON	ON	ON	Immediately change the machine operation.	Severe damage to system components
3	ON	Flash ON and OFF	Pulse ON and OFF	Immediately perform a safe engine shutdown.	Injury to operator or severe damage to components

⁽¹⁾ Possible result if no action is taken by the operator.

Caterpillar Electronic Technician (Cat[®] ET)

When a power train abnormal operating condition occurs, the status screen on Cat[®] ET indicates that there is an active event.

Event codes are displayed on Cat[®] ET in the following format:

EXXXX Description of the code

The "E" means that the code is an event code. The "XXXX" is a numeric identifier. The numeric identifier is followed by a description of the code.

Active event codes are listed in ascending numerical order, the lowest number is listed first. Active event codes are removed from the list when the condition is no longer present.

Logged Event Codes

Some event codes are logged in the ECM memory. Some event codes are active only. The logged event codes are listed in chronological order, the most recent code is listed first.

A logged code is cleared from memory when one of the following occurs:

- The technician clears the code.
- The code does not reoccur for 1000 hours.
- A new code is logged and there are already ten logged codes in memory. In this case, the oldest logged code is cleared.

Note: Always clear logged event codes after investigating and correcting the problem which generated the code.

Troubleshooting

Perform the following steps to troubleshoot an event.

1. Obtain the following information from the operator:

- The event
- Time the event occurred
- Engine operating conditions at the time of the event.
- Any systems that were installed by the dealer or customer that could cause the event

2. Verify that the event is not due to normal machine operation or operator error.

3. Check all fluid levels.

4. Troubleshoot and repair any active diagnostic codes.

List of Event Codes For the Transmission/Chassis ECM

Table 18 lists the event codes that apply to the power train control system and the recommended responses. Use Cat ET to determine the event codes that are active or logged.

Table 18

Event Codes For the Transmission/Chassis ECM (MID 27)		
Code (Level)	Description	Possible Cause and Recommended Response
E77 (2)	Differential (Axle) Filter Restriction	Replace the differential oil filter.
E179 (2)	Alternator Not Charging	Charging system voltage is less than 18.0 VDC. • Check drive belt tension. • Check the amperage and voltage output at the alternator • Check alternator connections and if needed, clean, and tighten the battery cables, wiring, connections in the charging circuit. Ensure that the ground circuit connections are clean and tighten (engine, cab, battery, alternator). Replace any faulty parts. • Check for dirt/dust in the alternator (will cause the alternator to fail). • Check off for current draw with the disconnect ignition switch OFF. Refer to Special Instruction, REHS0354, "Charging System Troubleshooting".
E192 (3)	Steering System Malfunction	Immediate safe shutdown required. Activates when ECM does not receive expectant steering position signals. The following active CID diagnostic codes will cause E192 to activate: 262 (5 V Sensor DC Power Supply) 585 (Transmission Output Speed Sensor #1) * 597 (Main Hydraulic Pump Discharge Pressure Sensor) 673 (Transmission Output Speed Sensor #2) * 674 (Transmission Intermediate Speed Sensor #1) ** 675 (Transmission Intermediate Speed Sensor #2) ** 1471 (Steering Control Position Sensor #1) 1472 (Steering Control Position Sensor #2) 1473 (Steering Control Position Sensor #3) 1674 (Solenoid Return #1) 2175 (Secondary Steering System Steer Left Solenoid) 2176 (Secondary Steering System Steer Right Solenoid) 2200 (Left Steering Cylinder Position Sensor) 2201 (Right Steering Cylinder Position Sensor) 2202 (Primary Steering Valve Control Module) 2650 (Primary Steering Valve Control Module Power Supply Output) * Note: CID 585 and CID 673 must BOTH be present to set an E192. ** Note: CID 674 and CID 675 must BOTH be present to set an E192. Investigate and resolve the cause of the listed active diagnostic code. Then, reset the active event with a key start switch cycle.
E233 (1)	Low Engine Pre-Lube Pressure	The prelube relay is de-energized due to the prelube pressure target not being achieved within 15 seconds of the cycle start. • Check lube oil level. • Check for an active secondary steering pump event code. If present, problem could be related to the motor or relay. • Check the prelube pump or the pressure sensor. • Check for a kinked prelube line or blockage in a prelube line.

(continued)

(Table 18, contd)

Event Codes For the Transmission/Chassis ECM (MID 27)		
Code (Level)	Description	Possible Cause and Recommended Response
E256 (3)	Steering Output Detected in Wrong Direction	Immediate safe shutdown is required. Usually occurs after servicing. Possible causes are the following: - Hydraulic hose connections are reversed. - Electrical connections of the secondary solenoid are reversed. - Hydraulic steering valve is malfunctioning. Refer to Troubleshooting, "Steering Direction is Opposite of Expected Direction" for additional troubleshooting.
E257 (3)	Steering Output Detected with No Command Given	Immediate safe shutdown is required. Front wheels are moving without a command. Possible causes are the following: - Operating the machine in rough terrain is forcing unexpected movement of the front wheels. - Problem with the hydraulic control valve - Short circuit in the circuit of the steering control signal. Refer to Troubleshooting, "Steering Movement Without Request" for additional troubleshooting.
E258 (1)	No Steering Detected with Command Given	Travel speed is less than 9 km/h (5.6 mph) and no movement of the front wheel is detected. Possible causes are the following: - Front wheels are physically blocked and the front wheels do not respond to a command. - Mechanical steering linkage is physically blocked. - Mechanical problem in the steering control valve Refer to Troubleshooting, "Steering Does Not Function" for additional troubleshooting.
E258 (3)	No Steering Detected with Command Given	Immediate safe shutdown is required. Travel speed is greater than 9 km/h (5.6 mph) and no movement of the front wheel is detected. Possible causes are the following: - Mechanical problem in the steering control valve - Mechanical steering linkage is physically blocked. - Front wheels are physically blocked and the front wheels will not respond to a command. Refer to Troubleshooting, "Steering Does Not Function" for additional troubleshooting.

(continued)

(Table 18, contd)

Event Codes For the Transmission/Chassis ECM (MID 27)		
Code (Level)	Description	Possible Cause and Recommended Response
E284 (3)	Low Brake Accumulator Pressure	Immediate safe shutdown is required. The event will be logged if the event code is active for more than 10 seconds after the start of the machine. The event is active when brake accumulator pressure is less than 8101.3 kPa (1175.0 psi). The event deactivates when brake accumulator pressure reaches 9825.0 kPa (1425.0 psi). If the machine is logging this event, perform the following steps: 1. Verify that the service brake accumulator pressure sensor is reading accurately. Compare the pressure sensor reading to a hydraulic pressure gage hooked to same hydraulic circuit. 2. If the pressure sensor is reading accurately, do not replace the pressure sensor. Troubleshoot the hydraulic system. Look for hydraulic leaks. 3. Verify that the brake accumulators hold charge per their specifications.
E329 (2)	Transmission Filter Plugged	Replace the transmission oil filter.
E334 (2)	Low Auto Lube Pressure	Activated during the autolube cycle (configured Autolube duration) when the pressure does not reach the minimum configured Autolube pressure target. Stays active until pressure is reached during a cycle. This event is logged. In Cat® ET, check the following configured parameters: · Cycle Duration. The default is 240 seconds. Low time setting may not allow time for pressure to be reached. · Minimum Pressure. Default is 18615.9 kPa (2700.0 psi). · High setting may not allow pressure to be reached in the configured duration time. Check for leaks, kinked or plugged lines, fuse or pump.
E358 (2S)	Engine Underspeed	"E358" will occur if the following conditions are true: - The engine speed has dropped to 575 RPM for 0.25 seconds or more This code warns the operator of abusive operating techniques and should be used as a training tool to encourage proper operation of the machine. Operation below low idle can lead to high torque events in the power train and should be avoided. No immediate repair is required if this event occurs. Continued accumulation of these events over time may damage power train components. The torsional coupling, bolted joint of torsional coupling with the flywheel, and transmission components are most likely to be affected. When the system flags an "E358" Code, changes in machine operation should be implemented immediately. Best Practices to minimize the accumulation of "E358" Codes: - Enable working low idle. This feature will elevate the low idle to 1000 RPM once the machine is placed into a Forward or Reverse gear. Reference the Operation and Maintenance Manual, "Operations"Working Low Idle for more detail. Set the throttle lock to 1500 RPM or greater. The throttle lock will help to maintain working engine speed. By selecting the appropriate gear for the operation, will allow the engine to maintain proper speed when the engine is placed under load. Avoid engaging a drive gear under load from a low idle speed. Choose a lower gear based on working conditions. Maintain a higher engine speed (1500 RPM or greater) and use the inching pedal to modulate into the load. Avoid lugging the engine. Adjust Operating Techniques based on working conditions. Adjust the engine speed, working gear, and blade load to prevent engine lugging which triggers the "E358" Code.

(continued)

(Table 18, contd)

Event Codes For the Transmission/Chassis ECM (MID 27)		
Code (Level)	Description	Possible Cause and Recommended Response
E490 (2)	Park Brake Applied While Shift Lever Not In Neutral	Disengage the parking brake before shifting out of neutral.
E521 (2)	Auto Lube Pressure Not Decreasing After Cycle	Activated when the autolube pressure does not decrease below 7584.2 kPa (1100.0 psi) within the configured interval time. This event is logged and stays active until auto-lube pressure decreases. Check for kinked or plugged lines that will prevent the decrease in system pressure.
E560 (3)	Secondary Steering Pump Pressure Not Responding to Command	Immediate safe shutdown is required. Secondary steering test indicates insufficient pump pressure. Check for an active MID 027 - CID 420 - FMI 03 diagnostic code. If the code is active, refer to the Diagnostic Code Procedures, "MID 027 - CID 420 - FMI 03" Story in this manual for details. If the MID 027 - CID 420 - FMI 03 diagnostic code is not active, refer to the System Operation, "Secondary Steering System" in this manual and use good troubleshooting to diagnose the problem.
E562 ⁽¹⁾ (1)	Steering Lever Has Not Been Aligned to Wheel Steering Angle	Left joystick must be "swept" fully left and right to align the front wheel angle with the correct joystick position for that angle. Must be aligned when the machine is started. If machine is parked and the operator leaves the seat. Possible causes for not aligning are the following: - Operator present switch is indicating no operator in the seat. Operator must be seated. - Left Joystick is being swept too fast. Sweep slower - Wheels are out of the accepted angle (extreme angle). Manually move the wheels into the accepted range.
E627 (2)	Parking Brake Applied with Machine in Motion	Caused by driving the machine with the parking brake ON. E627 will occur if the machine is traveling at a speed that is equal to or greater than 8.0 km/h (5.0 mph) but less than 16.0 km/h (10.0 mph) and the parking brake switch is toggled to the ON position. Disengage the parking brake before shifting out of neutral.
E627 (3)	Parking Brake Applied with Machine in Motion	Immediate safe shutdown is required. Caused by driving the machine with the parking brake ON. E627 will occur if the machine is traveling at a speed that is greater than 16.0 km/h (10.0 mph) and the parking brake switch is toggled to the ON position. Disengage the parking brake before shifting out of neutral.
E644 (3)	Low Transmission Oil Pressure	Activated when the transmission oil pressure is low for five seconds. Shut down the machine and check for transmission problems.
E737 (2)	Inching Control Disabled Due to System Fault	Active when both the inching pedal sensor and the inching pedal switch are faulted.
E792 (1)	High Air Conditioning Clutch Cycle Rate	Activated when the AC clutch is cycling ON and OFF more than is expected. Decrease the temperature setting to allow the system compressor to stay ON longer. Check for problems in the AC clutch relay and solenoid circuits.

(continued)

Symptom Troubleshooting

(Table 18, contd)

Event Codes For the Transmission/Chassis ECM (MID 27)		
Code (Level)	Description	Possible Cause and Recommended Response
E794 (3)	Steering Systems Not Synchronized	Immediate safe shutdown is required. One ECM (Implement or Transmission/Chassis) has lost steer alignment between joystick and steer cylinders and the other ECM is still aligned. Can be caused by rapid key ON/OFF/ON cycle. Shut down machine, restart, and align steering (see event code 0562 above). Check for data link communication, CID diagnostic codes: 247 (SAE J1939 Data Link) 296 (Transmission Control) 590 (Engine Control Module) 596 (Implement Control) Resolve and clear any active fault. Restart the machine and align steering. Can be caused by activation of the following CID diagnostic codes: 1471 (Steering Control Position Sensor #1) 1472 (Steering Control Position Sensor #2) 1473 (Steering Control Position Sensor #3) 2200 (Left Steering Cylinder Position Sensor) 2201 (Right Steering Cylinder Position Sensor) Or a failure of the Implement ECM. Resolve and clear any active fault. Restart machine and align steering errors.
E795 ⁽¹⁾ (3)	Machine Speed Excessive for Machine Articulation Angle	Immediate safe shutdown is required. Machine articulation angle is greater than 5.5°. Machine will not operate in high gears. Decrease the articulation angle to operate in the high gears.
E861 (1)	Clock Manual Alignment Required	The ECM internal clock is also known as an electronic service hour meter. The transmission/chassis hour meter is too far out of alignment with other ECM hour meters. Use the Cat ET to synchronize the ECM hour meters. At the top menu, click Service, and Synchronize Service Hour Meters from the drop-down menu. Next, click the Synchronize button to synchronize all the service hour meters on the machine. A pop-up dialog box will inform you of a successful synchronization of each ECM.
E877 (1)	High Transmission Oil Temperature	Activation/De-activation points are not dependent on the speed of machine. Activated when transmission oil temperature reaches 109° C (228° F) for greater than 300 seconds. Resets when oil temperature decreases to less than 107° C (224° F). Check the oil level of the transmission.
E877 (2)	High Transmission Oil Temperature	Activation/De-activation points are not dependent on the speed of the machine. Activated when transmission oil temperature reaches 115° C (239° F) for 300 seconds or 120° C (248° F) for 15 seconds. Resets when oil temperature decreases to less than 107° C (224° F). • Check transmission oil level. • Modify machine operation to reduce system load.
E1256 (3)	Key Input Off While Machine in Operation	Immediate safe shutdown is required. May occur if the key is turned off while the machine is operating. If this condition occurs while the keyswitch is in the ON position, check the keyswitch circuit for a failure.

⁽¹⁾ Code may be active only, will not be logged.

Diagnostic Code Procedures

i06682065

Diagnostic Code List

SMCS Code: 7569

Use the Messenger or the Caterpillar Electronic Technician (Cat ET) service tool to view the active diagnostic codes for the transmission/chassis ECM. Perform the procedure that corresponds to the Module Identifier (MID), the Component Identifier (CID), and the Failure Mode Identifier (FMI) of the diagnostic code.

Module Identifier (MID)

The module identifier (MID) identifies the electronic control module that activated the diagnostic code. Each electronic control module on the machine has a unique MID. Use the following chart to match the MID for each diagnostic code to a specific electronic control module. The chart for the Module Identifier (MID) is on the electrical schematic for your machine. See the chart if the MID is not shown on the display of your machine. After the operator determines the electronic control module that has detected the failure, see the service manual module for that particular ECM for more troubleshooting information. The service manual for each ECM is part of the machine Service Manual.

Table 19

Module Identifiers	
MID	Description
027	Transmission/Chassis ECM
082	Implement ECM
145	Implement ECM 2

Component Identifier (CID)

Each component has a component identifier (CID). The ECM will activate the CID diagnostic code for a particular component when a problem in the circuit is detected.

All the CID codes that can be activated by the transmission/chassis ECM are shown in Table 20.

Table 20

Diagnostic Code List of the Transmission/Chassis ECM (MID 027) ⁽¹⁾
CID 0041 - 8V DC Sensor Power Supply

(Table 20, contd)

FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 0070 - Parking Brake Switch	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 0096 - Fuel Level Sensor	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 0127 - Transmission Oil Pressure Sensor	
FMI 03	Voltage above normal
CID 0127 - Transmission Oil Pressure Sensor	
FMI 04	Voltage below normal
CID 0144 - Backup Alarm Relay	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
CID 0168 - Electrical System Voltage	
FMI 00	Data is valid, but above normal operational range
FMI 01	Voltage below normal
FMI 02	Incorrect, intermittent, erratic data
CID 0177 - Transmission Oil Temperature Sensor	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 0247 - SAE J1939 Data Link	
FMI 09	Abnormal update
FMI 14	Special instruction
CID 0248 - Cat Data Link	
FMI 09	Abnormal update
FMI 14	Special Instruction
CID 0262 - 5V Sensor DC Power Supply	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 0368 - Transmission Auto/Manual Switch	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 0420 - Secondary Steering Relay	
FMI 03	Voltage above normal

(continued)

(continued)

Diagnostic Code Procedures

(Table 20, contd)

FMI 05	Current below normal
FMI 06	Current above normal
CID 0444 Starter Motor Relay	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
CID 0573 - Inching Pedal Position Sensor	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
FMI 08	Abnormal frequency, pulse width, or period
CID 0585 - Transmission Output Speed Sensor 1	
FMI 02	Incorrect, intermittent, erratic data
CID 0588 - Monitoring System Display	
FMI 09	Abnormal update
FMI 14	Special instruction
CID 0590 - Engine ECM	
FMI 09	Abnormal update
FMI 14	Special instruction
CID 0596 - Implement ECM	
FMI 09	Abnormal update
FMI 12	Bad device or component
FMI 14	Special instruction
CID 0615 - Machine Articulation Angle Position Sensor	
FMI 02	Incorrect, intermittent, erratic data
FMI 03	Voltage above normal
FMI 04	Voltage below normal
FMI 08	Abnormal frequency, pulse width, or period
FMI 13	Out of calibration
FMI 14	Special instruction
CID 0621 - Downshift Switch	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 0622 - Upshift Switch	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 0623 - Directional Switch	
FMI 03	Voltage above normal

(Table 20, contd)

FMI 04	Voltage below normal
CID 0627 - Park Brake Pressure Switch	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 0669 - Transmission Input Speed Sensor	
FMI 02	Incorrect, intermittent, erratic data
CID 0673 - Transmission Output Speed Sensor 2	
FMI 02	Incorrect, intermittent, erratic data
CID 0674 - Transmission Intermediate Speed Sensor 1	
FMI 02	Incorrect, intermittent, erratic data
CID 0675 - Transmission Intermediate Speed Sensor 2	
FMI 02	Incorrect, intermittent, erratic data
CID 0681 - Parking Brake Solenoid Valve	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
CID 0967 - Machine Application	
FMI 02	Incorrect, intermittent, erratic data
FMI 09	Abnormal update
CID 1326 - Location Code	
FMI 02	Incorrect, intermittent, erratic data
CID 1401 - Transmission Clutch Solenoid 1	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
FMI 13	Out of calibration
CID 1402 - Transmission Clutch Solenoid 2	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
FMI 13	Out of calibration
CID 1403 - Transmission Clutch Solenoid 3	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
FMI 13	Out of calibration
CID 1404 - Transmission Clutch Solenoid 4	

(continued)

(continued)

(Table 20, contd)

FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
FMI 13	Out of calibration
CID 1405 - Transmission Clutch Solenoid 5	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
FMI 13	Out of calibration
CID 1406 - Transmission Clutch Solenoid 6	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
FMI 13	Out of calibration
CID 1407 - Transmission Clutch Solenoid 7	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
FMI 13	Out of calibration
CID 1408 - Transmission Clutch Solenoid 8	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
FMI 13	Out of calibration
CID 1471 - Steering Control Position Sensor 1	
FMI 02	Incorrect, intermittent, erratic data
FMI 03	Voltage above normal
FMI 04	Voltage below normal
FMI 08	Abnormal frequency, pulse width, or period
FMI 14	Special instruction
CID 1472 - Steering Control Position Sensor 2	
FMI 02	Incorrect, intermittent, erratic data
FMI 03	Voltage above normal
FMI 04	Voltage below normal
FMI 08	Abnormal frequency, pulse width, or period
FMI 14	Special instruction
CID 1473 - Steering Control Position Sensor 3	
FMI 02	Incorrect, intermittent, erratic data

(Table 20, contd)

FMI 03	Voltage above normal
FMI 04	Voltage below normal
FMI 08	Abnormal frequency, pulse width, or period
FMI 14	Special instruction
CID 1482 - 10V Sensor DC Power Supply	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 1484 Inching Pedal Switch	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 1674 - Solenoid Return 1	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
FMI 05	Current below normal
FMI 06	Current above normal
CID 1960 - Ignition Key Reader	
FMI 09	Abnormal update
CID 1961 - Service Brake Accumulator Pressure Sensor	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 2113 - Operator Present Switch	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 2175 - Secondary Steer Left Solenoid	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
CID 2176 - Secondary Steer Right Solenoid	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
CID 2199 - Secondary Steering Request Signal Line	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
FMI 08	Abnormal frequency, pulse width, or period
CID 2200 - Left Steering Cylinder Position Sensor	

(continued)

(continued)

Diagnostic Code Procedures

(Table 20, contd)

FMI 00	Data valid but above normal operational range
FMI 01	Voltage below normal
FMI 02	Incorrect, intermittent, erratic data
FMI 03	Voltage above normal
FMI 04	Voltage below normal
FMI 08	Abnormal frequency, pulse width, or period
FMI 13	Out of calibration
FMI 14	Special instruction
CID 2201 - Right Steering Cylinder Position Sensor	
FMI 00	Data valid but above normal operational range
FMI 01	Voltage below normal
FMI 02	Incorrect, intermittent, erratic data
FMI 03	Voltage above normal
FMI 04	Voltage below normal
FMI 08	Abnormal frequency, pulse width, or period
FMI 13	Out of calibration
FMI 14	Special instruction
CID 2252 - Machine Articulation Angle Sensor 2	
FMI 02	Incorrect, intermittent, erratic data
FMI 03	Voltage above normal
FMI 04	Voltage below normal
FMI 08	Abnormal frequency, pulse width, or period
FMI 13	Out of calibration
FMI 14	Special instruction
CID 2304 - Differential Lock Relay	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal
CID 2734 - Compression Brake Switch	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
CID 2976- Parking Brake Oil Pressure Sensor	
FMI 03	Voltage above normal
FMI 04	Voltage below normal
FMI 08	Abnormal frequency, pulse width, or period
CID 3210 - Transmission Pump Bypass Solenoid	
FMI 03	Voltage above normal

(Table 20, contd)

FMI 05	Current below normal
FMI 06	Current above normal
CID 3382 - Fan/Brake Pump Load Sense Bypass Solenoid	
FMI 03	Voltage above normal
FMI 05	Current below normal
FMI 06	Current above normal

(1) This table is only for MID 027 diagnostic codes that can be activated by the transmission/chassis ECM.

Failure Mode Identifier

The codes for the Failure Mode Identifier are defined by the SAE standards. The following list contains a CAT version of definitions.

Table 21

Failure Mode Identifier and Message Center Displays	
FMI	Description of Failure
00	"Data valid but above normal operating range"
01	"Data valid but below normal operating range"
02	"Incorrect, intermittent, erratic data"
03	"Voltage above normal"
04	"Voltage below normal"
05	"Current below normal"
06	"Current above normal"
07	"Mechanical system not responding properly"
08	"Abnormal frequency, pulse width, or period"
09	"Abnormal update"
10	"Abnormal rate of change"
11	"Failure mode not identifiable"
12	"Bad device or component"
13	"Out of calibration"
14	"Special Instruction"

Detailed FMI Explanation

FMI 00 Data Valid But Above Normal Operating Range – Every electronic control system sets a high limit for the expected operating range of the signal. The high limit includes over range signals. This could be a high temperature. A sensor that is still operating but sending a signal above the expected limit will cause an FMI 00 to be activated.

Some of the conditions that can cause the FMI 00 diagnostic code to be activated are listed below:

(continued)

- The medium or the component that is being monitored is above the normal range.
- The signal is shorted to another voltage source.
- Calibrate the sensor.
- An ECM has failed. An ECM failure is unlikely.

FMI 01 Data Valid But Below Normal Operating Range – Every electronic control system sets a low limit for the expected operating range of the signal. The limit includes signals that are under the lower limit. The low signal could be the oil pressure signal. The sensor is still working but sending a signal below the expected limit will cause an FMI 01 to be stored.

Some of the conditions that can cause the FMI 01 diagnostic code to be activated are listed below:

- The medium or the component that is being monitored is above the normal range.
- There are poor connections in the circuit.
- The sensor has failed.
- An ECM has failed. An ECM failure is unlikely.

FMI 02 Data erratic, intermittent, or incorrect – The signal from a component is present. The control that reads the diagnostic information cannot read the signal properly. The signal appears to be gone, unstable, or invalid. The data can be correct or incorrect intermittently. Also, this condition relates to communication between controls. This is an example of communication between controls. When the monitoring system is looking for the engine speed from the Engine ECM over the CAT Data Link.

Some of the conditions that can cause the FMI 02 diagnostic code to be activated are listed below:

- There is a poor connection in the circuit.
- The signal is intermittent or erratic.
- The software has been changed.
- The signal is receiving interference from another circuit.
- The signal is out of the range.
- An ECM has failed. An ECM failure is unlikely.

FMI 03 Voltage Above Normal – The component or system voltage is higher than the limit. An FMI 03 most often relates to a signal circuit.

Some of the conditions that could cause an FMI 03 diagnostic code to be activated are listed below.

- Loss of power supply

- An open circuit or a bad connection
- A short to another voltage source
- The sensor or the switch has failed.
- An ECM has failed. An ECM failure is unlikely.

FMI 04 Voltage Below Normal – The component or system voltage is lower than the limit. An FMI 04 diagnostic code most often relates to a power supply circuit.

Conditions that could cause an FMI 04 diagnostic code are listed below.

- The circuit is shorted to a ground source.
- The circuit is an open circuit or the circuit has a poor connection.
- The ground circuit has failed.
- A component has failed.
- An ECM has failed. An ECM failure is unlikely.

FMI 05 Current Below Normal – The current through the component or the system is lower than the limit. FMI 05 is most often related to a driver circuit.

Conditions that could cause an FMI 05 diagnostic code are listed below.

- There is an open circuit or a poor harness connection.
- The component has failed or the component has an open internally.
- An ECM has failed. An ECM failure is unlikely.

FMI 06 Current Above Normal – The current through the circuit of the component is higher than the limit. FMI 06 is most often related to a driver circuit for a solenoid. This diagnostic code is similar to an FMI 04 diagnostic code.

Conditions that could cause an FMI 06 diagnostic code are listed below.

- The component has failed.
- There is a short circuit to a ground source in the machine harness.
- An ECM has failed. An ECM failure is unlikely.

FMI 07 Mechanical System Not Responding Properly – The control detects a signal that is sent to a mechanical system and the response is not correct.

Conditions that could cause an FMI 07 diagnostic code are listed below.

- The component responds improperly.
- The component is mechanically stuck in a position.
- The mechanical component has failed.
- The engine has shut down.
- The machine is being used improperly.

FMI 08 Abnormal Frequency, Pulse Width, or Period – This occurs when the signal is not in the expected range. FMI 08 can also relate to a faulty sensor.

Conditions that could cause an FMI 08 diagnostic code are listed below.

- The harness connections are intermittent or poor.
- The signal is noisy due to nearby interference.
- There are loose mechanical devices.
- The component has failed.
- An ECM has failed. An ECM failure is unlikely.

FMI 09 Abnormal Update – This relates to communications on the data link. FMI 09 occurs when a control is not able to get information from another control.

Conditions that could cause an FMI 09 diagnostic code are listed below.

- The control module is not communicating on the data link correctly.
- The rate of data transmission is abnormal.
- The data link circuit has failed.
- There is a mismatch of software.
- An ECM has failed. An ECM failure is unlikely.

FMI 10 Abnormal Rate of Change – This code relates to a signal that has a rate of change that is too fast or too slow. The rate of change is outside of the expected limit.

Conditions that could cause an FMI 10 diagnostic code are listed below.

- The component has failed.
- Poor connections in the circuit
- The medium or the component that is being monitored has failed.
- An ECM has failed. An ECM failure is unlikely.

FMI 11 Failure Mode Not Identifiable – The control identifies more than one FMI as being responsible for a single failure.

Conditions that could cause an FMI 11 diagnostic code are listed below.

- There is a mechanical failure.
- There is damage to multiple circuits.
- An ECM has failed. An ECM failure is unlikely.

FMI 12 Bad Device or Component – The electronic control sends a signal and the electronic control expects a response. The control receives no response or the response is incorrect.

Conditions that could cause an FMI 12 diagnostic code are listed below.

- The component has failed.
- There is a failure on the data link.
- There are one or more controls with mismatched software.
- An ECM has failed. An ECM failure is unlikely.

FMI 13 Out of Calibration – The electrical signal is not within limits for a specific mechanical condition.

Conditions that could cause an FMI 13 diagnostic code are listed below.

- Calibration is required.
- The component has failed.
- The data is out of the range.
- An ECM has failed. An ECM failure is unlikely.

FMI 14 Parameter Failures – This diagnostic code is set up for special circumstances for a particular component. The FMI 14 troubleshooting procedure for the component will list the possible conditions that can cause this code.

i05897588

Using Messenger to Determine Diagnostic Codes

SMCS Code: 7490; 7569

Active and logged diagnostic codes can be viewed and cleared using Messenger.

Perform the following steps to view the active and logged diagnostic codes:

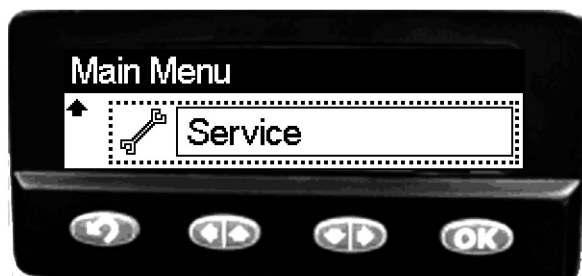


Illustration 106

g02352535

Messenger Main Menu

1. From the Messenger Main Menu page, scroll to the "Service" menu and press the "OK" button.



Illustration 107

g02352538

Messenger Service Menu

2. From the Messenger Service Menu page, the first option in the service menu will be "Diagnostics/Events". Press "OK" to view the list of Active codes and Logged codes.

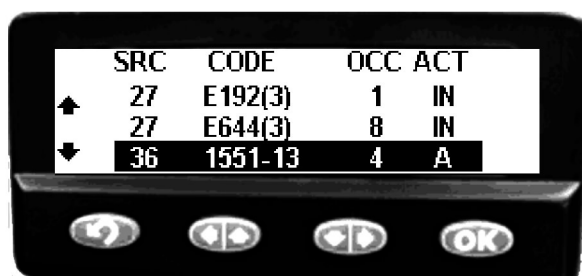


Illustration 108

g02352533

The Messenger Diagnostics/Events List screen

The Messenger Diagnostics/Events List screen shows the following:

SRC – Source

CODE – MID, CID, FMI, EID, and WCI

OCC – The number of occurrences of the codes.

ACT – The status of the code ("A" = active, "IN" = previously logged").

Pressing "OK" on any of these codes (when highlighted) will display the Diagnostic/Event screen.

Note: If the code is Active, there will be an "A" in the "ACT" column. There will be an "IN" if the code was previously logged.



Illustration 109

g02352539

The Messenger Diagnostic/Event Detail screen

The Messenger Diagnostic/Event Detail screen will display the following:

- Source of the failure
- Code: CID, FMI, EID, or WCI
- Text description of failed component
- Text description of the type of failure

i05897609

Using Caterpillar Electronic Technician to Determine Diagnostic Codes

SMCS Code: 0785-UE; 7569

Perform the following steps to use Cat[®] Electronic Technician (Cat ET) Service Tool to determine diagnostic codes:

1. Connect Cat ET to the machine.

- 2. Turn the keyswitch on.
- 3. Start Cat ET.

Cat ET will initiate communication with the Electronic Control Modules (ECMs) on the machine. After communication has been established, Cat ET will list the ECMs.

- 4. Select the desired ECM.
- 5. After the diagnostic codes have been determined with Cat ET, see the test procedure for the desired diagnostic code.

Reference: Troubleshooting, “Service Tools”

Active Diagnostic Codes

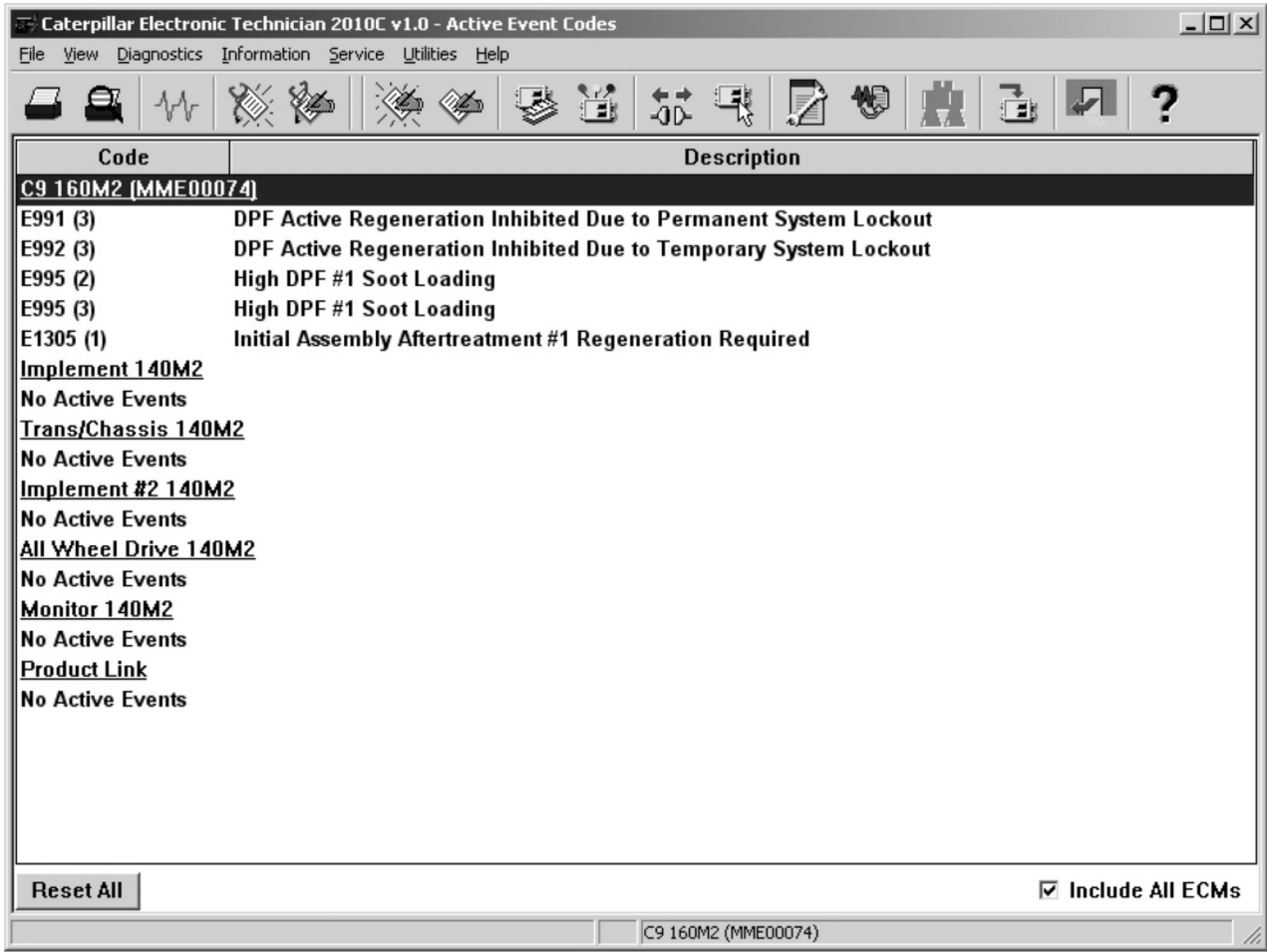


Illustration 110

g02355999

Typical Cat® Electronic Technician (Cat ET) Service Tool screen for active diagnostic codes.

Cat ET has an active diagnostic code screen. The screen shows component identifier (CID), failure mode identifier (FMI) and text description of the problem.

The following procedures may cause new diagnostic codes to be logged. Therefore, before any procedures are performed, make a list of all the active diagnostic codes and perform the desired procedure. Clear any diagnostic codes caused by the procedure.

Note: Before performing a procedure, always check all the circuit breakers. Repair the cause of any circuit breaker that has been tripped.

Logged Diagnostic Codes

Caterpillar Electronic Technician 2010C v1.0 - Logged Event Codes				
File View Diagnostics Information Service Utilities Help				
Code	Description	Occ.	First	Last
C9 160M2 [MME00074] - Diagnostic Clock = 635 hours				
E993 (2)	DPF Active Regeneration Inhibited Due to Inhibit Switch	29	606	635
E360 (3)	Low Engine Oil Pressure	3	570	607
E1190 (3)	Low Aftertreatment Cooling Fan Speed	5	606	607
E1096 (1)	High EGR Mass Flow Rate	6	576	607
E499 (3)	Fuel Rail #1 Pressure Leak	2	578	607
E991 (3)	DPF Active Regeneration Inhibited Due to Permanent Syste	1	596	596
E992 (3)	DPF Active Regeneration Inhibited Due to Temporary Syste	1	592	592
E995 (3)	High DPF #1 Soot Loading	1	591	591
Implement 140M2 - Diagnostic Clock = 635 hours				
No Logged Events				
Trans/Chassis 140M2 - Diagnostic Clock = 635 hours				
E644 (3)	Low Transmission Oil Pressure	8	606	607
Implement #2 140M2 - Diagnostic Clock = 635 hours				
E263 (3)	Low main pump pressure	3	606	607
All Wheel Drive 140M2 - Diagnostic Clock = 635 hours				
No Logged Events				
Monitor 140M2 - Diagnostic Clock = 635 hours				
No Logged Events				
Product Link - Diagnostic Clock = 635 hours				
No Logged Events				

Illustration 111

g02356001

Typical Cat ET screen for logged diagnostic codes.

Cat ET has a logged diagnostic code screen. Cat ET will log diagnostic codes that are intermittent. The logged diagnostic data includes component identifier (CID), failure mode identifier (FMI), and a text description of the problem. Also, the logged diagnostic data includes the number of occurrences of the problem and two time stamps. The time stamps display the first occurrence and the most recent occurrence of the problem.

Diagnostics are logged in non-volatile memory. On powerup, the ECM will clear any diagnostic codes that have not been detected or active within the last 1000 hours of machine operation.

i03794625

MID 027 - CID 0041 - FMI 03

SMCS Code: 1439-038

Conditions Which Generate This Code:

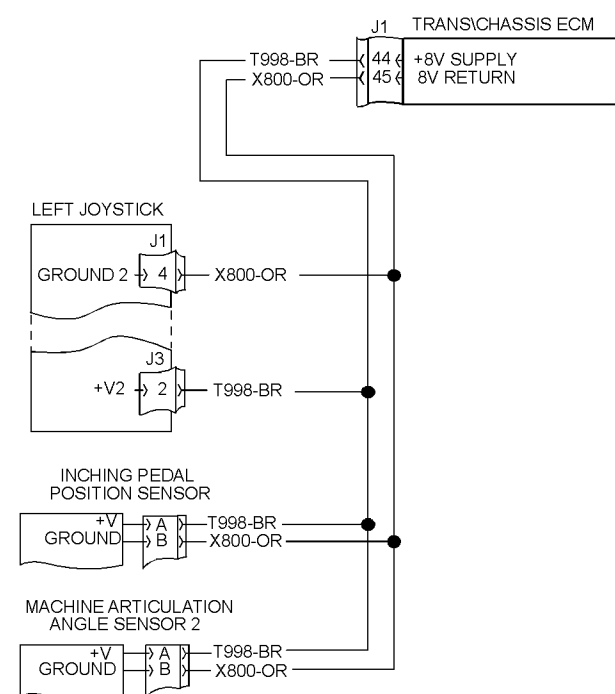


Illustration 112

g02101074

8.0 VDC Power Supply connections for the ECM

This diagnostic code is associated with the 8.0 volt power supply of the "Transmission/Chassis ECM". The 8.0 volt power supply provides power for the left joystick, the inching pedal position sensor and the machine articulation angle sensor 2.

Note: The 8.0 volt power supply for the "Transmission/Chassis ECM" is one of two power supplies that are used for the left hand joystick. The other power source for the left hand joystick is supplied by the Implement ECM.

The CID 0041 FMI 03 diagnostic code is activated when the ECM detects that the voltage of the 8.0 volt power supply circuit is above normal.

The following conditions could cause this diagnostic code:

- The power supply circuit is shorted to a higher voltage source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE VOLTAGE AT A COMPONENT

- Turn the disconnect switch and the key start switch to the ON position.
- Disconnect the machine harness connector from the inching pedal position sensor.
- At the machine harness connector for the sensor, measure the voltage from the contact of the supply A (wire T998-BR(Brown)) to return contact B (wire X800-OR(Orange)).

Expected Result:

The voltage measurement is 8.0 ± 0.3 VDC.

Results:

- OK – The voltage measurement is 8.0 ± 0.3 VDC. The voltage is correct. Proceed to Test Step 4.
- NOT OK – The voltage measurement is greater than 8.0 ± 0.3 VDC. The measurement is not correct. Proceed to Test Step 2.

Test Step 2. CHECK THE POWER SUPPLY AT THE ECM

- Turn the disconnect switch and the key start switch to the OFF position.

- B.** At the connector of the “Transmission/Chassis ECM” J1, use a 151 - 6320 Removal Tool to remove the supply wire and the socket at contact J1-44 (wire T998-BR(Brown)) and remove the return wire and the socket at contact J1-45 (wire X800-OR(Orange)) from the connector. The machine harness connector J1 remains connected to the ECM.
- C.** Turn the disconnect switch and the key start switch to the ON position.
- D.** Use the multimeter probes in order to make contact on the connector pins of the ECM. Measure the voltage at the ECM pins between the contact of the power supply J1-44 and the return contact J1-45.

Expected Result:

The voltage measurement is 8.0 ± 0.3 VDC.

Results:

- OK – The voltage measurement is 8.0 ± 0.3 VDC. The voltage is correct. The ECM power supply is correct. Install the wires and sockets that were removed from the J1 connector back into the original locations. Proceed to Test Step 3.
- NOT OK – The voltage measurement is greater than 8.0 ± 0.3 VDC. The ECM power supply is not correct. The ECM has failed.

Repair: Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

Test Step 3. CHECK FOR A SHORT CIRCUIT IN THE MACHINE HARNESS

The machine harness connector remains disconnected from the inching pedal position sensor.

- A.** Turn the disconnect switch and the key start switch to the OFF position.
- B.** Disconnect the machine harness connector J3 from the connector of the left joystick. Disconnect the machine harness connector from the “machine articulation sensor 2”.
- C.** Disconnect the machine harness connectors J1 and J2 from the “Transmission/Chassis ECM”.

- D.** At the harness connector J1 for the “Transmission/Chassis ECM”, check the resistance from contact J1-44 (wire T998-BR(Brown)) to all of the other ECM +battery (wire 126-RD(Red)) contacts that are connected to the ECM. The contacts are J1-31, J1-38, J1-39, J1-46 and J1-47.
- E.** At the harness connector J1 for the “Transmission/Chassis ECM”, check the resistance from contact J1-44 (wire T998-BR(Brown)) to all of the other contacts that are used in connectors J1 and J2 for the “Transmission/Chassis ECM”.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The supply circuit is not shorted to another circuit in the machine harness. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness.

Repair: The power supply circuit is shorted to another circuit in the machine harness. Refer to the complete Electrical System Schematic of the machine. Examine the supply circuit in order to determine the location of the problem.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, “Wiring Harness (Short Circuit) - Test”. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.

F. Determine if the CID 0041 FMI 03 diagnostic code is active.

i03794637

Expected Result:

The CID 0041 FMI 03 diagnostic code is no longer active.

Results:

- YES – The CID 0041 FMI 03 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NO – The CID 0041 FMI 03 diagnostic code is active. The problem has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may be activating the diagnostic code incorrectly. The ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

MID 027 - CID 0041 - FMI 04

SMCS Code: 1439-038

Conditions Which Generate This Code:

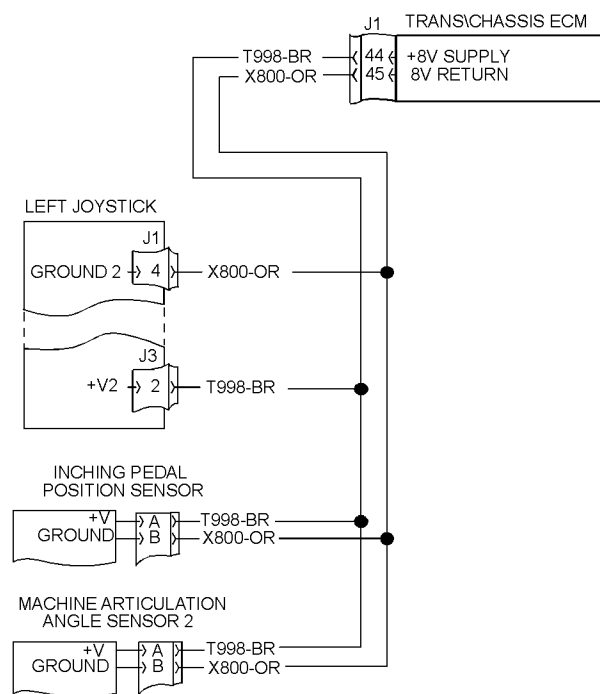


Illustration 113

g02101074

8.0 VDC Power Supply connections of the ECM

This diagnostic code is associated the 8.0 volt power supply of the "Transmission/Chassis ECM". The 8.0 volt power supply provides power for the left joystick, the inching pedal position sensor and the machine articulation angle sensor 2.

The 8.0 volt power supply for the "Transmission/Chassis ECM" is one of two power supplies that are used for the left hand joystick. The other power source for the left hand joystick is supplied by the Implement ECM.

The CID 0041 FMI 04 diagnostic code is recorded when the ECM detects that the voltage of the 8.0 volt power supply circuit is below normal.

The following conditions could cause this diagnostic code:

- A sensor has failed.
- The sensor supply circuit is shorted to a ground source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SENSORS

- A. Turn the key start switch and the disconnect switch to the ON position.
- B. Observe the status of the diagnostic code, as each component is disconnected. Disconnect the connector of the left joystick (J3), the "machine articulation" sensor 2 and the "inching pedal position" sensor from the machine harness.

Expected Result:

The CID 0041 FMI 04 diagnostic code is no longer active when one of the components in the supply circuit is disconnected.

Results:

- YES – The diagnostic code is not active when one of the components in the supply circuit is disconnected. The power supply circuit is correct. The sensor that was disconnected, when the diagnostic code was cleared, has failed.

Repair: Repeat this test step in order to verify the component that is causing the problem. Replace the component that is causing the problem.

STOP.

- NO – The diagnostic code is still active. Disconnecting the components in the circuit did not affect the status of the diagnostic code. Proceed to Test Step 2.

Test Step 2. CHECK THE POWER SUPPLY AT THE ECM

- A. Turn the disconnect switch and the key start switch to the OFF position.

- B. At the connector of the Transmission/Chassis ECM, J1, use a 151 - 6320 Removal Tool to remove the supply wire and the socket at contact J1-44 (wire T998-BR(Brown)) and the return wire and the socket at contact J1-45 (wire X800-OR(Orange)) from the connector. The machine harness connector J1 remains connected to the ECM.

- C. Turn the disconnect switch and the key start switch to the ON position.

- D. Use the multimeter probes in order to make contact on the connector pins of the ECM. Measure the voltage at the ECM pins between the power supply, contact J1-44, and the return contact J1-45.

Expected Result:

The voltage measurement is 8.0 ± 0.3 VDC.

Results:

- OK – The voltage measurement is 8.0 ± 0.3 VDC. The voltage is correct. The ECM power supply is correct. Install the wires and sockets that were removed from the J1 connector back into the original locations. Proceed to Test Step 3.
- NOT OK – The voltage measurement is less than 8.0 ± 0.3 VDC. The ECM power supply is not correct. The ECM has failed.

Repair: Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK FOR A SHORT TO GROUND

The components that are powered by the 8.0 volt power supply remain disconnected from the machine harness.

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connectors J1 and J2 from the "Transmission/Chassis ECM".

- C.** At the harness connector for the ECM, measure the resistance between the supply voltage, contact J1-44 (wire T998-BR(Brown)), and the frame ground. Measure the resistance between supply voltage, contact J1-44 (wire T998-BR(Brown)), and all of the other contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The harness circuit resistance is correct. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. The circuit is shorted in the machine harness.

Repair: The power supply wire T998-BR(Brown) is shorted to ground in the machine harness. Refer to the complete Electrical System Schematic for your machine. Check all harness connectors that are in the power supply circuit. Ensure that the connectors are clean and secure.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Determine if the CID 0041 FMI 04 diagnostic code is active.

Expected Result:

The CID 0041 FMI 04 diagnostic code is no longer active.

Results:

- YES – The CID 0041 FMI 04 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NO – The CID 0041 FMI 04 diagnostic code is active. The problem has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may be activating the diagnostic code incorrectly. The ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i03794642

MID 027 - CID 0070 - FMI 03

SMCS Code: 7332-038-BRK

Conditions Which Generate This Code:

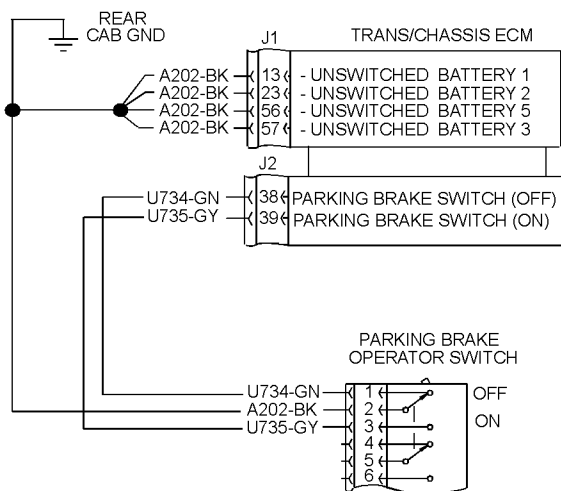


Illustration 114

g02101113

"Parking Brake Operator" Switch connections

The "parking brake operator" switch is a two-pole, double-throw switch. One pole is used to provide two switch-to-ground inputs to the ECM in order to indicate the status of the switch. The other pole of the switch is not used for operation of the ECM.

During normal operation, one of the inputs is not connected to ground and the other input is connected to ground through the contacts of the switch. An internal pull up voltage is present at the ECM switch inputs. When the input is grounded through the switch, the ECM detects the ground signal.

The FMI 03 diagnostic code is activated by the ECM when neither of the inputs is showing a ground signal.

The conditions that could cause the ECM to activate this diagnostic code are listed below:

- The switch has failed.
- The common ground circuit is an open connection or the circuit has a bad connection.
- There is an open or a bad connection in one or both of the switch input circuits.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SWITCH

Table 22

Contact states of the "Parking Brake Operator Switch"		
Switch Position	OFF Input J2-38 (wire U734-GN(Green))	ON) Input J2-39 (wire U735-GY(Grey))
Parking Brake ON	Open ⁽¹⁾	Closed ⁽²⁾
Parking Brake OFF	Closed	Open

⁽¹⁾ Open to ground circuit A202-BK(Black).

⁽²⁾ Closed to ground circuit A202-BK(Black).

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the switch.
- With the switch in the ON position, measure the resistance from the common contact of the switch 2 to the input contact of the switch 1. Compare the measurement to the table above.
- With the switch in the ON position, measure the resistance from the common contact of the switch 2 to the input contact of the switch 3. Compare the measurement to the table above.
- Move the switch to the OFF position and repeat Steps "C" and "D" .

Expected Result:

The resistance measurements for each position of the switch are correct according to the table at the beginning of this test step.

Results:

- YES – All of the resistance checks for the switch are correct in each switch position according to the table above. The switch is working correctly. Proceed to Test Step 2.

- NO – The states of the switch are not correct according to the table above. The switch has failed.

Repair: Replace the operator switch for the parking brake. After the switch is replaced, verify that the switch operation is correct before operating the machine.

STOP.

Test Step 2. CHECK COMMON GROUND OF THE SWITCH FOR AN OPEN

The key start switch and the disconnect switch remain in the OFF position. The machine harness remains disconnected from the switch.

- At the machine harness connector for the switch, measure the resistance from the common ground of the switch, contact 2 (wire A202-BK(Black)), and frame ground.
- Use a multimeter in order to observe the resistance measurement and wiggle the connector of the machine harness for the switch. Gently pull on the wires and move the wires in a circular motion.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the harness.

Results:

- OK – The resistance measurement is less than 5 ohms. The common ground circuit of the switch is correct. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the common ground circuit of the switch (wire A202-BK(Black)).

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is either not connected or that a wire is open. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points or splices in the ground circuit is not an open connection but not a good connection.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the ground circuit. Start the check of the connectors at the switch. Work back to the ground terminal that is located at the rear of the cab. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE INPUT CIRCUITS OF THE SWITCH FOR AN OPEN CONNECTION

The key start switch and the disconnect switch remain in the OFF position. The machine harness remains disconnected from the switch.

- At the machine harness connector for the switch, place a jumper wire between input contact 1 (wire U734-GN(Green)) and input contact 3 (wire U735-GY(Grey)).
- Disconnect the machine harness connectors J1 and J2 from the ECM.
- At the machine harness connector of the ECM, J2, measure the resistance from switch input contact J2-38 (wire U734-GN(Green)) to the input of the switch, contact J2-39 (wire U735-GY(Grey)).
- Observe the resistance measurement of the multimeter and wiggle the connector of the machine harness for the switch. Gently pull on the wires and move the wires in a circular motion. Do not disconnect the jumper wire.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the harness.

Results:

- OK – The resistance measurement is less than 5 ohms. The input circuits of the switch are not open in the machine harness. Proceed to Test Step 4.
- NOT OK – The resistance measurement is greater than 5 ohms. There is a problem with one or both of the switch input circuits in the machine harness.

Repair: Refer to the connection diagram at the beginning of this procedure.

Connect one end of the jumper wire to the common ground of the harness connector of the switch contact 2 (wire A202-BK(Black)).

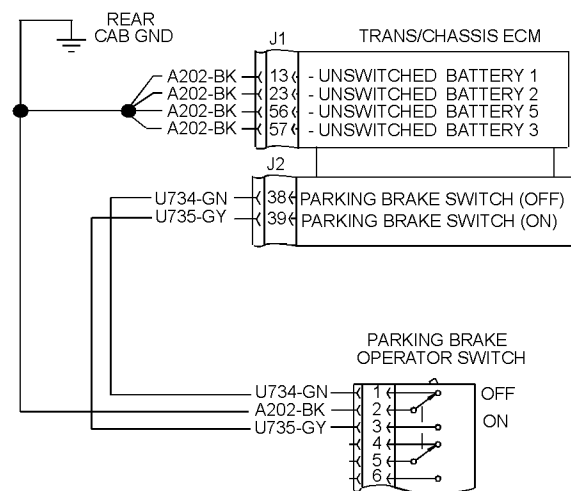
Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the faulty input circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition. Repair the machine harness or replace the machine harness.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Repair:** The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

i03795149

Conditions Which Generate This Code:



Connections for the “Parking Brake Operator” Switch

The “parking brake operator” switch is a two-pole, double-throw switch. One pole is used to provide two switch to ground inputs to the ECM in order to indicate the status of the switch. The other pole of the switch is not used for the operation of the ECM.

During normal operation, one of the inputs is not connected to ground and the other input is connected to ground through the switch contacts. An internal pull-up voltage is present at the ECM switch inputs. When the input is grounded through the switch, the ECM detects the ground signal.

The FMI 04 diagnostic code is activated by the ECM when both of the inputs are showing a ground signal at the same time.

The conditions that could cause the ECM to activate this diagnostic code are listed below:

- The switch has failed.
- There is a short to a ground source in one or both of the switch input circuits.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SWITCH

Table 23

Contact States for the “Parking Brake Operator” Switch		
Switch Position	OFF Input J2-38 (wire U734-GN(Green))	ON Input J2-39 (wire U735-GY(Grey))
Parking Brake ON	Open ⁽¹⁾	Closed ⁽²⁾
Parking Brake OFF	Closed	Open

⁽¹⁾ Open to ground circuit A202-BK(Black).

⁽²⁾ Closed to ground circuit A202-BK(Black).

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the switch.

- With the switch in the ON position, measure the resistance from common contact of the switch, 2, to the switch input contact 1. Compare the measurement to the table for the switch contacts.
- With the switch in the ON position, measure the resistance from the common contact of the switch 2, to the contact of the switch input 3. Compare the measurement to the table for the switch contacts.
- Move the switch to the OFF position and repeat Steps “C” and “D”.

Expected Result:

The resistance measurements for each of the switch positions agree with the table for the contact of the switch found at the beginning of this test step.

Results:

- YES – All of the resistance checks for the switch are correct in each of the switch positions, according to the contact status table. The switch is working correctly. Proceed to Test Step 2.
- NO – The states of the switch are not correct according to the table of the switch contact. The switch has failed.

Repair: Replace the operator switch for the parking brake. After the switch is replaced verify that the operation of the switch is correct before operating the machine.

STOP.

Test Step 2. CHECK THE SWITCH INPUT CIRCUITS FOR A SHORT

The key start switch and the disconnect switch remain in the OFF position. The machine harness remains disconnected from the switch.

- Disconnect the machine harness connectors J1 and J2 from the ECM.
- At the machine harness connector J2 for the ECM, measure the resistance between the switch input, contact J2-38 (wire U734-GN(Green)), and the frame ground. Measure the resistance between the switch input, contact J2-38 (wire U734-GN(Green)), and all of the other contacts that are used in the J1 and J2 harness connectors for the ECM.

C. At the machine harness connector J2 for the ECM, measure the resistance between the switch input, contact J2-39 (wire U735-GY(Grey)), and the frame ground. Measure the resistance between the switch input, contact J2-39 (wire U735-GY(Grey)), and all of the other contacts that are used in the J1 and J2 harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The input circuits of the switch are not shorted to ground or to another circuit in the machine harness. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short to ground or to another circuit in the machine harness.

Repair: The input circuit that checks the low resistance to frame ground or to another circuit is the cause of the problem.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the faulty input circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated and that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.

E. Operate the machine.

F. Check the status of the CID 0070 FMI 04 diagnostic code.

Expected Result:

The CID 0070 FMI 04 diagnostic code is no longer active.

Results:

- YES – The CID 0070 FMI 04 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NO – The CID 0070 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the input circuits of the switch again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause can not be found, the ECM may have failed. Verify that all possible causes of the diagnostic code have been investigated before replacement of the ECM.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i04860193

MID 027 - CID 0096 - FMI 03

SMCS Code: 1439-038

Conditions Which Generate This Code:

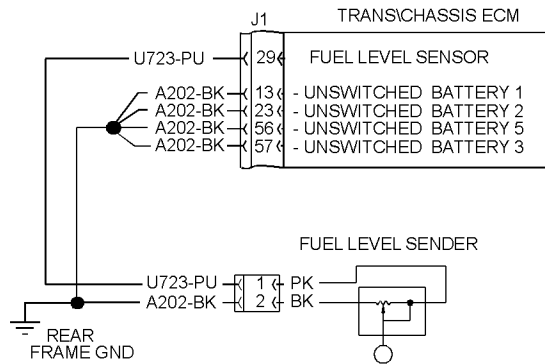


Illustration 116

g02101793

Connections of the "Fuel Level Sender"

This diagnostic code is associated with the "Fuel Level Sender". The FMI 03 diagnostic code means that the "Transmission/Chassis ECM" has detected that the voltage for the circuit of the "Fuel Level Sender" is above 4.5 VDC.

In addition to monitoring the voltage of the sender signal, the ECM monitors the resistance of the sender signal. The ECM associates the resistance value of the sender circuit with a specific amount of fuel in the fuel tank. The ECM sends this information to the Messenger over the data link.

When the fuel tank is nearly empty, the resistance in the circuit of the sender is approximately 248 ± 8 ohms. When the fuel tank is nearly full, the resistance in the circuit of the sender is approximately 27 ± 2 ohms.

Conditions that can cause this diagnostic code to be activated are listed below:

- The ground circuit for the sender is open in the machine harness.
- The signal circuit in the machine harness is open or the sender is disconnected.
- The sender has failed.
- The ECM has failed. A failure of the Transmission/Chassis ECM is unlikely.

Test Step 1. CHECK THE RESISTANCE OF THE SENDER

- Turn the disconnect switch and the key start switch to the OFF position.

- Disconnect the machine harness connector from the "Fuel Level Sender".

- At the connector for the sender, measure the resistance between the contact 1 and the contact 2.

Expected Result:

The resistance measurement should be around 247 ohms when the tank is empty. The resistance measurement should be around 27 ohms when the tank is full.

Results:

- OK – The resistance measurement is in the correct range. The sender is OK. Proceed to Test Step 2.
- NOT OK – The resistance measurement is not in the correct range. The fuel level sender has failed.

Repair: Replace the fuel level sender. Ensure that the new sender corrects the problem.

STOP.

Test Step 2. CHECK THE CONTROL AND THE HARNESS

- Turn the disconnect switch and the key start switch to the ON position.
- Disconnect the machine harness connector from the fuel level sender.
- At the machine harness connector for the sender, measure the voltage (DCV) between the signal contact 1 (wire U723-PU(Purple)) and the return contact 2 (wire A202-BK(Black)).

Expected Result:

The voltage is between 4.5 and 8.0 DCV.

Results:

- OK – The voltage is between 4.5 and 8.0 DCV. The main display module and the harness are correct.

Repair: Replace the sender.

STOP.

- NOT OK – The voltage is not between 4.5 and 8.0 DCV. The Transmission/Chassis ECM or the harness has failed. Proceed to Test Step 3.

Test Step 3. CHECK THE GROUND CIRCUIT OF THE HARNESS

Diagnostic Code Procedures

The sender remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- A. Disconnect the J1 machine harness connector from the ECM.
- B. At the machine harness connector for the sender, measure the resistance between contact 2 (wire A202-BK(Black)) and frame ground.

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5.0 ohms. The ground circuit is correct. Proceed to Test Step 4.
- NOT OK – The resistance measurement is greater than 5.0 ohms. There is an open circuit or a bad connection in the ground circuit for the sender.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is either not connected or that a wire is open. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points or a splice in the circuit is not an open connection but not a good connection.

Refer to the complete Electrical System Schematic of the machine. Ensure that all connections and splices in the ground circuit for the sender are clean. Observe that all connections are secure and that all connections are in good condition.

Start at the component connector for the faulty circuit. When checking the wire for an open point or a bad connection point, work your way through the circuit to isolate the location of the problem. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SIGNAL CIRCUIT OF THE HARNESS

The sender remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- A. The ECM machine harness connector J1 is disconnected from the ECM. Disconnect the J2 machine harness connector from the ECM.

- B. At the machine harness connector J1, measure the resistance between the signal circuit at contact J1-29 (wire U723-PU(Purple)) and all of the other contacts that are used for the J1 and J2 contacts for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The circuit is not shorted in the machine harness. Proceed to Test Step 5.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. The signal circuit for the sender is shorted to another circuit in the machine harness.

Repair: The short is between signal wire U723-PU(Purple) and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Ensure that all connections in the signal circuit for the sender are clean. Check that all connections are secure. Observe that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are fastened securely.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 0096 FMI 03 diagnostic code.

Expected Result:

The CID 0096 FMI 03 diagnostic code is not active.

Results:

- OK – The CID 0096 FMI 03 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0096 FMI 03 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the circuit for the sender again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause cannot be found, the ECM may have failed.

Prior to replacing an ECM, always contact the Technical Communicator at your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Machine ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i03795294

MID 027 - CID 0096 - FMI 04

SMCS Code: 1439-038

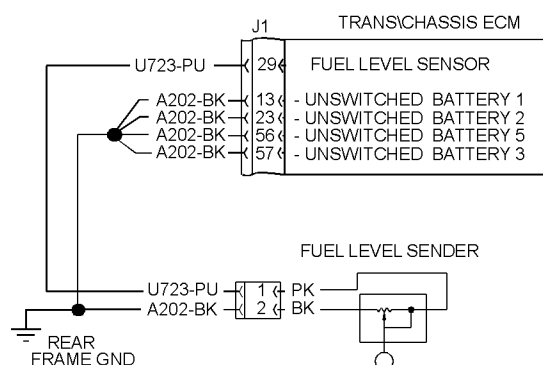
Conditions Which Generate This Code:

Illustration 117

g02101793

Connections of the "Fuel Level Sender"

This diagnostic code is associated with the "Fuel Level Sender". The FMI 04 diagnostic code means that the "Transmission/Chassis ECM" has detected that the voltage of the fuel level sender circuit is below 0.1 VDC.

In addition to monitoring the voltage of the sender signal, the ECM monitors the resistance of the sender signal. The ECM associates the resistance value of the sender with the amount of fuel in the fuel tank. The ECM sends this information to the Messenger over the data link.

When the fuel tank is nearly empty, the resistance in the circuit of the sender is around 248 ± 8 ohms. When the fuel tank is nearly full, the resistance in the circuit of the sender is around 27 ± 2 ohms.

Conditions that can cause this diagnostic code to be activated are listed below:

- The sender has failed.
- The signal circuit in the machine harness is shorted to a ground source.
- The ECM has failed. This is unlikely.

Test Step 1. CHECK THE RESISTANCE OF THE SENDER

- Turn the disconnect switch and the key start switch to the OFF position.
- Disconnect the machine harness connector from the "Fuel Level Sender".

- C. At the connector for the sender, measure the resistance between the contact 1 and the contact 2.

Expected Result:

The resistance measurement should be approximately 247 ohms when the tank is empty. The resistance measurement should be approximately 27 ohms when the tank is full.

Results:

- OK – The resistance measurement is in the correct range. The sender is OK. Proceed to Test Step 2.
- NOT OK – The resistance measurement is not in the correct range. The “Fuel Level Sender” has failed.

Repair: Replace the “Fuel Level Sender” . Ensure that the new sender corrects the problem.

STOP.

Test Step 2. CHECK THE SIGNAL CIRCUIT OF THE HARNESS

The sender remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- A. Disconnect the J1 and J2 machine harness connectors from the ECM.
- B. At the machine harness connector J1, measure the resistance from the signal circuit, contact J1-29 (wire U723-PU(Purple)), and frame ground. Measure the resistance from the signal circuit, contact J1-29 (wire U723-PU(Purple)), and all of the other contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The circuit is not shorted in the machine harness. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. The signal circuit for the sender is shorted to another circuit or to frame ground in the machine harness.

Repair: The short is between signal wire U723-PU(Purple) and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Ensure that all connections in the signal circuit for the sender are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, “Wiring Harness (Short Circuit) - Test”. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 0096 FMI 04 diagnostic code.

Expected Result:

The CID 0096 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 0096 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0096 FMI 04 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the circuit of the sender again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The

wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause can not be found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Machine ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i07035039

MID 027 - CID 0127 - FMI 03

SMCS Code: 1439-038-T3; 3080-038-PXS

Conditions Which Generate This Code:

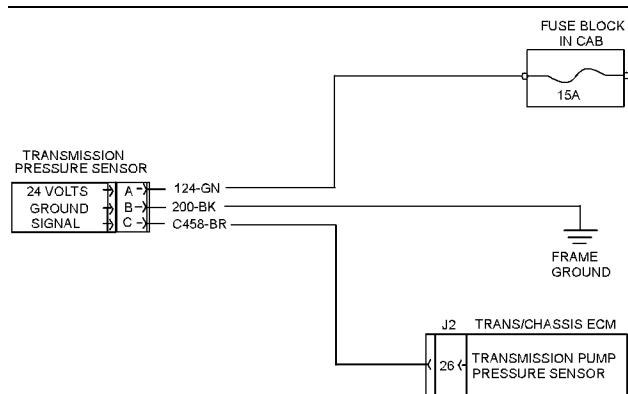


Illustration 118

g02161515

Transmission pump pressure sensor circuit

This diagnostic code is associated with the transmission pump pressure sensor. The FMI 03 means that the transmission/chassis electronic control module (ECM) has determined that the voltage of the circuit for the sensor is above normal.

The output of the sensor is an analog signal from 0.2 DCV to 4.95 DCV. The voltage changes as the pressure changes. The ECM recognizes a voltage in the range of 0.2 DCV to 4.95 DCV as valid input from the sensor. If the voltage is below 0.2 DCV for more than 2 seconds, the ECM determines that the sensor is shorted to ground. If the voltage is above 4.95 DCV for more than 2 seconds, the ECM determines that the sensor is shorted to the + battery.

The possible causes of this diagnostic code are listed below:

- HVAC fuse failure
- The signal circuit for the sensor is open.

- The signal circuit for the sensor is shorted to the +battery circuit.
- The sensor has failed.
- The power circuit or the ground circuit has failed.
- The ECM has failed. ECM failure is unlikely.
- AC arc suppressor failure

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0127 FMI 03 is active before performing this procedure.**

Note: Use a calibrated 146 - 4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK FOR POWER AT THE SENSOR.

- Do not disconnect the harness connector from the sensor.
- Turn the keyswitch to the ON position.
- Turn the disconnect switch to the ON position.
- At the back of the harness connector for the sensor, insert a 7X - 1710 Multimeter Probe along the voltage supply wire (contact A).
- Measure the voltage from contact A to frame ground.

Expected Result:

The voltage is +24 DCV.

Results:

- OK – The voltage is +24 DCV. Proceed to Test Step 2.
- NOT OK – The voltage is not +24 DCV. The + battery circuit in the harness has failed.

Repair: Replace or repair the harness.

STOP.

Test Step 2. CHECK FOR PROPER GROUND AT THE SENSOR.

Note: The harness remains connected to the sensor.

- Turn the keyswitch and the disconnect switch to the OFF position.

- B.** Remove the 7X - 1710 Multimeter Probe from the voltage supply wire (contact A).
- C.** At the back of the harness connector for the sensor, insert a 7X - 1710 Multimeter Probe along the ground wire (contact B).
- D.** Measure the resistance from contact B to frame ground.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The ground circuit is correct. Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5 ohms. The ground circuit in the harness has failed.

Repair: Replace or repair the harness.

STOP.

Test Step 3. CHECK THE WIRING HARNESS OF THE SENSOR FOR AN OPEN CIRCUIT.

Note: The keyswitch and the disconnect switch remain in the OFF position.

- A.** Disconnect the harness from the sensor.
- B.** At the harness connector for the sensor, connect a jumper wire between contact B and contact C.
- C.** Disconnect the harness connectors from the ECM.
- D.** At the harness connector for the ECM, measure the resistance between the contact for (wire 200-BK(Black)) and the contact for (wire C458-BR(Brown)).

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The circuit is correct. Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The circuit is not correct. There is an open circuit in the wiring harness.

Repair: There is an open circuit in the wiring harness. Repair or replace the wiring harness.

STOP.

Test Step 4. CHECK THE WIRING HARNESS OF THE SENSOR FOR A SHORT TO THE +BATTERY CIRCUIT.

Note: The keyswitch and the disconnect switch remain in the OFF position. The harness remains disconnected from the sensor. The harness connectors remain disconnected from the ECM.

- A.** Remove the jumper wire that was installed in the previous step.
- B.** At the harness connector for the ECM, measure the resistance from the signal contact J2-26 (wire C458-BR(Brown)) of the harness to all contacts that are used in the harness connectors for the ECM.

Expected Result:

Each resistance is greater than 5000 ohms.

Results:

- OK – Each resistance is greater than 5000 ohms. The harness is correct. Proceed to Test Step 5.
- NOT OK – A resistance is not correct. There is a short in the harness.

Repair: The short is between the contact for (wire C458-BR(Brown)) and the circuit with the low resistance. Repair or replace the harness.

STOP.

Test Step 5. CHECK THE OUTPUT OF THE SENSOR.

- A.** Reconnect the harness connectors to the ECM.
- B.** Reconnect the harness connector to the sensor.
- C.** At the back of the harness connector for the sensor, insert a 7X - 1710 Multimeter Probe along the signal wire (contact C).
- D.** At the back of the harness connector for the sensor, insert a 7X - 1710 Multimeter Probe along the ground wire (contact B).
- E.** Turn the disconnect switch to the ON position.
- F.** Turn the keyswitch to the ON position.
- G.** Measure the signal of the sensor. The proper signal is described at the beginning of this procedure.

Expected Result:

The signal from the sensor is valid.

Results:

i03966191

- OK – The signal from the sensor is valid. Proceed to Test Step 6.
- NOT OK – The signal from the sensor is not valid.

Repair: The sensor has failed. Replace the sensor.

STOP.

Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

- Inspect and clean the contacts of the harness connectors.
- Reconnect all harness connectors.
- Turn the disconnect switch to the ON position.
- Turn the keyswitch to the ON position.
- Operate the machine.
- Check the status of the CID 0127 FMI 03.

Expected Result:

The CID 0127 FMI 03 is active.

Results:

- YES – The CID 0127 FMI 03 is active. The diagnostic code has not been corrected. The ECM may have failed, however, ECM failure is unlikely.

Repair: Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact technical communicator at your dealer for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the transmission/chassis ECM. If the ECM must be replaced, refer to the Testing and Adjusting, "Electronic Control Module (ECM) - Replace" section of this manual.

STOP.

- NO – The CID 0127 FMI 03 is not active. The diagnostic code does not exist at this time.

Repair: The diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

MID 027 - CID 0127 - FMI 04

SMCS Code: 1439-038-T3; 3080-038-PXS

Conditions Which Generate This Code:

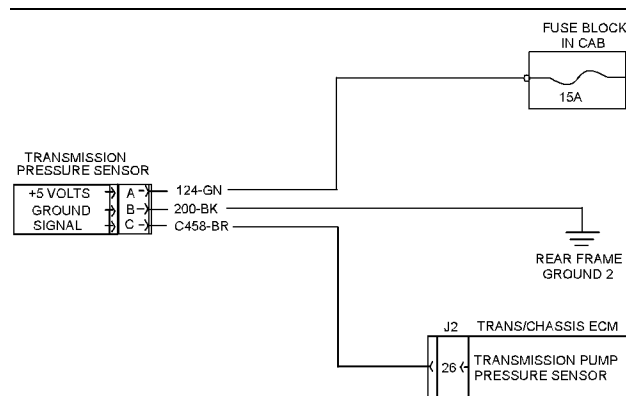


Illustration 119

g01943324

Transmission pump pressure sensor circuit

This diagnostic code is associated with the transmission pump pressure sensor. The FMI 04 means that the ECM has determined that the voltage of the circuit for the position sensor is below normal.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is shorted to ground.
- The sensor has failed.
- The ECM has failed. ECM failure is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 0127 FMI 04 is active before performing this procedure.**

Note: Use a calibrated 146 - 4080 Digital Multimeter for the measurements in this procedure.

Test Step 1. CHECK THE SENSOR.

- Turn the disconnect switch to the ON position.
- Turn the keyswitch to the ON position.
- Ensure that the diagnostic code is active.
- Observe the status of the diagnostic code. Disconnect the sensor from the harness.

Expected Result:

Diagnostic Code Procedures

The CID 0127 FMI 04 remains active. FMI 04 is still active.

Results:

- OK – The diagnostic code remains active. The sensor is correct. Proceed to Test Step 2.
- NOT OK – The diagnostic code is no longer active. The sensor has failed.

Repair: Replace the sensor.

STOP.

Test Step 2. CHECK THE WIRING HARNESS OF THE SENSOR FOR A SHORT TO GROUND.

- Turn the keyswitch and the disconnect switch to the OFF position.
- Disconnect the harness from the sensor.
- Disconnect the harness connectors from the ECM.
- At the harness connector for the ECM, measure the resistance from the signal contact J2-26 (wire C458-BR(Brown)) of the harness to all possible sources of ground. Measure the resistance to all contacts of the harness connectors for the ECM.

Expected Result:

Each resistance is greater than 5000 ohms.

Results:

- OK – Each resistance is greater than 5000 ohms. The harness is correct. Proceed to Test Step 3.
- NOT OK – A resistance is not correct. There is a short in the harness.

Repair: The short is between signal contact J2-26 (wire C458-BR(Brown)) and the circuit with the low resistance. Repair or replace the harness.

STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

- Inspect and clean the contacts of the harness connectors.
- Reconnect all harness connectors.
- Turn the disconnect switch to the ON position.
- Turn the keyswitch to the ON position.

E. Operate the machine.

F. Check the status of the CID 0127 FMI 04.

Expected Result:

The CID 0127 FMI 04 is active.

Results:

- YES – The CID 0127 FMI 04 is active. The diagnostic code has not been corrected. The ECM may have failed, however, ECM failure is unlikely.

Repair: Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact technical communicator at your dealer for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to the Testing and Adjusting, "Electronic Control Module (ECM) - Replace" section of this manual.

STOP.

- NO – The CID 0127 FMI 04 is not active. The diagnostic code does not exist at this time.

Repair: The diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02839788

MID 027 - CID 0144 - FMI 03

SMCS Code: 4493-038-UB

Conditions Which Generate This Code:

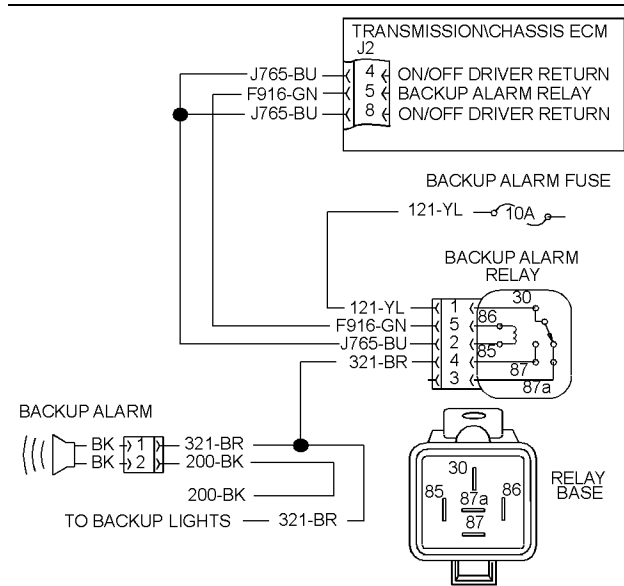


Illustration 120

g01287438

Back Up Alarm Relay connections

This diagnostic code is associated with the back up alarm relay. The back up alarm relay is controlled by the ECM through an ON/OFF output driver. The FMI 03 means that the ECM has determined that the voltage is present in the relay circuit when the output driver is OFF.

The conditions that could cause this diagnostic code to activate are listed:

- The relay has failed.
- The energize circuit of the relay is shorted to another voltage source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, secure and in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE RELAY

- Turn the key start switch and the disconnect switch to the ON position.
- While observing the status of the active CID 0144 FMI 03 diagnostic code, disconnect the backup alarm relay from the machine harness.
- At the relay, measure the resistance of the coil between contact 85 and contact 86. Measure the resistance between power contact 30 and all of the other relay contacts.

Expected Result:

When the relay is disconnected from the harness, the status of the active CID 0144 FMI 03 diagnostic code does not change.

The resistance of the relay coil is in the range of 288 to 396 ohms at 25 °C (77 °F).

The resistance measurement between power contact 30 and contact 87a is less than 5 ohms. The resistance measurement between power contact 30 and all the other relay contacts is greater than 5000 ohms.

Results:

- YES – All of the checks for the relay are correct. The relay is not causing the problem. The CID 0144 FMI 03 diagnostic code is still active. Proceed to Test Step 2.
- NO – The active CID 0144 FMI 03 diagnostic code became inactive when the relay was disconnected. The resistance checks are not correct according to the expected results listed above. The relay has failed.

Repair: Verify that the relay has failed by substituting a known good relay that is the same part number for the defective relay. The cab flood lights relay can be substituted. Replace the defective relay.

STOP.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE RELAY FOR A SHORT

The relay remains disconnected from the machine harness.

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.

Diagnostic Code Procedures

- C.** At the machine harness connector J2 for the ECM, measure the resistance from contact J2-5 (wire F916-GN(Green)) to all of the other contacts that are used in the machine harness connectors J1 and J2 for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The energize circuit is not shorted to another circuit in the machine harness. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-5 (wire F916-GN(Green)) and the circuit that has a low resistance measurement.

Repair: Refer to the complete machine Electrical System Schematic. Check all of the connectors that are in the relay circuit. Ensure that all connections are clean, secure and in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors and clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C.** Reconnect all harness connectors making sure that the connectors are fully seated and the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Determine if the CID 0144 FMI 03 diagnostic code is active.

Expected Result:

The CID 0144 FMI 03 diagnostic code is active.

Results:

- YES – The CID 0144 FMI 03 diagnostic code is active. The problem has not been corrected.

Repair: Check the relay circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a "Wiggle Test" on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Troubleshooting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0144 FMI 03 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors or at the relay base that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02443494

MID 027 - CID 0144 - FMI 05

SMCS Code: 4493-038-UB

Conditions Which Generate This Code:

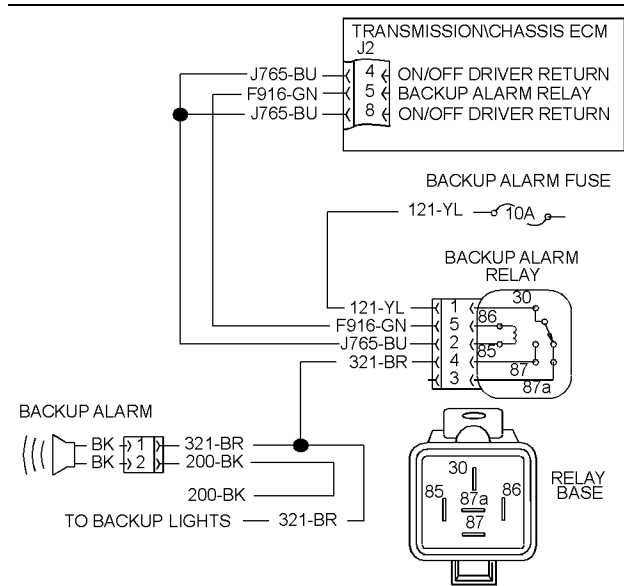


Illustration 121

g01287438

Back Up Alarm Relay connections

This diagnostic code is associated with the back up alarm relay. The back up alarm relay is controlled by the ECM through an ON/OFF output driver. The FMI 05 means that the ECM has energized the output for the relay and the current for the relay circuit is below normal.

The conditions that could cause this diagnostic code to activate are listed:

- The relay has failed.
- The energize circuit of the relay is open or has a bad connection in the machine harness.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, secure and in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE RELAY

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the relay.
- At the harness connector for the relay, connect a jumper wire between contact 5 (wire F916-GN(Green)) and contact 2 (wire J765-BU(Blue)).
- Turn the disconnect switch and the key start switch to the ON position.
- Observe the status of the active CID 0144 FMI 05 diagnostic code.

Expected Result:

The active CID 0144 FMI 05 diagnostic code is no longer active when the key start switch is turned ON. A CID 0144 FMI 06 diagnostic code is now active.

Results:

- YES – The CID 0144 FMI 05 diagnostic code is no longer active, a CID 0144 FMI 06 diagnostic code becomes active when the key start switch is turned ON.

Repair: The relay is causing the problem. Verify that the relay has failed by substituting a known good relay that is the same part number as the defective relay. The cab flood lights relay can be substituted. Replace the defective relay.

STOP.

- NO – The jumper wire does not affect the status of the active CID 0144 FMI 05 diagnostic code when the key switch is turned ON. The relay is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE RELAY CIRCUIT FOR AN OPEN

The relay remains disconnected from machine harness. The jumper wire remains connected between contact 5 and contact 2.

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connectors J1 and J2 from the Transmission Chassis ECM.
- At the machine harness connector J2 for the ECM, measure the resistance between contact J2-5 (wire F916-GN(Green)) and contact J2-4 (wire J765-GN(Green)).

- D. At the machine harness connector J2 for the ECM, measure the resistance between contact J2-5 (wire F916-GN(Green)) and contact J2-8 (wire J765-GN(Green)).

Expected Result:

Both resistance measurements are less than 5 ohms.

Results:

- OK – The resistance measurements are less than 5 ohms. The energize circuit and the return circuit are not open in the machine harness. Proceed to Test Step 3.
- NOT OK – One or both of the resistance measurements is greater than 5 ohms. There is an open or a bad connection in either the return circuit or the energize circuit.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is either not connected or is open. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points or a splice connection in the circuit is not open but is not a good connection.

If one of the resistance measurements is greater than 5 ohms and the other measurement is less than 5 ohms, one of the return circuits is not correct. This will not cause the diagnostic code to activate as the other return circuit is working correctly, however, this is a problem that needs to be investigated and corrected.

If both measurements are greater than 5 ohms, determine whether the energize circuit or the return circuit is causing the problem. Disconnect the jumper wire. Use a spare length of wire in order to check the resistance of the energize circuit and the return circuit individually.

Refer to the complete machine Electrical System Schematic. Check all of the connectors that are in the circuit. Ensure that all connections are clean, secure and in good condition.

Start at either the ECM connector or the component connector for the defective circuit. While checking the wire for an open or a bad connection point, work your way through the circuit in order to isolate where the problem is. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors and clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all harness connectors making sure that the connectors are fully seated and the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 0144 FMI 05 diagnostic code is active.

Expected Result:

The CID 0144 FMI 05 diagnostic code is active.

Results:

- YES – The CID 0144 FMI 05 diagnostic code is active. The problem has not been corrected.

Repair: Check the relay circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a "Wiggle Test" on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Troubleshooting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0144 FMI 05 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors or at the relay base that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02443502

MID 027 - CID 0144 - FMI 06

SMCS Code: 4493-038-UB

Conditions Which Generate This Code:

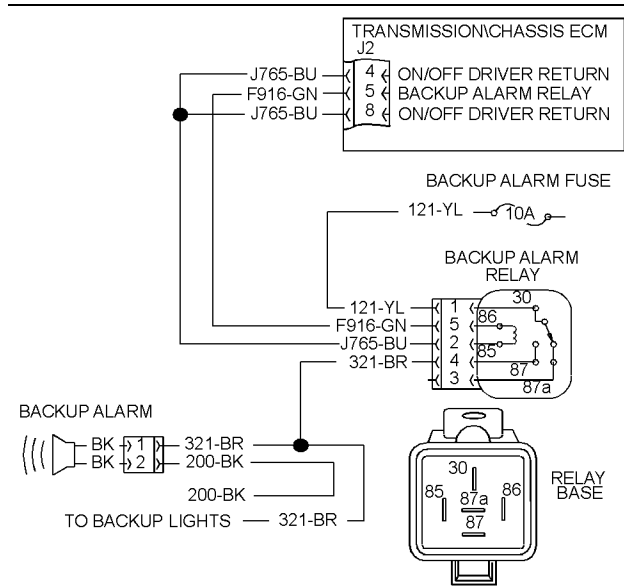


Illustration 122

g01287438

Back Up Alarm Relay connections

This diagnostic code is associated with the back up alarm relay. The back up alarm relay is controlled by the ECM through an ON/OFF output driver. The FMI 06 means that the ECM has energized the output for the relay and the current for the relay circuit is above normal.

The conditions that could cause this diagnostic code to activate are listed:

- The relay has failed.
- The energize circuit of the relay is shorted to a ground source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, secure and in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE RELAY

- Turn the key start switch and the disconnect switch to the ON position.
- While observing the status of the active CID 0144 FMI 06 diagnostic code, disconnect the machine harness connector from the relay.

Expected Result:

When the relay is disconnected from the harness, the CID 0144 FMI 06 diagnostic code is no longer active. A CID 0144 FMI 05 is now active.

Results:

- YES – When the relay is disconnected from the harness, the CID 0144 FMI 06 diagnostic code is no longer active. A CID 0144 FMI 05 diagnostic code becomes active. The relay is causing the problem.

Repair: Verify that the relay has failed by substituting a known good relay that is the same part number as the defective relay. The cab flood lights relay can be substituted. Replace the defective relay.

STOP.

- NO – The status of the active CID 0144 FMI 06 diagnostic code did not change when the relay is disconnected from the machine harness. The relay is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE RELAY FOR A SHORT

The relay remains disconnected from the machine harness.

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connectors J1 and J2 from the Transmission Chassis ECM.
- At the machine harness connector J2 for the ECM, measure the resistance from contact J2-5 (wire F916-GN(Green)) to frame ground. Measure the resistance from contact J2-5 (wire F916-GN(Green)) to all of the other contacts that are used in the Machine harness connectors J1 and J2 for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The energize circuit is not shorted to another circuit in the machine harness. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-5 (wire F916-GN(Green)) and the circuit that has a low resistance measurement.

Repair: Refer to the complete machine Electrical System Schematic. Check all of the connectors that are in the relay circuit. Ensure that all connections are clean, secure and in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors and clean the contacts of the harness connectors and check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- Reconnect all harness connectors making sure that the connectors are fully seated and the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Determine if the CID 0144 FMI 06 diagnostic code is active.

Expected Result:

The CID 0144 FMI 06 diagnostic code is active.

Results:

- YES – The CID 0144 FMI 06 diagnostic code is active. The problem has not been corrected.

Repair: Check the relay circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a "Wiggle Test" on the machine wiring harness. The

wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Troubleshooting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0144 FMI 06 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors or at the relay base that was disconnected and reconnected. Resume normal machine operation.

STOP.

i04814856

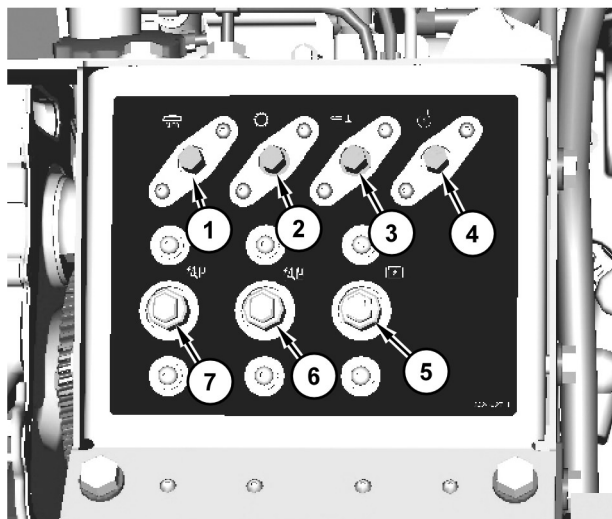
MID 027 - CID 0168 - FMI 00**SMCS Code:** 1406-038**Conditions Which Generate This Code:**

Illustration 123

g01323933

Power Breaker Box located on left side of machine behind the Cab

- (1) Accugrade Breaker (20 Amp)
- (2) Transmission Control Breaker (15 Amp)
- (3) Key Switch Breaker (15 Amp)
- (4) Engine Control Breaker (20 Amp)
- (5) Alternator Breaker (150 Amp)
- (6) Load Breaker (80 Amp)
- (7) Main Breaker (80 Amp)

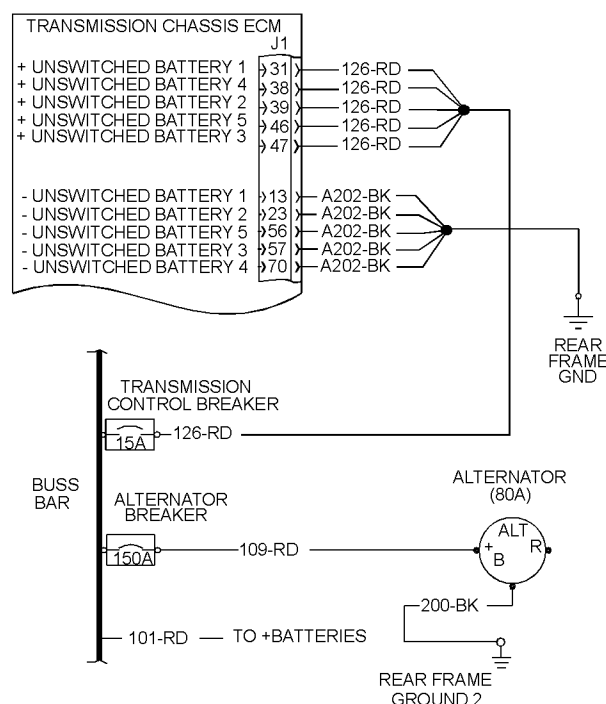


Illustration 124

g01287806

Transmission/Chassis ECM System Voltage connections

This diagnostic code is associated with the system voltage of the machine that is supplied to the Transmission/Chassis ECM. The FMI 00 means that the ECM has detected that the system voltage is above normal. The ECM activates this diagnostic code when the system voltage is above 32.0 VDC.

The possible causes of this diagnostic code are listed below:

- A charging system component has failed.
- The harness wiring has failed.
- The ECM has failed, however ECM failure is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Test Step 1. CHECK THE SYSTEM VOLTAGE AT THE ECM

Diagnostic Code Procedures

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. At the J1 harness connector for the Transmission/ Chassis ECM, insert a 7X - 1710 Multimeter Probe along the supply connection for the system power J1-31 (wire 126-RD(Red)). Use the other multimeter probe to make contact to frame ground.
- C. Turn the disconnect switch to the ON position.
- D. Start the engine and run the engine at half throttle.
- E. Measure the voltage between contact J1-31 (wire 126-RD(Red)) and frame ground.
- F. At the J1 harness connector for the ECM, insert the 7X - 1710 Multimeter Probe that was used for the frame ground contact along the system power supply negative battery contact J1-13 (wire A202-BK(Black)).
- G. Measure the voltage between contact J1-31 (wire 126-RD(Red)) and contact J1-13 (wire A202-BK(Black)).

Expected Result:

Both voltage measurements are approximately in the range of 18.0 VDC to 32.0 VDC.

Results:

- OK – Both voltage measurements are approximately in the range of 18.0 VDC to 32.0 VDC. The system voltage is correct. Proceed to Test Step 5.
- NOT OK – Each voltage measurement is greater than 32.0 VDC. The system voltage is above normal. Proceed to Test Step 3.
- NOT OK – The measurement from the positive battery contact to frame ground is in the range of 18.0 VDC to 32.0 VDC, however, the measurement between the ECM positive battery contact and the ECM negative battery contact is not in the correct range. The ground circuit may have failed. Proceed to Test Step 2.

Test Step 2. CHECK THE GROUND CIRCUITS

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness J1 connector from the ECM.

- C. At the J1 harness connector for the ECM, measure the resistance between each of the five negative battery contacts and frame ground. The contacts for the negative battery connections are illustrated in the connection diagram at the beginning of this procedure.

Expected Result:

Each resistance measurement is less than 5.0 ohms.

Results:

- OK – Each resistance measurement is less than 5.0 ohms. The ground circuit is correct. Reconnect the J1 machine harness connector to the ECM before proceeding to the next test step. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is greater than 5.0 ohms. There is an open circuit or a poor connection in the ground circuit.

Repair: The open circuit or the possible poor connection is in the ground circuit wire of the ECM A202-BK(Black) in the machine harness. Refer to the complete Electrical System Schematic of the machine. Check the ground connection at the rear frame by locating wire A202-BK(Black). Ensure that the ground connection is clean, that the ground connection is tight and that the ground connection is in good condition. Check all of the connectors and splice points that are in the ground circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE ALTERNATOR CURRENT OUTPUT

- A. Before performing this test step, partially discharge the batteries. Partially discharging the batteries can be done by cranking the engine for approximately 30 seconds without starting the engine. Partially discharging the batteries can also be done by turning on the lights for about 10 minutes without running the engine.
- B. Turn the disconnect switch and the key start switch to the OFF position.
- C. At the alternator, connect multimeter probes between the alternator "B" terminal (wire 109-RD(Red)) and the alternator case (frame ground).

- D. Connect a clamp on 225 - 8266 Ammeter Tool Gp or an equivalent ammeter around the output wire 109-RD(Red).
- E. Turn the disconnect switch to the ON position.
- F. Start the engine.
- G. Run the engine at approximately half throttle.
- H. Immediately check the output current of the alternator.

Expected Result:

The output current of the alternator at half throttle is approximately 40 amps, half of the alternator full current output rating (80 Amps).

Results:

- YES – The output current of the alternator at half throttle is approximately 40 amps. Proceed to Test Step 4.
- NO – The output current of the alternator at half throttle is not approximately 40 amps. The current output of the alternator is not correct.

Repair: Refer to Service Manual, SENR4130 for brushless alternators for further testing and repair procedures for the alternator.

STOP.

Test Step 4. CHECK THE ALTERNATOR VOLTAGE OUTPUT

The multimeter and the ammeter are still connected as in the last test step. The engine is running.

- A. Run the engine for approximately 10 minutes at half throttle.
- B. Check the voltage at the alternator output "B" terminal.

Expected Result:

The voltage measurement is 28.0 ± 1.0 VDC.

Results:

- YES – The voltage measurement is 28.0 ± 1.0 VDC. The voltage output of the alternator is correct. Proceed to Test Step 5.
- NO – The voltage is greater than 32.0 VDC.

Repair: Refer to the complete Electrical System Schematic for your machine. Check all connections that are in the charging circuit.

Ensure that all ground connections are clean, that all connections are tight and that all connections are in good condition.

If a problem is not found in the machine harness or connection points, refer to Service Manual, SENR4130 for brushless alternators for further testing and repair procedures for the alternator.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. Reconnect any harness connectors that were disconnected and checked.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Operate the machine.
- E. Determine if the CID 0168 FMI 00 diagnostic code is active.

Expected Result:

The CID CID 0168 FMI 00 diagnostic code is active.

Results:

- YES – The CID 0168 FMI 00 diagnostic code is active.

Repair: Perform this procedure again. Verify that the measurements of the alternator are correct. Verify that the circuit connections for the system voltage are in good condition and that the connections are tight.

If the problem remains and no cause can be found, the ECM may have failed.

However, ECM failure is unlikely. Verify that all possible causes of the diagnostic code have been investigated. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0168 FMI 00 code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection

Diagnostic Code Procedures

or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i04814866

MID 027 - CID 0168 - FMI 01

SMCS Code: 1406-038

Conditions Which Generate This Code:

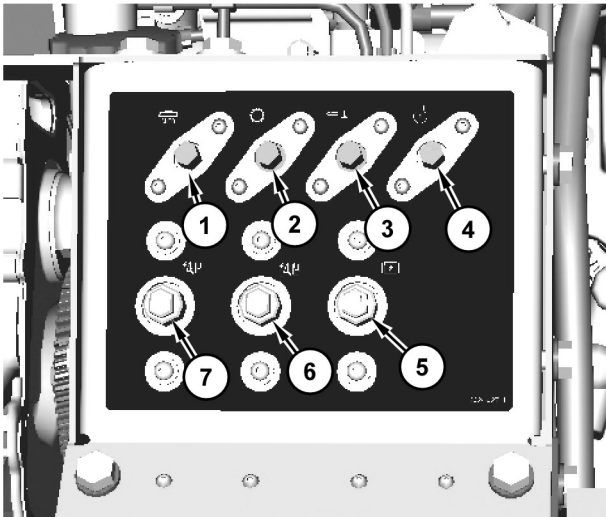


Illustration 125

g01323933

Power Breaker Box located on left side of machine behind the Cab

- (1) Accugrade Breaker (20 Amp)
- (2) Transmission Control Breaker (15 Amp)
- (3) Key Switch Breaker (15 Amp)
- (4) Engine Control Breaker (20 Amp)
- (5) Alternator Breaker (150 Amp)
- (6) Load Breaker (80 Amp)
- (7) Main Breaker (80 Amp)

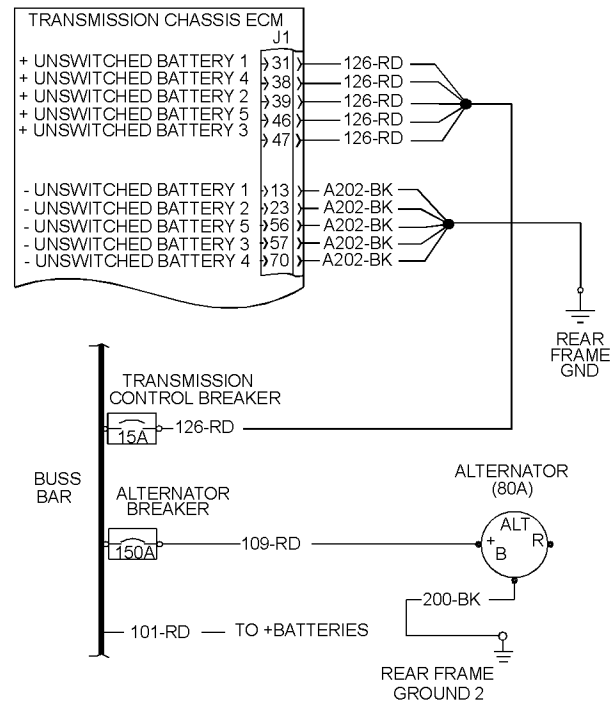


Illustration 126

g01287806

Transmission/Chassis ECM System Voltage connections

This diagnostic code is associated with the system voltage of the machine that is supplied to the Transmission/Chassis ECM. The FMI 01 means that the ECM has detected that the system voltage is below normal. The ECM activates this diagnostic code when the system voltage is below 18.0 VDC.

The possible causes of this diagnostic code are listed below:

- An open circuit or a poor system ground circuit connection.
- An open circuit or poor connection in the system voltage supply circuit.
- A charging system component has failed.
- The ECM has failed, however ECM failure is unlikely.

Note: Before performing this procedure, verify that all circuit breakers and fuses in the charging circuit and the supply circuit of the ECM are closed. If a problem with a circuit breaker or a fuse is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Test Step 1. CHECK THE SYSTEM VOLTAGE AT THE ECM

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. At the J1 harness connector for the ECM, insert a 7X - 1710 Multimeter Probe along the system power supply, contact J1-31 (wire 126-RD(Red)). Use the other multimeter probe to make contact to frame ground.
- C. Turn the disconnect switch to the ON position.
- D. Start the engine and run the engine at half throttle.
- E. Measure the voltage between contact J1-31 (wire 126-RD(Red)) and frame ground.
- F. At the J1 harness connector for the Implement ECM, insert the 7X - 1710 Multimeter Probe that was used for the frame ground contact along the system power supply negative battery contact J1-13 (wire A202-BK(Black)).
- G. Measure the voltage between contact J1-31 (wire 126-RD(Red)) and contact J1-13 (wire A202-BK(Black)).

Expected Result:

Both voltage measurements are approximately in the range of 18.0 VDC to 32.0 VDC.

Results:

- OK – Each voltage measurement is approximately in the range of 18.0 VDC to 32.0 VDC. The system voltage is correct. Proceed to Test Step 6.
- NOT OK – Each voltage measurement is approximately the same, however, the measurements are less than 18.0 VDC. The system voltage is below normal. Proceed to Test Step 4.
- NOT OK – The measurement from the positive battery contact to frame ground is in the range of 18.0 VDC to 32.0 VDC, however, the measurement between the ECM positive battery contact and the ECM negative battery contact is not in the correct range. The ground circuit may have failed. Proceed to Test Step 2.

Test Step 2. CHECK THE GROUND CIRCUIT

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness J1 connector from the ECM.

- C. At the J1 harness connector for the ECM, measure the resistance between each of the five negative battery contacts and frame ground. The contacts for the negative battery connections are illustrated in the connection diagram at the beginning of this procedure.

Expected Result:

Each resistance measurement is less than 5.0 ohms.

Results:

- OK – Each resistance measurement is less than 5.0 ohms. The ground circuit is correct. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is greater than 5.0 ohms. There is an open circuit or a poor connection in the ground circuit.

Repair: The open or the possible poor connection is in the ground circuit of the ECM (wire A202-BK(Black)) in the machine harness. Refer to the complete Electrical System Schematic of the machine. Check the ground connection point of the rear frame by locating wire A202-BK(Black). Ensure that the ground connection is clean, that the ground connection is tight and that the ground connection is in good condition. Check all of the connectors and splice points that are in the ground circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SUPPLY CIRCUITS

The key start switch and the disconnect switch remain in the OFF position. The machine harness J1 connector remains disconnected from the ECM.

- A. At the J1 harness connector for the ECM, using a length of spare wire, measure the resistance between the alternator "B" terminal (wire 109-RD(Red)) to each of the five positive battery contacts that are connected to the J1 harness connector. The contacts for the five positive battery connections are illustrated in the connection diagram at the beginning of this procedure.

Expected Result:

Each resistance measurement is less than 5.0 ohms.

Results:

- OK – Each resistance measurement is less than 5.0 ohms. The supply circuit is correct. Reconnect the J1 machine harness connector to the ECM before proceeding to the next test step. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is greater than 5.0 ohms. There is an open circuit or a poor connection in the supply circuit.

Repair: The open or the possible poor connection is in the supply circuit for the system voltage of the ECM (wire 126-RD(Red)) in the machine harness. Verify that there are no open circuit breakers or fuses in the circuit.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors and splice points that are in the supply circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE ALTERNATOR CURRENT OUTPUT

- Before performing this test step, partially discharge the batteries. Partially discharging the batteries can be done by cranking the engine for approximately 30 seconds without starting the engine. Partially discharging the batteries can also be done by turning on the lights for about 10 minutes without running the engine.
- Turn the disconnect switch and the key start switch to the OFF position.
- At the alternator, connect multimeter probes between the alternator "B" terminal (wire 109-RD(Red)) and the alternator case (frame ground).
- Connect a clamp on 225 - 8266 Ammeter Tool Gp or equivalent ammeter around the output wire 109-RD(Red).
- Turn the disconnect switch to the ON position.
- Start the engine.
- Run the engine at approximately half throttle.
- Immediately check the output current of the alternator.

Expected Result:

The output current of the alternator at half throttle is approximately 40 amps, half the alternator full current output rating (80 Amps).

Results:

- YES – The output current of the alternator at half throttle is approximately 40 amps. Proceed to Test Step 5.
- NO – The output current of the alternator at half throttle is not approximately 40 amps. The current output of the alternator is not correct.

Repair: Refer to Service Manual, SENR4130 for brushless alternators for further testing and repair procedures for the alternator.

STOP.

Test Step 5. CHECK THE ALTERNATOR VOLTAGE OUTPUT

The multimeter and the ammeter are still connected from the last test step. The engine is running.

- Run the engine for approximately 10 minutes at half throttle.
- Check the voltage at the alternator output "B" terminal.

Expected Result:

The voltage measurement is 28.0 ± 1.0 VDC.

Results:

- YES – The voltage measurement is 28.0 ± 1.0 VDC. The voltage output of the alternator is correct. Proceed to Test Step 6.
- NO – The voltage is less than 18.0 VDC.

Repair: Refer to the complete Electrical System Schematic for your machine. Check all connections that are in the charging circuit. Ensure that all ground connections are clean, that all connections are tight and that all connections are in good condition.

If a problem is not found in the machine harness or connection points, refer to Service Manual, SENR4130 for brushless alternators for further testing and repair procedures for the alternator.

STOP.

Test Step 6. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. Reconnect any harness connectors that were disconnected and checked.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Operate the machine.
- E. Determine if the CID 0168 FMI 01 diagnostic code is active.

Expected Result:

The CID 0168 FMI 01 diagnostic code is active.

Results:

- YES – The CID 0168 FMI 01 diagnostic code is active.

Repair: Perform this procedure again. Verify that the measurements of the alternator are correct. Verify that the circuit connections for the system voltage are in good condition and that the connections for system voltage are tight.

If the problem remains and no cause can be found, the ECM may have failed. faulty.

However, ECM failure is unlikely. Verify that all possible causes of the diagnostic code have been investigated. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0168 FMI 01 code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i04814874

MID 027 - CID 0168 - FMI 02

SMCS Code: 1406-038

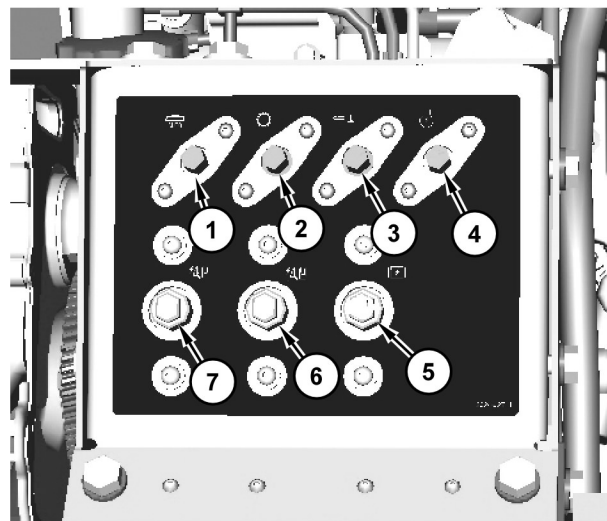
Conditions Which Generate This Code:

Illustration 127

g01323933

Power Breaker Box located on the left side of the machine behind the Cab

- (1) Accugrade Breaker (20 Amp)
- (2) Transmission Control Breaker (15 Amp)
- (3) Key Switch Breaker (15 Amp)
- (4) Engine Control Breaker (20 Amp)
- (5) Alternator Breaker (150 Amp)
- (6) Load Breaker (80 Amp)
- (7) Main Breaker (80 Amp)

Diagnostic Code Procedures

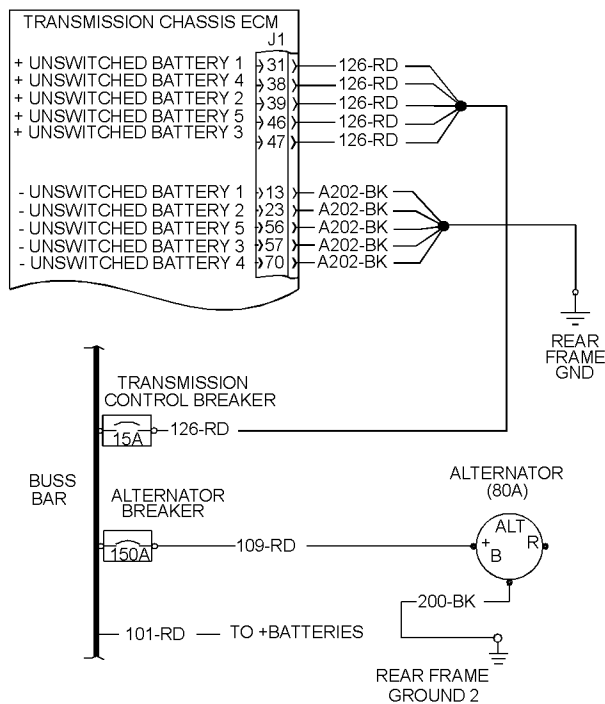


Illustration 128

g01287806

Transmission/Chassis ECM System Voltage connections

This diagnostic code is associated with the system voltage of the machine that is supplied to the Transmission/Chassis ECM. The FMI 02 means that the ECM has detected that the system voltage is erratic or that the system voltage is intermittent. The ECM activates this diagnostic code when the system voltage is not in the range of 18.0 VDC to 32.0 VDC for more than a few seconds.

The possible causes of this diagnostic code are listed below:

- A poor circuit connection to the system ground
- A poor circuit connection to system voltage
- A charging system component has failed.
- The ECM has failed, however ECM failure is unlikely.

Note: Before performing this procedure, verify that all circuit breakers and fuses in the charging circuit and the system supply circuit of the ECM are closed. If a problem with a circuit breaker or the fuse is found, correct the problem. Verify that this diagnostic code is active before performing this procedure.

Test Step 1. CHECK THE SYSTEM VOLTAGE AT THE ECM

- Turn the disconnect switch and the key start switch to the OFF position.
- At the J1 harness connector for the Implement ECM, insert a 7X - 1710 Multimeter Probe along the supply circuit for the system power J1-31 (wire 126-RD(Red)). Use the other multimeter probe to make contact to frame ground.
- Turn the disconnect switch to the ON position.
- Start the engine and run the engine at half throttle.
- Measure the voltage between contact J1-31 (wire 126-RD(Red)) and frame ground.
- Observe the resistance measurement of the multimeter and wiggle the machine harness connectors for the ECM. Gently pull on the wires and move the wires around.
- At the J1 harness connector for the ECM, insert the 7X - 1710 Multimeter Probe that was used for the frame ground contact along the system power supply negative battery contact J1-13(wire A202-BK(Black)).
- Measure the voltage between contact J1-31 (wire 126-RD(Red)) and contact J1-13 (wire A202-BK(Black)).
- Observe the resistance measurement of the multimeter and wiggle the machine harness connectors for the ECM. Gently pull on the wires and wiggle the wires.

Expected Result:

Both voltage measurements are approximately the same and are in the range of 18.0 VDC to 32.0 VDC at all times during the manipulation of the harness and the connectors.

Results:

- OK – Each voltage measurement is approximately the same and is in the range of 18.0 VDC to 32.0 VDC. The system voltage is correct at all times during the manipulation of the harness and connectors. Proceed to Test Step 6.
- NOT OK – Each voltage measurement is approximately the same, however, the measurements are not stable. The voltage measurements are showing a large amount of variation. The manipulation of the machine harness and connectors does not affect the measurement. Proceed to Test Step 4.

- NOT OK – The measurement from the positive battery contact to frame ground is stable and is in the range of 18.0 VDC to 32.0 VDC, however, the measurement between the ECM positive battery contact and the ECM negative battery contact is not stable in the correct range at all times. Proceed to Test Step 2.

Test Step 2. CHECK THE GROUND CIRCUITS

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness J1 connector from the ECM.
- At the J1 harness connector for the ECM, measure the resistance between each of the five negative battery contacts and frame ground. The contacts for the negative battery connections are illustrated in the connection diagram at the beginning of this procedure.

Expected Result:

Each resistance measurement is less than 5.0 ohms.

Results:

- OK – Each resistance measurement is less than 5.0 ohms. The ground circuit is correct. Reconnect the J1 machine harness connector to the ECM before proceeding to the next test step. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is greater than 5.0 ohms. There is an open circuit or a poor connection in the ground circuit.

Repair: The open or the possible poor connection is in the ground circuit of the ECM (wire A202-BK(Black)) in the machine harness. Refer to the complete Electrical System Schematic of the machine. Check the ground connection located on the rear frame (wire A202-BK(Black)). Ensure that the ground connection is clean, that the ground connection is tight and that the ground connection is in good condition. Check all of the connectors and splice points that are in the ground circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SUPPLY CIRCUITS

The key start switch and the disconnect switch remain in the OFF position. The machine harness J1 connector remains disconnected from the ECM.

- At the J1 harness connector for the ECM, using a length of spare wire, measure the resistance between the alternator "B" terminal (wire 109-RD(Red)) and each of the five positive battery contacts that are connected to the J1 harness connector. The contacts for the five positive battery connections are illustrated in the connection diagram at the beginning of this procedure.

Expected Result:

Each resistance measurement is less than 5.0 ohms.

Results:

- OK – Each resistance measurement is less than 5.0 ohms. The supply circuit is correct. Reconnect the J1 machine harness connector to the ECM before proceeding to the next test step. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is greater than 5.0 ohms. There is an open circuit or a poor connection in the supply circuit.

Repair: The open or the possible poor connection is in the voltage supply circuit of the ECM (wire 126-RD(Red)) in the machine harness. Verify that there are no open circuit breakers or fuses in the circuit.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors and splice points that are in the supply circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE ALTERNATOR CURRENT OUTPUT

- Before performing this test step, partially discharge the batteries. Partially discharging the batteries can be done by cranking the engine for approximately 30 seconds without starting the engine. Partially discharging the batteries can also be done by turning on the lights for about 10 minutes without running the engine.
- Turn the disconnect switch and the key start switch to the OFF position.

Diagnostic Code Procedures

- C. At the alternator, connect multimeter probes between the alternator "B" terminal (wire 109-RD(Red)) and the alternator case (frame ground).
- D. Connect a clamp on 225 - 8266 Ammeter Tool Gp or an equivalent ammeter around the output wire 109-RD(Red).
- E. Turn the disconnect switch to the ON position.
- F. Start the engine.
- G. Run the engine at approximately half throttle.
- H. Immediately check the output current of the alternator.

Expected Result:

The output current of the alternator at half throttle is approximately 40 amps, half the alternator full current output rating (80 Amps). The current measurement is stable.

Results:

- YES – The output current of the alternator at half throttle is approximately 40 amps and is stable. Proceed to Test Step 5.
- NO – The output current of the alternator at half throttle is not stable. The measurement is showing a large variation of current values. The current output of the alternator is not correct.

Repair: Refer to Service Manual, SENR4130 for brushless alternators for further testing and repair procedures for the alternator.

STOP.

Test Step 5. CHECK THE ALTERNATOR VOLTAGE OUTPUT

The multimeter and the ammeter are still connected as used in the last test step. The engine is running.

- A. Run the engine for approximately 10 minutes at half throttle.
- B. Check the voltage at the alternator output terminal ("B").

Expected Result:

The voltage measurement is 28.0 ± 1.0 VDC. There is little variation or no variation in the voltage measurement.

Results:

- YES – The voltage measurement is 28.0 ± 1.0 VDC. The voltage is stable. The voltage output of the alternator is correct. Proceed to Test Step 6.
- NO – The voltage is not stable. There is a large variation in the measured voltage. The voltage output is not correct.

Repair: Refer to Service Manual, SENR4130 for brushless alternators for further testing and repair procedures for the alternator.

STOP.

Test Step 6. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. Reconnect any harness connectors that were disconnected and checked.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Operate the machine.
- E. Determine if the CID 0168 FMI 02 diagnostic code is active.

Expected Result:

The CID 0168 FMI 02 diagnostic code is active.

Results:

- YES – The CID 0168 FMI 02 diagnostic code is active.

Repair: Perform this procedure again. Verify that the measurements at the alternator are correct. Confirm that the circuit connections for the system voltage are in good condition and that the circuit connections are tight.

If the problem remains and no cause can be found, the ECM may have failed.

However, ECM failure is unlikely. Verify that all possible causes of the diagnostic code have been investigated. Exit this procedure and perform this procedure again. If the cause of the diagnostic code is not found, replace the ECM. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0168 FMI 02 code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i04853130

MID 027 - CID 0168 - FMI 03

SMCS Code: 1406-038

Conditions Which Generate This Code:

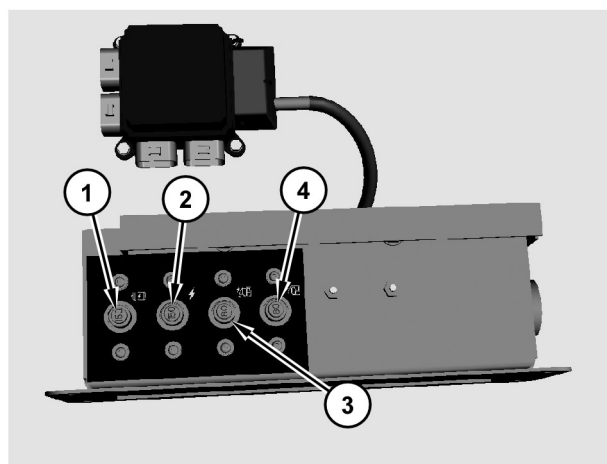


Illustration 129

g01405586

Circuit breaker box located in the engine compartment behind the right rear wheel

- (1) Alternator circuit breaker (150 amp)
- (2) Battery circuit breaker (150 amp)
- (3) Main breaker (80 amp)
- (4) Load circuit breaker (80 amp)

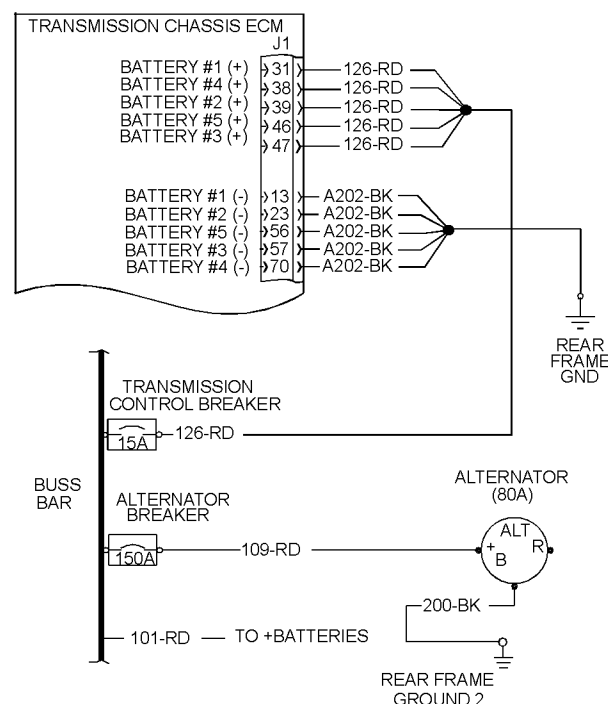


Illustration 130

g01379576

Transmission/chassis ECM system voltage connections

This diagnostic code is associated with the Transmission/Chassis ECM supply voltage. The ECM activates this diagnostic code when the system voltage is above 32.0 VDC.

The possible causes of this diagnostic code are listed below:

- Charging system component failure
- Harness failure
- The ECM failure, however ECM failure is unlikely

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can be the cause of an electrical circuit problem. Verify that all connections in the circuit are clean, secure, and in good condition. If a connection problem is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Test Step 1. CHECK SYSTEM VOLTAGE AT THE TRANSMISSION/CHASSIS ECM

A. Turn off the disconnect switch and the keyswitch.

- B.** At the J1 harness connector for the transmission/chassis ECM, insert a7X - 1710 Multimeter Probe along the positive battery contact, J1-31 (wire 126-RD(Red)). Use the other multimeter probe to contact the frame ground.
- C.** Turn on the disconnect switch.
- D.** Start the engine and run at half throttle.
- E.** Measure the voltage between contact J1-31, (wire 126-RD(Red)) and the frame ground.
- F.** At the J1 harness connector for the ECM, insert the 7X - 1710 Multimeter Probe along the negative battery contact J1-13 (wire A202-BK(Black)).
- G.** Measure the voltage between contact J1-31 (wire 126-RD(Red)) and contact J1-13 (wire A202-BK(Black)).

Expected Result:

Both voltages are approximately the same and are 18 to 32 VDC.

Results:

- OK – Voltages are approximately the same and are 18 to 32 VDC. Proceed to Test Step 5.
- NOT OK – Voltages are approximately the same, but are greater than 32 VDC. Proceed to Test Step 3.
- NOT OK – The voltage from the positive battery contact to frame (ground) is 18 to 32 VDC. However, the voltage between the ECM positive battery contact and the ECM negative battery contact is not 18 to 32 VDC. Proceed to Test Step 2.

Test Step 2. CHECK THE GROUND CIRCUITS

- A.** Turn the keyswitch and the disconnect switch off.
- B.** Disconnect the harness J1 connector from the ECM.
- C.** At the J1 harness connector for the ECM, measure the resistance between each negative battery contact and ground. The contacts for the negative battery connections are shown in Illustration 130 .

Expected Result:

Each resistance is less than 5.0 ohms.

Results:

- OK – Each resistance is less than 5.0 ohms. Reconnect the J1 harness connector to the ECM. Proceed to Test Step 3.
- NOT OK – A resistance is greater than 5.0 ohms. There is an open or poor connection in ECM ground wire A202-BK(Black).

Repair: Check the ground A202-BK(Black) connection at the rear frame. Ensure that the ground connection is clean, tight, and in good condition. Check all of the ground circuit connectors and splices. Ensure that all connections are clean, tight, and in good condition. Repair or replace the harness.

STOP.

Test Step 3. CHECK THE ALTERNATOR CURRENT OUTPUT

- A.** Before performing this test step, partially discharge the batteries. Crank the engine for approximately 30 seconds or turn on the lights for about 10 minutes without the running the engine.
- B.** Turn off the disconnect switch and keyswitch.
- C.** Connect multimeter probes between the alternator "B" terminal (wire 109-RD(Red)) and the alternator case (frame ground).
- D.** Connect a clamp on 225 - 8266 Ammeter Tool Gp or an equivalent ammeter around the output wire 109-RD(Red).
- E.** Turn on the disconnect switch.
- F.** Start the engine.
- G.** Run the engine at approximately half throttle.
- H.** Immediately check the alternator output current.

Expected Result:

The alternator output current at half throttle is approximately 40 amps.

Results:

- YES – The alternator output current at half throttle is approximately 40 amps. Proceed to Test Step 4.
- NO – The alternator output current at half throttle is not approximately 40 amps.

Repair: See Service Manual, SENR4130.

STOP.

Test Step 4. CHECK THE ALTERNATOR VOLTAGE OUTPUT

The multimeter and the ammeter are still connected.

- A. Run the engine for approximately 10 minutes at half throttle.
- B. Check the voltage at the alternator "B" terminal.

Expected Result:

The voltage is 28 ± 1.0 VDC.

Results:

- YES – The voltage is 28 ± 1.0 VDC. Proceed to Test Step 5.
- NO – The voltage is greater than 32 VDC.

Repair: See the machine Electrical Schematic. Check all charging circuit connections. Ensure that all ground connections are clean, tight, and in good condition.

If a problem is not found, see Service Manual, SENR4130.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Turn off the keyswitch and disconnect switch.
- B. Reconnect any disconnected harness connectors.
- C. Turn on the disconnect switch and keyswitch.
- D. Operate the machine.
- E. Determine if CID 0168 FMI 03 is active.

Expected Result:

CID 0168 FMI 03 is active.

Results:

- YES – CID 0168 FMI 03 is active.

Repair: Perform this procedure again. Verify that the alternator voltage is correct and the connections are in good condition.

If the problem remains and no cause can be found, the ECM may have failed. However, ECM failure is unlikely.

If the cause of the diagnostic code is not found, contact your Cat® dealer. If ECM replacement is required, see Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – CID 0168 FMI 03 is not active.

Repair: The initial diagnostic code was probably caused by a poor connection or short. Resume machine operation.

STOP.

i04831784

MID 027 - CID 0168 - FMI 04

SMCS Code: 1406-038

Conditions Which Generate This Code:

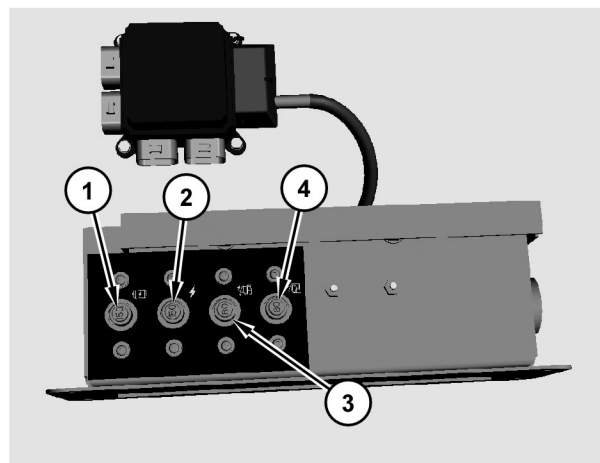


Illustration 131

g01405586

Power circuit breaker box located in the engine compartment behind the right rear wheel

- (1) Alternator circuit breaker (150 amp)
- (2) Battery circuit breaker (80 amp)
- (3) Main breaker (80 amp)
- (4) Load circuit breaker (80 amp)

Diagnostic Code Procedures

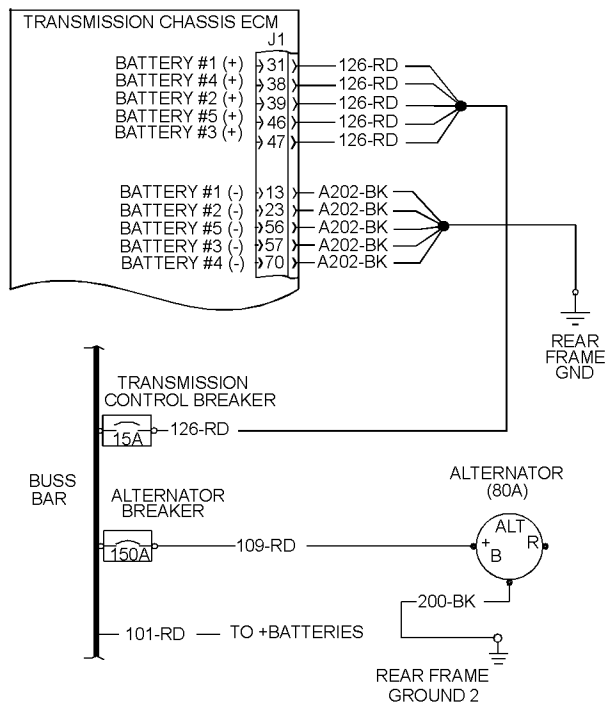


Illustration 132

g01379576

Transmission/Chassis ECM voltage connections

This diagnostic code is associated with the Transmission/Chassis ECM supply voltage. FMI 04 means that the ECM has detected the voltage is below 19.0 VDC.

The possible causes of this diagnostic code are listed below:

- An open or poor ground circuit connection
- An open or poor voltage supply connection
- Charging system component failure
- ECM failure (ECM failure is unlikely)

Note: Before performing this procedure, verify that all circuit breakers and fuses in the charging circuit and ECM supply circuit are closed. If a problem with a circuit breaker or fuse is found, correct the problem. Verify that this diagnostic code is active before performing this procedure.

Test Step 1. CHECK SYSTEM VOLTAGE AT THE TRANSMISSION/CHASSIS ECM

A. Turn off the keyswitch and disconnect switch.

B. At the J1 harness connector for the ECM, insert a 7X - 1710 Multimeter Probe along the positive battery contact, J1-31 (wire 126-RD(Red)). Use the other multimeter probe to contact to frame ground.

C. Turn on the disconnect switch.

D. Start the engine and run at half throttle.

E. Measure the voltage between contact J1-31 (wire 126-RD(Red)) and frame ground.

F. At the J1 harness connector for the ECM, insert the 7X - 1710 Multimeter Probe along -battery contact J1-13, (wire A202-BK(Black)).

G. Measure the voltage between contact J1-31 (wire 126-RD(Red)) and contact J1-13 (wire A202-BK(Black)).

Expected Result:

Both voltages are approximately the same and are 19 to 32 VDC.

Results:

- OK – Voltages are approximately the same and are 19 to 32 VDC. Proceed to Test Step 6.
- NOT OK – Voltages are approximately the same, but are less than 19 VDC. Proceed to Test Step 4.
- NOT OK – The voltage from the positive battery contact to frame ground is 8 to 32 VDC. However, the measurement between the ECM positive battery contact and the ECM negative battery contact is not in 8 to 32 VDC. The ground circuit may have failed. Proceed to Test Step 2.

Test Step 2. CHECK THE GROUND CIRCUIT

A. Turn off the keyswitch and disconnect switch.

B. Disconnect the harness J1 connector from the ECM.

C. At the J1 harness connector for the ECM, measure the resistance between each negative battery contacts and frame ground. The contacts for the negative battery connections are shown in Illustration 132 .

Expected Result:

Each resistance is less than 5.0 ohms.

Results:

- OK – Each resistance is less than 5.0 ohms. Proceed to Test Step 3.

- NOT OK – A resistance is greater than 5.0 ohms. There is an open or poor connection in the ECM ground circuit (wire A202-BK(Black)).

Repair: Check ground wire A202-BK(Black) at the rear frame. Ensure that the ground connection is clean, tight, and in good condition. Check all of the ground circuit connectors and splice points. Ensure that all connections are clean, secure, and in good condition. Repair or replace the harness.

STOP.

Test Step 3. CHECK THE SUPPLY CIRCUITS

The keyswitch and disconnect switch remain off. The harness J1 connector remains disconnected from the ECM.

- A.** At the J1 harness connector for the ECM, using a jumper wire, measure the resistance between the alternator “B” terminal (wire 109-RD(Red)) and each positive battery contacts that are connected to the J1 harness connector. The contacts for the positive battery connections are shown in Illustration 132 .

Expected Result:

Each resistance is less than 5.0 ohms.

Results:

- OK – Each resistance is less than 5.0 ohms. Reconnect the J1 harness connector to the ECM before proceeding to the next test step. Proceed to Test Step 4.
- NOT OK – A resistance is greater than 5.0 ohms. There is an open or a poor connection at (wire 126-RD(Red)).

Repair: Verify that there are no open circuit breakers or fuses in the circuit.

See the machine Electrical Schematic. Check all of the supply circuit connectors and splice points. Ensure that all connections are clean, secure, and in good condition. Repair or replace the harness.

STOP.

Test Step 4. CHECK THE ALTERNATOR CURRENT OUTPUT

- A.** Before performing this test step, partially discharge the batteries. Crank the engine for approximately 30 seconds without starting the engine or turn on the lights for about 10 minutes without running the engine.
- B.** Turn off the keyswitch and disconnect switch.
- C.** Connect multimeter probes between the alternator “B” terminal (wire 109-RD(Red)) and the alternator case.
- D.** Connect a clamp on 225 - 8266 Ammeter Tool Gp around output wire 109-RD(Red).
- E.** Turn on the disconnect switch.
- F.** Start the engine.
- G.** Run the engine at approximately half throttle.
- H.** Immediately check the alternator output current.

Expected Result:

The alternator output current at half throttle is approximately 40 amps.

Results:

- YES – The alternator output current at half throttle is approximately 40 amps. Proceed to Test Step 5.
- NO – The alternator output current at half throttle is not approximately 40 amp.

Repair: See Service Manual, SENR4130.

STOP.

Test Step 5. CHECK THE ALTERNATOR VOLTAGE OUTPUT

The multimeter and ammeter are still connected.

- A.** Run the engine for approximately 10 minutes at half throttle.
- B.** Check the voltage at alternator terminal “B” .

Expected Result:

The voltage is 28 ± 1.0 VDC.

Results:

- YES – The voltage is 28 ± 1.0 VDC. Proceed to Test Step 6.
- NO – The voltage is less than 19.0 VDC.

Repair: See the machine Electrical Schematic. Check all charging circuit connections. Ensure that all ground connections are clean, tight, and in good condition.

If a problem is not found in the harness or connection points, see the machine Service Manual.

STOP.

Test Step 6. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Turn off the keyswitch and disconnect switch.
- B. Reconnect any disconnected connectors.
- C. Turn on the disconnect switch and keyswitch.
- D. Operate the machine.
- E. Determine if CID 0168 FMI 04 is active.

Expected Result:

CID 0168 FMI 04 is active.

Results:

- YES – CID 0168 FMI 04 is active. The ECM may have failed. However, ECM failure is unlikely.

Repair: Perform this procedure again.

If the cause of the diagnostic code is not found, contact your Cat® dealer. If ECM replacement is required, see Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NO – CID 0168 FMI 04 is not active.

Repair: The initial diagnostic code was probably caused by a poor connection or short. Resume normal machine operation.

STOP.

i04862170

MID 027 - CID 0177 - FMI 03

SMCS Code: 3194-038-OC

Conditions Which Generate This Code:

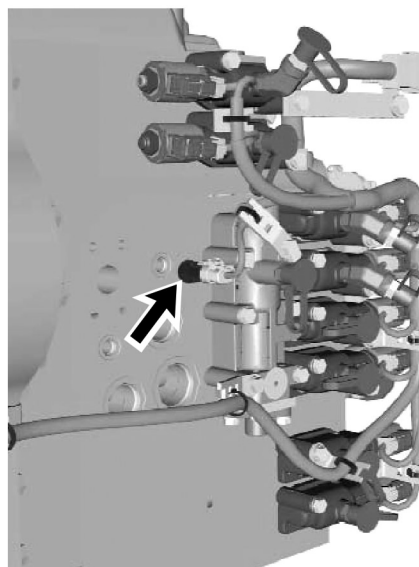


Illustration 133

g01321613

Transmission Oil Temperature Sensor location on the left side of the transmission (arrow)

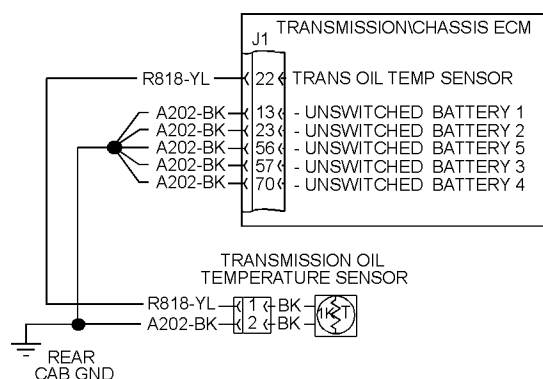


Illustration 134

g01287815

Transmission Oil Temperature sensor connections

This diagnostic code is associated with the transmission oil temperature sensor. The FMI 03 means that the Transmission/Chassis ECM has detected that the voltage of the sensor circuit is above 4.9 VDC and the resistance of the sensor is more than 33650 ohms.

In addition to monitoring the voltage of the sensor signal, the ECM monitors the resistance of the sensor signal. The ECM associates the resistance value of the sensor circuit with a specific temperature of the transmission oil.

The resistance range of the sensor that the ECM will consider valid is 33650 ohms at -40°C (-40.0°F) to 18.6 ohms at 150°C (302.0°F).

Conditions that can cause this diagnostic code to be activated are listed below:

- The sensor has failed.
- The ground circuit for the sensor is open in the machine harness.
- The signal circuit in the machine harness is open or the sensor is disconnected.
- The ECM has failed. This is unlikely.
- The oil temperature is below -40°C (-40.0°F).

Test Step 1. CHECK THE RESISTANCE OF THE SENSOR

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. Disconnect the machine harness connector from the sensor.
- C. At the connector for the sensor, measure the resistance between contact 1 and contact 2.

Expected Result:

The resistance measurement is less than 33650 ohms.

Results:

- OK – The resistance measurement is less than 33650 ohms. The resistance of the sensor is correct. Proceed to Test Step 2.
- NOT OK – The resistance measurement is greater than 33650 ohms. The transmission oil temperature sensor has failed.

Repair: Replace the transmission oil temperature sensor. Ensure that the new sensor corrects the problem.

STOP.

Test Step 2. CHECK THE GROUND CIRCUIT OF THE HARNESS

The sensor remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- A. Disconnect the J1 machine harness connector from the ECM.

- B. At the machine harness connector for the sensor, measure the resistance between contact 2 (wire A202-BK(Black)) to frame ground.

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5.0 ohms. The ground circuit is correct. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5.0 ohms. There is an open circuit or a bad connection in the ground circuit for the sensor.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is either not connected or a wire is open. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points or a splice connection in the circuit is not open but is not a good connection.

Refer to the complete Electrical System Schematic of the machine. Ensure that all connections and splices in the ground circuit for the sensor are clean, secure and in good condition.

Start at the component connector for the defective circuit. While checking the wire for an open or a bad connection point, work your way through the circuit in order to isolate the problem. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT OF THE HARNESS

The sensor remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- A. The ECM machine harness connector J1 is disconnected from the ECM. Disconnect the J2 machine harness connector from the ECM.
- B. At the machine harness connector J1, measure the resistance between the signal circuit at contact J1-22 (wire R818-YL(Yellow)) and all of the other contacts that are used in the J1 and J2 contacts for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The circuit is not shorted in the machine harness. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. The signal circuit for the sensor is shorted to another circuit in the machine harness.

Repair: The short is between signal wire R818-YL (Yellow) and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Ensure that all connections in the signal circuit for the sensor are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated and that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 0177 FMI 03 diagnostic code.

Expected Result:

The CID 0177 FMI 03 diagnostic code is not active.

Results:

- OK – The CID 0177 FMI 03 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0177 FMI 03 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the sensor circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause can not be found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Machine ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02906333

MID 027 - CID 0177 - FMI 04

SMCS Code: 3194-038-OC

Conditions Which Generate This Code:

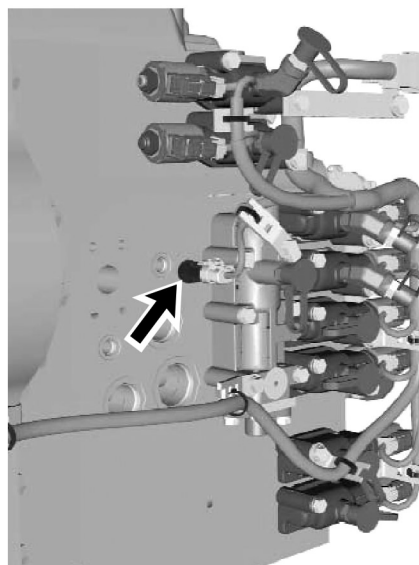


Illustration 135

g01321613

Transmission Oil Temperature sensor location is on the left side of the transmission (arrow).

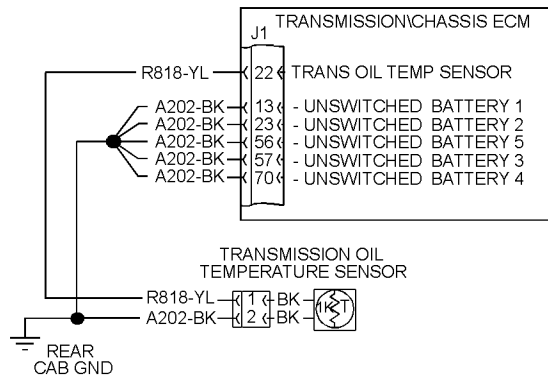


Illustration 136

g01287815

Transmission Oil Temperature sensor connections

This diagnostic code is associated with the transmission oil temperature sensor. The FMI 04 means that the Transmission/Chassis ECM has detected that the voltage of the sensor circuit is below 0.18 VDC and the resistance of the sensor is less than 18.6 ohms.

In addition to monitoring the voltage of the sensor signal, the ECM monitors the resistance of the sensor signal. The ECM associates the resistance value of the sensor circuit with a specific temperature of the transmission oil.

The resistance range of the sensor that the ECM will consider valid is 33650 ohms at -40°C (-40.0°F) to 18.6 ohms at 150°C (302.0°F).

Conditions that can cause this diagnostic code to be activated are listed below:

- The sensor has failed.
- The signal circuit in the machine harness is shorted to a ground source.
- The ECM has failed. This is unlikely.

Test Step 1. CHECK THE RESISTANCE OF THE SENSOR

- Turn the disconnect switch and the key start switch to the OFF position.
- Disconnect the machine harness connector from the sensor.
- At the connector for the sensor, measure the resistance between contact 1 and contact 2.

Expected Result:

The resistance measurement is greater than 18.6 ohms.

Results:

- OK – The resistance measurement is greater than 18.6 ohms. The resistance of the sensor is correct. Proceed to Test Step 2.
- NOT OK – The resistance measurement is less than 18.6 ohms. The sensor has failed.

Repair: Replace the transmission oil temperature sensor. Ensure that the new sensor corrects the problem.

STOP.

Test Step 2. CHECK THE SIGNAL CIRCUIT OF THE HARNESS

The sensor remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- Disconnect the J1 and J2 machine harness connectors from the ECM.
- At the machine harness connector J1, measure the resistance from the signal circuit at contact J1-22 (wire R818-YL(Yellow)) to frame ground. Measure the resistance from the signal circuit at contact J1-22 (wire R818-YL(Yellow)) to all of the other contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The circuit is not shorted in the machine harness. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. The signal circuit for the sensor is shorted to another circuit or to frame ground in the machine harness.

Repair: The short is between signal wire R818-YL(Yellow) and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Ensure that all connections in the signal circuit for the sensor are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

i02914601

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 0177 FMI 04 diagnostic code.

Expected Result:

The CID 0177 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 0177 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0177 FMI 04 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the sensor circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause can not be found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Machine ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

MID 027 - CID 0247 - FMI 09

SMCS Code: 7610-038-DTN

Conditions Which Generate This Code:

SAE J1939 Data Link

The CID 0247 FMI 09 diagnostic code is used by the Transmission/Chassis ECM as a "companion code" that is activated simultaneously with a diagnostic code from another control module in order to indicate that the SAE J1939 data link has an abnormal condition.

The FMI 09 code will match the FMI 09 code that is activated for the diagnostic code of the control module. The FMI 09 means that the Transmission/Chassis ECM has lost all communication with the other control module.

The CID 0247 FMI 09 diagnostic code will never be activated by the Transmission/Chassis ECM as a stand-alone diagnostic code. The Transmission/Chassis ECM will only activate the CID 0247 FMI 09 diagnostic code along with one of the following module communication codes.

CID 0590 FMI 09 – Engine ECM

CID 0596 FMI 09 – Implement ECM

For example, if the Transmission/Chassis ECM detects that no communication is being received from the Implement ECM over the SAE J1939 Data Link, the Transmission/Chassis ECM will simultaneously activate a CID0596 FMI 09 (Implement ECM) diagnostic code and a CID0247 FMI 09 (SAE J1939 Data Link) diagnostic code.

If the Transmission/Chassis ECM did not activate the companion diagnostic code CID 0247 FMI 09 along with the control module code, the technician would not know which data link circuit (Cat Data Link or J1939 Data Link) is involved.

When the CID 0247 FMI 09 diagnostic code is activated by the Transmission/Chassis ECM, always look for one of the control module diagnostic codes that are listed above in order to troubleshoot the problem.

Perform the following procedure when the CID 0247 FMI 09 diagnostic code is activated. Verify that the CID 0247 FMI 09 diagnostic code is active before performing this procedure.

- A. The CID 0247 FMI 09 diagnostic code for the SAE J1939 Data Link is active. Look for one of the active control module diagnostic codes that is listed at the beginning of this procedure.

Expected Result:

One of the control module diagnostic codes that is listed at the beginning of this procedure is active.

Results:

- YES – One of the control module diagnostic codes that is listed at the beginning of this procedure is active.

Repair: Go to the troubleshooting procedure for the active control module CID FMI diagnostic code. Perform the troubleshooting procedure for the SAE J1939 Data Link circuit that is detailed for the control module in order to isolate the problem.

STOP.

i02914658

MID 027 - CID 0247 - FMI 14

SMCS Code: 7610-038-DTN

Conditions Which Generate This Code:

SAE J1939 DATA LINK

The CID 0247 FMI 14 diagnostic code is used by the Transmission/Chassis ECM as a “companion code” that is activated simultaneously with a diagnostic code from another control module in order to indicate that the SAE J1939 Data Link has an abnormal condition.

The FMI 14 will match the FMI 14 that is activated for the control module diagnostic code. The FMI 14 means that the Transmission/Chassis ECM is communicating with the other control module, however, the Transmission/Chassis ECM is not receiving all of the expected information.

The CID 0247 FMI 14 diagnostic code will never be activated by the Transmission/Chassis ECM as a stand-alone diagnostic code. The Transmission/Chassis ECM will only activate the CID 0247 FMI 14 diagnostic code along with one of the following module communication codes.

CID 0596 FMI 14 – Implement ECM

CID 0590 FMI 14 – Engine ECM

For example, if the Transmission/Chassis ECM detects that some expected operating parameter information is not being received from the Implement ECM over the SAE J1939 Data Link, the Implement ECM will simultaneously activate a CID 0596 FMI 14 (Implement ECM) diagnostic code and a CID 0247 FMI 14 (SAE J1939 Data Link) diagnostic code.

If the Transmission/Chassis ECM did not activate the companion diagnostic code CID 0247 FMI 14 along with the control module code, the technician would not know which data link circuit (Cat Data Link or J1939 Data Link) is involved.

When the CID 0247 FMI 14 diagnostic code is activated by the Transmission/Chassis ECM, always look for one of the control module diagnostic codes that are listed above in order to troubleshoot the problem.

Perform the following procedure when the CID 0247 FMI 14 diagnostic code is activated. Verify that the CID 0247 FMI 14 diagnostic code is active before performing this procedure.

- A.** The CID 0247 FMI 14 diagnostic code for the SAE J1939 Data Link is active. Look for one of the active control module diagnostic codes that is listed at the beginning of this procedure.

Expected Result:

One of the control module diagnostic codes that is listed at the beginning of this procedure is active.

Results:

- YES – One of the control module diagnostic codes that is listed at the beginning of this procedure is active.

Repair: Go to the troubleshooting procedure for the active control module CID FMI diagnostic code. Perform the troubleshooting procedure for the SAE J1939 Data Link circuit that is detailed for the control module in order to isolate the problem.

STOP.

i02914790

MID 027 - CID 0248 - FMI 09

SMCS Code: 7610-038-DTN

Conditions Which Generate This Code:

CAT DATA LINK

The CID 0248 FMI 09 diagnostic code is used by the Transmission/Chassis ECM as a companion diagnostic code that is activated simultaneously with another control module diagnostic code in order to indicate that the Cat Data Link has an abnormal condition.

The FMI 09 will match the FMI 09 that is activated for the control module diagnostic code. The FMI 09 means that the Transmission/Chassis ECM has lost all communication with the other control module.

The CID 0248 FMI 09 diagnostic code will never be activated by the Transmission/Chassis ECM as a stand-alone diagnostic code. The Transmission/Chassis ECM will only activate the CID 0248 FMI 09 diagnostic code along with one of the following module communication codes.

CID 0588 FMI 09 – Monitoring System**CID 0596 FMI 09 – Implement ECM****CID 0590 FMI 09 – Engine ECM**

For example, if the Transmission/Chassis ECM detects that no communication is being received from the Implement ECM over the Cat Data Link, the Implement ECM will simultaneously activate a CID 0596 FMI 09 (Implement ECM) diagnostic code and a CID 0248 FMI 09 (Cat Data Link) diagnostic code.

If the Transmission/Chassis ECM did not activate the companion diagnostic code CID 0248 FMI 09 along with the control module code, the technician would not know which data link circuit (Cat Data Link or J1939 Data Link) is involved.

When the CID 0248 FMI 09 diagnostic code is activated by the Transmission/Chassis ECM, always look for one of the control module diagnostic codes that are listed above in order to troubleshoot the problem.

Perform the following procedure when the CID 0248 FMI 09 diagnostic code is activated. Verify that the CID 0248 FMI 09 diagnostic code is active before performing this procedure.

- A.** The CID 0248 FMI 09 diagnostic code for the Cat Data Link is active. Look for one of the active control module diagnostic codes that is listed at the beginning of this procedure.

Expected Result:

One of the control module diagnostic codes that is listed at the beginning of this procedure is active.

Results:

- YES – One of the control module diagnostic codes that is listed at the beginning of this procedure is active.

Repair: Go to the troubleshooting procedure for the active control module CID FMI diagnostic code. Perform the troubleshooting procedure for the Cat Data Link circuit that is detailed for the control module in order to isolate the problem.

STOP.

i03820799

MID 027 - CID 0248 - FMI 14

SMCS Code: 7610-038-DTN

Conditions Which Generate This Code:**Cat Data Link**

The CID 0248 FMI 14 diagnostic code is used by the Transmission/Chassis ECM as a companion diagnostic code that is activated simultaneously with a diagnostic code from another control module in order to indicate that the Cat Data Link has an abnormal condition.

The FMI 14 will match the FMI 14 that is activated by the control module. The FMI 14 diagnostic code means that the Transmission/Chassis ECM is communicating with another control module, however, the Transmission/Chassis ECM is not receiving all of the expected information.

The CID 0248 FMI 14 diagnostic code will never be activated by the Transmission/Chassis ECM as a stand-alone diagnostic code. The Transmission/Chassis ECM will only activate the CID 0248 FMI 14 diagnostic code along with one of the following module communication codes:

CID 0588 FMI 14 – Monitoring System**CID 0590 FMI 14 – Engine ECM****CID 0596 FMI 14 – Implement ECM**

For example, if the Transmission/Chassis ECM detects that some expected operating parameter information is not being received from the Implement ECM over the Cat Data Link, the Transmission/Chassis ECM will simultaneously activate a CID 0596 FMI 14 (Implement ECM) diagnostic code and a CID 0248 FMI 14 (Cat Data Link) diagnostic code.

If the Transmission/Chassis ECM did not activate the companion diagnostic code CID 0248 FMI 14 along with the control module code, the technician would not know which data link circuit (Cat Data Link or J1939 Data Link) is involved.

When the CID 0248 FMI 14 diagnostic code is activated by the Transmission/Chassis ECM, always look for one of the control module diagnostic codes that are listed above in order to troubleshoot the problem.

Perform the following procedure when the CID 0248 FMI 14 diagnostic code is activated. Verify that the CID 0248 FMI 14 diagnostic code is active before performing this procedure.

- A.** The CID 0248 FMI 14 diagnostic code for the Cat Data Link is active. Look for one of the active diagnostic codes that is listed at the beginning of this procedure.

Expected Result:

One of the diagnostic codes that is listed at the beginning of this procedure is active.

Results:

- YES – One of the diagnostic codes that is listed at the beginning of this procedure is active.

Repair: Go to the troubleshooting procedure for the CID-FMI diagnostic code. Perform the troubleshooting procedure for the Cat Data Link circuit that is detailed for the control module in order to isolate the problem.

STOP.

i02839878

MID 027 - CID 0262 - FMI 03

SMCS Code: 1439-038

Conditions Which Generate This Code:

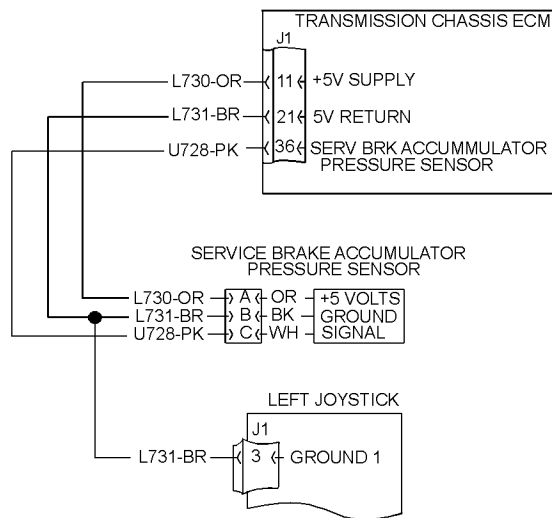


Illustration 137

g01287820

5 VDC Power Supply Connections

This diagnostic code is associated with the ECM 5 volt power supply. The 5 volt power supply provides power for the accumulator pressure sensor of the service brake. The return circuit of the power supply is also used by the left joystick.

The CID 0262 FMI 03 diagnostic code is active when the ECM detects that the voltage of the 5 volt power supply circuit is higher than normal.

The following conditions could cause this diagnostic code to be active:

- The power supply circuit is shorted to a higher voltage source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE VOLTAGE AT THE SENSOR

- Turn the disconnect switch and the key start switch to the ON position.
- Disconnect the connector of the machine harness from the accumulator pressure sensor of the service brake.
- At the connector of the machine harness for the sensor, measure the voltage from supply contact A (wire L730-OR(Orange)) to the return contact B (wire L731-BR(Brown)).

Expected Result:

The voltage measurement is 5.0 ± 0.5 DCV.

Results:

- OK – The voltage measurement is 5.0 ± 0.5 DCV. The voltage is correct. Proceed to Test Step 4.
- NOT OK – The voltage measurement is greater than 5.0 ± 0.5 DCV. The measurement is not correct. Proceed to Test Step 2.

Test Step 2. CHECK THE POWER SUPPLY AT THE ECM

- Turn the disconnect switch and the key start switch to the OFF position.
- At ECM connector J1, use a 151 - 6320 Removal Tool to remove the supply wire and the socket at contact J1-11 (wire L730-OR(Orange)) and the return wire and the socket at contact J1-21 (wire L731-BR(Brown)) from the connector. The machine harness connector J1 remains connected to the ECM.
- Turn the disconnect switch and the key start switch to the ON position.

Diagnostic Code Procedures

- D.** Use the multimeter probes in order to make contact at the connector pins of the ECM. Measure the voltage at the ECM pins between the contact of the power supply J1-11 and the return contact J1-21.

Expected Result:

The voltage measurement is 5.0 ± 0.5 DCV.

Results:

- OK – The voltage measurement is 5.0 ± 0.5 DCV. The voltage is correct. The ECM power supply is correct. Install the wires and sockets that were removed from the J1 connector in the original locations. Proceed to Test Step 3.
- NOT OK – The voltage measurement is greater than 5.0 ± 0.5 DCV. The ECM power supply is not correct.

Repair: Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK FOR A SHORT CIRCUIT IN THE MACHINE HARNESS

The machine harness connector remains disconnected from the sensor.

- Turn the disconnect switch and the key start switch to the OFF position.
- Disconnect the machine harness connectors J1 and J2 from the ECM.
- At the harness connector J1, check the resistance from contact J1-11 (wire L730-OR(Orange)) to all of the other ECM +battery (wire 126-RD(Red)) contacts that are connected to the ECM. The contacts are J1-31, J1-38, J1-39, J1-46 and J1-47.
- At the harness connector J1, check the resistance from contact J1-11 (wire L730-OR(Orange)) to all of the other contacts that are used in connectors J1 and J2.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The supply circuit is not shorted to another circuit in the machine harness. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness.

Repair: The power supply circuit is shorted to another circuit in the machine harness. Refer to the complete Electrical System Schematic of the machine. Examine the supply circuit in order to determine the possible location for the problem.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Determine if the CID 0262 FMI 03 diagnostic code is active.

Expected Result:

The CID 0262 FMI 03 diagnostic code is active.

Results:

- YES – The CID 0262 FMI 03 diagnostic code is active. The problem has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, replace the pressure sensor. After the sensor is replaced, perform this test step again.

If the problem is still present after the sensor has been replaced, the ECM may have failed. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0262 FMI 03 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02839871

MID 027 - CID 0262 - FMI 04

SMCS Code: 1439-038

Conditions Which Generate This Code:

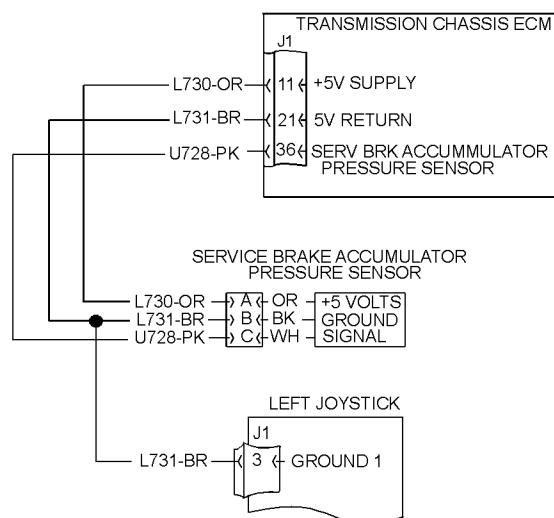


Illustration 138

g01287820

5 VDC Power Supply Connections

This diagnostic code is associated with the ECM 5 volt power supply. The 5 volt power supply provides power for the accumulator pressure sensor of the service brake. The return circuit of the power supply is also used by the left joystick.

The CID 0262 FMI 04 diagnostic code is active when the ECM detects that the voltage of the power supply circuit is below normal.

The following conditions could cause this diagnostic code to be active:

- A sensor has failed.
- The sensor supply circuit is shorted to a ground source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SENSOR

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the accumulator pressure sensor of the service brake from the machine harness.
- After disconnecting the sensor, check the status of the CID 262 FMI 04 diagnostic code.

Expected Result:

The CID 262 FMI 04 diagnostic code is no longer active.

Results:

- OK – The diagnostic code is not active. The harness circuit is correct. The sensor that was just disconnected has failed.

Repair: Replace the sensor. Verify that the new sensor corrected the problem before operating the machine.

STOP.

- NOT OK – The diagnostic code is still active. The sensor is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE POWER SUPPLY AT THE ECM

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. At ECM connector J1, use a 151 - 6320 Removal Tool to remove the supply wire and the socket at contact J1-11 (wire L730-OR(Orange)) and the return wire and the socket at contact J1-21 (wire L731-BR(Brown)) from the connector. The machine harness connector J1 remains connected to the ECM.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Use the multimeter probes in order to make contact on the connector pins of the ECM. Measure the voltage at the ECM pins between the contact of the power supply J1-11 and the return contact J1-21.

Expected Result:

The voltage measurement is 5.0 ± 0.5 DCV.

Results:

- OK – The voltage measurement is 5.0 ± 0.5 DCV. The voltage is correct. The ECM power supply is correct. Install the wires and the sockets that were removed from the J1 connector in the original locations. Proceed to Test Step 3.
- NOT OK – The voltage measurement is less than 5.0 ± 0.5 DCV. The ECM power supply is not correct.

Repair: Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK FOR A SHORT TO GROUND

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connectors J1 and J2 from the ECM.

- C. At the harness connector for the ECM, measure the resistance between contact of the supply J1-11 (wire L730-OR(Orange)) and frame ground. Measure the resistance between contact of the supply J1-11 and all of the other contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The harness circuit resistance is correct. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. The circuit is shorted in the machine harness.

Repair: The power supply wire L730-OR(Orange) is shorted to ground in the machine harness. Refer to the complete Electrical System Schematic for your machine. Check all harness connectors that are in the power supply circuit. Ensure that the connectors are clean and secure.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 0262 FMI 04 diagnostic code is active.

Expected Result:

The CID 0262 FMI 04 diagnostic code is active.

i02915156

Results:

- YES – The CID 0262 FMI 04 diagnostic code is active. The problem has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may be activating the diagnostic code incorrectly. The ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0262 FMI 04 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

MID 027 - CID 0368 - FMI 03

SMCS Code: 7332-038-T3

Conditions Which Generate This Code:

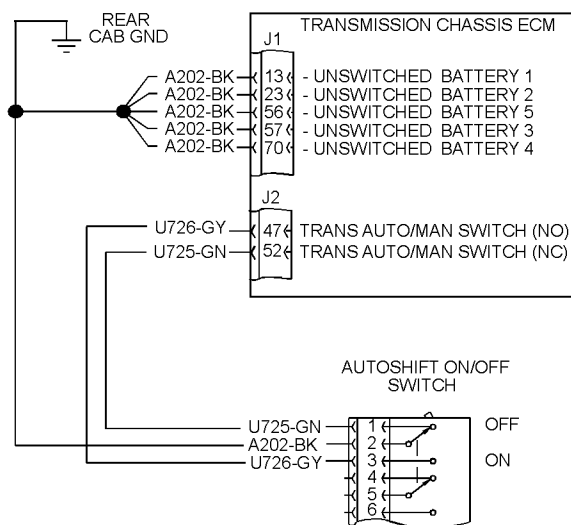


Illustration 139

g01376083

Connections of the Transmission Auto/Manual Switch

The auto/manual switch of the transmission is a two pole, double-throw switch. One pole is used to provide two switch to ground inputs to the ECM in order to indicate the status of the switch. The other pole of the switch is not used for operations of the ECM.

During normal operation, one of the inputs is not connected to ground and the other input is connected to ground through the switch contacts. An internal pull-up voltage is present at the ECM switch inputs. When the input is grounded through the switch, the ECM detects the ground signal.

The FMI 03 diagnostic code is activated by the ECM when neither of the inputs is showing a ground signal.

The conditions that could cause the ECM to activate this diagnostic code are listed below:

- The switch has failed.
- The common ground circuit has an open or a bad connection.
- There is an open or a bad connection in one or both of the switch input circuits.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SWITCH

Table 24

States of Contact for the Transmission Auto/Manual Switch		
Switch Position	"N/O" Input J2-47 (wire U726-GY(Grey))	"N/C" Input J2-52 (wire U725-GN(Green))
Autoshift OFF	Open ⁽¹⁾	Closed ⁽²⁾
Autoshift ON	Closed	Open

⁽¹⁾ Open to ground (wire A202-BK(Black)).

⁽²⁾ Closed to ground (wire A202-BK(Black)).

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector from the switch.
- C. With the switch in the ON position, measure the resistance from common contact of the switch (2) to input contact of the switch (1). Compare the measurement of the status of the switch to the table above.
- D. With the switch in the ON position, measure the resistance from common contact of the switch (2) to the input contact of the switch (3). Compare the measurement of the status of the switch to the table above.
- E. Move the switch to the OFF position and repeat Steps "C" and "D".

Expected Result:

The resistance measurements in each position of the switch are correct according to the table at the beginning of this test step.

Results:

- YES – All of the resistance checks for the switch are correct in each switch position according to the table. The switch is working correctly. Proceed to Test Step 2.
- NO – The states of the switch are not correct according to the table. The switch has failed.

Repair: Replace the transmission auto/manual switch. After the switch is replaced, verify that the switch operation is correct before operating the machine.

STOP.

Test Step 2. CHECK THE SWITCH OF THE COMMON GROUND CIRCUIT FOR AN OPEN

The key start switch and the disconnect switch remain in the OFF position. The machine harness remains disconnected from the switch.

- A. At the machine harness connector for the switch, measure the resistance from common ground contact of the switch 2 (wire A202-BK(Black)) to frame ground.
- B. Observe the resistance measurement of the multimeter as you wiggle the machine harness connector for the switch. Gently pull on the wires and wiggle the wires.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the harness.

Results:

- OK – The resistance measurement is less than 5 ohms. The common ground circuit of the switch is correct. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the common ground circuit of the switch (wire A202-BK(Black)).

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is not connected. A resistance measurement of greater than 5000 ohms could also indicate that a wire has an open connection. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points or splice connection in the ground circuit does not have an open connection but does not have a good connection.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the ground circuit. Start from the switch. Work your way back to the connections for the ground terminal, located at the rear of the cab. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE INPUT CIRCUITS OF THE SWITCH FOR AN OPEN

The key start switch and the disconnect switch remain in the OFF position. The machine harness remains disconnected from the switch.

- A. At the machine harness connector for the switch, place a jumper wire between input contact 1 (wire U725-GN(Green)) and input contact 3 (wire U726-GY(Grey)).
- B. Disconnect the machine harness connectors J1 and J2 from the ECM.
- C. At the machine harness connector for the ECM J2, measure the resistance between the input contact of the switch J2-52 (wire U725-GN(Green)) and input contact of the switch J2-47 (wire U726-GY(Grey)).
- D. Observe the resistance measurement of the multimeter and wiggle the machine harness connectors for the ECM. Gently pull on the wires and wiggle the wires.
- E. Observe the resistance measurement of the multimeter and wiggle the machine harness connector for the switch. Gently pull on the wires and wiggle the wires. Do not disconnect the jumper wire.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the harness.

Results:

- OK – The resistance measurement is less than 5 ohms. The inputs circuits of the switch are not open in the machine harness. Proceed to Test Step 4.
- NOT OK – The resistance measurement is greater than 5 ohms. There is a problem with one or both of the switch input circuits in the machine harness.

Repair: Refer to the illustration of the connection diagram at the beginning of this procedure.

Connect one end of the jumper wire to the harness connector of the switch, common ground contact 2 (wire A202-BK(Black)).

One at a time, connect the other end of the jumper wire to each switch input and check the resistance at the harness connector for the ECM J1 from the appropriate input contact to one of the ground contacts (wire A202-BK(Black)) that are used on the J1 connector. This will identify the input circuit that has an open or a bad connection.

A resistance measurement that is greater than 5000 ohms could indicate a wire that is not connected or a wire that is open. A resistance measurement that is greater 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit has an open or a poor connection.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the faulty input circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 0368 FMI 03 diagnostic code.

Expected Result:

The CID 0368 FMI 03 diagnostic code is active.

Results:

- YES – The CID 0368 FMI 03 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the input circuits of the switch again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the wiring harness of the machine. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause can not be found, the ECM may have failed. Verify that all possible causes of the diagnostic code have been investigated before replacement of the ECM.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0368 FMI 03 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02915216

MID 027 - CID 0368 - FMI 04

SMCS Code: 7332-038-T3

Conditions Which Generate This Code:

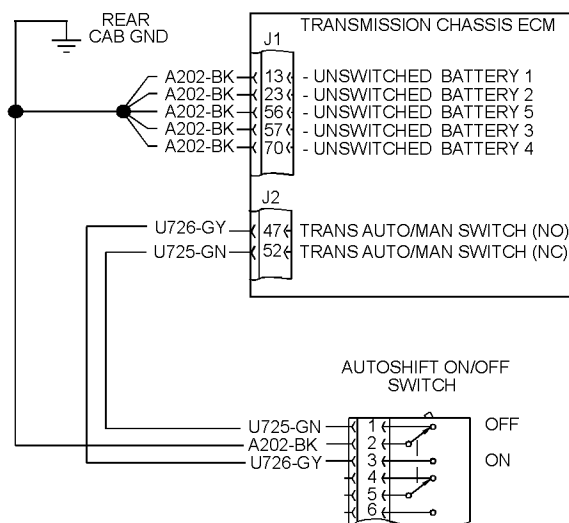


Illustration 140

g01376083

"Transmission Auto/Manual" switch connections

The "transmission auto/manual" switch is a two pole, double-throw switch. One pole is used to provide two switch to ground inputs to the ECM in order to indicate the status of the switch. The other pole of the switch is not used for operations of the ECM.

During normal operation, one of the inputs is not connected to ground and the other input is connected to ground through the switch contacts. An internal pull-up voltage is present at the ECM switch inputs. When the input is grounded through the switch, the ECM detects the ground signal.

The FMI 04 diagnostic code is activated by the ECM when both of the inputs are showing a ground signal at the same time.

The conditions that could cause the ECM to activate this diagnostic code are listed below:

- The switch has failed.
- There is a short to a ground source in one or both of the switch input circuits.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SWITCH

Table 25

States of Contact for the Transmission Auto/Manual Switch		
Switch Position	N/O Input J2-47 (wire U726-GY(Grey))	N/C Input J2-52 (wire U725-GN(Green))
Autoshift OFF	Open ⁽¹⁾	Closed ⁽²⁾
Autoshift ON	Closed	Open

⁽¹⁾ Open to ground (wire A202-BK(Black)).

⁽²⁾ Closed to ground (wire A202-BK(Black)).

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector from the switch.
- C. With the switch in the ON position, measure the resistance from the common contact of the switch (2) to the input contact of the switch (1). Compare the measurement of the switch to the table above.
- D. With the switch in the ON position, measure the resistance from the common contact of the switch (2) to the input contact of the switch (3). Compare the status of the switch to the table above.
- E. Move the switch to the OFF position and repeat Steps "C" and "D".

Expected Result:

The measurements of resistance for each of the positions of the switch agree with the status shown in the table at the beginning of this test step.

Results:

- YES – All of the resistance checks for the switch are correct in each switch position according to the table above. The switch is working correctly. Proceed to Test Step 2.

- NO – The states of the switch are not correct according to the table. The switch has failed.

Repair: Replace the "Transmission Auto/Manual" switch. After the switch is replaced, verify that the switch operation is correct before operating the machine.

STOP.

Test Step 2. CHECK THE INPUT CIRCUITS OF THE SWITCH FOR A SHORT

The key start switch and the disconnect switch remain in the OFF position. The machine harness remains disconnected from the switch.

- A. Disconnect the machine harness connectors J1 and J2 from the ECM.
- B. At the machine harness connector J2 for the ECM, measure the resistance between input contact of the switch J2-52 (wire U725-GN(Green)) and the frame ground. Measure the resistance between input contact of the switch J2-52 (wire U725-GN(Green)) and all of the other contacts that are used in the J1 and J2 harness connectors for the ECM.
- C. At the machine harness connector J2 for the ECM, measure the resistance between input contact of the switch J2-47 (wire U726-GY(Grey)) and the frame ground. Measure the resistance between input contact of the switch J2-47 (wire U726-GY(Grey)) and all of the other contacts that are used in the J1 and J2 harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The input circuits of the switch are not shorted to ground or to another circuit in the machine harness. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short to ground or to another circuit in the machine harness.

Repair: The input circuit that checks the low resistance to frame ground or to another circuit is causing the problem.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the faulty input circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Check the status of the CID 0368 FMI 04 diagnostic code.

Expected Result:

The CID 0368 FMI 04 diagnostic code is active.

Results:

- YES – The CID 0368 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the input circuits of the switch again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause can not be found, the ECM may have failed. Verify that all possible causes of the diagnostic code have been investigated before replacement of the ECM.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0368 FMI 04 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02915576

MID 027 - CID 0420 - FMI 03

SMCS Code: 4493-038-ZH

Conditions Which Generate This Code:

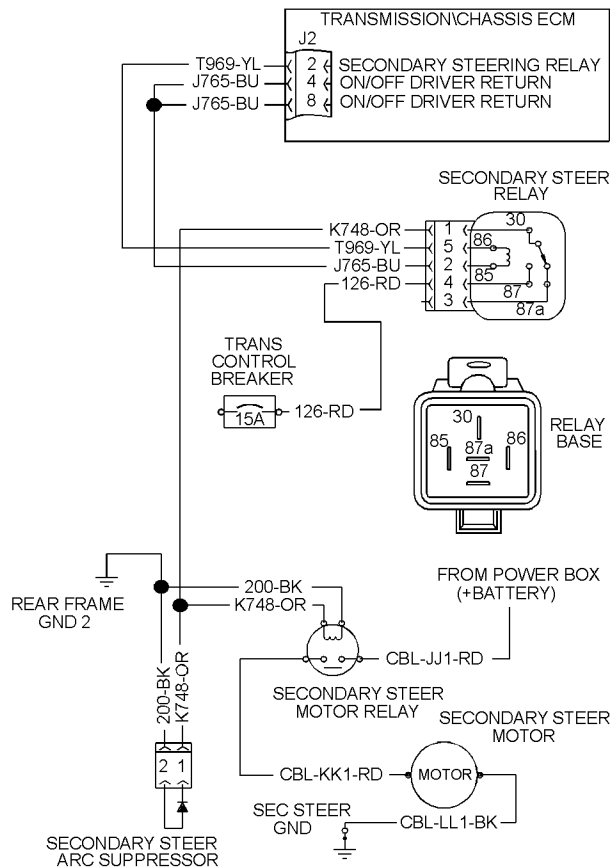


Illustration 141

g01288273

Relay Connections for Secondary Steer

This diagnostic code is associated with the relay for secondary steer. The relay is controlled by the ECM through an "ON/OFF" output driver. The FMI 03 means that the ECM has determined that the voltage is present in the relay circuit when the output driver is OFF.

The conditions that could cause this diagnostic code to activate are listed:

- The relay has failed.
- The energize circuit of the relay is shorted to another voltage source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE RELAY

- Turn the key start switch and the disconnect switch to the ON position.
- Observe the status of the active CID 0420 FMI 03 diagnostic code and disconnect the relay for secondary steer from the machine harness.
- At the relay, measure the resistance of the coil between contact 85 and contact 86. Measure the resistance between power contact 87 and all of the other relay contacts.

Expected Result:

When the relay is disconnected from the harness, the status of the active CID 0420 FMI 03 diagnostic code does not change.

The resistance of the relay coil is in the range of 288 to 396 ohms at 25 °C (77 °F).

The resistance measurement between the power contact 87 and all the other relay contacts is greater than 5000 ohms.

Results:

- YES – All of the checks for the relay are correct. The relay is not causing the problem. The CID 0420 FMI 03 diagnostic code is still active. Proceed to Test Step 2.
- NO – The active CID 0420 FMI 03 diagnostic code became inactive when the relay was disconnected. The resistance checks are not correct compared to the expected results listed above. The relay has failed.

Repair: Verify that the relay has failed by substituting a known good relay that is the same part number for the faulty relay. The relay for the flood lights of the cab can be substituted. Replace the faulty relay.

STOP.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE RELAY FOR A SHORT

The relay remains disconnected from the machine harness.

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- C. At the machine harness connector J2 for the ECM, measure the resistance from contact J2-2 (wire T969-YL (Yellow)) to all of the other contacts that are used in the machine harness connectors J1 and J2 for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The energize circuit is not shorted to another circuit in the machine harness. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between wire T969-YL (Yellow) and the circuit that has a low resistance measurement.

Repair: Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the relay circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all harness connectors in order to make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 0420 FMI 03 diagnostic code is active.

Expected Result:

The CID 0420 FMI 03 diagnostic code is active.

Results:

- YES – The CID 0420 FMI 03 diagnostic code is active. The problem has not been corrected.

Repair: Check the relay circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Machine ECM. Refer to Troubleshooting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0420 FMI 03 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors or a short at the base of the relay that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02915696

MID 027 - CID 0420 - FMI 05

SMCS Code: 4493-038-ZH

Conditions Which Generate This Code:

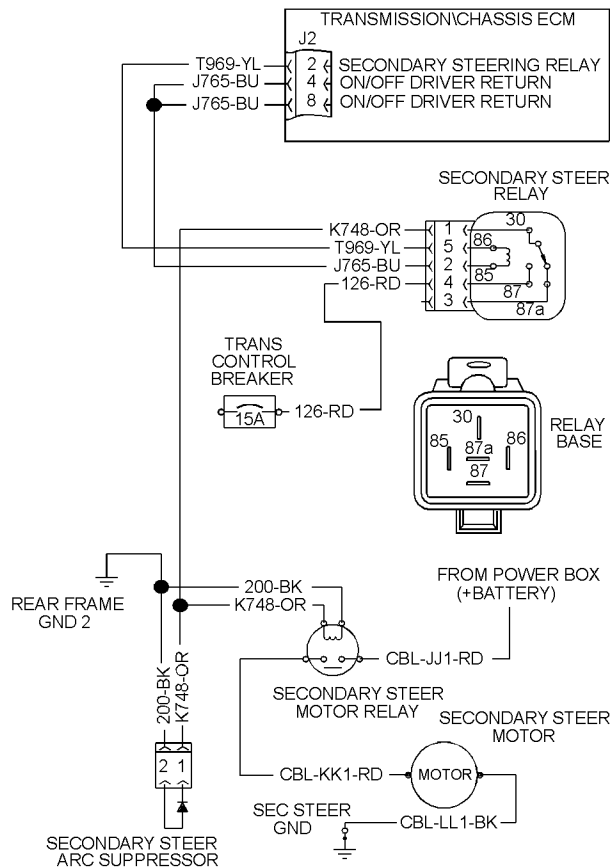


Illustration 142

g01288273

Relay Connections for Secondary Steer

This diagnostic code is associated with the relay for secondary steer. The relay is controlled by the ECM through an "ON/OFF" output driver. The FMI 05 means that the ECM has energized the output for the relay and the current for the relay circuit is below normal.

The conditions that could cause this diagnostic code to activate are listed below:

- The relay has failed.
- The energize circuit of the relay has an open or a bad connection in the machine harness.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE RELAY

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the relay.
- At the harness connector for the relay, connect a jumper wire between contact 5 (wire T969-YL (Yellow)) and contact 2 (wire J765-BU (Blue)).
- Turn the disconnect switch and the key start switch to the ON position.
- Observe the status of the active CID 0420 FMI 05 diagnostic code.

Expected Result:

The active CID 0420 FMI 05 diagnostic code is no longer active when the key start switch is turned ON. A CID 0420 FMI 06 diagnostic code is now active.

Results:

- YES – The CID 0420 FMI 05 diagnostic code is no longer active. A CID 0420 FMI 06 diagnostic code becomes active when the key start switch is turned ON.

Repair: The relay is causing the problem. Verify that the relay has failed by substituting a known good relay that is the same part number as the faulty relay. The relay for the flood lights of the cab can be substituted for the suspect relay. Replace the faulty relay.

STOP.

- NO – The jumper wire does not affect the status of the active CID 0420 FMI 05 diagnostic code when the key start switch is turned ON. The relay is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT OF THE RELAY FOR AN OPEN

The relay remains disconnected from the machine harness. The jumper wire remains connected between contact 5 and contact 2.

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- C. At the machine harness connector J2 for the ECM, measure the resistance between contact J2-2 (wire T969-YL(Yellow)) and contact J2-4 (wire J765-GN(Green)).
- D. At the machine harness connector J2 for the ECM, measure the resistance between contact J2-2 (wire T969-YL(Yellow)) and contact J2-8 (wire J765-GN(Green)).

Expected Result:

Both resistance measurements are less than 5 ohms.

Results:

- OK – The resistance measurements are less than 5 ohms. The energize circuit and the return circuit are not open in the machine harness. Proceed to Test Step 3.
- NOT OK – One or both of the resistance measurements is greater than 5 ohms. There is an open or a bad connection in the machine harness.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is not connected or that a wire is open. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points or a splice connection in the circuit is not open but is not a good connection.

If one of the resistance measurements is greater than 5 ohms and the other measurement is less than 5 ohms, one of the return circuits is not correct. This will not cause the diagnostic code to activate as the other return circuit is working correctly, however, this is a problem that needs to be investigated and corrected.

If both measurements are greater than 5 ohms, determine whether the energize circuit or the return circuit is causing the problem. Disconnect the jumper wire. Use a spare length of wire in order to check the resistance of the energize circuit and the return circuit individually.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

Start at either the ECM connector or the component connector for the faulty circuit. Check the wire for an open or a bad connection point by working your way through the circuit in order to isolate the location of the suspect wire or connection. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all the harness connectors and make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 0420 FMI 05 diagnostic code is active.

Expected Result:

The CID 0420 FMI 05 diagnostic code is active.

Results:

- YES – The CID 0420 FMI 05 diagnostic code is active. The problem has not been corrected.

Repair: Check the relay circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the wiring harness of the machine. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Machine ECM. Refer to Troubleshooting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0420 FMI 05 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors or at the base of the relay that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02915968

MID 027 - CID 0420 - FMI 06

SMCS Code: 4493-038-ZH

Conditions Which Generate This Code:

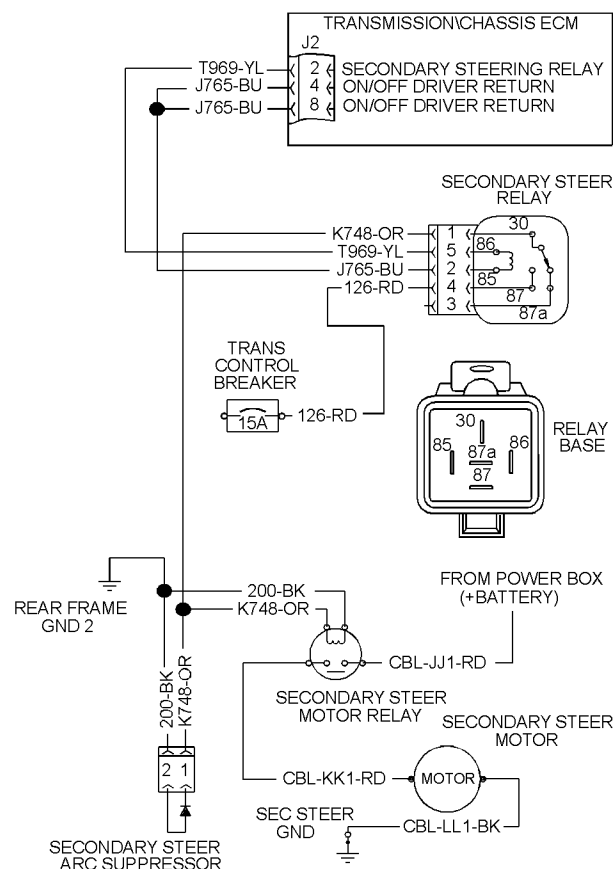


Illustration 143

g01288273

Relay Connections for Secondary Steer

This diagnostic code is associated with the relay for the secondary steer. The relay is controlled by the ECM through an "ON/OFF" output driver. The FMI 06 means that the ECM has energized the output for the relay and the current for the relay circuit is above normal.

The conditions that could cause this diagnostic code to activate are listed:

- The relay has failed.
- The energize circuit of the relay is shorted to a ground source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE RELAY

- A. Turn the key start switch and the disconnect switch to the ON position.
- B. Observe the status of the active CID 0420 FMI 06 diagnostic code and disconnect the machine harness connector from the relay.

Expected Result:

When the relay is disconnected from the harness, the CID 0420 FMI 06 diagnostic code is no longer active. A CID 0420 FMI 06 is now active.

Results:

- YES – When the relay is disconnected from the harness, the CID 0420 FMI 06 diagnostic code is no longer active. A CID 0420 FMI 05 diagnostic code becomes active. The relay is causing the problem.

Repair: Verify that the relay has failed by substituting a known good relay that is the same part number as the faulty relay. The relay used for the flood lights of the cab can be substituted for the suspect relay. Replace the faulty relay.

STOP.

- NO – The status of the active CID 0420 FMI 06 diagnostic code did not change when the relay was disconnected from the machine harness. The relay is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE RELAY FOR A SHORT

The relay remains disconnected from the machine harness.

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- C. At the machine harness connector J2 for the ECM, measure the resistance from contact J2-2 (wire T969-YL(Yellow)) to frame ground. Measure the resistance from contact J2-2 (wire T969-YL(Yellow)) to all of the other contacts that are used in the machine harness connectors J1 and J2 for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The energize circuit is not shorted to another circuit in the machine harness. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between wire T969-YL(Yellow) and the circuit that has a low resistance measurement.

Repair: Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the relay circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all harness connectors in order to make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.

- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 0420 FMI 06 diagnostic code is active.

i02916173

Expected Result:

The CID 0420 FMI 06 diagnostic code is active.

Results:

- YES – The CID 0420 FMI 06 diagnostic code is active. The problem has not been corrected.

Repair: Check the relay circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Machine ECM. Refer to Troubleshooting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0420 FMI 06 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors or at the base of the relay that was disconnected and reconnected. Resume normal machine operation.

STOP.

MID 027 - CID 0444 - FMI 03

SMCS Code: 1426-038

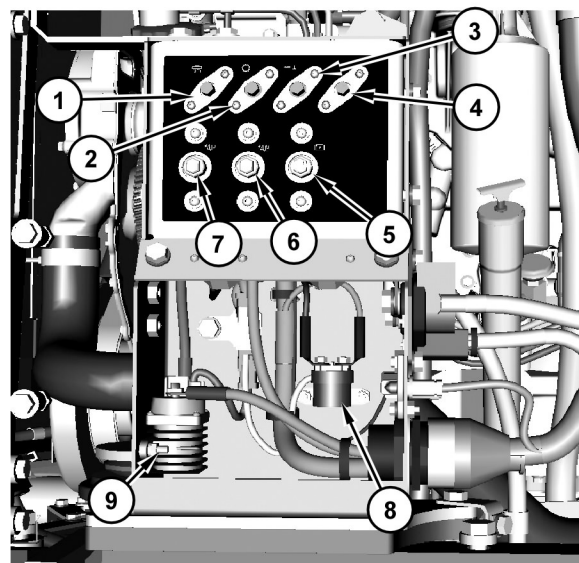
Conditions Which Generate This Code:

Illustration 144

g01324002

Power Breaker Box located on left side of machine behind the Cab

- (1) Accugrade Breaker (20 Amp)
- (2) Transmission Control Breaker (15 Amp)
- (3) Key Switch Breaker (15 Amp)
- (4) Engine Control Breaker (20 Amp)
- (5) Alternator Breaker (150 Amp)
- (6) Load Breaker (80 Amp)
- (7) Main Breaker (80 Amp)
- (8) Start Relay
- (9) Main Power Relay

Diagnostic Code Procedures

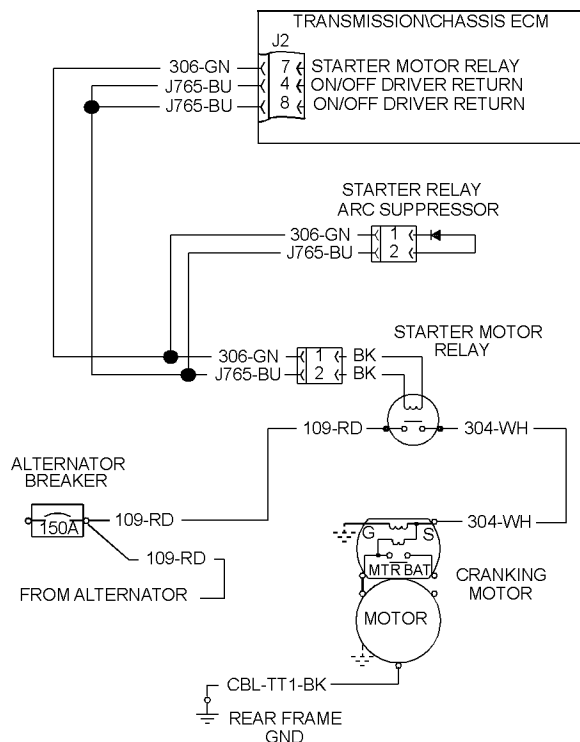


Illustration 145

g01288379

Starter Motor Relay connections

This diagnostic code is associated with the starter motor relay. The FMI 03 means that the ECM has determined that voltage is present in the relay circuit when the output driver is OFF.

The possible causes of the diagnostic code are listed below:

- The relay has failed.
- The power circuit of the relay is shorted to another voltage source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to activate. Ignore these created diagnostic codes and clear these diagnostic codes when the original problem has been corrected.

Test Step 1. CHECK THE RELAY

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the relay for the starter motor.
- At the connector for the relay, measure the resistance of the coil between contact 1 and contact 2.

Expected Result:

The resistance of the relay coil should measure approximately 27.5 ± 3 ohms at 20°C (68.0°F).

Results:

- OK – The resistance measurement of the relay coil is within the acceptable range. Proceed to Test Step 2.
- NOT OK – The resistance measurement of the relay coil is NOT within the acceptable range.

Repair: The relay coil is not correct. Replace the relay for the starter motor. After the relay has been replaced, verify that the new relay corrected the problem before operating the machine.

STOP.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE RELAY FOR A SHORT

The key start switch and the disconnect switch remain in the OFF position. The machine harness connector remains disconnected from the relay.

- Disconnect the harness connectors J1 and J2 from the ECM.
- Disconnect the machine harness connector from the diode for the arc suppressor.
- At the machine harness connector for the ECM, measure the resistance from contact J2-7 (wire 306-GN(Green)) to all of the contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between wire 306-GN(Green) and the circuit that has a low resistance measurement.

Repair: Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors in circuits for points in the machine harness where the circuits could be shorted. For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Determine if the CID 0444 FMI 03 diagnostic code is active.

Expected Result:

The CID 0444 FMI 03 diagnostic code is active.

Results:

- YES – The CID 0444 FMI 03 diagnostic code is active. The problem has not been corrected.

Repair: Check the starter relay circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause can not be found, the ECM may have failed. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0444 FMI 03 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02916178

MID 027 - CID 0444 - FMI 05

SMCS Code: 1426-038

Conditions Which Generate This Code:

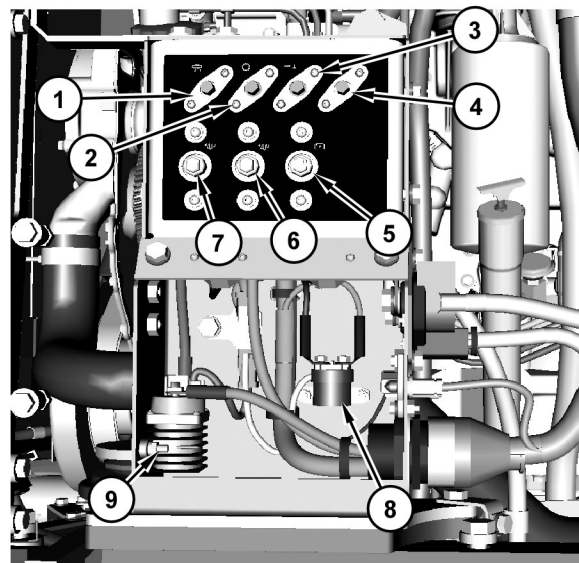


Illustration 146

g01324002

Power Breaker Box located on left side of machine behind the Cab

- (1) Accugrade Breaker (20 Amp)
- (2) Transmission Control Breaker (15 Amp)
- (3) Key Switch Breaker (15 Amp)
- (4) Engine Control Breaker (20 Amp)
- (5) Alternator Breaker (150 Amp)
- (6) Load Breaker (80 Amp)
- (7) Main Breaker (80 Amp)
- (8) Start Relay
- (9) Main Power Relay

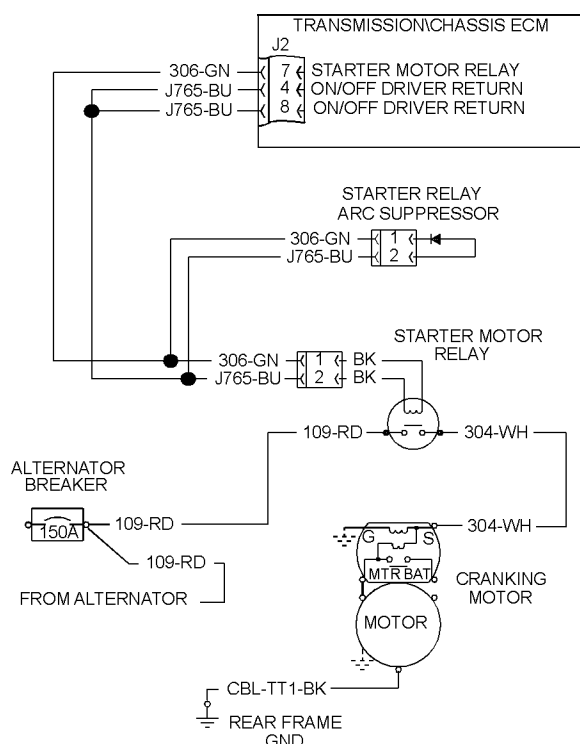


Illustration 147

q01288379

Starter Motor Relay connections

This diagnostic code is associated with the relay for the starter motor. The FMI 05 means that the ECM has determined that the current of the relay circuit is below normal.

Conditions that can cause this diagnostic code are listed below:

- The relay has failed.
- The energize circuit of the relay is an open connection or the circuit has a bad connection.
- The return circuit of the relay is an open connection or the circuit has a bad connection.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Note: The coil resistance of the start relay should measure 27.5 ± 3 ohms at 20°C (68.0°F).

Test Step 1. CHECK THE RELAY

- A.** Turn the disconnect switch and the key start switch to the OFF position.
- B.** Disconnect the relay for the starter motor from the machine harness.
- C.** At the machine harness connector for the relay, place a jumper wire from contact 1 (wire 306-GN(Green)) to contact 2 (wire J765-BU(Blue)).
- D.** Turn the disconnect switch and the key start switch to the START position for a few seconds.
- E.** Observe the status of the CID 0444 FMI 05 diagnostic code.

Expected Result:

The CID 0444 FMI 05 diagnostic code is no longer active. A CID 0444 FMI 06 diagnostic code has been activated when the jumper wire is installed.

Results:

- YES – The CID 0444 FMI 05 diagnostic is no longer active. A CID 0444 FMI 06 becomes active when the jumper wire is installed. The relay is causing the problem.

Repair: The relay has failed. Repeat this Test Step “CHECK THE RELAY” in order to verify the failure of the relay.

Check the resistance of the relay coil. Measure the resistance from contact 1 to contact 2 on the relay connector. The resistance of a good relay coil should be 27.5 ± 3 ohms at 20°C (68.0°F). The likely cause of this problem is a greater resistance of the relay coil.

Replace the relay. Verify that the new relay corrects the problem.

STOP.

- NO – The CID 0444 FMI 05 diagnostic remains active after the jumper wire has been installed. The jumper wire did not affect the status of the active diagnostic code. Proceed to Test Step 2.

Test Step 2. CHECK THE RELAY CIRCUIT FOR AN OPEN

The relay for the starter motor remains disconnected from the machine harness. The jumper wire that was installed in the previous test step remains in place.

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector J2 from the ECM.
- C. At the machine harness connector J2, measure the resistance from signal contact J2-7 (wire 306-GN(Green)) to contact J2-4 (wire J765-BU(Blue)).
- D. Observe the resistance measurement of the multimeter as you wiggle the machine harness connectors for the ECM. Observe the resistance measurement of the multimeter and wiggle the machine harness connector for the relay. Gently pull on the wires and wiggle the wires.
- E. At the machine harness connector J2, measure the resistance from signal contact J2-7 (wire 306-GN(Green)) to contact J2-8 (wire J765-BU(Blue)).
- F. Observe the resistance measurement of the multimeter and wiggle the machine harness connectors for the ECM. Observe the resistance measurement of the multimeter and wiggle the machine harness connector for the relay. Gently pull on the wires and wiggle the wires.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the harness and connectors.

Results:

- OK – The resistance is less than 5.0 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5 ohms. The resistance measurement is not correct. There could be an open connection or a poor connection in the harness circuit of the machine.

Repair: If one of the resistance measurements is greater than 5 ohms and the other measurement is less than 5 ohms, one of the return circuits is not correct. This will not cause the diagnostic code to activate as the other return circuit is working correctly. However, this is a problem that needs to be investigated.

A resistance measurement greater than 5000 ohms could indicate a wire that is not connected or a wire that is open. A resistance measurement that is greater 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but a connection point that is not a good connection.

If both measurements are greater than 5 ohms, determine whether the energize circuit or the return circuit is causing the problem.

Disconnect the jumper wire. Use a spare length of wire in order to check the resistance of the energize circuit and the return circuit individually.

Once the faulty circuit is identified, a poor connection could be causing the problem. A connector may be loose, dirty or corroded. Inspect the connectors that are in the circuit. Ensure that all connectors are clean, that all connections are tight and that all connections are in good condition.

Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all harness connectors and make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 0444 FMI 05 diagnostic code.

Expected Result:

The CID 0444 FMI 05 diagnostic code is active.

Results:

- YES – The CID 0444 FMI 05 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the relay circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause can not be found, the ECM may have failed. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0444 FMI 05 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02916190

MID 027 - CID 0444 - FMI 06

SMCS Code: 1426-038

Conditions Which Generate This Code:

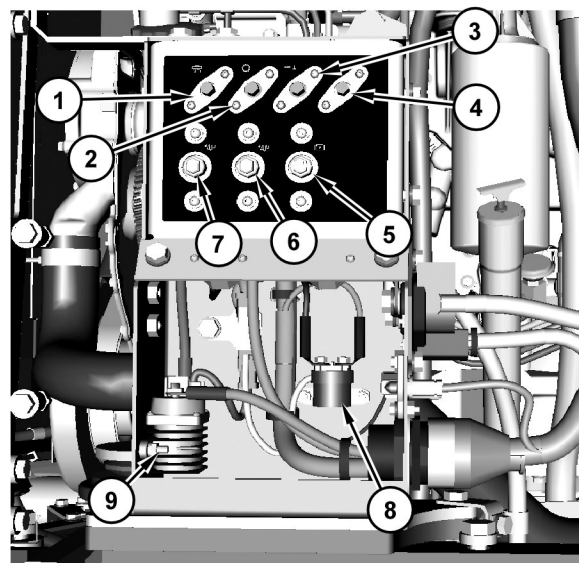


Illustration 148

g01324002

Power Breaker Box located on left side of machine behind the Cab

- (1) Accugrade Breaker (20 Amp)
- (2) Transmission Control Breaker (15 Amp)
- (3) Keyswitch Breaker (15 Amp)
- (4) Engine Control Breaker (20 Amp)
- (5) Alternator Circuit Breaker (150 Amp)
- (6) Load Breaker (80 Amp)
- (7) Main Breaker (80 Amp)
- (8) Start Relay
- (9) Main Power Relay

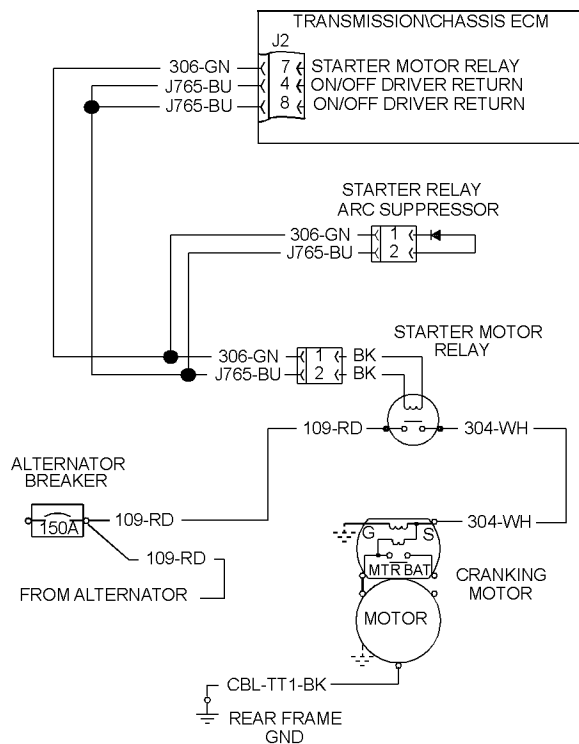


Illustration 149

g01288379

Starter Motor Relay connections

This diagnostic code is associated with the relay for the starter motor. The FMI 06 means that the ECM has determined that the current of the relay circuit is above normal.

Conditions that can cause this diagnostic code are listed below:

- The diode for the arc suppressor has failed.
- The relay has failed.
- The energize circuit of the relay is shorted to a ground source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Note: The coil resistance of the start relay should measure 27.5 ± 3 ohms at 20°C (68.0°F).

Test Step 1. CHECK THE DIODE FOR THE ARC SUPPRESSOR

- Turn the disconnect switch and the starter keyswitch to the OFF position.
- Disconnect the diode for the arc suppressor from the machine harness.
- Check the resistance of the diode for the arc suppressor between contact 1 and contact 2.
- Check the resistance of the diode again. For this check, reverse the placement of the multimeter probes to the opposite contacts of the diode that were checked in the previous step.

Expected Result:

The resistance measurement of the diode is less than 5 ohms when checked one way and the resistance measurement is greater than 5000 ohms when the multimeter probes are reversed.

Results:

- YES – The resistance measurement of the diode is less than 5 ohms when the diode is checked one way and the resistance measurement is greater than 5000 ohms when the multimeter probes are reversed. The diode for the arc suppressor is not shorted. Proceed to Test Step 2.
- NO – The resistance measurement of the diode is less than 5 ohms when checked in one direction and is still less than 5 ohms when the multimeter probes are reversed. The diode is faulty.

Repair: Replace the diode of the arc suppressor. After replacement of the diode, verify that the problem has been corrected before operating the machine.

NOTE: If the resistance checks on the diode indicate greater than 5000 ohms one way and greater than 5000 ohms when the multimeter probes are reversed, the diode for the arc suppressor should be replaced. This condition would not cause this code to activate, however, this condition needs to be corrected.

STOP.

Test Step 2. CHECK THE RELAY

The diode for the arc suppressor remains disconnected from the machine harness.

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. Disconnect the starter relay from the machine harness.
- C. Observe the status of the diagnostic code. Turn the disconnect switch to the ON position and turn the starter keyswitch to the START position for a few seconds.

Expected Result:

The active CID 0444 FMI 06 diagnostic code changes to an active CID 0444 FMI 05 diagnostic code when the relay is disconnected.

Results:

- YES – The active CID 0444 FMI 06 diagnostic code changes to an active CID 0444 FMI 05 diagnostic code when the relay is disconnected. The circuit is correct.

Repair: The relay has failed. Repeat this test "CHECK THE RELAY" in order to verify the failure of the relay.

Check the resistance of the relay coil. Measure the resistance from contact 1 to contact 2 on the relay connector. The resistance of a good relay coil should be 27.5 ± 3 ohms at 20 °C (68.0 °F). To cause this problem, the resistance of the relay coil is most likely much less.

Replace the relay. Verify that the new relay corrects the problem.

STOP.

- NO – The CID 0444 FMI 06 diagnostic code remains active. Disconnecting the relay did not change the status of the diagnostic code. Proceed to Test Step 3.

Test Step 3. CHECK THE ENERGIZE CIRCUIT OF THE RELAY FOR A SHORT TO GROUND

The relay remains disconnected from the machine harness. The diode for the arc suppressor remains disconnected from the machine harness.

- A. Turn the starter keyswitch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connectors J1 and J2 from the ECM.

- C. At the machine harness connectors for the ECM, measure the resistance from the signal contact J2-7 (wire 306-GN(Green)) to frame ground. Measure the resistance from the signal contact J2-7 (wire 306-GN(Green)) to all of the other contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 4.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between wire 306-GN(Green) and the circuit with the low resistance measurement.

Repair: Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors in circuits for points in the machine harness where the circuits could be shorted. For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all connectors of the wiring harness. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the starter keyswitch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 0444 FMI 06 diagnostic code.

Expected Result:

The CID 0444 FMI 06 diagnostic code is active.

i02906526

Results:

- YES – The CID 0444 FMI 06 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the starter relay circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the diagnostic code is still active and the cause can not be found, the ECM may have failed. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace"

STOP.

- NO – The CID 0444 FMI 06 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

MID 027 - CID 0573 - FMI 03

SMCS Code: 1439-038-P9

Conditions Which Generate This Code:

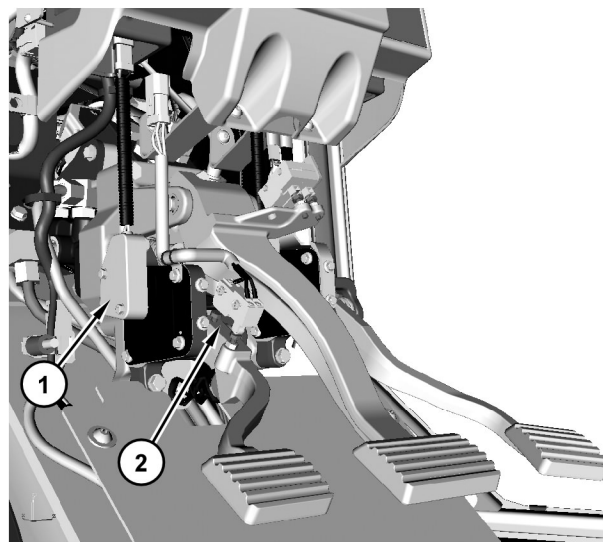


Illustration 150

g01324021

Inching Pedal position sensor location

- (1) Inching pedal position sensor
(2) Inching pedal Switch

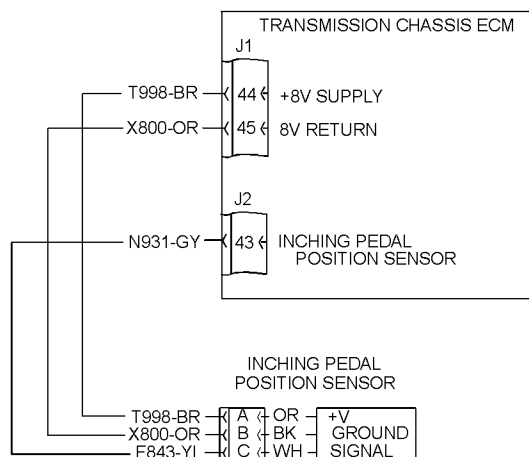


Illustration 151

g01288530

Inching Pedal position sensor connections

Diagnostic Code Procedures

This diagnostic code is associated with the inching pedal position sensor. The FMI 03 diagnostic code means that the Transmission/Chassis ECM has detected that the voltage of the signal circuit for the position sensor is above normal.

The position sensor is a PWM sensor that operates in a frequency range of between 200 hertz to 600 hertz. The optimal operating frequency is approximately 500 hertz. The position sensor sends a PWM input signal to the Transmission/Chassis ECM. The ECM will recognize a duty cycle of 4% to 96% as valid. If the ECM detects a duty cycle that is greater than 96%, the FMI 03 diagnostic code is activated.

For inching pedal operation, the Transmission/Chassis ECM is constantly running an auto calibration when the inching pedal is being used. The ECM defaults to a 30 percent duty cycle when the pedal is not depressed. The ECM defaults to a 70 percent duty cycle when the pedal is fully depressed. Using the auto calibration procedure, the ECM will adjust the acceptable pedal position limits from a possible 4 percent duty cycle when the pedal is not depressed to a possible 96 percent duty cycle when the pedal is fully depressed. Duty cycles beyond these limits will cause the ECM to activate a diagnostic code for the position sensor.

The possible causes of this diagnostic code are listed below:

- There is a problem with the sensor power supply.
- The signal circuit for the sensor has an open or a bad connection.
- The signal circuit for the sensor is shorted to a voltage source.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SENSOR POWER SUPPLY

- A. Turn the key start switch and the disconnect switch to the ON position.
- B. At the machine harness connector for the sensor, insert 7X - 1710 Multimeter Probes along the contact of the power supply A (wire T998-BR(Brown)) and along ground contact B (wire X800-OR(Orange)).
- C. Measure the DC voltage of the sensor power supply.

Expected Result:

The voltage measurement is 8.0 ± 0.3 VDC.

Results:

- OK – The voltage measurement is approximately 8.0 ± 0.3 VDC. The power supply for the sensor is correct. Proceed to Test Step 2.
- NOT OK – The voltage measurement is less than 8.0 ± 0.3 VDC. The power supply for the sensor is not correct.

Repair: Either the wire of the return circuit X800-OR(Orange) or the wire of the supply circuit T998-BR(Brown) has a bad connection or an open in the machine harness. Examine all of the connectors that are in the circuit. Ensure that the connections are clean, that the connections are secure and that the connections are in good condition.

Refer to the CID 0041 diagnostic code procedures in this manual for troubleshooting the 8 VDC power supply. Correct the ECM power supply. After the power supply is correct, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK FOR AN OPEN IN THE SENSOR CIRCUIT

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector from the position sensor.
- C. At the machine harness connector for the sensor, place a jumper wire between the contact of the sensor return B (wire X800-OR(Orange)) and the contact of the signal C (wire F843-YL(Yellow)) .
- D. Disconnect machine harness connectors J1 and J2 from the ECM.

E. At the harness connectors for the ECM, measure the resistance from return contact J1-45 (wire X800-OR(Orange)) to signal contact J2-43 (wire F843-YL(Yellow)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The sensor circuit is not open. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the signal circuit.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is either not connected or that a wire is open. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not open but is not a good connection.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor signal circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT OF THE SENSOR FOR A SHORT

The sensor remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors remain disconnected from the ECM.

- A.** Remove the jumper wire that was used in the last test step.
- B.** At the harness connector J2 for the ECM, measure the resistance from signal contact J2-43 (wire F843-YL(Yellow)) to all of the other contacts that are used for the J1 and J2 connectors on the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The signal circuit is not shorted to another circuit in the machine harness. Proceed to Test Step 4.
- NOT OK – One or more resistance of the resistance measurements is less than 5000 ohms. There is a short in the machine harness.

Repair: The wire of the sensor signal circuit F843-YL(Yellow) is shorted to the circuit with the low resistance measurement in the machine harness.

Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors in the circuits for points in the machine harness where a short could occur.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SIGNAL AT THE SENSOR

The key start switch and the disconnect switch remain in the OFF position.

- A.** Reconnect the machine harness connectors to the sensor and to the ECM.
- B.** At the machine harness for the sensor connector, use a 151 - 6320 Removal Tool to remove the signal wire F843-YL(Yellow) and the socket at contact C from the harness connector. The machine harness connector remains connected to the connector of the inching pedal sensor.
- C.** At the back of the sensor connector, insert 7X - 1710 Multimeter Probes along the sensor signal contact C and the return contact at B.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Measure the duty cycle of the sensor at the sensor contacts C and B. Move the inching pedal through the full range of movement.

Expected Result:

For inching pedal operation, the position sensor duty cycle is in the range of 4 percent when the pedal is not depressed to 96 percent when the inching pedal is fully depressed. The duty cycle of the sensor is never above 96%.

Results:

Diagnostic Code Procedures

- OK – The duty cycle of the sensor is correct. The sensor is not the problem. Proceed to Test Step 5.
- NOT OK – The duty cycle of the sensor is NOT correct according to the description above. The sensor has failed.

Repair: The operation of the inching pedal position sensor is not correct. Replace the inching pedal position sensor. After replacement of the sensor, verify that the operation of the new sensor is correct before operating the machine.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Determine if the CID 0573 FMI 03 diagnostic code is active.

Expected Result:

The CID 0573 FMI 03 diagnostic code is not active.

Results:

- OK – The CID 0573 FMI 03 diagnostic code is not active. The problem has been corrected.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NOT OK – The CID 0573 FMI 03 diagnostic code is still active. The problem has not been corrected.

Repair: Perform this test step again. If the problem has not been corrected, use the Caterpillar Electronic Technician (ET) service

tool, if available, in order to perform a wiggle test on the sensor circuit in the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If a problem is not found in the machine harness, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Implement ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02906561

MID 027 - CID 0573 - FMI 04

SMCS Code: 1439-038-P9

Conditions Which Generate This Code:

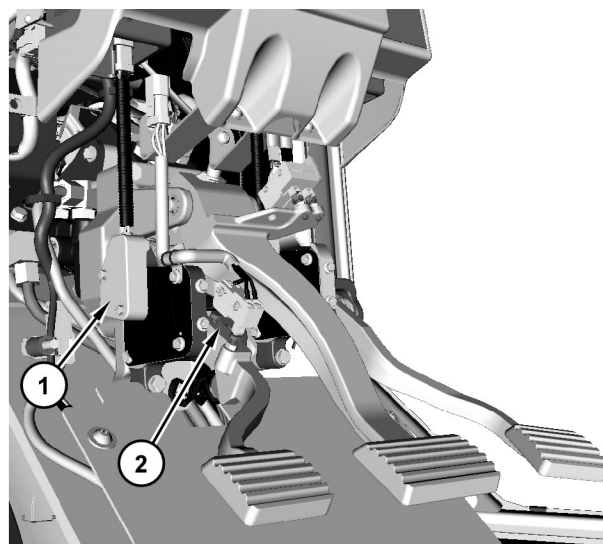


Illustration 152

g01324021

Inching Pedal position sensor location

- (1) Inching pedal position sensor
- (2) Inching pedal Switch

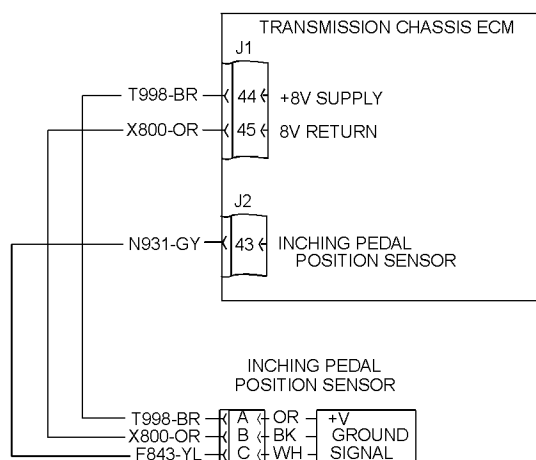


Illustration 153

g01288530

Inching Pedal position sensor connections

This diagnostic code is associated with the inching pedal position sensor. The FMI 04 means that the Transmission/Chassis ECM has detected that the duty cycle and the voltage of the position sensor signal circuit are below normal.

The position sensor is a PWM sensor that operates in a frequency range of between 200 hertz to 600 hertz. The optimal operating frequency is approximately 500 hertz. The position sensor sends a PWM input signal to the Transmission/Chassis ECM. The ECM will recognize a duty cycle of 4% to 96% as valid. If the ECM detects a duty cycle that is less than 4%, the FMI 04 diagnostic code is activated.

For inching pedal operation, the Transmission/Chassis ECM is constantly running an auto calibration when the inching pedal is being used. The ECM defaults to a 30 percent duty cycle when the pedal is not depressed. The ECM defaults to a 70 percent duty cycle when the pedal is fully depressed. Using the auto calibration procedure, the ECM will adjust the acceptable pedal position limits from a possible 4 percent duty cycle when the pedal is not depressed to a possible 96 percent duty cycle when the pedal is fully depressed. Duty cycles beyond these limits will cause the ECM to activate a diagnostic code for the position sensor.

The possible conditions that can cause this diagnostic code to activate are listed below:

- The sensor has failed.
- The signal circuit for the sensor is shorted to a ground source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: This procedure can cause new diagnostic codes to be activated. Ignore these created diagnostic codes. When the problem has been corrected, clear the created diagnostic codes.

Test Step 1. CHECK THE SENSOR

- Turn the disconnect switch and the key start switch to the ON position.
- While observing the status of the diagnostic code, disconnect the machine harness connector from the position sensor of the inching pedal.

Expected Result:

The FMI 04 diagnostic code will remain active if the sensor is not the cause of the problem. The sensor is internally shorted if the FMI 04 diagnostic code changes to an active FMI 03 diagnostic code when the sensor is disconnected from the machine harness.

Results:

- OK – The FMI 04 diagnostic code remains active. The sensor has not failed. Proceed to Test Step 2.
- NOT OK – The FMI 04 diagnostic code changes to an FMI 03 diagnostic code when the sensor is disconnected. The machine harness and the ECM are operating correctly.

Repair: The inching pedal position sensor has failed. Replace the sensor. After replacement of the sensor, verify that the operation of the new sensor is correct before operating the machine.

STOP.

Test Step 2. CHECK THE SENSOR CIRCUIT FOR A SHORT

The position sensor remains disconnected from the machine harness.

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector J1 and J2 from the ECM.

- C.** At the machine harness connector J2 for the ECM, measure the resistance from the signal contact J2-43 (wire F743-YL(Yellow)) to frame ground. Measure the resistance from the signal contact J2-43 (wire F743-YL(Yellow)) to all of the contacts that are used in the machine harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more resistance measurements is not correct. There is a short in the machine harness.

Repair: The short is between the signal wire F743-YL(Yellow) and the circuit with the low resistance measurement or frame ground.

Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors in circuits for points in the machine harness where a short circuit could occur.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Check the status of the CID 0573 FMI 04 diagnostic code.

Expected Result:

The CID 0573 FMI 04 diagnostic code is active.

Results:

- YES – The CID 0573 FMI 04 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Perform this procedure again. If the problem has not been corrected, Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the sensor circuit in the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0573 FMI 04 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02906061

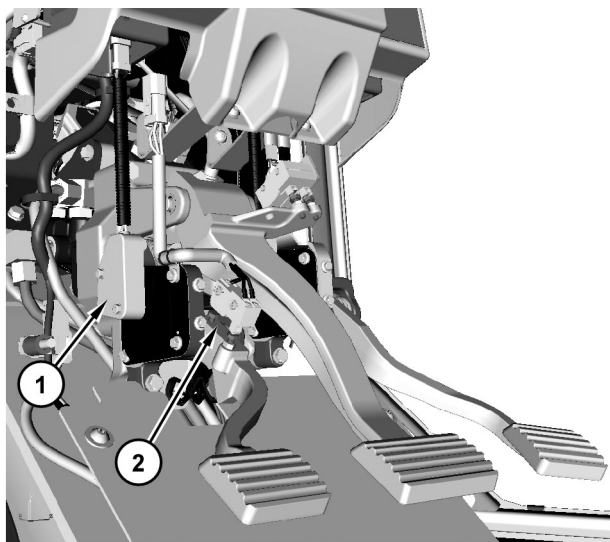
MID 027 - CID 0573 - FMI 08**SMCS Code:** 1439-038-P9**Conditions Which Generate This Code:**

Illustration 154

g01324021

Inching Pedal Position sensor location

- (1) Inching pedal position sensor
(2) Inching pedal Switch

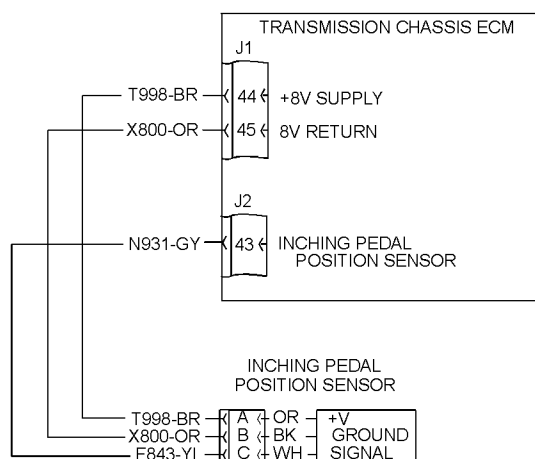


Illustration 155

g01288530

Inching Pedal position sensor connections

This diagnostic code is associated with the inching pedal position sensor. The FMI 08 means that the ECM has determined that the signal frequency or the signal pulse width is not within the expected range.

The position sensor is a PWM sensor that operates in a frequency range of between 200 hertz to 600 hertz. The optimal operating frequency is approximately 500 hertz. The position sensor sends a PWM input signal to the Transmission/Chassis ECM. The ECM will recognize a duty cycle of 4% to 96% as valid. If the ECM detects a duty cycle that is greater than 96%, the FMI 03 diagnostic code is activated.

For inching pedal operation, the Transmission/Chassis ECM is constantly running an auto calibration when the inching pedal is being used. The ECM defaults to a 20 percent duty cycle when the pedal is not depressed. The ECM defaults to a 70 percent duty cycle when the pedal is fully depressed. Using the auto calibration procedure, the ECM will adjust the acceptable pedal position limits from a possible 4 percent duty cycle when the pedal is not depressed to a possible 96 percent duty cycle when the pedal is fully depressed. Duty cycles beyond these limits will cause the ECM to activate a diagnostic code for the position sensor.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- Intermittent connections or poor connections in the sensor signal circuit.
- The ECM has failed. This is unlikely.

Note:

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SIGNAL AT THE SENSOR

Turn the key start switch and the disconnect switch to the OFF position.

- A.** At the machine harness for the sensor connector, use a 151 - 6320 Removal Tool to remove the signal wire F843-YL (Yellow) and the socket at contact C from the harness connector. The machine harness connector remains connected to the connector of the inching pedal sensor.

- B. At the back of the sensor connector**, insert 7X-1710 Multimeter Probes along the sensor signal contact C and the return contact at B.
- C.** Turn the disconnect switch and the key start switch to the ON position.
- D.** Measure the frequency of the sensor signal. Measure the duty cycle of the sensor at the contacts of the sensor connector C and B. Move the inching pedal through the full range of movement.
- E.** While measuring the frequency and the duty cycle of the sensor, wiggle the sensor connector.

Expected Result:

The frequency and the duty cycle of the inching pedal position sensor are correct according to the description at the beginning of this procedure at all times during manipulation of the connector.

Results:

- OK – The frequency and the duty cycle of the inching pedal position sensor are correct. The sensor is not the problem. Reinstall the disconnected wire and the socket in the machine harness connector for the sensor before proceeding to the next test step. Proceed to Test Step 2.
- NOT OK – The duty cycle of the sensor is NOT correct according to the description at the beginning of this procedure. The sensor has failed. A circuit connection of the sensor signal has failed.

Repair: Investigate the cause of the incorrect measurement. Check the wiring and connections of the sensor. If the sensor is faulty, replace the sensor. After replacement of the sensor, verify that the operation of the inching pedal is correct before operating the machine.

STOP.

Test Step 2. CHECK FOR AN OPEN IN THE SENSOR CIRCUIT

- A.** Turn the key start switch and the disconnect switch to the OFF position.
- B.** Disconnect the machine harness connector from the position sensor.
- C.** At the machine harness connector for the sensor, place a jumper wire between the sensor return contact B (wire X800-OR(Orange)) and the signal contact C (wire F843-YL(Yellow)) .
- D.** Disconnect machine harness connectors J1 and J2 from the ECM.

- E.** At the harness connectors for the ECM, measure the resistance from return contact J1-45 (wire X800-OR(Orange)) to signal contact J2-43 (wire F843-YL(Yellow)).
- F.** While observing the resistance measurement, wiggle the machine harness at the ECM connector and wiggle the machine wiring harness at the sensor connector. Do not disconnect the jumper wire.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the machine harness.

Results:

- OK – The resistance measurement is less than 5 ohms. The sensor circuit is not open. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the signal circuit.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is either not connected or is open. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not open but is not a good connection.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor signal circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT OF THE SENSOR FOR A SHORT

The sensor remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors remain disconnected from the ECM.

- A.** Remove the jumper wire that was used in the last test step.
- B.** At the harness connector J2 for the ECM, measure the resistance from signal contact J2-43 (wire F843-YL(Yellow)) to all of the other contacts that are used for the J1 and J2 connectors on the Transmission/Chassis ECM.

- C.** While observing the resistance measurements, wiggle the machine harness at the ECM connector and wiggle the machine wiring harness at the sensor connector.

Expected Result:

Each resistance measurement is greater than 5000 ohms at all times during the manipulation of the machine harness.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The signal circuit is not shorted to another circuit in the machine harness. Proceed to Test Step 4.
- NOT OK – One or more resistance of the resistance measurements is less than 5000 ohms. There is a short in the machine harness.

Repair: The circuit wire for the signal of the sensor F843-YL(Yellow) is shorted to the circuit with the low resistance measurement in the machine harness.

Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors in the circuits for points in the machine harness where a short could occur.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C.** Reconnect all harness connectors and make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Check the status of the CID 0573 FMI 08.

Expected Result:

The CID 0573 FMI 08 is not active.

Results:

- OK – The CID 0573 FMI 08 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0573 FMI 08 is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the diagnostic code is not found, the ECM may have failed.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i05164395

MID 027 - CID 0585 - FMI 02

SMCS Code: 3175-038-OJ

Conditions Which Generate This Code:

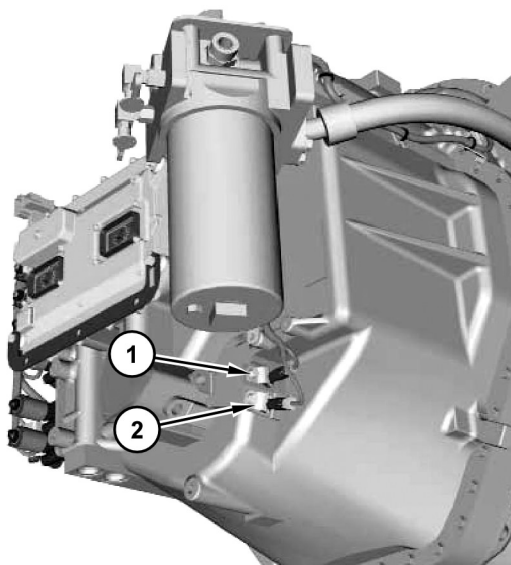


Illustration 156

g01323251

Transmission Output Speed Sensors are located on the right side rear of the transmission.

- (1) Transmission Output Speed Sensor 2
(2) Transmission Output Speed Sensor 1

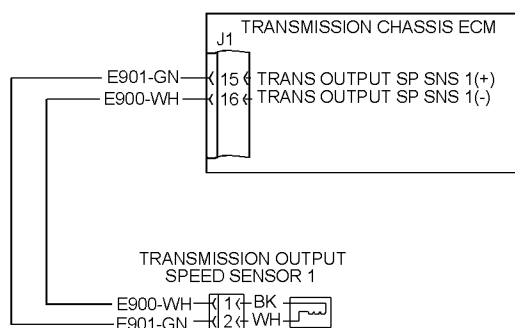


Illustration 157

g03317475

Transmission Output Speed Sensor 1 connections

This diagnostic code is associated with the Transmission Output Speed Sensor 1. The transmission output speed sensor 1 is located toward the rear of the transmission on the right-hand side.

The ECM monitors the signals from the transmission output speed sensor 1 and the transmission output speed sensor 2. When the ECM detects that the signal of the speed sensor 1 is not within the accepted limits and that the speed sensor 2 signal is within the accepted limits, the ECM will activate the FMI 02 diagnostic code.

The following conditions could cause the ECM to activate this diagnostic code:

- The speed sensor has failed.
- There is an intermittent short or an open in the speed sensor circuit.
- The speed sensor is not mounted securely.
- Failure of the ECM is unlikely.

Note: Before performing this procedure, verify that the speed sensor is mounted securely. A loose mount could cause this diagnostic code to be activated. Ensure that this diagnostic code is active before performing this procedure.

Test Step 1. CHECK THE SENSOR

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness from the speed sensor.
- At the connector for the speed sensor, measure the resistance from contact 2 to contact 1.

Expected Result:

The correct range of resistance for the sensor is approximately 75 ohms at -40°C (-40°F) to 230 ohms at 120°C (248°F). The resistance will be approximately 140 ohms at 25°C (77°F).

Results:

- YES – The resistance of the speed sensor is within the correct resistance range. The sensor is correct. Proceed to Test Step 2.
- NO – The resistance of the speed sensor is not within the correct resistance range. The speed sensor has failed.

Repair: Verify that the speed sensor is causing the problem. Mark the harness connector for the transmission output speed sensor 1. Connect the marked machine harness connector for transmission output speed sensor 1 to the transmission output speed sensor 2. Connect the machine harness connector for transmission output speed sensor 2 to the

transmission output speed sensor 1. Turn the disconnect switch and the key start switch to the ON position.

If the transmission output speed sensor 1 has failed, the CID 0585 FMI 02 diagnostic code will no longer be active. A CID 0673 FMI 02 diagnostic code for the transmission output speed sensor 2 will become active.

Replace the transmission output speed sensor 1. Verify that the new sensor corrects the problem before operating the machine.

STOP.

Test Step 2. SWITCH THE SENSORS

The key start switch and the disconnect switch remain in the OFF position. The transmission output speed sensor 1 remains disconnected from the machine harness.

- A. Mark the transmission output speed sensor 1 harness connector in order to track the connector that is used for each sensor.
- B. Disconnect the transmission output speed sensor 2 from the machine harness.
- C. Switch the speed sensor harness connectors. Connect the marked machine harness connector for transmission output speed sensor 1 to the transmission output speed sensor 2. Connect the machine harness connector for transmission output speed sensor 2 to the transmission output speed sensor 1.
- D. Turn the key start switch and the disconnect switch to the ON position.
- E. Observe the status of the active diagnostic code.

Expected Result:

The CID 0585 FMI 02 diagnostic code is no longer active. A CID 0673 FMI 02 diagnostic code for the transmission output speed sensor 2 is active after the switch.

Results:

- YES – The CID 0585 FMI 02 diagnostic code is no longer active after the sensors are switched. A CID 0673 FMI 02 diagnostic code for the transmission output speed sensor 2 is now active.

Repair: The transmission output speed sensor 1 has failed. Replace the speed sensor. Verify that the new speed sensor corrects the problem before operating the machine.

STOP.

- NO – The CID 0585 FMI 02 diagnostic code is still active. Switching the speed sensors did not affect the status of the CID 0585 FMI 02 diagnostic code. The sensor is not causing the problem. Reconnect the machine harness connectors to the correct transmission output speed sensor before proceeding to the next test step. Proceed to Test Step 3.

Test Step 3. CHECK THE SENSOR CIRCUIT FOR AN OPEN

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. Disconnect the machine harness connector from the sensor.
- C. Disconnect the machine harness connectors J1 from the ECM.
- D. At the machine harness connector for the sensor, connect a jumper wire between contact 1 (wire E900-WH(White)) and contact 2 (wire E901-GN(Green)).
- E. At the machine harness connector J1 for the ECM, measure the resistance between contact J1-15 (wire E901-GN(Green)) and contact J1-16 (wire E900-WH(White)).
- F. Observe the resistance measurement and wiggle the ECM connector. Gently pull on the wires and wiggle the wires.
- G. Observe the resistance measurement and wiggle the speed sensor connector. Gently pull on the wires and wiggle the wires. Do not disconnect the jumper wire.

Expected Result:

The resistance measurement is less than 5 ohms all times during the manipulation of the wires and the connectors.

Results:

- YES – The resistance measurement is less than 5 ohms. The speed sensor circuit is not open in the machine harness. Proceed to Test Step 4.
- NO – The resistance measurement is greater than 5 ohms for all of the time or for part of the time that the resistance is being measured. There is an open connection or a bad connection in the one of the wires for the circuit of the speed sensor. Check each wire individually in order to determine whether the problem is in the signal circuit or the ground circuit.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a

wire is either not connected or that a wire is open. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points or a splice connection in the circuit is not open but is not a good connection.

A resistance measurement that is greater than 5 ohms at some time during the manipulation of the machine harness indicates that there is an intermittent open or a loose connection in the machine harness.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the circuit. Ensure that all of the contacts for the circuit are in good condition, that all the contacts are clean, and that all the contacts are securely fastened in each of the harness connectors. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SIGNAL CIRCUIT FOR A SHORT

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors remain disconnected from the sensor and the ECM.

- A. Disconnect the jumper wire that was used in the last test step.
- B. Disconnect the machine harness connectors J2 from the ECM.
- C. At the machine harness connector J1 for the ECM, measure the resistance between contact J1-15 (wire E901-GN(Green)) and frame ground. Measure the resistance between contact J1-15 (wire E901-GN(Green)) and all of the other contacts that are used in the J1 and J2 connectors for the ECM.
- D. Observe the resistance measurements and wiggle the ECM connectors and the speed sensor connector. Gently pull on the wires and wiggle the wires.
- E. At the machine harness connector J1 for the ECM, measure the resistance between contact J1-16 (wire E900-WH(White)) and frame ground. Measure the resistance between contact J1-16 (wire E900-WH(White)) and all of the other contacts that are used in the J1 and J2 connectors for the ECM.
- F. Observe the resistance measurements and wiggle the ECM connectors and the speed sensor connector. Gently pull on the wires and wiggle the wires.

Expected Result:

Each resistance measurement is greater than 5000 ohms at all times during the manipulation of the machine harness.

Results:

- YES – Each resistance measurement is greater than 5000 ohms. The measurements do not indicate a short circuit. Proceed to Test Step 5.
- NO – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness.

Repair: The short is between the circuit for the speed sensor that was being checked and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the faulty speed sensor circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all harness connectors in order to make sure that the connectors are fully seated. Observe that the clips for each connector are fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 0585 FMI 02 diagnostic code is active.

Expected Result:

The CID 0585 FMI 02 diagnostic code is active.

Results:

- YES – The CID 0585 FMI 02 diagnostic code is active. The problem has not been corrected.

Repair: Check the relay circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NO – The CID 0585 FMI 02 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i03850449

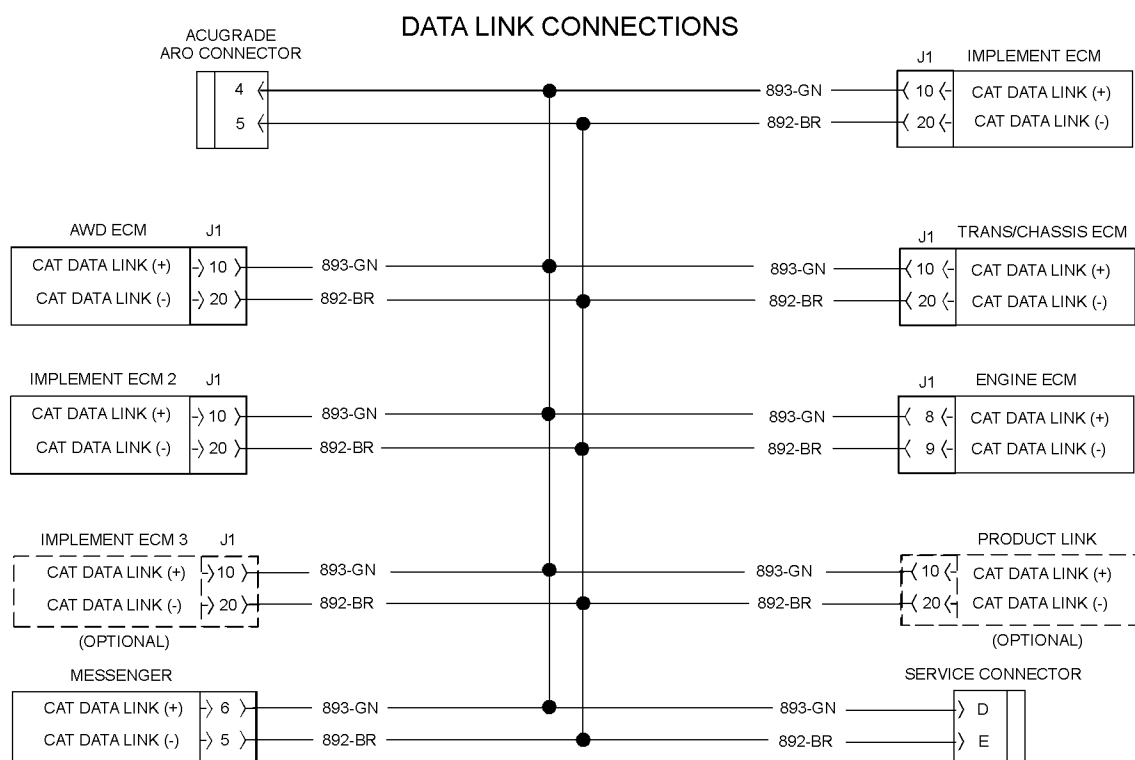
MID 027 - CID 0588 - FMI 09**SMCS Code:** 7490-038**Conditions Which Generate This Code:**

Illustration 158

g02072336

Cat Data Link connections

The CID 0590 FMI 09 diagnostic code is associated with the communication between the “Transmission/Chassis ECM” and the Monitoring System (Messenger) that is conducted on the Cat Data Link circuit.

The FMI 09 means that the “Transmission/Chassis ECM” is not receiving any communication from the Monitoring System over the Cat Data Link circuit.

The possible causes of the CID 0588 FMI 09 diagnostic code are listed below:

- An open or a poor connection in the Cat Data Link circuit
- The “Messenger” Module has failed. This is unlikely.

- The “Transmission/Chassis ECM” has failed. This is unlikely.

Note: A loss of power to the Monitoring System can cause the “Transmission/Chassis ECM” to activate this diagnostic code. Ensure that the Monitoring System is powered up before proceeding with this procedure.

Note: Ensure that the CID 0588 FMI 09 diagnostic code is active before performing this procedure.

Test Step 1. CHECK THE CAT DATA LINK CIRCUIT FOR AN OPEN

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector J1 from the "Transmission/Chassis ECM". Disconnect the machine harness connector from the Messenger.
- C. Inspect the harness connectors and clean all of the contacts of the harness connectors. Refer to the illustration above in order to check the Cat Data Link connection on each of the connectors for the machine harness. Ensure that the wires are secured in the connector, that the contacts are clean and that the contacts are in good condition.
- D. At the disconnected harness connector for the Monitoring System, connect a jumper wire between contact 6 (wire 893-GN(Green)) and contact 5 (wire 892-BR(Brown)).
- E. At the disconnected harness connector J1 for the "Transmission/Chassis ECM", measure the resistance between contact J1-10 (wire 893-GN(Green)) and contact J1-20 (wire 892-BR(Brown)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The Cat Data Link circuit in the machine harness is not open. Proceed to Test Step 2.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the Cat Data Link circuit in the machine harness.

Repair: A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the wires or one of the connection points in the circuit is not an open connection but not a good connection.

Refer to the complete Electrical System Schematic of the machine. Locate all the connectors and examine all of the connectors of the machine harness that are involved in the data link circuit. Check each wire section from each end of the connectors for an open or a bad connection. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the data link circuit.
- B. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Operate the machine.
- E. Check the status of the CID 0588 FMI 09 diagnostic code.

Expected Result:

The CID 0588 FMI 09 diagnostic code is not active.

Results:

- OK – The CID 0588 FMI 09 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0588 FMI 09 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, one of the ECM modules may have failed. The ECM that activated the diagnostic code may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02916304

MID 027 - CID 0588 - FMI 14

SMCS Code: 7490-038

Conditions Which Generate This Code:

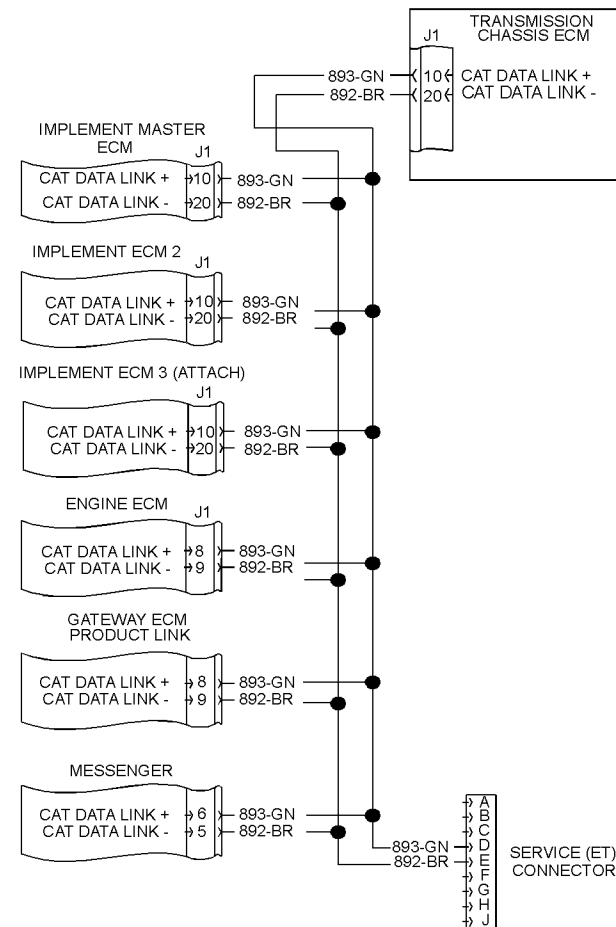


Illustration 159

g01332252

Cat Data Link connections

This CID 0588 FMI 14 diagnostic code is associated with the communication between the Transmission/Chassis ECM and the Monitoring System (Messenger) that is conducted on the circuit for the Cat Data Link.

The FMI 14 means that the Transmission/Chassis ECM is not receiving the expected operating parameter information from the Messenger. The Messenger and the Transmission/Chassis ECM are still communicating over the CAT data link.

The possible causes of the CID 0588 FMI 14 diagnostic code are listed below:

- The software that is installed on the Messenger is incorrect.

- The software that is installed on the Transmission/Chassis ECM is incorrect.
- A new ECM has been installed but the ECM is not the correct part.

Note: Ensure that the CID 0588 FMI 14 diagnostic code is active before performing this procedure.

Test Step 1. VERIFY THE HARDWARE AND THE SOFTWARE PART NUMBERS

A. Verify that the following information is correct:

- The part number of the installed software for the Transmission/Chassis ECM
- The part number of the installed software for the Messenger
- The part number of the Transmission/Chassis ECM
- The part number of the Messenger

Note: Contact your dealership's Technical Communicator for the correct part numbers of the hardware and the correct part numbers for the configuration software for your machine.

Expected Result:

All hardware and software part numbers are correct.

Results:

- OK – All hardware and software part numbers are correct. Proceed to Test Step 2.
- NOT OK – All hardware and software part numbers are NOT correct.

Repair: Replace the hardware or software that is incorrect with the correct version. For flashing software, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Flash Program". For replacing ECM modules, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace"

STOP.

Test Step 2. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.

- C.** Check the status of the CID 0588 FMI 14 diagnostic code.

Expected Result:

The CID 0588 FMI 14 diagnostic code is not active.

Results:

- OK – The CID 0588 FMI 14 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code could have been caused by a problem at start-up with one of the controls of the ECM. Resume normal operation.

STOP.

- NOT OK – The CID 0588 FMI 14 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Repeat this procedure again and verify that the information is correct.

If the cause of the problem is not found, the ECM that has activated the diagnostic code may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02916317

MID 027 - CID 0590 - FMI 09

SMCS Code: 1901-038

Conditions Which Generate This Code:

The CID 0590 FMI 09 diagnostic code is associated with the communication between the Transmission/Chassis ECM and the Engine ECM that is conducted on the Cat Data Link or the communication that is conducted over the SAE J1939 Data Link.

The FMI 09 means that the Transmission/Chassis ECM is not receiving any communication from the Engine ECM on the involved data link circuit.

When this diagnostic code is activated by the Transmission/Chassis ECM, a "companion" diagnostic code is activated in order to indicate the data link that is involved. The companion diagnostic code that has been activated will be either of the following:

CID 0247 FMI 09 – SAE J1939 Data Link

CID 0248 FMI 09 – Cat Data Link

Determine the companion diagnostic codes that are active, along with the CID 0590 FMI 09 diagnostic code, to indicate the data link system that is involved.

When the CID 0590 FMI 09 diagnostic code is cleared, the data link companion diagnostic code will also clear.

The possible causes of the CID 0590 FMI 09 diagnostic code are listed below:

- An open connection or a poor connection in the data link circuit
- The Engine ECM has failed. This is unlikely.
- The Transmission/Chassis ECM has failed. This is unlikely.

Note: A loss of power to the Engine ECM can cause the Transmission/Chassis ECM to activate this diagnostic code. Ensure that the Engine ECM is powered up before proceeding with this procedure.

Note: Ensure that the CID 0590 FMI 09 diagnostic code is active before performing this procedure.

Test Step 1. DETERMINE THE COMPANION DIAGNOSTIC CODE OF THE DATA LINK THAT IS ACTIVE

- A.** Check the list of active diagnostic codes in order to determine which of the following companion diagnostic codes is active: **CID 0247 FMI 09 - SAE J1939 Data Link** **CID 0248 FMI 09 - Cat Data Link**

Results:

- OK – The CID 0248 FMI 09 diagnostic code is active indicating that the problem is in the Cat Data Link. In order to perform the troubleshooting procedure for the Cat Data Link, proceed to Test Step 2.
- OK – The CID 0247 FMI 09 diagnostic code is active indicating that the problem is in the SAE J1939 Data Link. In order to perform the troubleshooting procedure for the SAE J1939 Data Link, proceed to Test Step 4.

Test Step 2. CHECK THE CAT DATA LINK CIRCUIT FOR AN OPEN

Diagnostic Code Procedures

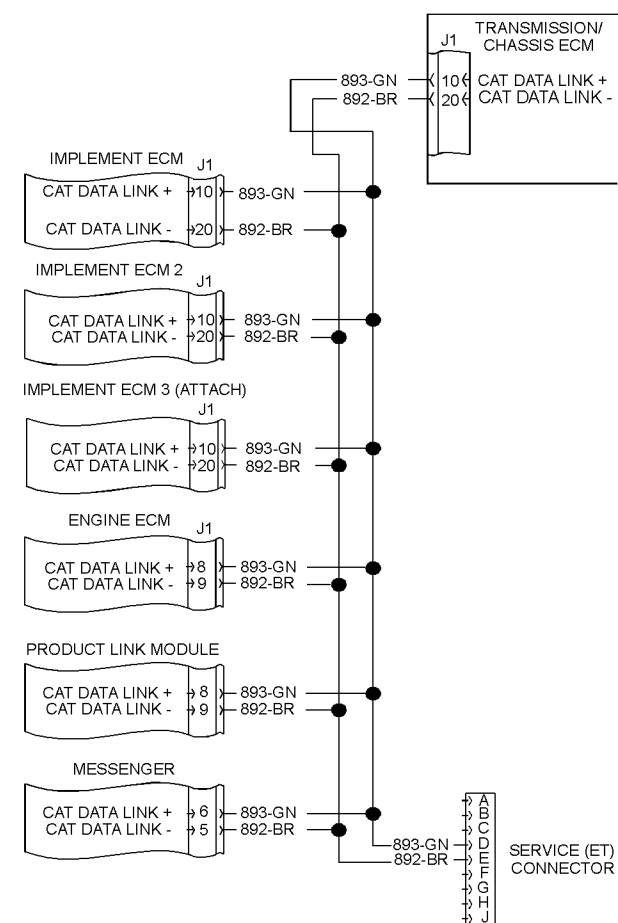


Illustration 160

g01321267

Cat Data Link connections

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector J1 from the Transmission/Chassis ECM. Disconnect the machine harness connector J1 from the Engine ECM.
- C. Inspect the harness connectors and clean all of the contacts of the harness connectors. Refer to the illustration above in order to check the connection of the Cat Data Link on each of the machine harness connectors. Ensure that the wires are secured in the connector, that the contacts are clean and that the contacts are in good condition.
- D. At the disconnected harness connector J1 for the Engine ECM, connect a jumper wire between contact J1-8 (wire 893-GN(Green)) and contact J1-9 (wire 892-BR(Brown)).

- E. At the disconnected harness connector J1 for the Transmission/Chassis ECM, measure the resistance between contact J1-10 (wire 893-GN(Green)) and contact J1-20 (wire 892-BR(Brown)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The Cat Data Link circuit in the machine harness is not open. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the Cat Data Link circuit in the machine harness.

Repair: A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the wires or one of the connection points in the circuit is not an open connection but not a good connection.

Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors for the machine harness that are involved in the data link circuit. Check each section from one wire connector to the other wire connector for an open or a bad connection. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the data link circuit.
- B. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Operate the machine.
- E. Check the status of the CID 0590 FMI 09 diagnostic code.

Expected Result:

The CID 0590 FMI 09 diagnostic code is not active.

Results:

- OK – The CID 0590 FMI 09 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0590 FMI 09 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, one of the ECM modules may have failed. The ECM that activated the diagnostic code may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE SAE J1939 DATA LINK CIRCUIT FOR AN OPEN

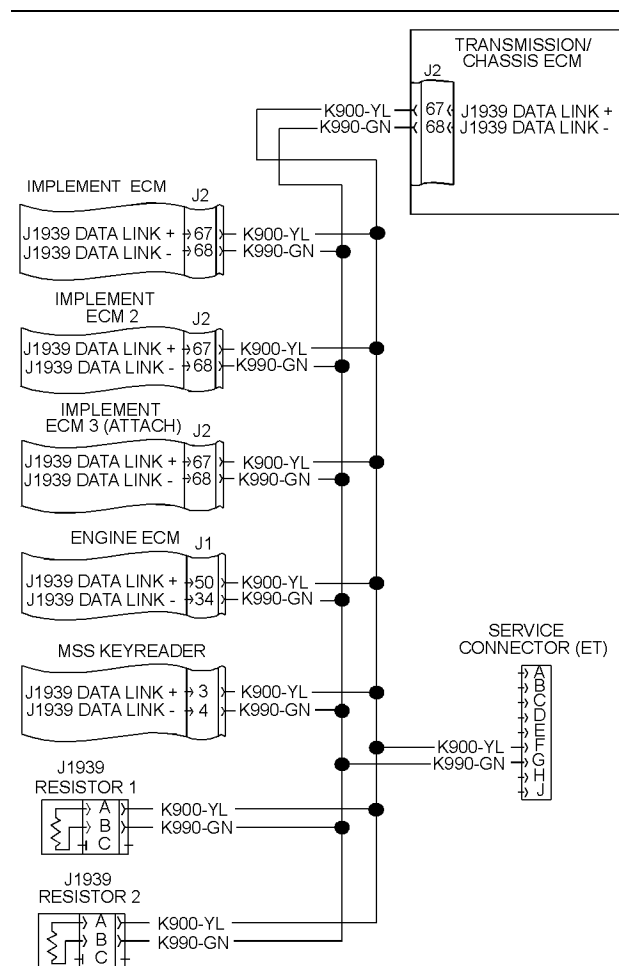


Illustration 161

g01321279

SAE J1939 Data Link Circuit connections

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector J2 from the Transmission/Chassis ECM. Disconnect the machine harness connector J1 from the Engine ECM.
- Inspect the harness connectors and clean all of the contacts of the harness connectors. Refer to the illustration above in order to check the SAE J1939 Data Link connection on each of the machine harness connectors. Ensure that the wires are secured in the connector, that the contacts are clean and that the contacts are in good condition.
- At the disconnected harness connector J1 for the Engine ECM, connect a jumper wire between contact J1-50 (wire K900-YL(Yellow)) and contact J1-34 (wire K990-GN(Green)).

E. At the disconnected harness connector J2 for the Transmission/Chassis ECM, measure the resistance between contact J2-67 (wire K900-YL(Yellow)) and contact J2-68 (wire K990-GN(Green)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The SAE J1939 Data Link circuit in the machine harness is not open. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the SAE J1939 Data Link circuit in the machine harness.

Repair: Refer to the complete Electrical System Schematic of the machine. Examine all of the harness connections of the machine that are involved in the data link circuit. Check each wire section from one connector to the other connector for an open or a bad connection. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the data link circuit.
- B.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- C.** Turn the disconnect switch and the key start switch to the ON position.
- D.** Operate the machine.
- E.** Check the status of the CID 0590 FMI 09 diagnostic code.

Expected Result:

The CID 0590 FMI 09 diagnostic code is not active.

Results:

- OK – The CID 0590 FMI 09 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably

caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0590 FMI 09 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, one of the ECM modules may have failed. The ECM that activated the diagnostic code may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i04862471

MID 027 - CID 0590 - FMI 14

SMCS Code: 1901-038

Conditions Which Generate This Code:

This CID 0590 FMI 14 diagnostic code is associated with the communication between the Transmission/Chassis ECM and the Engine ECM that is conducted on the Cat Data Link or the communication that is conducted over the SAE J1939 Data Link.

The FMI 14 means that the Transmission/Chassis ECM is not receiving expected operating parameter information from the Engine ECM. However, the Transmission/Chassis ECM and the Engine ECM are communicating.

When the CID 0590 FMI 14 diagnostic code is activated by the Transmission/Chassis ECM, a "companion" diagnostic code will be activated in order to indicate the data link that is involved. The companion diagnostic code that has been activated will be either of the following diagnostic codes:

CID 0247 FMI 14 – SAE J1939 Data Link

CID 0248 FMI 14 – Cat Data Link

Determine the companion diagnostic codes that have been activated along with the CID 0590 FMI 14 diagnostic code in order to indicate the data link that is involved.

Note: When the CID 0590 FMI 14 diagnostic code is cleared, the companion diagnostic code for the data link will also clear.

The possible causes of the CID 0590 FMI 14 diagnostic code are listed below:

- The software that is installed on the Engine ECM is incorrect.
- The software that is installed on the Transmission/Chassis ECM is incorrect.
- A new ECM has been installed and the ECM is not the correct part.

Note: Ensure that the CID 0590 FMI 14 diagnostic code is active before performing this procedure.

Test Step 1. VERIFY THE HARDWARE AND THE SOFTWARE PART NUMBERS

A. Verify that the following information is correct:

- The part number of the installed software for the Transmission/Chassis ECM
- The part number of the installed software for the Engine ECM
- The part number of the Transmission/Chassis ECM
- The part number of the Engine ECM

Note: Contact your dealership's Technical Communicator for the correct part numbers of the hardware and the correct part numbers for the configuration software for your machine.

Expected Result:

All hardware and software part numbers are correct.

Results:

- OK – All hardware and software part numbers are correct. Proceed to Test Step 2.
- NOT OK – All hardware and software part numbers are NOT correct.

Repair: Replace the hardware or software that is incorrect with the correct version. For flashing software, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Flash

Program". For replacing ECM modules, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace"

STOP.

Test Step 2. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Turn the disconnect switch and the key start switch to the ON position.
- B.** Operate the machine.
- C.** Check the status of the CID 0590 FMI 14 diagnostic code.

Expected Result:

The CID 0590 FMI 14 diagnostic code is not active.

Results:

- OK – The CID 0590 FMI 14 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code could have been caused by a problem during start-up with one of the ECM modules. Resume normal operation.

STOP.

- NOT OK – The CID 0590 FMI 14 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Repeat this procedure again and verify that the information is correct.

If the cause of the problem is not found, the ECM that has activated the diagnostic code may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02916378

MID 027 - CID 0596 - FMI 09

SMCS Code: 7610-038-II

Conditions Which Generate This Code:

The CID 0596 FMI 09 diagnostic code is associated with the communication between the Transmission/Chassis ECM and the Implement ECM that is conducted on the Cat Data Link or the communication that is conducted over the SAE J1939 Data Link.

The FMI 09 means that the Transmission/Chassis ECM is not receiving any communication from the Implement ECM on the involved data link circuit.

When this diagnostic code is activated by the Transmission/Chassis ECM, a “companion” diagnostic code will be activated in order to indicate the data link that is involved. The companion diagnostic code that has been activated will be either of the following:

CID 0247 FMI 09 – SAE J1939 Data Link

CID 0248 FMI 09 – Cat Data Link

Determine the companion diagnostic codes that have been activated in conjunction with the CID 0596 FMI 09 diagnostic code in order to indicate the data link that is involved.

When the CID 0596 FMI 09 diagnostic code is cleared, the companion diagnostic code of the data link will also clear.

The possible causes of the CID 0596 FMI 09 diagnostic code are listed below:

- An open connection or a poor connection in the data link circuit
- The Implement ECM has failed. This is unlikely.
- The Transmission/Chassis ECM has failed. This is unlikely.

Note: A loss of power to the Implement ECM can cause the Transmission/Chassis ECM to activate this diagnostic code. Ensure that the Implement ECM is powered up before proceeding with this procedure.

Note: Ensure that the CID 0596 FMI 09 diagnostic code is active before performing this procedure.

Test Step 1. DETERMINE THE COMPANION DIAGNOSTIC CODE OF THE DATA LINK THAT IS ACTIVE

A. Check the list of active diagnostic codes in order to determine which of the following companion diagnostic codes is active: **CID 0247 FMI 09 - SAE J1939 Data Link** **CID 0248 FMI 09 - Cat Data Link**

Results:

- OK – The CID 0248 FMI 09 diagnostic code is active indicating that the problem is in the Cat Data Link. In order to perform the troubleshooting procedure for the Cat Data Link, proceed to Test Step 2.
- OK – The CID 0247 FMI 09 diagnostic code is active indicating that the problem is in the SAE J1939 Data Link. In order to perform the troubleshooting procedure for the SAE J1939 Data Link, proceed to Test Step 4.

Test Step 2. CHECK THE CAT DATA LINK CIRCUIT FOR AN OPEN

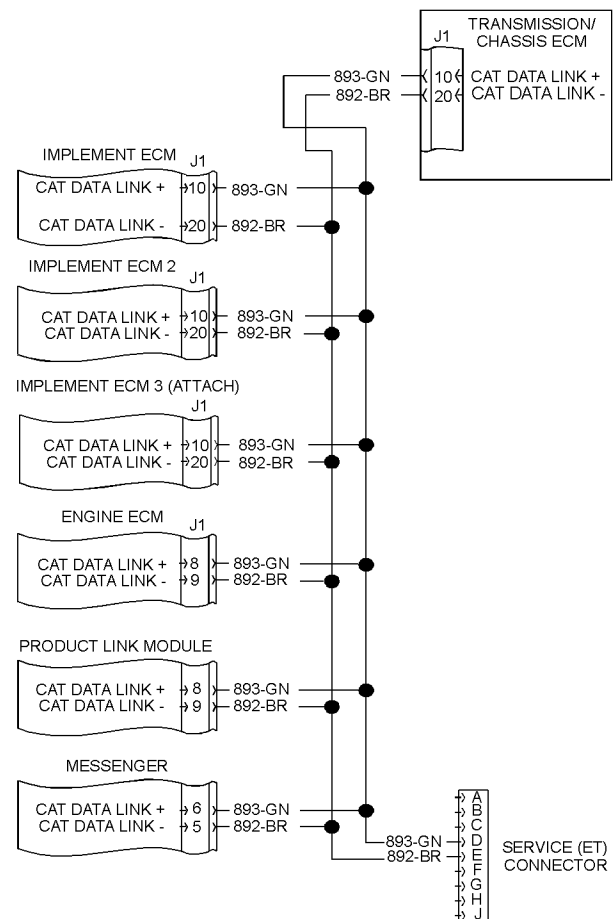


Illustration 162

g01321267

Cat Data Link connections

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector J1 from the Transmission/Chassis ECM. Disconnect the machine harness connector J1 from the Implement ECM.
- C. Inspect the harness connectors and clean all of the contacts of the harness connectors. Refer to the illustration above in order to check the Cat Data Link connection on each of the machine harness connectors. Ensure that the wires are secured in the connector, that the contacts are clean and that the contacts are in good condition.
- D. At the disconnected harness connector J1 for the Implement ECM, connect a jumper wire between contact J1-10 (wire 893-GN(Green)) and contact J1-20 (wire 892-BR(Brown)).
- E. At the disconnected harness connector J1 for the Transmission/Chassis ECM, measure the resistance between contact J1-10 (wire 893-GN(Green)) and contact J1-20 (wire 892-BR(Brown)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The Cat Data Link circuit in the machine harness is not open. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the Cat Data Link circuit in the machine harness.

Repair: A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the wires or one of the connection points in the circuit is not an open connection but not a good connection.

Refer to the complete Electrical System Schematic of the machine. Examine all of the harness connections for the machine that are involved in the data link. Check each wire section from one connector to another connector for an open or a bad connection. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the data link circuit.
- B. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Operate the machine.
- E. Check the status of the CID 0596 FMI 09 diagnostic code.

Expected Result:

The CID 0596 FMI 09 diagnostic code is not active.

Results:

- OK – The CID 0596 FMI 09 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0596 FMI 09 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, one of the ECM modules may have failed. The ECM that activated the diagnostic code may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE SAE J1939 DATA LINK CIRCUIT FOR AN OPEN

Diagnostic Code Procedures

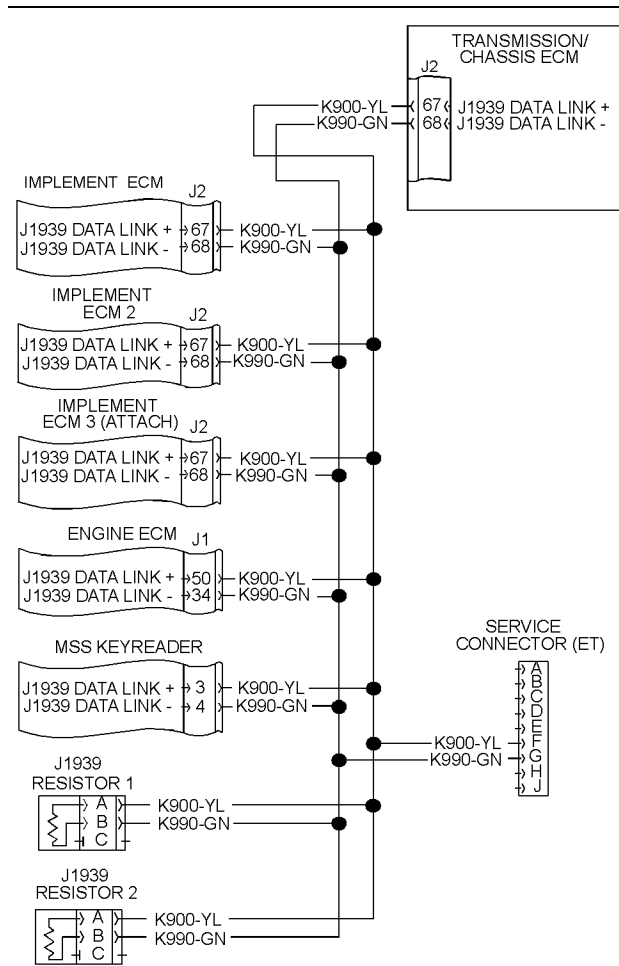


Illustration 163

g01321279

SAE J1939 Data Link Circuit connections

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector J2 from the Transmission/Chassis ECM. Disconnect the machine harness connector J2 from the Implement ECM.
- C. Inspect the harness connectors and clean all of the contacts of the harness connectors. Refer to the illustration above in order to check the SAE J1939 Data Link connection on each of the machine harness connectors. Ensure that the wires are secured in the connector, that the contacts are clean and that the contacts are in good condition.
- D. At the disconnected harness connector J2 for the Implement ECM, connect a jumper wire between contact J2-67 (wire K900-YL(Yellow)) and contact J2-68 (wire K990-GN(Green)).

- E. At the disconnected harness connector J2 for the Transmission/Chassis ECM, measure the resistance between contact J2-67 (wire K900-YL(Yellow)) and contact J2-68 (wire K990-GN(Green)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The SAE J1939 Data Link circuit in the machine harness is not open. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open connection or a bad connection in the SAE J1939 Data Link circuit in the machine harness.

Repair: Refer to the complete Electrical System Schematic of the machine. Examine all of the harness connections of the machine that are involved in the data link circuit. Check each wire section from one connector to another connector for an open or a bad connection. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the data link circuit.
- B. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Operate the machine.
- E. Check the status of the CID 0596 FMI 09 diagnostic code.

Expected Result:

The CID 0596 FMI 09 diagnostic code is not active.

Results:

- OK – The CID 0596 FMI 09 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably

caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0596 FMI 09 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, one of the ECM modules may have failed. The ECM that activated the diagnostic code may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i03850559

MID 027 - CID 0596 - FMI 12

SMCS Code: 7610-038-II

Conditions Which Generate This Code:

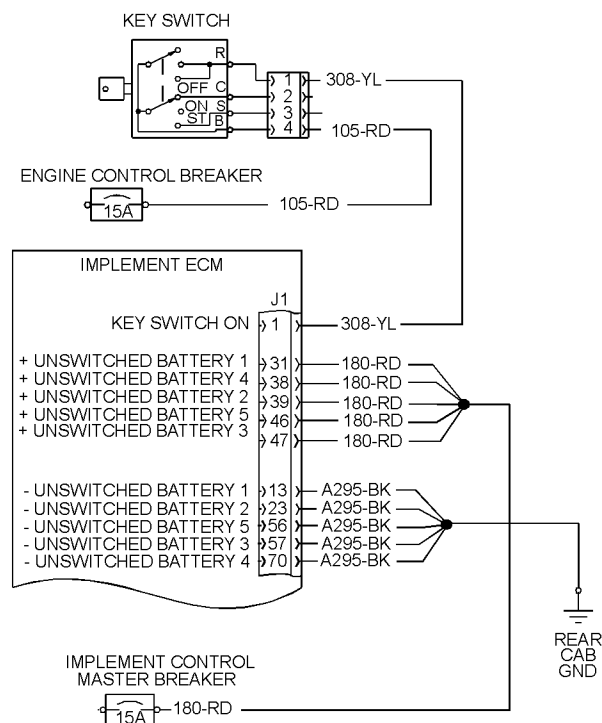


Illustration 164

g01375418

Key Start Switch ON and Power Connections of the Implement ECM

DATA LINK CONNECTIONS

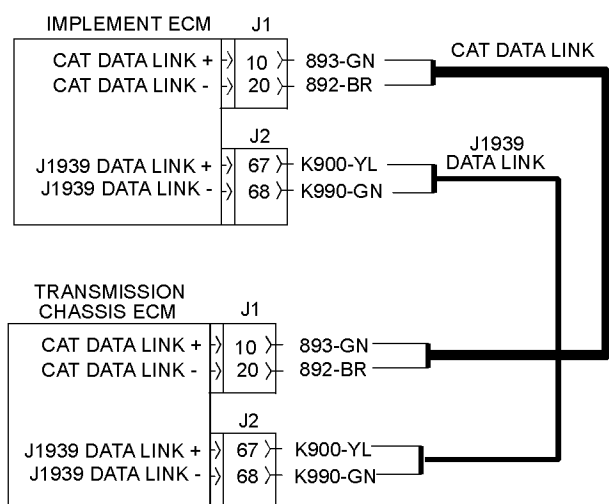


Illustration 165

g01375409

Connections of the System Data Link

This diagnostic code is associated with the communication between the "Transmission/Chassis ECM" and the "Implement ECM" that is conducted on the Cat Data Link and the J1939 CAN Data Link.

The FMI 12 means that the "Transmission/Chassis ECM" is not receiving expected communication from the "Implement ECM" on the J1939 CAN data Link and on the CAT Data Link circuit. However, the "Transmission/Chassis ECM" is receiving expected data from the other control modules on the machine.

Specifically, the "Transmission/Chassis ECM" is NOT receiving ANY of the following information from the "Implement ECM".

- The steering lever to alignment status information for the angle of the wheel over the CAT Data Link.
- The hydraulic system pressure over the SAE J1939 Data Link

In addition to the loss of the information above, an active diagnostic code of the secondary steering request circuit (CID 2199) is present.

The possible causes of the active CID 0596 FMI 12 diagnostic code are listed below:

- The "Implement ECM" is not powered up.
- The key start switch ON input for the "Implement ECM" is an open connection or is a poor connection
- An open connection or a poor connection in both of the data link circuits at the "Implement ECM"
- The Implement ECM has failed.

Note: Ensure that the CID 0596 FMI 12 diagnostic code is active before performing this procedure.

Test Step 1. CHECK THE INPUT OF THE KEY START SWITCH AND THE ECM POWER SUPPLY

- Turn the disconnect switch and the key start switch to the ON position.
- At the connector for the "Implement ECM" J1, insert a 7X - 1710 Multimeter Probes along the contact for ground J1-13 (wire A295-BK(Black)) and along the contact of the key start switch ON J1-1 (wire 308-YL(Yellow)). Measure the voltage.
- At the connector for the Implement ECM J1, remove the multimeter probe from the key start switch "ON" contact J1-1 (wire 308-YL(Yellow)) and insert the probe along the +battery contact J1-31 (wire 180-RD(Red)). The other multimeter probe that is inserted along ground contact J1-13 (wire A295-BK(Black)) remains in place. Measure the voltage.
- Repeat the last test step and measure the voltage between each of the +battery connections and the ground connections that are illustrated in the diagram at the beginning of this procedure.

Expected Result:

All of the voltage measurements are at the level of the battery voltage.

Results:

- OK – All of the voltage measurements are at the level of the battery voltage. The key start switch "ON" input voltage and the ECM supply voltages are correct. Proceed to Test Step 2.
- NOT OK – One or more of the voltage measurements are NOT at the level of the battery voltage. There is a problem with either the input voltage of the key start switch "ON" or the supply voltage of the ECM.

Repair: If the input voltage of the key start switch "ON" did not measure the level of the battery voltage, there is an open or a poor connection in the input circuit between a connection point or a splice and the "Implement ECM".

Turn the disconnect switch and the key start switch to the OFF position.

Refer to the complete Electrical Schematic for your machine. Examine the circuit connections at each connector. Start at the connector of the "Implement ECM" J1 and work your way back through the harness connectors. Verify that each circuit connection in each connector is clean, that each connector is secure and that each connector is in good condition.

Less likely than a failure of the harness connection, a splice point in the harness of the machine may have failed. If no other cause can be found, locate the splice connections and examine the splice connections for failures. Fix the machine harness or replace the machine harness.

A failure in one or two of the Implement ECM supply circuits or ground circuits would most likely not cause the ECM to lose all power. However, the cause of a loss of power for any one of the supply circuits or the ground circuits must be investigated and the problem must be fixed in order for the ECM to operate correctly.

If none of the ECM supply contacts measured the same as the battery voltage, check the Implement Control Master Circuit Breaker for an open. Check the ground circuits for continuity to frame ground.

Refer to the complete Electrical Schematic for your machine. Examine the +battery circuit connections and the ground at each connector starting at the "Implement ECM" J1 connector and working your way back through the harness connectors. Verify that each circuit connection in each connector is clean, that the circuit connection is secure and that the circuit connection is in good condition. Fix the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE CAT DATA LINK CIRCUIT FOR AN OPEN

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector J1 from the Implement ECM.
- C. Inspect the harness connector and clean all of the contacts of the harness connector. Refer to the illustration above in order to check the Cat Data Link connections on the harness connector of the ECM. Ensure that the wires are secured in the connector, that the contacts are clean and that the contacts are in good condition.

D. At the disconnected harness connector J1 for the Implement ECM, connect a jumper wire between contact J1-10 (wire 893-GN(Green)) and contact J1-20 (wire 892-BR(Brown)).

E. Disconnect the harness connector J1 from the Transmission/Chassis ECM. Measure the resistance between contact J1-10 (wire 893-GN(Green)) and contact J1-20 (wire 892-BR(Brown)) on the connector of the Transmission/Chassis ECM.

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The Cat Data Link circuit between the "Transmission/Chassis ECM" and the Implement ECM is not open. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the Cat Data Link circuit in the machine harness between the "Transmission/Chassis ECM" and the Implement ECM.

Repair: A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the wires or one of the connection points in the circuit is not an open connection but not a good connection.

Refer to the complete Electrical System Schematic of the machine. Starting at the "Implement ECM", locate and examine all of the machine harness connections that are involved in the data link circuit. Check each wire section from one connector to another connector for an open or a bad connection. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE J1939 CIRCUIT OF THE CAN DATA LINK FOR AN OPEN

The key start switch and the disconnect switch remain in the OFF position.

- A. Disconnect the connector of the "Implement ECM" J2 from the machine harness.

- B.** At the connector of the “Implement ECM” J2, clean all of the contacts of the harness connector. Refer to the illustration above in order to check the J1939 connections of the CAN Data Link on the harness connector of the ECM. Ensure that the wires are secured in the connector, that the contacts are clean and that the contacts are in good condition.
- C.** At the disconnected harness connector J2 for the Implement ECM, connect a jumper wire between contact J2-67 (wire K900-YL(Yellow)) and contact J2-68 (wire K990-GN(Green)).
- D.** Disconnect the harness connector J2 from the Transmission/Chassis ECM. Measure the resistance between contact J2-67 (wire K900-YL(Yellow)) and contact J2-68 (wire K990-GN(Green)) on the connector of the Transmission/Chassis ECM.

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The J1939 CAN Data Link between the “Transmission/Chassis ECM” and the “Implement ECM” is not open. Proceed to Test Step 4.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the J1939 CAN Data Link in the machine harness between the “Transmission/Chassis ECM” and the “Implement ECM”.

Repair: A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the wires or one of the connection points in the circuit is not an open connection but not a good connection.

Refer to the complete Electrical System Schematic of the machine. Start at the “Implement ECM” and examine all of the connections of the machine harness that are involved in the circuit of the data link. Check each wire section from one connector to another connector for an open or a bad connection. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- B.** Turn the disconnect switch and the key start switch to the ON position.
- C.** Check the status of the CID 0596 FMI 12 diagnostic code.

Expected Result:

The CID 0596 FMI 12 diagnostic code is not active.

Results:

- OK – The CID 0596 FMI 12 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0596 FMI 12 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the data link circuits again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the Implement ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the “Implement ECM”. Refer to Testing and Adjusting, RENR 9004, “Electronic Control Module (ECM) - Replace”.

STOP.

i02916571

MID 027 - CID 0596 - FMI 14

SMCS Code: 7610-038-II

Conditions Which Generate This Code:

This CID 0596 FMI 14 diagnostic code is associated with the communication between the Transmission/Chassis ECM and the Implement ECM that is conducted on the Cat Data Link or the communication that is conducted over the SAE J1939 Data Link.

The FMI 14 means that the Transmission/Chassis ECM is communicating with the Implement ECM on the involved data link. However, the Transmission/Chassis ECM is not receiving expected operating parameter information from the Implement ECM.

When the CID 0596 FMI 14 diagnostic code is activated by the Transmission/Chassis ECM, a companion diagnostic code will be activated in order to indicate the data link that is involved. The companion diagnostic code that has been activated will be either of the following diagnostic codes:

CID 0247 FMI 14 – SAE J1939 Data Link

CID 0248 FMI 14 – Cat Data Link

Determine the companion diagnostic codes that have been activated along with the CID 0596 FMI 14 diagnostic code in order to indicate the data link system that is involved.

Note: After the CID 0596 FMI 14 diagnostic code has been cleared, the data link companion diagnostic code will also clear.

The possible causes of the CID 0596 FMI 14 diagnostic code are listed below:

- The software that is installed on the Implement ECM is incorrect.
- The software that is installed on the Transmission/Chassis ECM is incorrect.
- A new ECM has been installed and the ECM is not the correct part.

Note: Ensure that the CID 0596 FMI 14 diagnostic code is active before performing this procedure.

Test Step 1. DETERMINE THE COMPANION DIAGNOSTIC CODE OF THE DATA LINK THAT IS ACTIVE

Note: If incorrect software or an incorrect control module is causing the problem, both of the companion diagnostic codes of the data link may be active.

- A.** Check the list of active diagnostic codes in order to determine the companion diagnostic codes that are active: **CID 0247 FMI 14 - SAE J1939 Data Link** **CID 0248 FMI 14 - Cat Data Link**

Results:

- OK – The CID 0248 FMI 09 diagnostic code is active indicating that the problem is in the Cat Data Link. In order to perform the troubleshooting procedure for the Cat Data Link, proceed to Test Step 2.

- OK – The CID 0247 FMI 09 diagnostic code is active indicating that the problem is in the SAE J1939 Data Link. In order to perform the troubleshooting procedure for the SAE J1939 Data Link, proceed to Test Step 2.

Test Step 2. VERIFY THE HARDWARE AND THE SOFTWARE PART NUMBERS

- A.** Verify that the following information is correct:

- The part number of the installed software for the Transmission/Chassis ECM
- The part number of the installed software for the Implement ECM
- The part number of the Transmission/Chassis ECM
- The part number of the Implement ECM

Note: Contact your dealership's Technical Communicator for the correct part numbers of the hardware and the correct part numbers for the configuration software for your machine.

Expected Result:

All hardware and software part numbers are correct.

Results:

- OK – All hardware and software part numbers are correct. Proceed to Test Step 3.
- NOT OK – All hardware and software part numbers are NOT correct.

Repair: Replace the hardware or software that is incorrect with the correct version. For flashing software, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Flash Program". For replacing ECM modules, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace"

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Turn the disconnect switch and the key start switch to the ON position.
- B.** Operate the machine.
- C.** Check the status of the CID 0596 FMI 14 diagnostic code.

Expected Result:

The CID 0596 FMI 14 diagnostic code is not active.

i05758191

Results:

- OK – The CID 0596 FMI 14 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code could have been caused by a problem during start-up with one of the controls of the ECM. Resume normal operation.

STOP.

- NOT OK – The CID 0596 FMI 14 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Repeat this procedure again and verify that the information is correct.

If the cause of the problem is not found, the ECM that has activated the diagnostic code may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

MID 027 - CID 0615 - FMI 02

SMCS Code: 4806-038

Conditions Which Generate This Code:

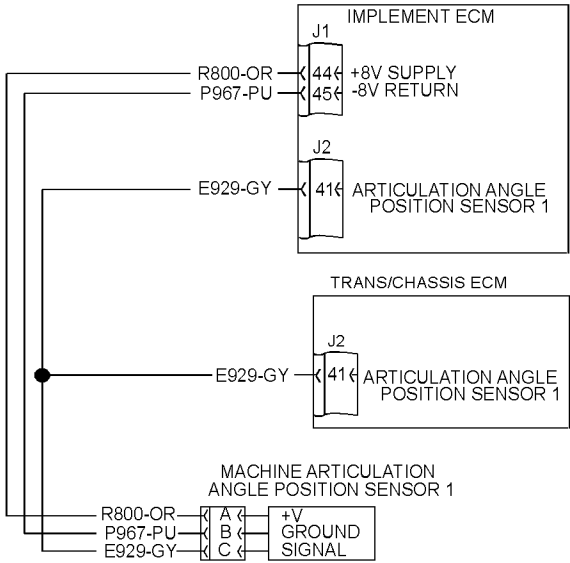


Illustration 166

g03663346

Connections of the Machine Articulation Angle Sensor 1

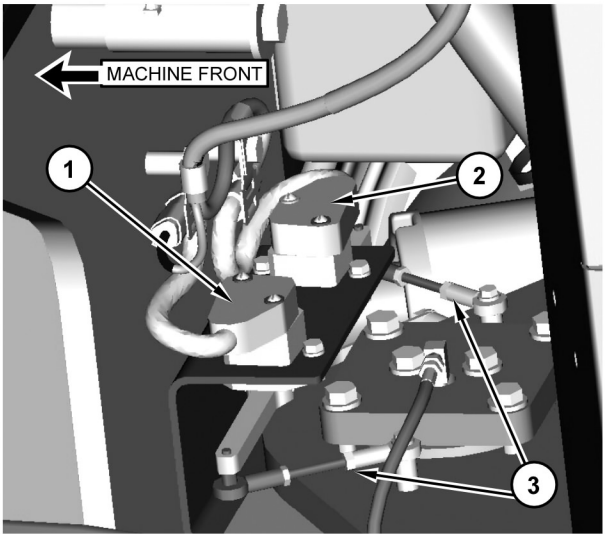


Illustration 167

g03663349

Locations of Articulation Angle Sensors

- (1) Articulation angle sensor 1
- (2) Articulation angle sensor 2
- (3) Mechanical linkage

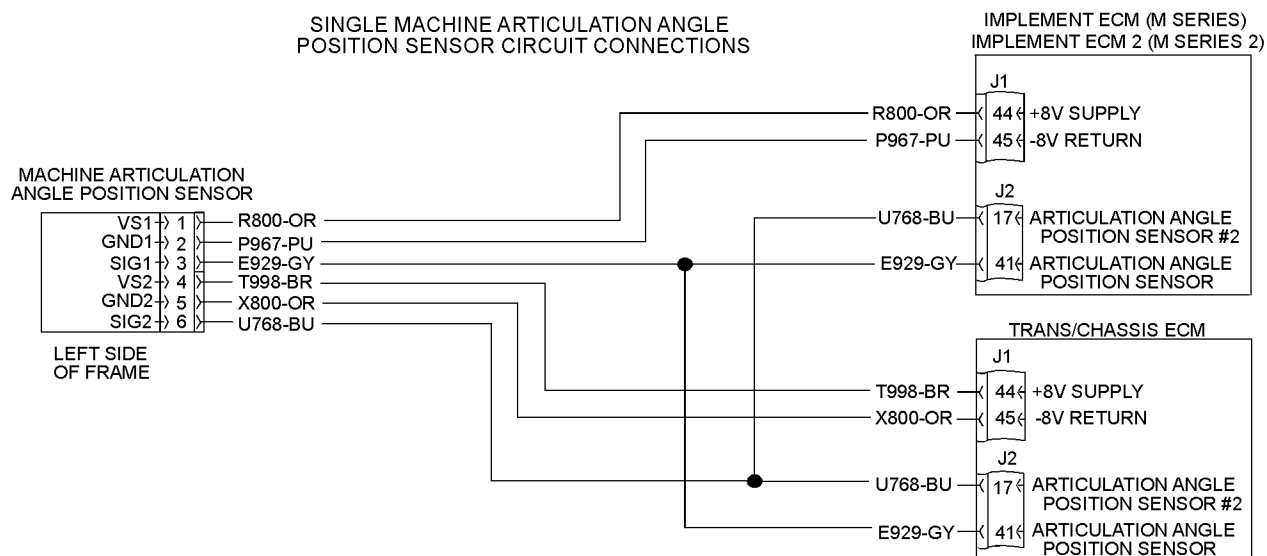


Illustration 168

g03655165

Single Sensor with two outputs

This single sensor sends a signal 1 to J2-41 and signal 2 to J2-17

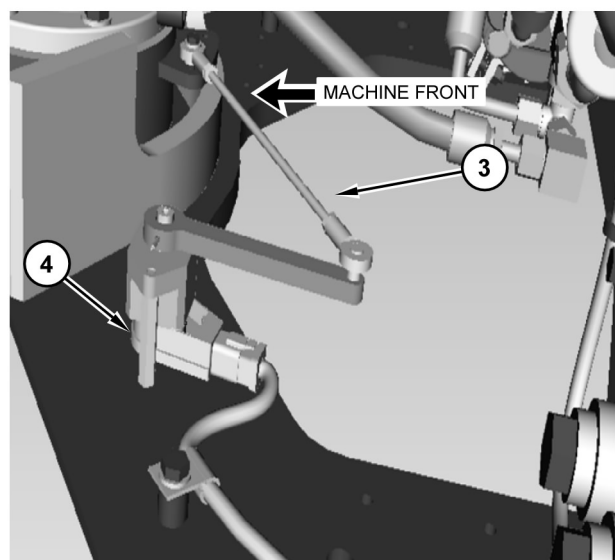


Illustration 169

g03655166

“Machine Articulation Angle Position” Sensor location (View from the left side of the machine at the articulation hitch)

- (3) Mechanical linkage
(4) Articulation angle sensor

Two articulation angle sensor signals are required for correct operation of the articulation of the machine. Either the two separate sensors or the dual output sensor will provide a PWM input to the Transmission/Chassis ECM and the Implement ECM.

This diagnostic code is associated with the number one sensor signal for the angle of machine articulation connected to each ECM at J2-41. The FMI 02 means that the ECM has determined that the input data from the sensor is erratic, intermittent, or incorrect. The Implement ECM, the Transmission/Chassis ECM or both of the ECM modules can activate this diagnostic code.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. When the machine is in the neutral position, the duty cycle of the sensor to the ECM is approximately 55%. When the machine is articulated to the full left position, the duty cycle will be approximately 33%. When the machine is articulated to the full right position, the duty cycle will be approximately 74%.

The possible causes of this diagnostic code are listed below:

- Mechanical devices are loose or mechanical devices are not adjusted correctly.
- There is an Intermittent connection or a poor connection in the circuit.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the articulation sensor signal 1. Both ECM modules can activate a CID 0615 FMI 02 diagnostic code when an erratic signal or an intermittent signal is detected. If one ECM has activated a CID 0615 FMI 02 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both of the ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL LINKAGE

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Remove any guards or shielding for the articulation sensors.
- C. Check the mounting bolts for the articulation sensors. Ensure that the sensors are securely mounted.
- D. Visually inspect the mechanical linkage for the articulation sensors. Verify that all mechanical components are tight and that all components are in good condition. Verify that the adjustment of the linkage is correct.

Expected Result:

All mechanical linkage and adjustment components for the articulation sensor(s) are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical linkage and adjustment for the articulation sensor is correct. Proceed to Test Step 2.
- NOT OK – All mechanical linkage and adjustment for the articulation sensors is not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the articulation sensor(s). After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK FOR POWER AT THE SENSOR

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Do not disconnect the harness connector from the sensor.
- C. At the back of the harness connector for the sensor, insert 7X-1710 Multimeter Probes along the contact for the power circuit A (wire R800-OR(Orange)) and along the contact for the return circuit B (wire P967-PU(Purple)).
- D. Turn the key start switch and the disconnect switch to the ON position.
- E. Measure the voltage from contact A to contact B.

Expected Result:

The voltage measurement is 8.0 ± 0.5 VDC.

Results:

- OK – The voltage measurement is 8.0 ± 0.5 VDC. The power supply circuit is correct. Proceed to Test Step 3.
- NOT OK – The voltage measurement is not 8.0 ± 0.5 VDC. The power supply circuit is not correct.

Repair: There is a problem with the 8 VDC power supply circuit of the Implement ECM for the sensor. Refer to the complete Electrical System Schematic of the machine. Check all of the connections that are in the power supply circuit and the return circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SIGNAL OF THE SENSOR

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. At the back of the harness connector for the sensor, remove the multimeter probe from contact A (wire R800-OR(Orange)) and insert the probe along the signal contact C (wire E929-GY(Grey)).
- C. The multimeter probe along return contact B (wire P967-PU(Purple)) remains in place.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Monitor the signal of the sensor with a digital multimeter.
- F. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 4.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

Repair: Replace the articulation angle 1 sensor. After replacement of the sensor, the sensor must be calibrated. Refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

STOP.

Test Step 4. CHECK FOR AN OPEN IN THE SIGNAL CIRCUIT

The key start switch and the disconnect switch remain in the OFF position.

- A. Disconnect the machine harness connector from the sensor.
- B. Disconnect the machine harness connector J2 from the Transmission/Chassis ECM.
- C. At the machine harness connector for the sensor, connect the jumper wire between a good contact of the frame ground and signal contact C (wire E929-GY(Grey)).

- D. At the machine harness connectors for the Transmission/Chassis ECM, measure the resistance from a good contact of the frame ground to the connector contact for the Transmission/Chassis ECM J2-41 (wire E929-GY(Grey)).
- E. Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the wiring harness.

Results:

- OK – The resistance measurement is less than 5 ohms. The resistance measurement is not indicating an open in the circuit. Proceed to Test Step 6.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open connection or a bad connection in the signal circuit.

Repair: If both of the ECM modules have activated this diagnostic code, there is most likely an open connection or a bad connection on the sensor side of the splice connection of the machine harness for the signal wire.

If only the Transmission/Chassis ECM has activated this diagnostic code, then there is most likely an open connection or a bad connection on the ECM side of the splice connection of the machine harness for the signal wire.

In either case, refer to the complete Electrical System Schematic for the machine. Check all of the connectors that are in the suspected section of the signal circuit for the sensor. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE OPERATION OF THE ECM

The key start switch and the disconnect switch remain in the OFF position. The machine harness connectors for the sensor and both the Implement ECM and the Transmission/Chassis ECM remain disconnected.

Note: This check should be performed on the ECM that has activated the diagnostic code. If both of the ECM modules have activated the diagnostic code, perform this check on both of the ECM modules.

- A.** At the machine harness connector J2 for the ECM, use a 151 - 6320 Removal Tool to remove the sensor signal wire E929-GY (Grey) and the socket at contact J2-41 from the harness connector.
- B.** Reconnect the machine harness J1 and J2 connectors to the ECM.
- C.** Turn the key start switch and the disconnect switch to the ON position.
- D.** Observe the status of the active CID 0615 FMI 02 diagnostic code.

Expected Result:

The CID 0615 FMI 02 diagnostic code is no longer active. A CID 0615 FMI 03 diagnostic code is now active.

Results:

- **YES** – The CID 0615 FMI 02 diagnostic code is no longer active. A CID 0615 FMI 03 diagnostic code has been activated after the wire for the sensor signal was disconnected. The ECM has responded correctly to the open circuit condition in the sensor circuit. Reinstall the disconnected sensor signal wire back into the correct spot in the connector of the ECM before proceeding to the next test step. Proceed to Test Step 6.
- **NO** – The CID 0615 FMI 03 diagnostic code remains active. The status of the active diagnostic code does not change as the sensor signal wire is disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the sensor circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 6. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Check the status of the CID 0615 FMI 02 diagnostic code.

Expected Result:

The CID 0615 FMI 02 diagnostic code is not active.

Results:

- **OK** – The CID 0615 FMI 02 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- **NOT OK** – The CID 0615 FMI 02 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, replace the sensor. After replacement of the sensor, the sensor must be calibrated. Refer to the Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

If the problem is still present after replacement of the sensor, the ECM may have failed. This is unlikely as the ECM responded correctly to the condition change in the previous test step.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM that activated the diagnostic code.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, and the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i05758195

MID 027 - CID 0615 - FMI 03

SMCS Code: 4806-038

Conditions Which Generate This Code:

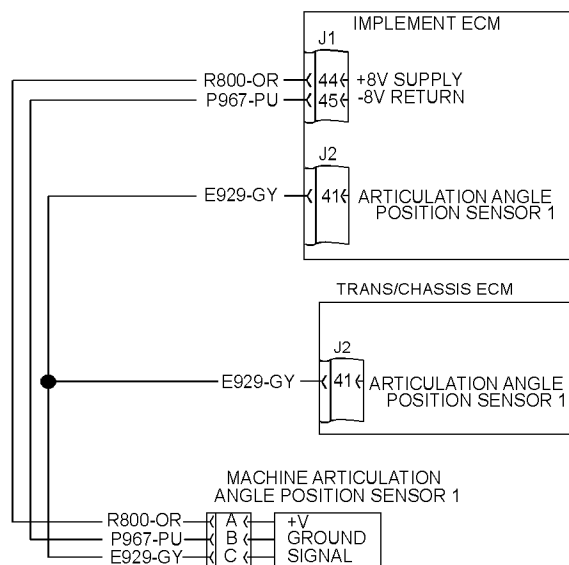


Illustration 170

g03663346

Connections of the Machine Articulation Angle Sensor 1

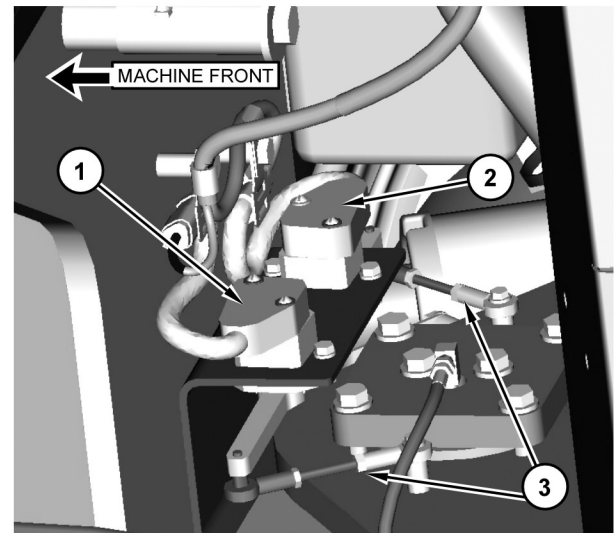


Illustration 171

g03663349

Locations of Articulation Angle Sensors

- (1) Articulation angle sensor 1
- (2) Articulation angle sensor 2
- (3) Mechanical linkage

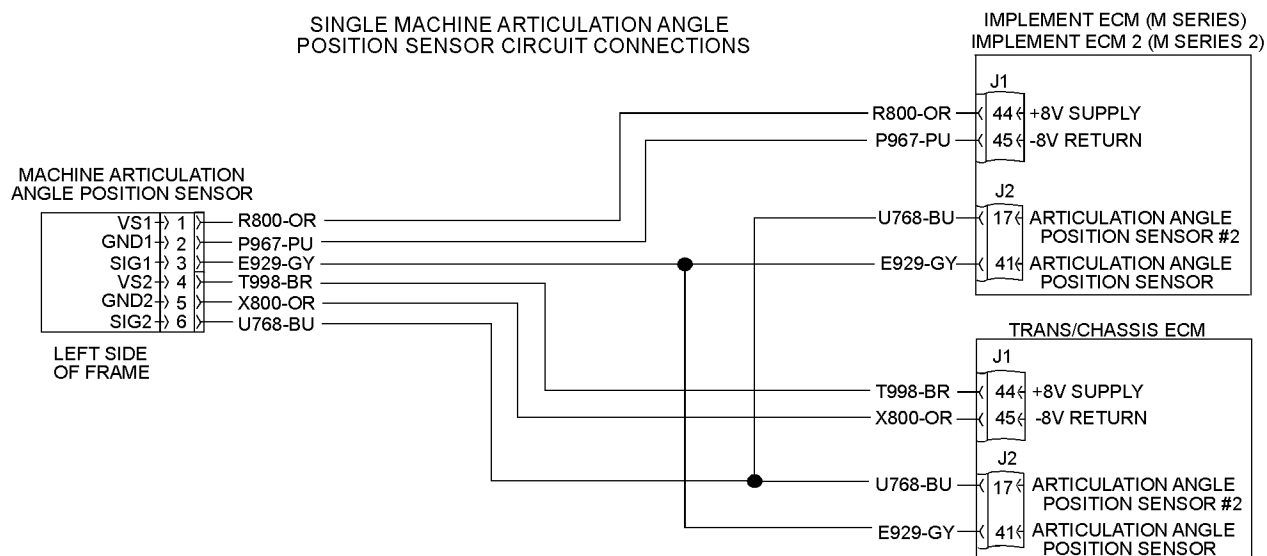


Illustration 172

g03655165

Single Sensor with two outputs

This single sensor sends a signal 1 to J2-41 and signal 2 to J2-17

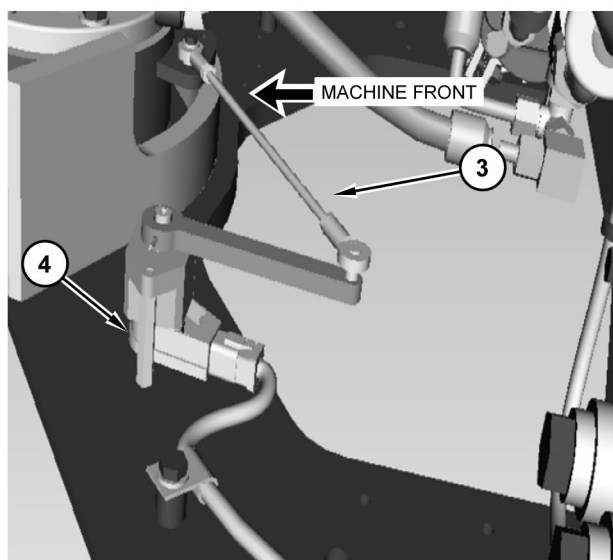


Illustration 173

g03655166

“Machine Articulation Angle Position Sensor” location
(View from the left side of the machine at the articulation hitch)

- (3) Mechanical linkage
(4) Articulation angle sensor

Two articulation angle sensor signals are required for correct operation of the articulation of the machine. Either the two separate sensors or the dual output sensor will provide a PWM input to the Implement ECM and the Transmission/Chassis ECM.

This diagnostic code is associated with the number one sensor signal for the angle of machine articulation connected to each ECM at J2-41. The FMI 03 diagnostic code is activated when the ECM reads the input signal from the articulation angle sensor of the machine 1 and the voltage of the signal is above normal. The Implement ECM, the Transmission/Chassis ECM or both ECM modules can activate this diagnostic code.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. When the machine is in the neutral position, the duty cycle of the sensor to the ECM is approximately 55%. When the machine is articulated to the full left position, the duty cycle will be approximately 33%. When the machine is articulated to the full right position, the duty cycle will be approximately 74%.

The possible causes of this diagnostic code are listed below:

- The circuit of the sensor power supply is open.
- The return circuit is open.
- The signal circuit is open or the sensor is disconnected.
- The signal circuit is shorted to the sensor power supply.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active CID 0041 diagnostic code for the 8 volt sensor power supply of the ECM. Correct any problem with the 8 volt power supply before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the articulation sensor signal 1. Both ECM modules can activate a CID 0615 FMI 03 diagnostic code when an above normal voltage signal is detected. If one ECM has activated a CID 0615 FMI 03 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL LINKAGE

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Remove any guards or shielding for the articulation sensors.
- C. Check the mounting bolts for the articulation sensors. Ensure that the sensors are securely mounted.
- D. Visually inspect the mechanical linkage for the articulation sensors. Verify that all mechanical components are tight and that all components are in good condition. Verify that the adjustment of the linkage is correct.

Expected Result:

All mechanical linkage and components for adjusting the articulation sensor(s) are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical linkage and adjustment for the articulation sensor is correct. Proceed to Test Step 2.
- NOT OK – All mechanical linkage and adjustment for the articulation sensors is not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the articulation sensor(s). After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SUPPLY VOLTAGE AT THE SENSOR

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Do not disconnect the harness connector from the sensor.
- C. At the back of the harness connector for the sensor, insert 7X - 1710 Multimeter Probes along contact for the supply A (wire R800-OR(Orange)). Insert a multimeter probe along return contact B (wire P967-PU(Purple)).
- D. Turn the key start switch and the disconnect switch to the ON position.
- E. Measure the voltage from contact A to contact B.

Expected Result:

The voltage measurement is 8.0 ± 0.5 VDC.

Results:

- OK – The voltage measurement is 8.0 ± 0.5 VDC. The power supply circuit is correct. Proceed to Test Step 3.
- NOT OK – The voltage measurement is not 8.0 ± 0.5 VDC. The power supply circuit is not correct.

Repair: There is a problem with the power supply (8 VDC) of the Implement ECM for the sensor. Refer to the complete Electrical System Schematic of the machine. Check all of the connections that are in the power supply circuit and the return circuit. Ensure that all connections are clean, that all connections are

secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK FOR AN OPEN IN THE SIGNAL CIRCUIT

The key start switch and the disconnect switch remain in the OFF position.

- A. Disconnect the machine harness connector from the sensor.
- B. At the machine harness connector for the sensor, connect the jumper wire between a good contact for the frame ground and the signal contact C (wire E929-GY(Grey)).
- C. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- D. At the machine harness connector for the Transmission/Chassis ECM, measure the resistance from a good contact for the frame ground and the connector contact for the Transmission/Chassis ECM J2-41 (wire E929-GY(Grey)).
- E. Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the wiring harness.

Results:

- OK – The resistance measurement is less than 5 ohms. The resistance measurement is not indicating an open in the circuit. Proceed to Test Step 4.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the signal circuit.

Repair: If both of the ECM modules have activated this diagnostic code, there is most likely an open connection or a bad connection on the sensor side of the splice connection for the machine harness of the signal wire.

If only the Transmission/Chassis ECM has activated this diagnostic code, there is most likely an open or a bad connection on the ECM side of the machine harness splice connection for the signal wire.

In either case, refer to the complete Electrical System Schematic of the machine. Check all of the connectors in the faulty section the signal circuit of the sensor. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SIGNAL CIRCUIT FOR A SHORT

The key start switch and the disconnect switch remain in the OFF position. The harness connectors of the Transmission/Chassis ECM remain disconnected from the machine harness.

- A. Remove the jumper wire that was installed in the last step.
- B. Disconnect the machine harness connectors J1 and J2 from the Implement ECM.
- C. At the J1 and J2 machine harness connectors for the Transmission/Chassis ECM, measure the resistance from the sensor signal contact J2-41 (wire E929-GY(Grey)) to all of the other J1 and J2 contacts that are used for the Transmission/Chassis ECM.
- D. At the J1 and J2 machine harness connectors for the Implement ECM, measure the resistance from the sensor signal contact J2-41 (wire E929-GY(Grey)) to all of the other J1 and J2 contacts that are used for the Implement ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The signal circuit is not shorted. Proceed to Test Step 5.
- NOT OK – A resistance measurement is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the signal circuit and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE SIGNAL OF THE SENSOR

The key start switch and the disconnect switch remain in the OFF position.

- A. Reconnect the harness connectors to the sensor and reconnect the J1 and J2 connectors to the Implement ECM and to the Transmission/Chassis ECM.
- B. At the back of the harness connector for the sensor, insert the multimeter probe along contact B (wire P967-GY(Grey)) and insert the probe along the signal contact C (wire E929-GY(Grey)).
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Monitor the signal of the sensor with a digital multimeter.
- E. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 6.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

Repair: Replace the articulation angle 1 sensor. After replacement of the sensor, the sensor must be calibrated. Refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

STOP.

Test Step 6. CHECK THE OPERATION OF THE ECM

Note: This check should be performed on the ECM that has activated the diagnostic code. If both of the ECM modules have activated the diagnostic code, perform this check on both of the ECM modules.

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. At the machine harness connector J2 for the ECM, use a 151 - 6320 Removal Tool to remove the sensor signal wire E929-GY(Grey) and the socket at contact J2-41 from the harness connector. The connector J2 remains connected to the ECM.
- C. Turn the key start switch and the disconnect switch to the ON position.
- D. Use a 7X - 1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the ECM pin at J2-41 through the empty space in the J2 connector.
- E. Observe the status of the active CID 0615 FMI 03 diagnostic code and ground the other end of the 7X - 1710 Multimeter Probe to frame ground.

Expected Result:

The CID 0615 FMI 03 diagnostic code is no longer active. A CID 0615 FMI 04 diagnostic code becomes active when the ECM pin at J2-41 is grounded.

Results:

- YES – The CID 0615 FMI 03 diagnostic code is no longer active. A CID 0615 FMI 04 diagnostic code has been activated after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition in the solenoid circuit. The problem is probably not caused by the ECM. Reinstall the disconnected sensor signal wire back into the correct spot in the ECM connector before proceeding to the next test step. Proceed to Test Step 7.
- NO – The CID 0615 FMI 03 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin for the sensor signal is grounded.

Repair: The ECM has not responded correctly to the grounded condition in the sensor circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 7. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 0615 FMI 03 diagnostic code is active.

Expected Result:

The CID 0615 FMI 03 diagnostic code is not active.

Results:

- OK – The CID 0615 FMI 03 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0615 FMI 03 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, replace the sensor. After replacement of the sensor, the sensor must be calibrated. Refer to the Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

If the problem is still present after replacement of the sensor, the ECM may have failed. This is unlikely as the ECM responded correctly to the condition change in the previous test step.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, and the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i05758211

MID 027 - CID 0615 - FMI 04

SMCS Code: 4806-038

Conditions Which Generate This Code:

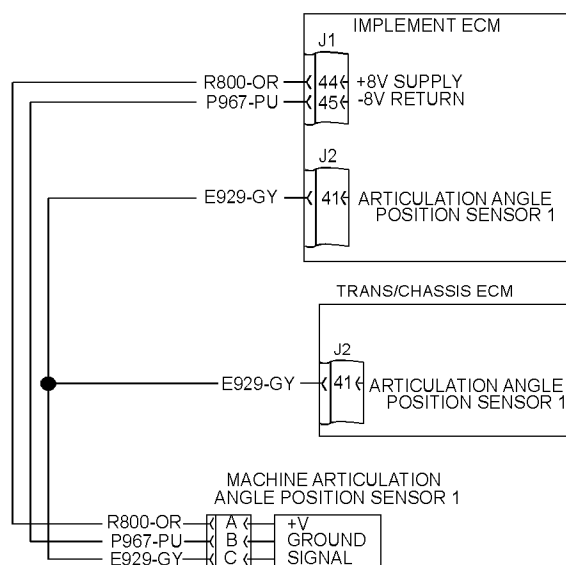


Illustration 174

g03663346

Connections of the Machine Articulation Angle Sensor 1

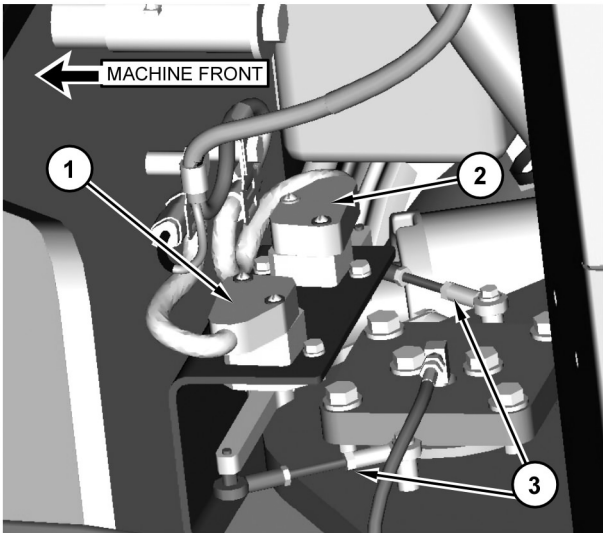


Illustration 175 g03663349

Locations of Articulation Angle Sensors

- (1) Articulation angle sensor 1
- (2) Articulation angle sensor 2
- (3) Mechanical linkage

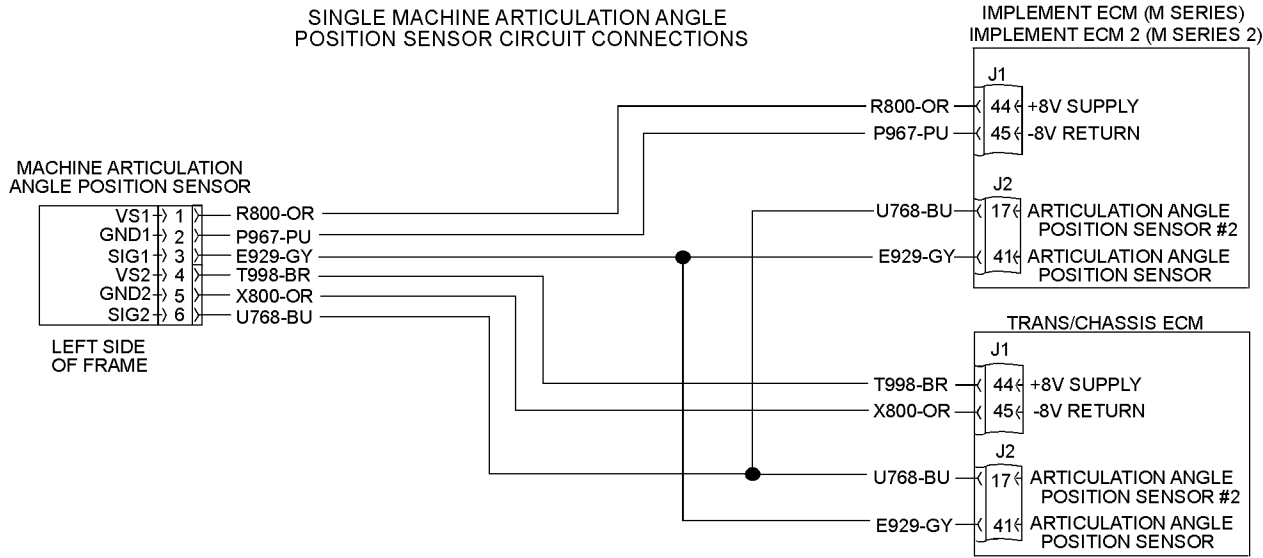


Illustration 176 g03655165

Single Sensor with two outputs

This single sensor sends a signal 1 to J2-41 and signal 2 to J2-17

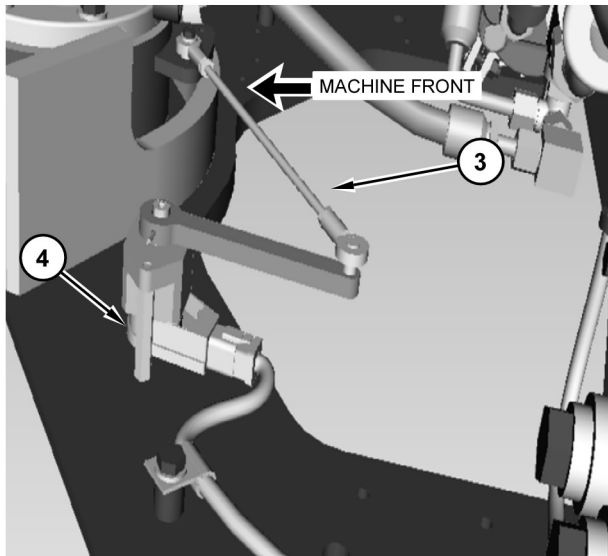


Illustration 177

g03655166

“Machine Articulation Angle Position Sensor” location
(View from the left side of the machine at the articulation hitch)

(3) Mechanical linkage

(4) Articulation angle sensor

Two articulation angle sensor signals are required for correct operation of the articulation control of the machine. Either the two separate sensors or the dual output sensor will provide a PWM input to the Implement ECM and the Transmission/Chassis ECM.

This diagnostic code is associated with the number one sensor signal 1 for the angle of machine articulation connected to each ECM at J2-41. The FMI 04 code means that the ECM has detected that the voltage of the sensor signal is below normal. Either the Implement ECM or the Transmission/Chassis ECM or both ECM's can activate this diagnostic code.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. When the machine is in the neutral position, the duty cycle of the sensor input to the ECM is approximately 55%. When the machine is articulated to the full left position, the duty cycle will be approximately 83%. When the machine is articulated to the full right position, the duty cycle will be approximately 37%.

The possible causes of this diagnostic code are listed:

- The signal circuit is shorted to ground.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the articulation sensor signal 1. Both ECM's can activate a CID 0615 FMI 04 diagnostic code when a below normal voltage signal is detected. If one ECM has an active CID 0615 FMI 04 diagnostic code and the other ECM does not, it is probable that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM's have an active diagnostic code, either the sensor OR a harness problem could be the cause. If both ECM's have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL LINKAGE

- Turn the key start switch and the disconnect switch to the OFF position.
- Remove any guards or shielding for the articulation sensors.
- Check the mounting bolts for the articulation sensors. Ensure that the sensors are securely mounted.
- Visually inspect the mechanical linkage for the articulation sensors. Verify that all mechanical components are tight. Verify that all mechanical components are in good condition. Verify that the adjustment of the linkage is correct.

Expected Result:

All mechanical linkage and adjustment components for the articulation sensor(s) are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical linkage and adjustment for the articulation sensor is correct. Proceed to Test Step 2.
- NOT OK – All mechanical linkage and adjustment for the articulation sensors is not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the articulation sensor(s). After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SENSOR

- A. Turn the disconnect switch and the key start switch to the ON position.
- B. Ensure that the diagnostic code is active.
- C. Observe the status of the diagnostic code while disconnecting the sensor from the machine harness.

Expected Result:

The CID 0615 FMI 04 diagnostic code is no longer active. A CID 0615 FMI 03 diagnostic code is now active.

Results:

- YES – The CID 0615 FMI 04 diagnostic code is no longer active. A CID 0615 FMI 03 diagnostic code is now active. The ECM and the circuit are correct. The position sensor is causing the problem.

Repair: The sensor has failed. Replace the articulation angle 1 sensor. After replacement of the sensor, the sensor must be calibrated. Refer to the Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

STOP.

- NO – The CID 0615 FMI 04 diagnostic code remains active. Disconnecting the sensor did not affect the status of the active diagnostic code. The position sensor is not causing the problem. Proceed to Test Step 3.

Test Step 3. CHECK THE SIGNAL CIRCUIT FOR A SHORT TO GROUND

- A. The sensor remains disconnected from the machine harness.

- B. Turn the key start switch and the disconnect switch to the OFF position.

- C. Disconnect the J1 and J2 machine harness connectors from the Implement ECM and the Transmission/Chassis ECM.

- D. At machine harness connector J2 for the Transmission/Chassis ECM, measure the resistance from contact J2-41 (wire E929-GY(Grey)) to frame ground. Measure the resistance between contact J2-41 (wire E929-GY(Grey)) and all of the other contacts that are used in the connectors of the machine harness for the Transmission/Chassis ECM.

- E. At machine harness connector J2 for the Implement ECM, measure the resistance from contact J2-41 (wire E929-GY(Grey)) to frame ground. Measure the resistance from contact J2-41 (wire E929-GY(Grey)) to all of the other contacts that are used in the machine harness connectors for the Implement ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is NOT correct. The machine harness has failed.

Repair: There is a short in the machine harness between the signal circuit and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE OPERATION OF THE ECM

The key start switch and the disconnect switch remain in the OFF position. The machine harness connectors for the sensor and both the Implement ECM and the Transmission/Chassis ECM remain disconnected.

Note: This check should be performed on the ECM that has activated the diagnostic code. If both of the ECM's have activated the diagnostic code, perform this check on both of the ECM's.

- A. At the machine harness connector J2 for the ECM, use a 151 - 6320 Removal Tool to remove the sensor signal wire E929-GY (Grey) and the socket at contact J2-41 from the harness connector.
- B. Reconnect the machine harness J1 and J2 connectors to the ECM.
- C. Turn the key start switch and the disconnect switch to the ON position.
- D. Observe the status of the active CID 0615 FMI 04 diagnostic code.

Expected Result:

The CID 0615 FMI 04 diagnostic code is no longer active. A CID 0615 FMI 03 diagnostic code is now active.

Results:

- YES – The CID 0615 FMI 04 diagnostic code is no longer active. A CID 0615 FMI 03 diagnostic code is active after the sensor signal wire is disconnected. The ECM has responded correctly to the open circuit condition in the sensor circuit. Reinstall the disconnected sensor signal wire back into the correct spot in the ECM connector before proceeding to the next test step. Proceed to Test Step 5.
- NO – The CID 0615 FMI 04 diagnostic code remains active. The status of the active diagnostic code does not change when the sensor signal wire is disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the sensor circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 0615 FMI 04 diagnostic code is active.

Expected Result:

The CID 0615 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 0615 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0615 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the problem is still present the ECM may have failed. This is not likely as the ECM responded correctly to the condition change in the previous test step.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, and the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i05758230

MID 027 - CID 0615 - FMI 08

SMCS Code: 4806-038

Conditions Which Generate This Code:

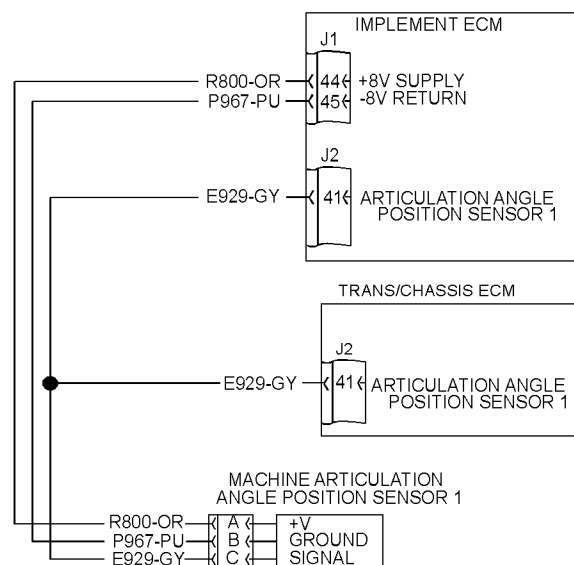


Illustration 178

g03663346

Connections of the Machine Articulation Angle Sensor 1

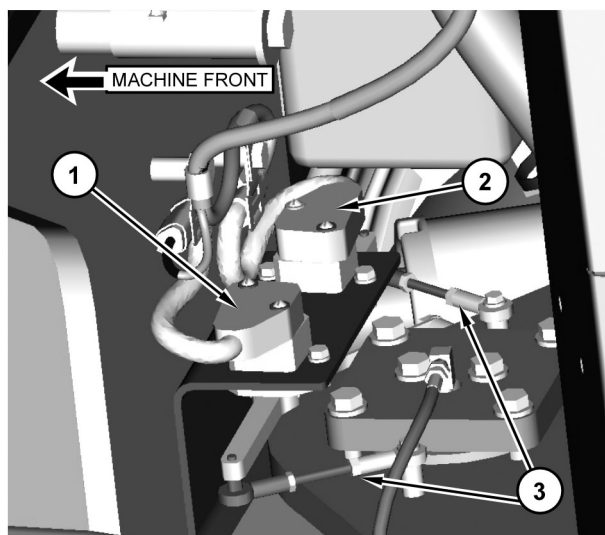


Illustration 179

g03663349

Locations of Articulation Angle Sensors

- (1) Articulation angle sensor 1
- (2) Articulation angle sensor 1
- (3) Mechanical linkage

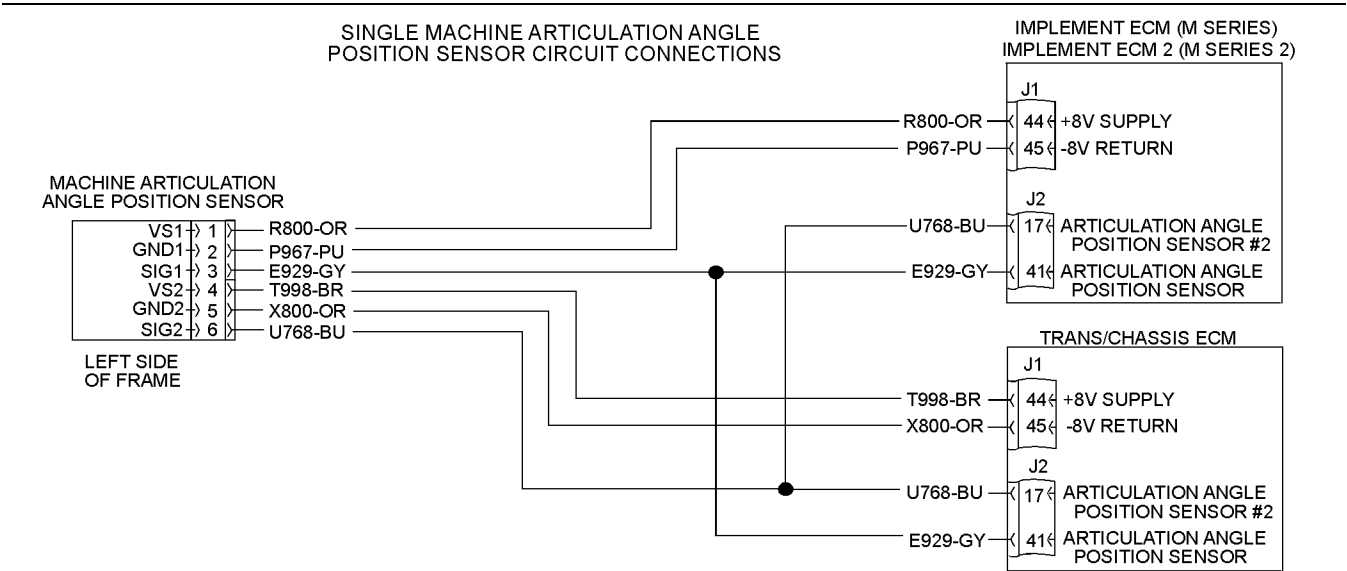


Illustration 180

g03655165

Single Sensor with two outputs

This single sensor sends a signal 1 to J2-41 and signal 2 to J2-17

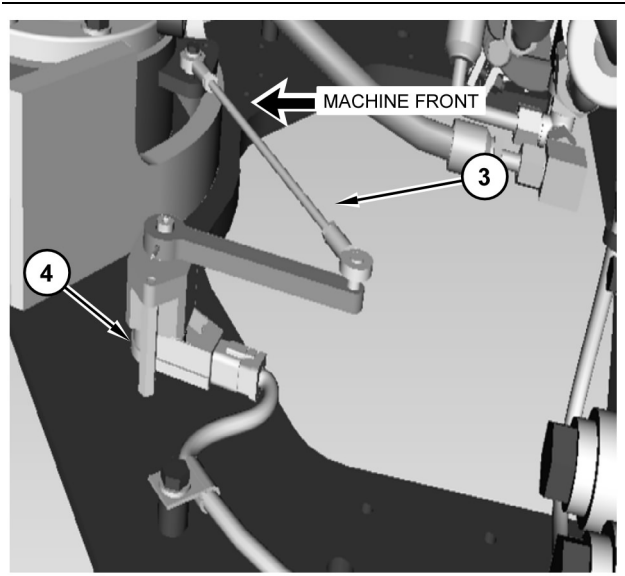


Illustration 181

g03655166

“Machine Articulation Angle Position” Sensor location
(View from the left side of the machine at the articulation hitch)

(3) Mechanical linkage
(4) Articulation angle sensor

Two articulation angle sensor signals are required for correct operation of the articulation of the machine. Either the two separate sensors or the dual output sensor will provide a PWM input to the Implement ECM and the Transmission/Chassis ECM.

This diagnostic code is associated with the number one sensor signal for the angle of machine articulation connected to each ECM at J2-41. The FMI 08 means that the ECM has determined that the signal frequency or the signal pulse width is not within the expected range. The Implement ECM, the Transmission/Chassis ECM or both ECM modules can activate this diagnostic code.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. When the machine is in the neutral position, the input of the duty cycle to the ECM is approximately 55%. When the machine is articulated to the full left position, the duty cycle will be approximately 33%. When the machine is articulated to the full right position, the duty cycle will be approximately 74%.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- Intermittent connections or poor connections
- Mechanical devices are loose.
- The ECM has failed. This is unlikely.

Before performing this procedure, check for an active CID 0041 diagnostic code for the 8 volt sensor power supply of the ECM. Correct any problem with the 8 volt power supply before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the articulation sensor signal 1. Both ECM modules can activate a CID 0615 FMI 08 diagnostic code when the signal frequency or the signal pulse width is not within the expected range. If one ECM has activated a CID 0615 FMI 08 diagnostic code and the other ECM has not activated the code, it is possible that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL LINKAGE

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Remove any guards or shielding for the articulation sensors.
- C. Check the mounting bolts for the articulation sensors. Ensure that the sensors are securely mounted.
- D. Visually inspect the mechanical linkage for the articulation sensors. Verify that all mechanical components are tight and that all mechanical components are in good condition. Verify that the adjustment of the linkage is correct.

Expected Result:

All mechanical linkage and components for adjustment of the articulation sensor(s) are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical linkage and adjustment for the articulation sensor is correct. Proceed to Test Step 2.
- NOT OK – All mechanical linkage and adjustment for the articulation sensors is not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the articulation sensor(s). After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SIGNAL OF THE SENSOR

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. At the back of the harness connector for the sensor, insert 7X-1710 Multimeter Probes along return contact B (wire P967-PU(Purple)) and insert a probe along the signal contact C (wire E929-GY(Grey)).
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Monitor the signal of the sensor with a digital multimeter.
- E. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 3.
- NOT OK – The sensor's signal does not respond correctly. The sensor is not operating correctly.

Repair: Replace the articulation angle 1 sensor. After replacement of the sensor, the sensor must be calibrated. Refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

STOP.

Test Step 3. CHECK FOR AN OPEN IN THE SIGNAL CIRCUIT

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector from the sensor.
- C. At the machine harness connector for the sensor, connect the jumper wire between a good ground contact of the frame and the signal contact C (wire E929-GY(Grey)).
- D. Disconnect the machine harness connector J2 from the Transmission/Chassis ECM.
- E. At the machine harness connectors for the Transmission/Chassis ECM, measure the resistance from the frame ground to the connector contact of the Transmission/Chassis ECM J2-41 (wire E929-GY(Grey)).
- F. Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the wiring harness.

Results:

- OK – The resistance measurement is less than 5 ohms. The resistance measurement is not indicating an open in the circuit. Proceed to Test Step 4.
- NOT OK – One or both of the resistance measurements is greater than 5 ohms. There is an open connection or a bad connection in the signal circuit.

Repair: If both of the ECM modules have activated this diagnostic code, there is most likely an open connection or a bad connection on the sensor side of the machine harness splice connection for the signal wire.

If only the Transmission/Chassis ECM has activated this diagnostic code, there is most likely an open or a bad connection on the ECM side of the machine harness splice connection for the signal wire.

In either case, refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the suspected section of the sensor signal circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE OPERATION OF THE ECM

The key start switch and the disconnect switch remain in the OFF position. The machine harness connector for the sensor and the J2 connector for the Transmission/Chassis ECM remain disconnected.

Note: This check should be performed on the ECM that has activated the diagnostic code. If both of the ECM modules have activated the diagnostic code, perform this check on both of the ECM modules.

- A. At the machine harness connector J2 for the ECM, use a 151 - 6320 Removal Tool to remove the sensor signal wire E929-GY(Grey) and the socket at contact J2-41 from the harness connector.
- B. Reconnect the machine harness J1 and J2 connectors to the ECM.
- C. Turn the key start switch and the disconnect switch to the ON position.
- D. Observe the status of the active CID 0615 FMI 08 diagnostic code.

Expected Result:

The CID 0615 FMI 08 diagnostic code is no longer active. A CID 0615 FMI 03 diagnostic code is now active.

Results:

- YES – The CID 0615 FMI 08 diagnostic code is no longer active. A CID 0615 FMI 03 diagnostic code has been activated after the sensor signal wire was disconnected. The ECM has responded correctly to the open circuit condition in the sensor circuit. Reinstall the disconnected sensor signal wire back into the correct spot in the ECM connector before proceeding to the next test step. Proceed to Test Step 5.
- NO – The CID 0615 FMI 08 diagnostic code remains active. The status of the active diagnostic code does not change when the sensor signal wire is disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the sensor circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 0615 FMI 08.

Expected Result:

The CID 0615 FMI 08 is not active.

Results:

- OK – The CID 0615 FMI 08 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0615 FMI 08 is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, replace the sensor. After replacement of the sensor, verify that the new sensor corrected the problem. If the problem is still present after the replacement of the sensor, the ECM may have failed. This is unlikely as the ECM responded correctly to the condition in the previous test step.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, and the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i05758236

MID 027 - CID 0615 - FMI 13

SMCS Code: 4806-038

Conditions Which Generate This Code:

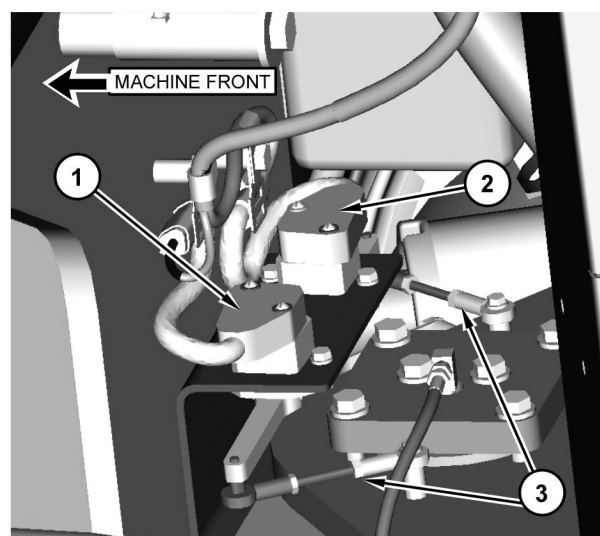


Illustration 182

g03663349

Locations of Articulation Angle Sensors

- (1) Articulation angle sensor 1
- (2) Articulation angle sensor 2
- (3) Mechanical linkage

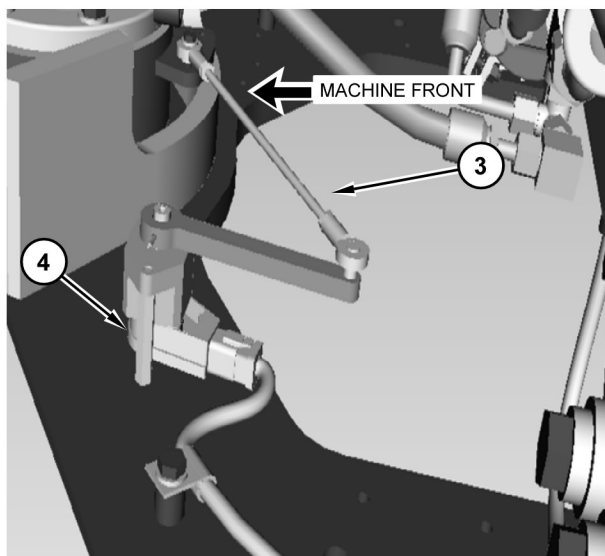


Illustration 183

g03655166

“Machine Articulation Angle Position Sensor” location (View from the left side of the machine at the articulation hitch)

(1) Articulation angle sensor

(2) Mechanical linkage

Two articulation angle sensors are required for correct operation of the articulation of the machine. Each sensor will provide a PWM input to the Implement ECM and the Transmission/Chassis ECM.

The CID 0615 FMI 13 diagnostic code is recorded when the ECM detects that the angle sensor 1 is out of calibration. The Implement ECM and the Transmission/Chassis ECM can activate this diagnostic code.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. When the machine is in the neutral position, the duty cycle to the ECM is approximately 55%. When the machine is articulated to the full left position, the duty cycle will be approximately 33%. When the machine is articulated to the full right position, the duty cycle will be approximately 74%.

Note: The sensor supply of the ECM provides power to the sensor. The sensor does not connect directly to the frame ground. The sensor connects to the return circuit of the ECM. The ECM internally connects the return wire to frame ground. In order to correct this diagnostic code, calibrate the sensor.

CALIBRATION

A. Perform the calibration procedure for the sensor. Refer to Testing and Adjusting, “Calibration” section of this manual for the correct calibration procedure.

Expected Result:

The calibration procedure was performed successfully.

Results:

- YES – The calibration procedure was performed successfully. Resume normal machine operation.

STOP.

- NO – The calibration was not successful.

Repair: Repeat the calibration procedure for the sensor.

If the second calibration procedure is not successful, replace the position sensor. Refer to the Testing and Adjusting, “Calibration” section of this manual for the correct calibration procedure. If the problem is still present after replacement and calibration of the new sensor, the ECM may be faulty.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that activated the diagnostic code. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i05758238

MID 027 - CID 0615 - FMI 14

SMCS Code: 4806-038

Conditions Which Generate This Code:

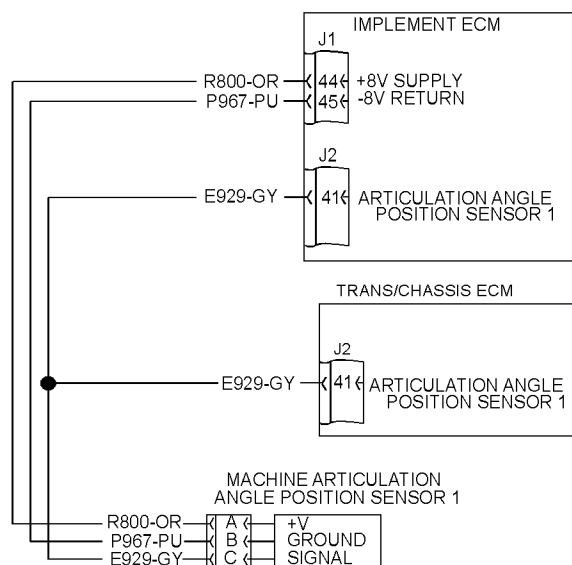


Illustration 184

g03663346

Connections of the Machine Articulation Angle Sensor 1

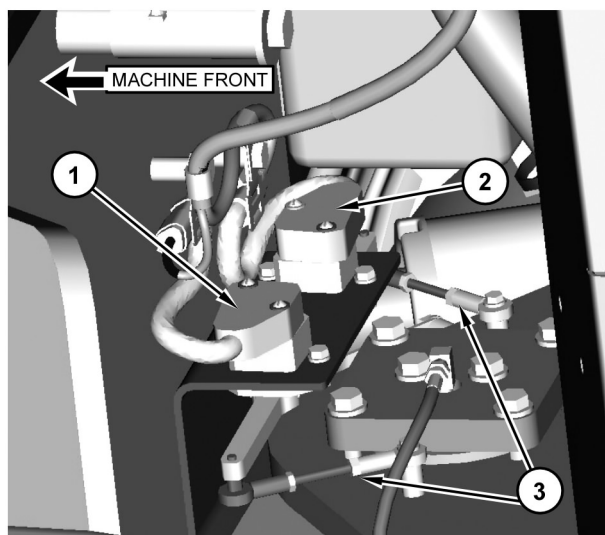


Illustration 185

g03663349

Locations of Articulation Angle Sensors

- (1) Articulation angle sensor 1
- (2) Articulation angle sensor 2
- (3) Mechanical linkage

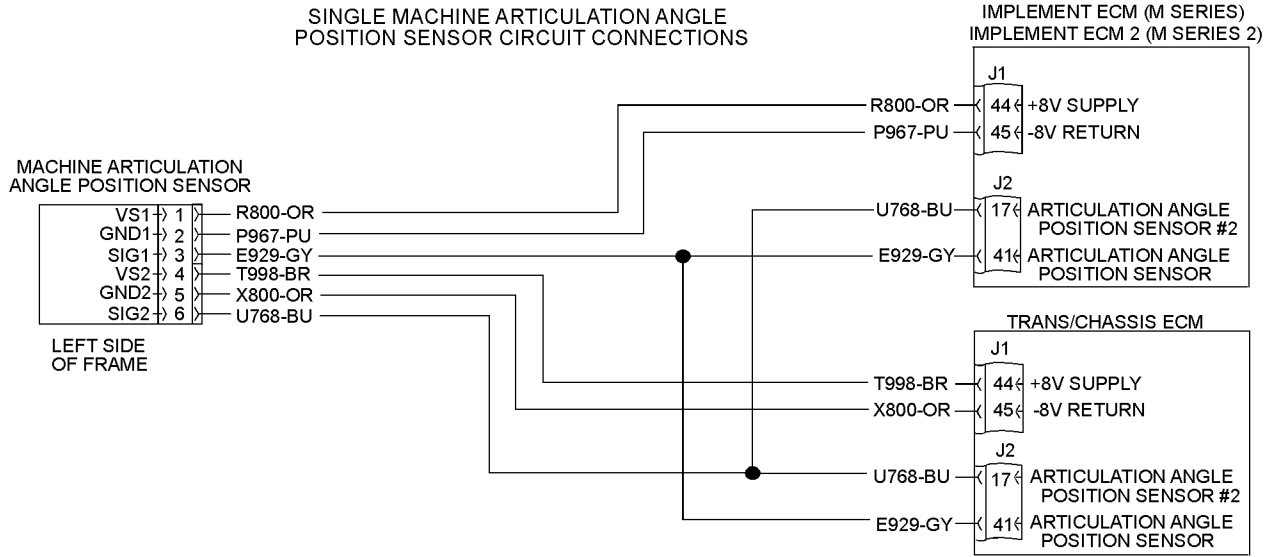


Illustration 186

g03655165

Single Sensor with two outputs

This single sensor sends a signal 1 to J2-41 and signal 2 to J2-17.

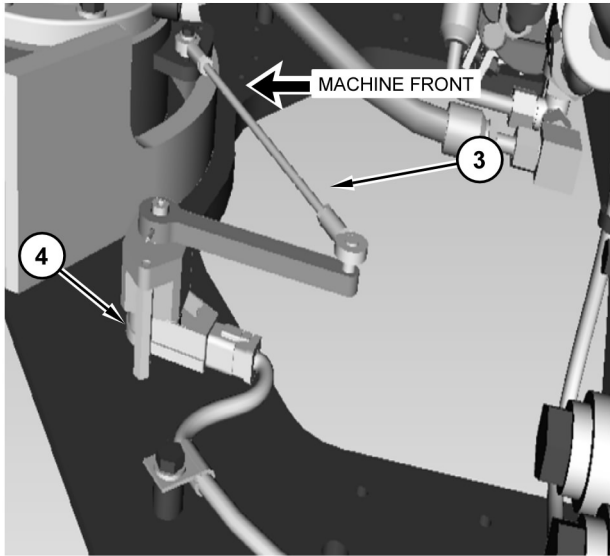


Illustration 187

g03655166

“Machine Articulation Angle Position Sensor” location (View from the left side of the machine at the articulation hitch)

- (3) Mechanical linkage
- (4) Articulation angle sensor

Two articulation angle sensor signals are required for correct operation of the articulation of the machine. Either the two separate sensors or the dual output sensor will provide a PWM input to the Implement ECM and the Transmission/Chassis ECM.

This diagnostic code is associated with the number one sensor signal for the angle of machine articulation connected to each ECM at J2-41. The FMI 14 diagnostic code is recorded when the ECM determines that the signal from the sensor is incorrect.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. When the machine is in the neutral position, the duty cycle of the sensor to the ECM is approximately 55%. When the machine is articulated to the full left position, the duty cycle will be approximately 33%. When the machine is articulated to the full right position, the duty cycle will be approximately 74%.

The possible causes of this diagnostic code are listed below:

- The mechanical linkage for the position sensor is not functioning correctly.
- The sensor needs to be calibrated.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, ensure that there are no active CID 0041 diagnostic codes for the power supply (8 VDC) of the sensor. Ensure that the power supply for the angular sensor is correct.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL LINKAGE

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Remove any guards or shielding for the articulation sensors.
- C. Check the mounting bolts for the articulation sensors. Ensure that the sensors are securely mounted.
- D. Visually inspect the mechanical linkage for the articulation sensors. Verify that all mechanical components are tight and that all mechanical components are in good condition. Verify that the adjustment of the linkage is correct.

Expected Result:

All mechanical linkage and components for adjustment of the articulation sensor(s) are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical linkage and adjustment for the articulation sensor is correct. Proceed to Test Step 2.
- NOT OK – All mechanical linkage and adjustment for the articulation sensors is not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the articulation sensor(s). After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CALIBRATE THE POSITION SENSOR

- A. Verify that the linkage for the sensor is correct. Use the Caterpillar Electronic Technician (ET) service tool in order to perform the calibration procedure for the articulation angle sensor 1. Refer to Testing and Adjusting, "Calibrations" for information on the process to access the articulation sensor calibration procedure.

Expected Result:

The calibration procedure has been performed for the articulation sensor 1 of the machine and the FMI 14 diagnostic code is no longer active.

Results:

- OK – The calibration procedure has been performed for the articulation sensor 1 of the machine and the FMI 14 diagnostic code is no longer active. NOTE: If the position sensor has been calibrated recently and the FMI 14 diagnostic code becomes active after a short time, the linkage for the articulation position sensor is most likely causing the problem. Repair the linkage or replace the linkage for the sensor.

STOP.

- NOT OK – The calibration procedure has been performed for the articulation sensor 1 of the machine. However, the FMI 14 diagnostic code is still active. The problem has not been corrected. Proceed to Test Step 3.

Test Step 3. CHECK THE SIGNAL CIRCUIT OF THE SENSOR

- A. The key start switch and the disconnect switch remain in the OFF position.
- B. Do not disconnect the harness connector from the sensor.
- C. At the back of the harness connector for the sensor, insert 7X-1710 Multimeter Probes along the return contact B (wire P967-PU(Purple)) and insert a multimeter probe along the contact of the signal wire C (wire E929-GY(Grey)).
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Monitor the signal of the sensor with a digital multimeter.
- F. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, articulate the machine through the full range of operation.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure.

i05720430

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 4.
- NOT OK – The sensor's signal does not respond correctly. The sensor is not operating correctly.

Repair: Replace the articulation angle 1 sensor. After replacement of the sensor, the sensor must be calibrated. Refer to the Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 0615 FMI 12 diagnostic code.

Expected Result:

The CID 0615 FMI 12 diagnostic code is not active.

Results:

- OK – The CID 0615 FMI 12 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0615 FMI 12 diagnostic code is active. The diagnostic code has not been corrected.

Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM that activated the diagnostic code. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

MID 027 - CID 0621 - FMI 03

SMCS Code: 3171-038; 7332-038-Q9

Conditions Which Generate This Code:

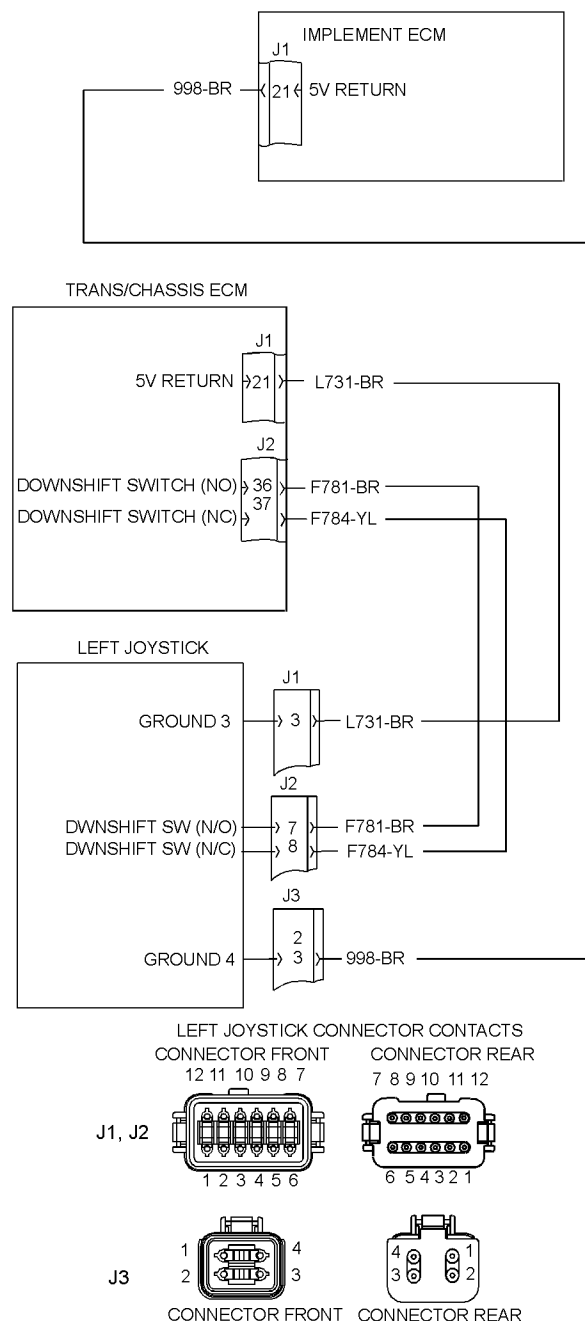


Illustration 188

g01301129

Connections of the Downshift Switch

This diagnostic code is associated with the downshift switch that is located on the left joystick handle. The switch supplies 2 switches to ground inputs to the Transmission/Chassis ECM. The ECM expects one of the two switch inputs to be grounded at all times. When the ECM detects that neither of the switch inputs is grounded, the ECM will activate an FMI 03 diagnostic code to indicate a voltage above normal condition.

The downshift switch is connected to ground at the Transmission/Chassis ECM 5 V sensor return (ECM ground) and the Implement ECM 5 V sensor return (ECM ground). The switch must lose both grounds in order to disrupt the switch operation. The illustration above indicates the power and ground connections for the switch.

Possible conditions that can cause this diagnostic code are listed:

- One or both of the switch circuits are open in the machine harness.
- Both of the switch ground circuits are open in the machine harness.
- One or more of the switch inputs are shorted to a voltage source.
- The switch has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SWITCH CIRCUITS FOR AN OPEN

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. Disconnect the connector of the left joystick J2 from the machine harness connector.
- C. At the joystick connector J2, connect a jumper wire between the normally open (N/O) contact J2-7 (wire F781-BR(Brown)) and the normally closed (N/C) contact J2-8 (wire F784-YL(Yellow)).

- D. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- E. At the ECM machine harness connector J2, measure the resistance between N/O contact J2-36 (wire F781-BR(Brown)) and N/C contact J2-37 (wire F784-YL(Yellow)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The input circuits of the switch are not open in the machine harness. Proceed to Test Step 2.
- NOT OK – The resistance measurement is greater than 5 ohms. One of the switch circuits is open in the machine harness.

Repair: There is an open or a bad connection in input wire of the switch F781-BR(Brown) or switch input wire F784-YL(Yellow). Refer to the complete Electrical System Schematic of the machine. Check the connectors that are in the switch circuits for a loose connection or a corroded connection. Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE GROUND CIRCUITS FOR AN OPEN

The disconnect switch and the key start switch remain in the OFF position. The connector of the left joystick J2 remains disconnected from the machine harness. The connectors of the Transmission/Chassis ECM remain disconnected from the machine harness.

- A. Disconnect the connectors of the left joystick J1 and J3 from the machine harness connector.
- B. Disconnect the machine harness connectors J1 from the Implement ECM.
- C. At the joystick connectors J1 and J3, connect a jumper wire between the ground 3 contact J1-3 (wire L731-BR(Brown)) and ground 4 contact J3-3 (wire 998-BR(Brown)).
- D. Obtain a spare length of wire that is long enough to reach from the Transmission/Chassis ECM to the cab of the machine. Connect one end of the spare wire to the Transmission/Chassis ECM return contact J1-21 (wire L731-BR(Brown)).

- E.** At the machine harness connector of the Implement ECM J1, measure the resistance between return contact J1-21 (wire 998-BR(Brown)) and the end of the spare wire that is connected to return contact of the Transmission/Chassis ECM J1-21 (wire L731-BR(Brown)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The ground circuits are not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. One or both of the switch ground circuits is an open connection or a bad connection in the machine harness.

Repair: Verify that the connection of the spare wire at the connector of the Transmission/Chassis ECM is a good connection. Check the ground circuits again to verify that there is an open or a bad connection present in the ground circuits.

If the resistance measurement is still greater than 5 ohms, there is an open or a bad connection in ground wire 998-BR(Brown) or wire L731-BR(Brown).

NOTE: Both of the ground circuits must be open in order to cause this diagnostic code to activate. However, if one of the ground circuits is faulty, the faulty circuit must be repaired before proceeding with this procedure.

Refer to the complete Electrical System Schematic of the machine. Check the connectors that are in the ground circuits for a loose connection or a corroded connection. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE HARNESS FOR A SHORT

The key start switch and the disconnect switch remain in the OFF position.

The harness connectors for the joystick and the harness connectors for the ECM remain disconnected.

- A.** Connect the jumper wire that was used in the last test step between the harness connector contact of the joystick J2-7 (wire F781-BR(Brown)) and contact J2-8 (wire F784-YL(Yellow)).

- B.** At the machine harness connector of the Transmission/Chassis ECM J2, measure the resistance between contact J2-36 (wire F781-BR(Brown)) to all of the other contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The input circuits of the switch are not shorted in the machine harness. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between one of the switch circuits and the circuit with the low resistance measurement.

Check each input circuit of the switch for a short, in order to determine the circuit that is shorted to the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the switch circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SWITCH OPERATION

The connectors of the left joystick remain disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- A.** At the joystick connectors, measure the resistance (continuity) between ground 3 contact J1-3 and the joystick N/O switch contact J2-7 when the switch is not depressed and when the switch is depressed.

B. At the joystick connectors, measure the resistance (continuity) between ground 3 contact J1-3 and the joystick N/C switch contact J2-8 when the switch is not depressed and when the switch is depressed.

Expected Result:

When the switch is not depressed, the measurement results are as listed below:

J1-3 (ground) to J2-7 (N/O) - No continuity (Open)

J1-3 (ground) to J2-8 (N/C) - Continuity (Closed)

When the switch is depressed, the measurement results are as listed below:

J1-3 (ground) to J2-7 (N/O) - Continuity (Closed)

J1-3 (ground) to J2-8 (N/C) - No continuity (Open)

Results:

- OK – The continuity checks between ground contact J1-3 to the switch contacts are correct. The switch is operating correctly. Proceed to Test Step 5.
- NOT OK – The continuity checks between the ground contact J1-3 and the switch contacts are not correct. The switch is not working correctly.

Repair: The downshift switch is not correct. Replace the left-hand joystick push-button faceplate.

Refer to Special Instruction, REHS7448, "Procedure To Remove And Replace The Left-Hand Joystick Push-Button Faceplate On M Series And M Series 2 Motor Graders".

Verify that the operation of the joystick is correct before operating the machine.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the contacts. Clean the contacts of any harness connectors that are disconnected.
- B.** Reconnect all harness connectors.
- C.** Turn the disconnect switch and the key start switch to the ON position.
- D.** Operate the machine.
- E.** Determine if the CID 0621 FMI 03 diagnostic code is not active.

Expected Result:

The CID 0621 FMI 03 diagnostic code is active.

Results:

- OK – The CID 0621 FMI 03 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0621 FMI 03 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact the Technical Communicator (TC) of your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i05720469

MID 027 - CID 0621 - FMI 04

SMCS Code: 3171-038; 7332-038-Q9

Conditions Which Generate This Code:

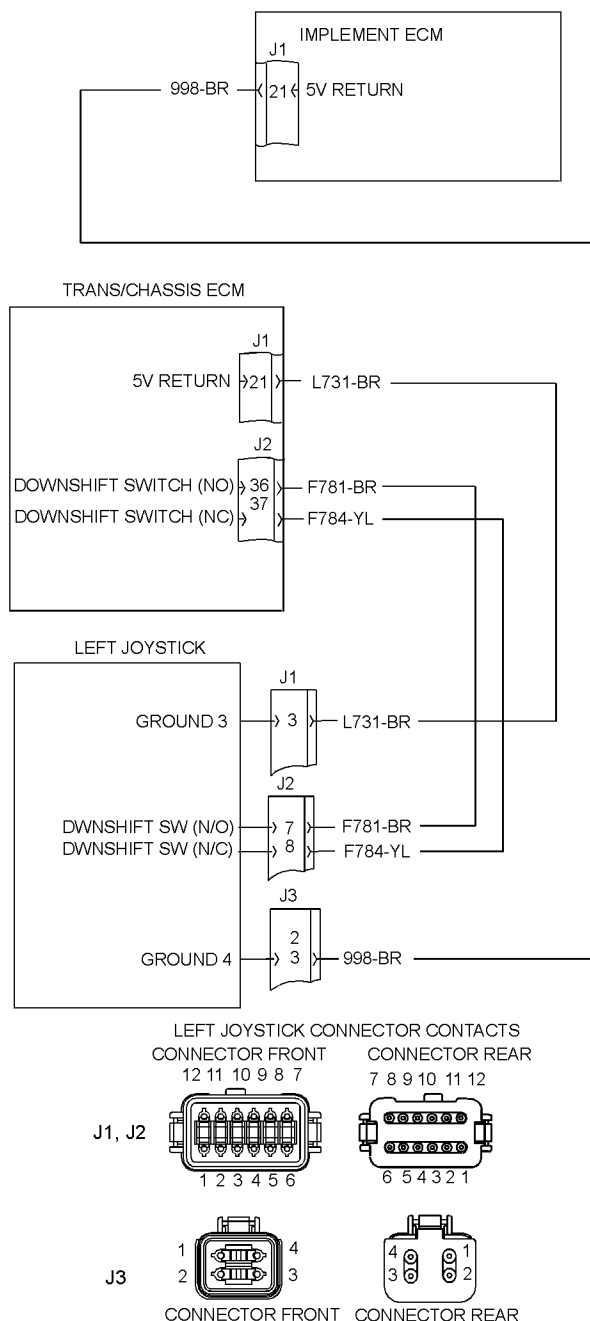


Illustration 189

g01301129

Downshift Switch connections

This diagnostic code is associated with the downshift switch that is located on the left joystick handle. The switch supplies two switch-to-ground type inputs to the Implement ECM. The ECM expects one of the two switch inputs to be grounded at all times. When the ECM detects that both of the switch inputs are grounded at the same time, the ECM will activate an FMI 04 diagnostic code indicating that the voltage is below normal.

The downshift switch is connected to ground at the Transmission/Chassis ECM 5 V sensor return (ECM ground) and the Implement ECM 5 V sensor return (ECM ground). The switch would have to lose both grounds in order to disrupt the switch operation. The illustration above indicates the power and ground connections for the switch.

Possible conditions that can cause this diagnostic code are listed:

- One or both of the switch inputs is shorted to a ground source.
- The switch has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SWITCH

- Turn the disconnect switch and the key start switch to the ON position.
- Ensure that the diagnostic code is active.
- Observe the status of the diagnostic code while disconnecting the left joystick J2 connector from the machine harness.

Expected Result:

If CID 0622 FMI 03 becomes active, the machine harness and the ECM are most likely OK.

If no CID 622 codes are active, the harness is most likely grounded in one circuit.

If CID 0622 FMI 04 remains active, both circuits likely have a short to ground.

Results:

- OK – The CID 0621 FMI 04 diagnostic code remains active. The switch has not failed, however both circuits in the harness likely have a short to ground. Proceed to Test Step 3.
- OK – No CID 622 codes are active. The switch has not failed, however the harness is likely grounded in one circuit. Proceed to Test Step 3.
- NOT OK – The CID 0622 FMI 04 diagnostic code is NO longer active. A CID 0622 FMI 03 diagnostic code becomes active when the J2 connector is disconnected. The machine harness and the ECM are operating correctly. The switch may have failed. Verify that the switch is not operating correctly. Proceed to Test Step 2.

Test Step 2. CHECK THE SWITCH OPERATION

The connector of the left joystick J2 remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- Disconnect the joystick J1 connector from the machine harness.
- At the joystick connectors, measure the resistance (continuity) between ground 3 contact J1-3 and the joystick N/O switch contact J2-7 when the switch is not depressed and when the switch is depressed.
- At the joystick connectors, measure the resistance (continuity) between ground 3 contact J1-3 and the joystick N/C switch contact J2-8 when the switch is not depressed and when the switch is depressed.

Expected Result:

When the switch is **NOT** depressed, the measurement results are as listed:

- J1-3 (ground) to J2-7 (N/O) - No continuity (Open)
 J1-3 (ground) to J2-8 (N/C) - Continuity (Closed)

When the switch **IS** depressed, the measurement results are as listed:

- J1-3 (ground) to J2-7 (N/O) - Continuity (Closed)
 J1-3 (ground) to J2-8 (N/C) - No continuity (Open)

Results:

- OK – The continuity checks between contact ground J1-3 to the switch contacts are correct. The switch is operating correctly. Proceed to Test Step 3.

- NOT OK – The continuity checks between the ground contact J1-3 to the switch contacts are not correct. The switch is not working correctly.

Repair: The downshift switch is not correct. Replace the left-hand joystick push-button faceplate.

Refer to Special Instruction, REHS7448, "Procedure To Remove And Replace The Left-Hand Joystick Push-Button Faceplate On M Series And M Series 2 Motor Graders".

Verify that the operation of the joystick is correct before operating the machine.

STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT FOR A SHORT TO GROUND

The connector of the left joystick J2 remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- Disconnect the J1 and J2 machine harness connectors from the Transmission/Chassis ECM.
- At machine harness connector J2 for the ECM, measure the resistance from contact J2-36 (wire F781-BR(Brown)) to frame ground. Measure the resistance to all of the contacts that are used in the J1 and J2 connectors for the ECM.
- At machine harness connector J2 for the ECM, measure the resistance from contact J2-37 (wire F784-YL(Yellow)) to frame ground. Measure the resistance to all of the contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The switch circuits are not shorted to another circuit in the machine harness. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is NOT correct. The machine harness has failed.

Repair: There is a short in the machine harness. The short is between the switch circuit and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the switch circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Determine if the CID 0621 FMI 04 diagnostic code is active.

Expected Result:

The CID 0621 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 0621 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0621 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact the Technical Communicator (TC) of your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

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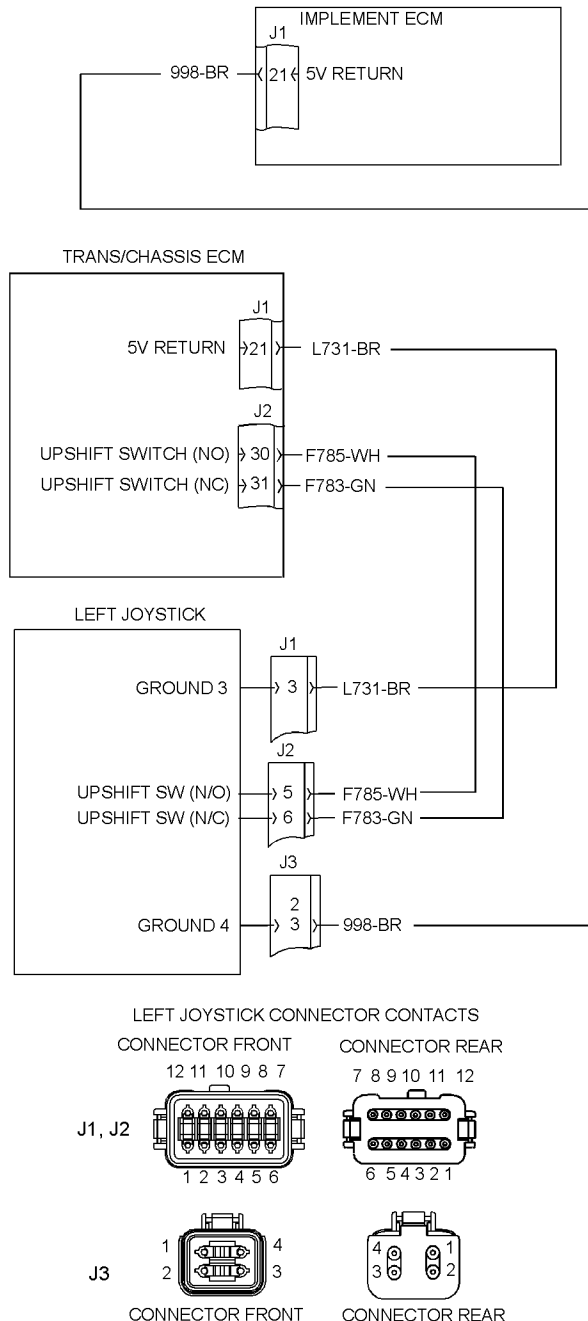
MID 027 - CID 0622 - FMI 03**SMCS Code:** 3171-038; 7332-038-Q9**Conditions Which Generate This Code:**

Illustration 190

g01301319

Connections of the Upshift Switch

This diagnostic code is associated with the upshift switch that is located on the left joystick handle. The switch supplies 2 switches to ground inputs to the Transmission/Chassis ECM. The ECM expects one of the two switch inputs to be grounded at all times. When the ECM detects that neither of the switch inputs is grounded, the ECM will activate an FMI 03 diagnostic code for "voltage above normal".

The upshift switch is connected to ground at the Transmission Chassis ECM 5 V sensor return (ECM ground) and the Implement ECM 5 V sensor return (ECM ground). The switch must lose both grounds in order to disrupt the switch operation. The illustration above indicates the power and ground connections for the switch.

Possible conditions that can cause this diagnostic code are listed:

- One or both of the switch circuits are open in the machine harness.
- Both of the switch ground circuits are open in the machine harness.
- One or more of the switch inputs are shorted to a voltage source.
- The switch has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SWITCH CIRCUITS FOR AN OPEN

- Turn the disconnect switch and the key start switch to the OFF position.
- Disconnect the left connector of the joystick J2 from the machine harness connector.
- At the joystick connector J2, connect a jumper wire between the normally open (N/O) contact J2-5 (wire F785-WH(White)) and the normally closed (N/C) contact J2-6 (wire F783-GN(Green)).
- Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.

- E.** At the ECM machine harness connector J2, measure the resistance between N/O contact J2-30 (wire F785-WH(White)) and N/C contact J2-31 (wire F783-GN(Green)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The input circuits of the switch are not open in the machine harness. Proceed to Test Step 2.
- NOT OK – The resistance measurement is greater than 5 ohms. One of the switch circuits is open in the machine harness.

Repair: There is an open or a bad connection in input wire of the switch F785-WH(White) or switch input wire F783-GN(Green). Refer to the complete Electrical System Schematic of the machine. Check the connectors that are in the switch circuits for a loose connection or a corroded connection. Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE GROUND CIRCUITS FOR AN OPEN

The disconnect switch and the key start switch remain in the OFF position. The connector of the left joystick J2 remains disconnected from the machine harness. The connectors of the Transmission/Chassis ECM remain disconnected from the machine harness.

- A.** Disconnect the connectors of the left joystick J1 and J3 from the machine harness connector.
- B.** Disconnect the machine harness connectors J1 from the Implement ECM.
- C.** At the connectors of the joystick J1 and J3, connect a jumper wire between the ground 3 contact J1-3 (wire L731-BR(Brown)) and ground 4 contact J3-3 (wire 998-BR(Brown)).
- D.** Obtain a spare length of wire that is long enough to reach from the Transmission Chassis ECM to the cab of the machine. Connect an end of the spare wire to the return contact of the Transmission/Chassis ECM J1-21 (wire L731-BR(Brown)).

- E.** At the machine harness connector of the Implement ECM J1, measure the resistance between return contact J1-21 (wire 998-BR(Brown)) and the end of the spare wire that is connected to return contact of the Transmission/Chassis ECM J1-21 (wire L731-BR(Brown)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The ground circuits are not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. One or both of the switch ground circuits is an open connection or a bad connection in the machine harness.

Repair: Verify that the connection of the spare wire at the connector of the Transmission/Chassis ECM is a good connection. Check the ground circuits to verify that there is an open connection or a bad connection present in the ground circuits.

If the resistance measurement is still greater than 5 ohms, there is an open or a bad connection in ground wire 998-BR(Brown) or wire L731-BR(Brown).

NOTE: Both of the ground circuits must be open in order to cause this diagnostic code to activate. However, if one of the ground circuits is faulty, the faulty circuit must be repaired before proceeding with this procedure.

Refer to the complete Electrical System Schematic of the machine. Check the connectors that are in the ground circuits for a loose connection or a corroded connection. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE HARNESS FOR A SHORT

The key start switch and the disconnect switch remain in the OFF position.

The harness connectors for the joystick and the harness connectors of the ECM remain disconnected.

- A.** Connect the jumper wire that was used in the last test step between the contact of the joystick harness, connector J2-5 (wire F785-WH(White)), and contact J2-6 (wire F783-GN(Green)).
- B.** At the machine harness connector of the Transmission/Chassis ECM J2, measure the resistance between contact J2-30 (wire F785-WH(White)) to all of the other contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The input circuits of the switch are not shorted in the machine harness. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between one of the switch circuits and the circuit with the low resistance measurement.

Check each input circuit of the switch individually for a short in order to determine the circuit that is shorted to the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the switch circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SWITCH OPERATION

The connectors of the left joystick remain disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- A.** At the joystick connectors, measure the resistance (continuity) between ground 3 contact J1-3 and the joystick N/O switch contact J2-5 when the switch is not depressed and when the switch is depressed.

- B.** At the joystick connectors, measure the resistance (continuity) between ground 3 contact J1-3 and the joystick N/C switch contact J2-6 when the switch is not depressed and when the switch is depressed.

Expected Result:

When the switch is not depressed, the measurement results are as listed below:

J1-3 (ground) to J2-5 (N/O) - No continuity (Open)

J1-3 (ground) to J2-6 (N/C) - Continuity (Closed)

When the switch is depressed, the measurement results are as listed below:

J1-3 (ground) to J2-5 (N/O) - Continuity (Closed)

J1-3 (ground) to J2-6 (N/C) - No continuity (Open)

Results:

- OK – The continuity checks between ground contact J1-3 and the switch contacts are correct. The switch is operating correctly. Proceed to Test Step 5.
- NOT OK – The continuity checks between the ground contact J1-3 and the switch contacts are not correct. The switch is not working correctly.

Repair: The upshift switch is not correct. Replace the left-hand joystick push-button faceplate.

Refer to Special Instruction, REHS7448, "Procedure To Remove And Replace The Left-Hand Joystick Push-Button Faceplate On M Series And M Series 2 Motor Graders".

Verify that the operation of the joystick is correct before operating the machine.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the contacts. Clean the contacts of any harness connectors that are disconnected.
- B.** Reconnect all harness connectors.
- C.** Turn the disconnect switch and the key start switch to the ON position.
- D.** Operate the machine.
- E.** Determine if the CID 0622 FMI 03 diagnostic code is not active.

Expected Result:

The CID 0622 FMI 03 diagnostic code is active.

i05720510

Results:

- OK – The CID 0622 FMI 03 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0622 FMI 03 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact the Technical Communicator (TC) of your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

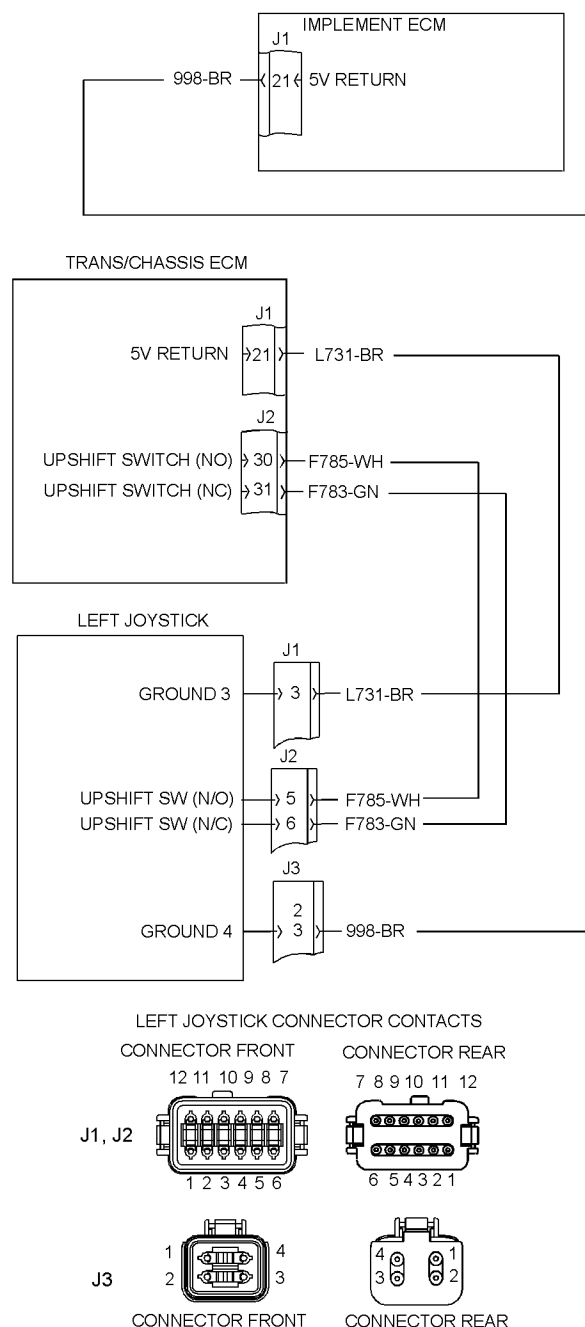
If the ECM must be replaced, refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

MID 027 - CID 0622 - FMI 04

SMCS Code: 3171-038; 7332-038-Q9

Conditions Which Generate This Code:



This diagnostic code is associated with the upshift switch. The upshift switch is located on the handle of the left joystick. The upshift switch supplies two switches to ground inputs to the Transmission/Chassis ECM. The ECM expects one of the two switch inputs to be grounded at all times. When the ECM detects that both of the switch inputs are grounded at the same time, an FMI 04 "Voltage Below Normal" diagnostic code is activated.

The upshift switch is connected to ground at the Transmission/Chassis ECM 5 V sensor return (ECM ground) and the Implement ECM 5 V sensor return (ECM ground). The switch must lose both grounds in order to disrupt the switch operation. The illustration above indicates the power and ground connections for the switch.

Possible conditions that can cause this diagnostic code are listed below:

- One or both of the switch inputs is shorted to a ground source.
- The switch has failed.
- The ECM has failed. ECM failure is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SWITCH

- A. Turn the disconnect switch and the key start switch to the ON position.
- B. Ensure that the diagnostic code is active.
- C. Observe the status of the diagnostic code and disconnect the connector of the left joystick J2 from the machine harness.

Expected Result:

If CID 0622 FMI 03 becomes active, the machine harness and the ECM are most likely OK. If no CID 622 codes are active, the harness is most likely grounded in one circuit. If CID 0622 FMI 04 remains active, both circuits likely have a short to ground.

Results:

- OK – The CID 0622 FMI 04 diagnostic code remains active. The switch has not failed, however both circuits in the harness likely have a short to ground. Proceed to Test Step 3.
- OK – No CID 622 codes are active. The switch has not failed, however the harness is likely grounded in one circuit. Proceed to Test Step 3.
- NOT OK – The CID 0622 FMI 04 diagnostic code is NO longer active. A CID 0622 FMI 03 diagnostic code becomes active when the J2 connector is disconnected. The machine harness and the ECM are operating correctly. The switch may have failed. Verify that the switch is not operating correctly. Proceed to Test Step 2.

Test Step 2. CHECK THE SWITCH OPERATION

The connector of the left joystick J2 remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- A. Disconnect the joystick J1 connector from the machine harness.
- B. At the joystick connectors, measure the resistance (continuity) between ground 3 contact J1-3 and the joystick N/O switch contact J2-5 when the switch is not depressed and depressed.
- C. At the joystick connectors, measure the resistance (continuity) between ground 3 contact J1-3 and the joystick N/C switch contact J2-6 when the switch is not depressed and depressed.

Expected Result:

When the switch is **NOT** depressed, the measurement results are as listed below:

J1-3 (ground) to J2-5 (N/O) - No continuity (Open)

J1-3 (ground) to J2-6 (N/C) - Continuity (Closed)

When the switch **IS** depressed, the measurement results are as listed below:

J1-3 (ground) to J2-5 (N/O) - Continuity (Closed)

J1-3 (ground) to J2-6 (N/C) - No continuity (Open)

Results:

- OK – The continuity checks between ground contact J1-3 and the switch contacts are correct. The switch is operating correctly. Proceed to Test Step 3.
- NOT OK – The continuity checks between the ground contact J1-3 and the switch contacts are not correct. The switch is not working correctly.

Repair: The upshift switch is not correct. Replace the left-hand joystick faceplate.

Refer to Special Instruction, REHS7448, "Procedure To Remove And Replace The Left-Hand Joystick Push-Button Faceplate On M Series And M Series 2 Motor Graders".

Verify that the operation of the joystick is correct before operating the machine.

STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT FOR A SHORT TO GROUND

The connector of the left joystick J2 remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- A. Disconnect the J1 and J2 machine harness connectors from the Transmission/Chassis ECM.
- B. At machine harness connector J2 for the ECM, measure the resistance from contact J2-30 (wire F785-WH(White)) to frame ground. Measure the resistance to all of the contacts that are used in the J1 and J2 connectors for the ECM.
- C. At machine harness connector J2 for the ECM, measure the resistance from contact J2-31 (wire F783-GN(Green)) to frame ground. Measure the resistance to all of the contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The switch circuits are not shorted to another circuit in the machine harness. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is not correct. The machine harness has failed.

Repair: There is a short in the machine harness. The short is between the switch circuit and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the switch circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are fastened completely.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 0622 FMI 04 diagnostic code is active.

Expected Result:

The CID 0622 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 0622 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation

STOP.

- NOT OK – The CID 0622 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary shorts, intermittent shorts, or open connections in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

Perform this procedure again. If the cause of the failure is not found, contact your dealer Technical Communicator (TC) for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i05720749

MID 027 - CID 0623 - FMI 03

SMCS Code: 3171-038; 7332-038-Q9

Conditions Which Generate This Code:

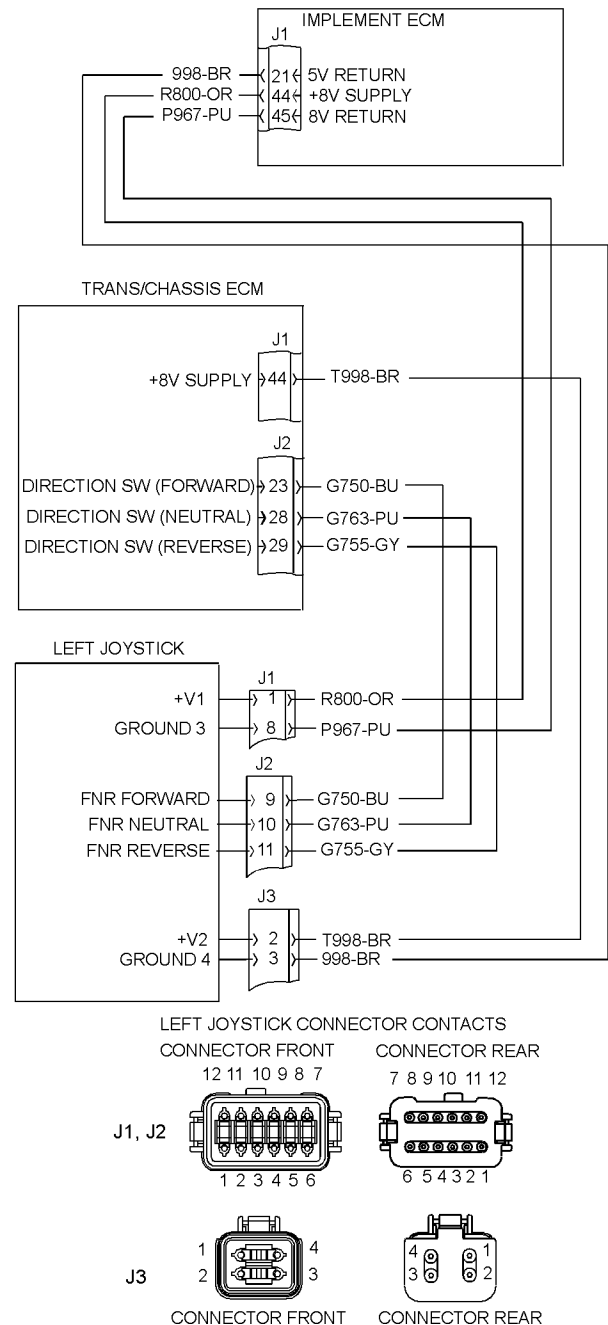


Illustration 192

g01301397

Directional Switch connections

Diagnostic Code Procedures

This diagnostic code is associated with the directional switch that is located on the left joystick handle. The switch supplies 3 switches to ground type of inputs to the Transmission/Chassis ECM. The ECM expects one of the three switch inputs to be grounded at all times. When the ECM detects that none of the switch inputs is grounded, the ECM will activate an FMI 03 diagnostic code for voltage above normal.

The directional switch is connected to ground at the Transmission/Chassis ECM 5 V sensor return (ECM ground) and the Implement ECM 5 V sensor return (ECM ground). The switch must lose both grounds in order to disrupt the switch operation. The illustration above indicates the ground connections and the input connections for the switch.

Possible conditions that can cause this diagnostic code are listed:

- One or more of the switch circuits are open in the machine harness.
- Both of the switch ground circuits are open in the machine harness.
- One or more of the switch inputs are shorted to a voltage source.
- The switch has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SWITCH CIRCUITS FOR AN OPEN

- A.** Turn the disconnect switch and the key start switch to the OFF position.
- B.** Disconnect the connector of the left joystick J2 from the connector of the machine harness.
- C.** At the connector of the joystick J2, connect a jumper wire between the forward contact J2-9 (wire G750-BU(Blue)) and the neutral contact J2-10 (wire G763-PU(Purple)).

- D.** Disconnect the connectors of the machine harness J1 and J2 from the Transmission/Chassis ECM.
- E.** At the ECM machine harness connector J2, measure the resistance between forward contact J2-23 (wire G750-BU(Blue)) and neutral contact J2-28 (wire G763-PU(Purple)).
- F.** At the connector of the joystick J2, leave one end of the jumper wire connected to the forward contact J2-9 (wire G750-BU(Blue)) and connect the other end of the jumper wire to the reverse contact J2-11 (wire G755-GY(Grey)).
- G.** At the ECM machine harness connector J2, measure the resistance between forward contact J2-23 (wire G750-BU(Blue)) and reverse contact J2-29 (wire G755-GY(Grey)).

Expected Result:

Both of the resistance measurements are less than 5 ohms.

Results:

- OK – Both of the resistance measurements are less than 5 ohms. The input circuits of the switch are not open in the machine harness. Proceed to Test Step 2.
- NOT OK – One or both of the resistance measurements is greater than 5 ohms. One or both of the switch circuits is open in the machine harness.

Repair: There is an open or a bad connection in at least one of the switch input circuits. Check each circuit individually in order to determine the circuits that have an open connection or a bad connection.

A resistance measurement that is more than 5 ohms but less than 5000 ohms could indicate that the circuit is not open but has a poor or corroded connection.

Refer to the complete Electrical System Schematic of the machine. Check the connectors in the switch circuits for a loose or a corroded connection. Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE GROUND CIRCUITS FOR AN OPEN

The disconnect switch and the key start switch remain in the OFF position. The connector of the left joystick J2 remains disconnected from the machine harness. The connectors of the Transmission/Chassis ECM remain disconnected from the machine harness.

- A. Disconnect the connectors of the left joystick J1 and J3 from the connector of the machine harness.
- B. Disconnect the machine harness connectors J1 from the Implement ECM.
- C. At the connectors of the joystick J1 and J3, connect a jumper wire between the ground 3 contact J1-3 (wire L731-BR(Brown)) and ground 4 contact J3-3 (wire 998-BR(Brown)).
- D. Obtain a spare length of wire that is long enough to reach from the Transmission/Chassis ECM to the cab of the machine. Connect one end of the spare wire to the Transmission/Chassis ECM return contact J1-21 (wire L731-BR(Brown)).
- E. At the machine harness connector of the Implement ECM J1, measure the resistance between return contact J1-21 (wire 998-BR(Brown)) and the end of the spare wire that is connected to return contact of the Transmission/Chassis ECM J1-21 (wire L731-BR(Brown)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The ground circuits are not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. One or both of the switch ground circuits is open or has a bad connection in the machine harness.

Repair: Verify that the connection of the spare wire at the connector of the Transmission/Chassis ECM is a good connection. Check the ground circuits again to verify that there is an open or bad connection present in the ground circuits.

If the resistance measurement is still greater than 5 ohms, there is an open or a bad connection in ground wire 998-BR(Brown) or wire L731-BR(Brown).

NOTE: Both of the ground circuits must be open in order to cause this diagnostic code to be active, however, if one of the ground circuits is faulty, the faulty circuit must be repaired before attempting this procedure.

Refer to the complete Electrical System Schematic of the machine. Check the connectors that are in the ground circuits for loose or corroded connections. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE HARNESS FOR A SHORT

The key start switch and the disconnect switch remain in the OFF position.

The harness connectors for the joystick and the harness connectors for the ECM remain disconnected.

- A. Connect the jumper wire that was used in the last test step between the harness connector of the joystick at the forward contact J2-9 (wire G750-BU(Blue)) and the neutral contact J2-10 (wire G763-PU(Purple)).
- B. At the machine harness connector of the Transmission/Chassis ECM J2, measure the resistance between contact J2-23 (wire G750-BU(Blue)) and all of the other contacts that are used in the J1 and J2 connectors for the ECM.
- C. At the connector of the joystick J2, leave one end of the jumper wire connected to the forward contact J2-9 (wire G750-BU(Blue)) and connect the other end of the jumper wire to the reverse contact J2-29 (wire G755-GY(Grey)).
- D. At the machine harness connector of the Transmission/Chassis ECM J2, measure the resistance between contact J2-29 (wire G755-GY(Grey)) to all of the other contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The input circuits of the switch are not shorted in the machine harness. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between one of the switch circuits and the circuit with the low resistance measurement.

Check each switch of the input circuit individually for a short in order to determine the circuit that is shorted to the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the switch circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SWITCH OPERATION

The connectors of the left joystick remain disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- A. At the connectors of the joystick, measure the resistance (continuity) between ground 3 contact J1-3 and the forward switch contact J2-9 when the switch is in the FORWARD, NEUTRAL, and REVERSE position.
- B. At the connectors of the joystick, measure the resistance (continuity) between ground 3 contact J1-3 and the neutral switch contact J2-10 when the switch is in the FORWARD, NEUTRAL, and REVERSE position.
- C. At the connectors of the joystick, measure the resistance (continuity) between ground 3 contact J1-3 and the reverse switch contact J2-11 when the switch is in the FORWARD, NEUTRAL, and REVERSE position.

Expected Result:

When the switch is in the FORWARD position, the results of the measurement are listed below:

J1-3 (ground) to forward contact J2-9 - Continuity (Closed)

J1-3 (ground) to neutral contact J2-10 - No continuity (Open)

J1-3 (ground) to reverse contact J2-11 - No continuity (Open)

When the switch is in the NEUTRAL position, the results of the measurement are as listed below:

J1-3 (ground) to forward contact J2-9 - No continuity (Open)

J1-3 (ground) to neutral contact J2-10 - Continuity (Closed)

J1-3 (ground) to reverse contact J2-11 - No continuity (Open)

When the switch is in the REVERSE position, the measurement results are as listed:

J1-3 (ground) to forward contact J2-9 - No continuity (Open)

J1-3 (ground) to neutral contact J2-10 - No continuity (Open)

J1-3 (ground) to reverse contact J2-11 - Continuity (Closed)

Results:

- OK – The continuity checks between ground contact J1-3 to the contacts of the switch are correct in all switch positions. The switch is operating correctly. Proceed to Test Step 5.
- NOT OK – The continuity checks between the ground contact J1-3 to the contacts of the switch are not correct. The switch is not working correctly.

Repair: The directional switch is not correct. Replace the left-hand joystick push-button faceplate.

Refer to Special Instruction, REHS7448, "Procedure To Remove And Replace The Left-Hand Joystick Push-Button Faceplate On M Series And M Series 2 Motor Graders".

Verify that the operation of the joystick is correct before operating the machine.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the contacts and clean the contacts of any harness connectors that are disconnected.
- B. Reconnect all harness connectors.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Operate the machine.
- E. Determine if the CID 0623 FMI 03 diagnostic code is not active.

Expected Result:

The CID 0623 FMI 03 diagnostic code is active.

Results:

- OK – The CID 0623 FMI 03 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0623 FMI 03 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact the Technical Communicator (TC) of your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i05720750

MID 027 - CID 0623 - FMI 04

SMCS Code: 3171-038; 7332-038-Q9

Conditions Which Generate This Code:

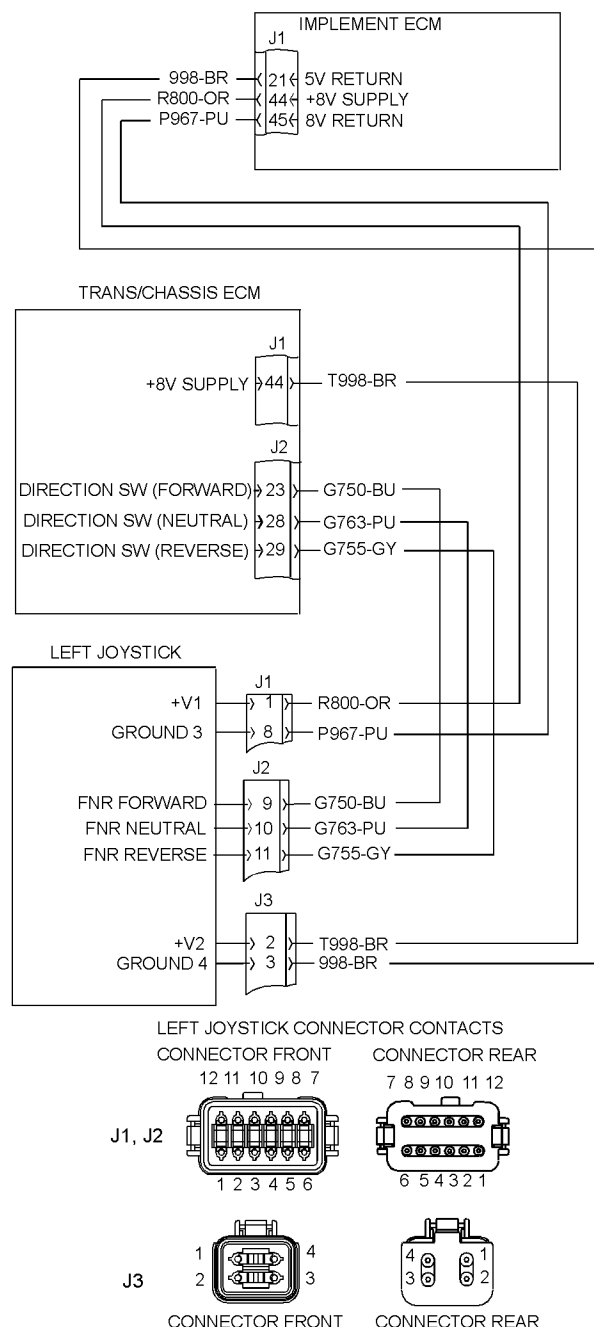


Illustration 193

g01301397

Directional Switch connections

This diagnostic code is associated with the directional switch that is located on the left joystick handle. The switch supplies 3 switches to ground types of inputs to the Transmission/Chassis ECM. The ECM expects one of the three switch inputs to be grounded at all times. When the ECM detects that more than one of the inputs to the switch is grounded at the same time, the ECM will activate an FMI 04 diagnostic code for "voltage below normal".

The directional switch is connected to ground at the Transmission/Chassis ECM 5 V sensor return (ECM ground) and the Implement ECM 5 V sensor return (ECM ground). The switch must lose both grounds in order to disrupt the switch operation. The illustration above indicates the power and ground connections for the switch.

Possible conditions that can cause this diagnostic code are listed:

- One or more of the switch inputs is shorted to a ground source.
- The switch has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SWITCH

- A. Turn the disconnect switch and the key start switch to the ON position.
- B. Ensure that the diagnostic code is active.
- C. Observe the status of the diagnostic code after disconnecting the connector of the left joystick J2 from the machine harness.

Expected Result:

If CID 0622 FMI 03 becomes active, the machine harness and the ECM are most likely OK.

If no CID 622 codes are active, the harness is most likely grounded in one circuit.

If CID 0622 FMI 04 remains active, both circuits likely have a short to ground.

Results:

- OK – The CID 0623 FMI 04 diagnostic code remains active. The switch has not failed, however both circuits in the harness likely have a short to ground. Proceed to Test Step 3.
- OK – No CID 622 codes are active. The switch has not failed, however the harness is likely grounded in one circuit. Proceed to Test Step 3.
- NOT OK – The CID 0622 FMI 04 diagnostic code is NO longer active. A CID 0622 FMI 03 diagnostic code becomes active when the J2 connector is disconnected. The machine harness and the ECM are operating correctly. The switch may have failed. Verify that the switch is not operating correctly. Proceed to Test Step 2.

Test Step 2. CHECK THE SWITCH OPERATION

The connector of the left joystick J2 remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- A. Disconnect the joystick J1 connector from the machine harness.
- B. At the connectors of the joystick, measure the resistance (continuity) between ground 3 contact J1-3 and the forward switch contact J2-9 when the switch is in the FORWARD, NEUTRAL, and REVERSE position.
- C. At the connectors of the joystick, measure the resistance (continuity) between ground 3 contact J1-3 and the neutral switch contact J2-10 when the switch is in the FORWARD, NEUTRAL, and REVERSE position.
- D. At the connectors of the joystick, measure the resistance (continuity) between ground 3 contact J1-3 and the reverse switch contact J2-11 when the switch is in the FORWARD, NEUTRAL, and REVERSE position.

Expected Result:

When the switch is in the FORWARD position, the measurement results are as follows:

J1-3 (ground) to forward contact J2-9 - Continuity (Closed)

J1-3 (ground) to neutral contact J2-10 - No continuity (Open)

J1-3 (ground) to reverse contact J2-11 - No continuity (Open)

When the switch is in the NEUTRAL position, the measurement results are as follows:

J1-3 (ground) to forward contact J2-9 - No continuity (Open)

J1-3 (ground) to neutral contact J2-10 - Continuity (Closed)

J1-3 (ground) to reverse contact J2-11 - No continuity (Open)

When the switch is in the REVERSE position, the measurement results are as follows:

J1-3 (ground) to forward contact J2-9 - No continuity (Open)

J1-3 (ground) to neutral contact J2-10 - No continuity (Open)

J1-3 (ground) to reverse contact J2-11 - Continuity (Closed)

Results:

- OK – The continuity checks between ground contact J1-3 to the contacts of the switch are correct in all switch positions. The switch is operating correctly. Proceed to Test Step 3.
- NOT OK – The continuity checks between the ground contact J1-3 to the contacts of the switch are not correct. The switch is not working correctly.

Repair: The directional switch is not correct. Replace the left-hand joystick push-button faceplate.

Refer to Special Instruction, REHS7448, "Procedure To Remove And Replace The Left-Hand Joystick Push-Button Faceplate On M Series And M Series 2 Motor Graders".

Verify that the operation of the joystick is correct before operating the machine.

STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT FOR A SHORT TO GROUND

The connectors of the left joystick J1 and J2 remain disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- Disconnect the J1 and J2 machine harness connectors from the Transmission/Chassis ECM.
- At machine harness connector J2 for the ECM, measure the resistance from contact J2-23 (wire G750-BU(Blue)) to frame ground. Measure the resistance to all of the contacts that are used in the J1 and J2 connectors for the ECM.

C. At machine harness connector J2 for the ECM, measure the resistance from contact J2-28 (wire G763-PU(Purple)) to frame ground. Measure the resistance to all of the contacts that are used in the J1 and J2 connectors for the ECM.

D. At machine harness connector J2 for the ECM, measure the resistance from contact J2-29 (wire G755-GY(Grey)) to frame ground. Measure the resistance to all of the contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The switch circuits are not shorted to another circuit in the machine harness. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is NOT correct. The machine harness has failed.

Repair: There is a short in the machine harness. The short is between the switch circuit and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the switch circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.

- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 0623 FMI 04 diagnostic code is active.

Expected Result:

The CID 0623 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 0623 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0623 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a “wiggle” test on the machine wiring harness. The “wiggle” test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact the Technical Communicator (TC) of your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i06832273

MID 027 - CID 0627 - FMI 03

SMCS Code: 1435-038-BRK

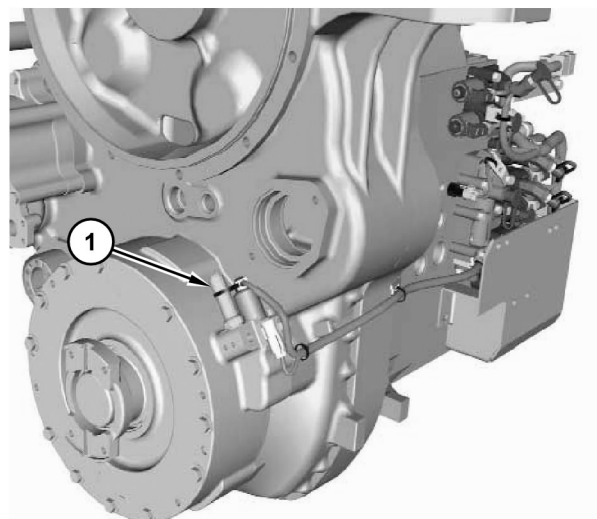
Conditions Which Generate This Code:

Illustration 194

g01323394

Park Brake Pressure Switch located on the park brake housing on the engine side of the transmission

(1) Park Brake Pressure Switch

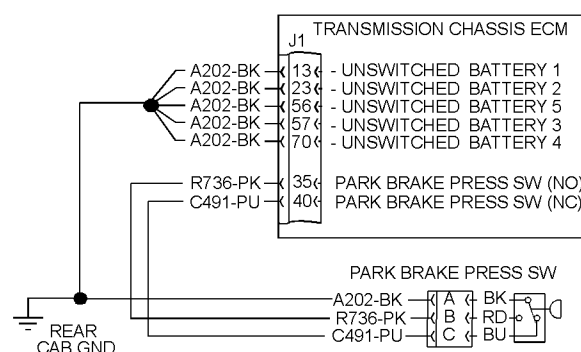


Illustration 195

g01375676

Park Brake Pressure Switch connections

This diagnostic code is associated with the park brake pressure switch. The switch supplies two inputs to the Transmission/Chassis ECM. The switch allows the ECM to detect whether the parking brake is applied or is not applied.

The ECM expects the two switch inputs to be connected through the switch contacts when the park brake is applied. The ECM expects the normally open (N/O) contact to be grounded when the park brake is not applied. When the ECM detects that the switch inputs are not connected and the N/O contact is not grounded, the ECM will activate an FMI 03 diagnostic code for voltage above normal.

Possible conditions that can cause this diagnostic code are listed:

- One or both of the switch circuits is open in the machine harness.
- The ground circuit is open in the machine harness.
- The switch has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Table 26

Contact States of the Park Brake Pressure Switch		
Park Brake Status	N/O Input J1-35 (wire R736-PK(Pink))	N/C Input J1-40 (wire C491-PU(Purple))
Applied	Connected to J1-40	Connected to J1-35
Not Applied	Grounded ⁽¹⁾	Open

⁽¹⁾ Connected to frame ground - switch contact B (wire A202-BK(Black)).

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE INPUT CIRCUITS OF THE SWITCH FOR AN OPEN

- Turn the disconnect switch and the key START switch to the OFF position.
- Disconnect the machine harness connector from the switch.

- At the machine harness connector for the switch, connect a jumper wire between the normally open (N/O) contact B (wire R736-PK(Pink)) and the normally closed (N/C) contact C (wire C491-PU(Purple)).
- Disconnect the machine harness connector J1 from the Transmission/Chassis ECM.
- At the Transmission/Chassis ECM machine harness connector J1, measure the resistance between N/C contact J1-40 (wire C491-PU(Purple)) and N/O contact J1-35 (wire R736-PK(Pink)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The input circuits of the switch are not open in the machine harness. Proceed to Test Step 2.
- NOT OK – The resistance measurement is greater than 5 ohms. One of the input circuits of the switch is an open connection or a poor connection in the machine harness.

Repair: There is an open or a poor connection in input wire of the switch C491-PU(Purple) or switch input wire R736-PK(Pink). Check each input circuit of the switch in order to determine the circuit that has the problem.

Refer to the complete Electrical System Schematic of the machine. Verify that all connection points in the suspected part of the circuits are clean, secure and in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE SWITCH GROUND CIRCUIT FOR AN OPEN

The disconnect switch and the key start switch remain in the OFF position. The machine harness connector J1 remains disconnected from the Transmission/Chassis ECM and the machine harness connector for the switch remains disconnected.

- At the machine harness connector for the switch, connect the jumper wire that was used in the last test step between the common ground contact A (wire A202-BK(Black)) and the normally closed (N/O) contact B (wire R736-PK(Pink)).

- B.** At the machine harness connector of the Transmission/Chassis ECM J1, measure the resistance between ground contact J1-13 (wire A202-BK(Black)) and N/O contact J1-35 (wire R736-PK(Pink)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The ground circuit is not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. The ground circuit is an open connection or a poor connection in the machine harness.

Repair: There is an open or a poor connection in switch ground wire A202-BK(Black). Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the ground circuit. Verify that all connection points for the circuit are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SWITCH OPERATION

The switch remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- A.** At the connector for the switch, measure the resistance (continuity) between N/O contact B and the switch N/C contact C when the park brake is applied and when the park brake is not applied.
- B.** At the connector for the switch, measure the resistance (continuity) between the common ground contact A and the switch N/O contact B when the park brake is applied and when the park brake is not applied.
- C.** At the connector for the switch, measure the resistance (continuity) between the common ground contact A and the switch N/C contact C when the park brake is applied and when the park brake is not applied.

Expected Result:

The continuity checks of the switch are correct according to the table at the beginning of this procedure.

Results:

- OK – The continuity checks between the switch contacts are correct according to the table at the beginning of this procedure. The switch is operating correctly. Proceed to Test Step 4.
- NOT OK – The continuity checks between the switch contacts are not correct. The switch is not working correctly.

Repair: The pressure switch of the park brake has failed. Replace the switch. After replacement of the switch, verify that the operation of the new switch is correct before operating the machine.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Determine if the CID 0627 FMI 03 diagnostic code is active.

Expected Result:

The CID 0627 FMI 03 diagnostic code is active.

Results:

- YES – The CID 0627 FMI 03 diagnostic code is active. The problem has not been corrected.

Repair: Repeat this procedure. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the switch circuits in the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0627 FMI 03 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02917723

MID 027 - CID 0627 - FMI 04

SMCS Code: 1435-038-BRK

Conditions Which Generate This Code:

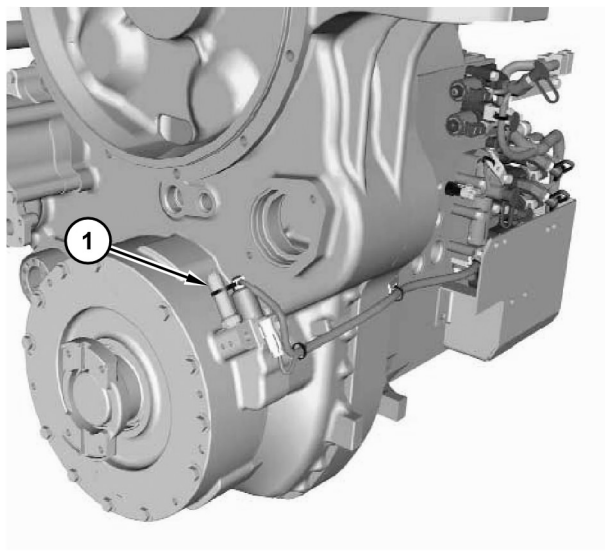


Illustration 196
g01323394
Park Brake Pressure Switch located on the park brake housing on the engine side of the transmission
(1) Park Brake Pressure Switch

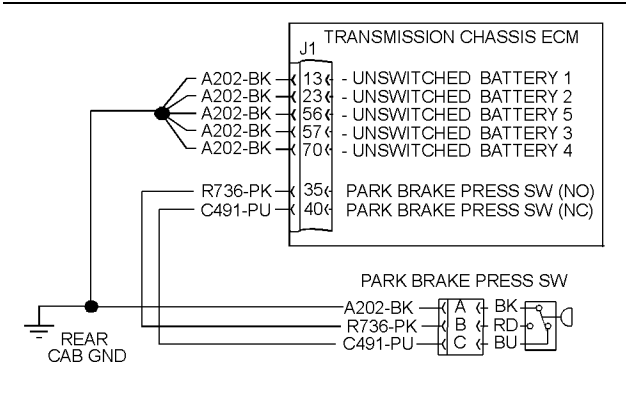


Illustration 197
g01375676
Connectors of the Park Brake Pressure Switch

This diagnostic code is associated with the pressure switch of the park brake. The switch supplies two inputs to the Transmission/Chassis ECM. The switch allows the ECM to detect if the parking brake is applied or if the parking brake is not applied.

The ECM expects the two switch inputs to be connected through the switch contacts when the park brake is applied. The ECM expects the normally open (N/O) contact to be grounded when the park brake is not applied. When the ECM detects that the both of the switch input circuits are grounded, the ECM will activate an FMI 04 diagnostic code for voltage below normal.

Possible conditions that can cause this diagnostic code are listed:

- One or both of the switch inputs is shorted to a ground source.
- The switch has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Table 27

Contact States of the Park Brake Pressure Switch		
Park Brake Status	N/O Input J1-35 (wire R736-PK(Pink))	N/C Input J1-40 (wire C491-PU(Purple))

(continued)

Diagnostic Code Procedures

(Table 27, contd)

Applied	Connected to J1-40	Connected to J1-35
Not Applied	Grounded ⁽¹⁾	Open

⁽¹⁾ Connected to frame ground - switch contact B (wire A202-BK(Black)).

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SWITCH

- A. Turn the disconnect switch and the key start switch to the ON position.
- B. Ensure that the diagnostic code is active.
- C. Observe the status of the diagnostic code and disconnect the connector of the pressure switch from the machine harness.

Expected Result:

The CID 0627 FMI 04 diagnostic code will remain active if the switch is not the cause of the diagnostic code. The switch is the cause of the diagnostic code if the CID 0627 FMI 04 diagnostic code is NO longer active and a CID 0627 FMI 03 diagnostic code becomes active.

Results:

- OK – The CID 0627 FMI 04 diagnostic code remains active. The pressure switch has not failed. Proceed to Test Step 2.
- NOT OK – The CID 0627 FMI 04 diagnostic code is NO longer active. A CID 0627 FMI 03 diagnostic code becomes active when the connector of the switch is disconnected. The machine harness and the Transmission/Chassis ECM are operating correctly. The pressure switch has failed.

Repair: Replace the pressure switch of the park brake. After replacement of the switch, verify that the operation of the new switch is correct before operating the machine.

STOP.

Test Step 2. CHECK THE HARNESS FOR A SHORT

The switch remains disconnected from the machine harness.

- A. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.

B. At the ECM machine harness connector J1, measure the resistance between contact J1-35 (wire R736-PK(Pink)) and frame ground. Measure the resistance between contact J1-35 (wire R736-PK(Pink)) to all of the other contacts that are used in the J1 and J2 connectors for the ECM.

C. At the connector of the machine harness of the ECM J1, measure the resistance between contact J1-40 (wire C491-PU(Purple)) and frame ground. Measure the resistance between contact J1-40 (wire C491-PU(Purple)) to all of the other contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The input circuits of the switch are not shorted in the machine harness. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms.

Repair: A input circuit of the switch is shorted to the frame or to the circuit with the low resistance measurement. Refer to the complete Electrical System Schematic of the machine. Check the connectors that are in the involved circuits. Verify that all connection points for the circuit are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the switch circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.

F. Determine if the CID 0627 FMI 04 diagnostic code is active.

i04664733

Expected Result:

The CID 0627 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 0627 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0627 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

MID 027 - CID 0669 - FMI 02

SMCS Code: 3175-038-IV

Conditions Which Generate This Code:

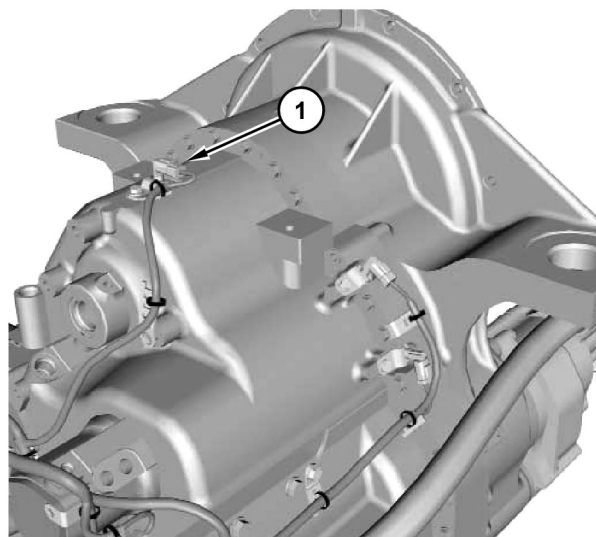


Illustration 198

g01323388

Transmission Input Speed Sensor located on the top of the transmission

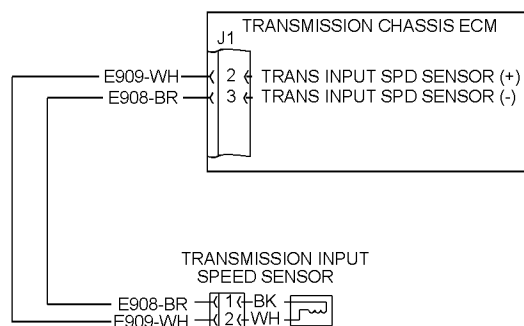


Illustration 199

g01321396

Connections of the Transmission Input Speed Sensor

This diagnostic code is associated with the transmission input speed sensor. The transmission input speed sensor is located on the top of the transmission.

The ECM monitors the signals from the input speed sensor of the transmission. The ECM compares the signal to other machine conditions such as the selected gear or the sensor signals for the output speed. When the ECM determines that the sensor signal for the input speed is not within the accepted limits, the ECM will activate the FMI 02 diagnostic code.

The following conditions could cause the ECM to activate this diagnostic code:

- The speed sensor has failed.
- There is an intermittent short or an open connection in the speed sensor circuit.
- The speed sensor is not mounted securely.
- Failure of the ECM is unlikely.

Note: Before performing this procedure, verify that the speed sensor is mounted securely. A loose mount could cause this diagnostic code to be activated. Ensure that this diagnostic code is active before performing this procedure.

Test Step 1. CHECK THE SENSOR

- A.** Turn the key start switch and the disconnect switch to the OFF position.
- B.** Disconnect the machine harness from the speed sensor.
- C.** At the connector for the speed sensor, measure the resistance from contact 2 to contact 1.

Expected Result:

The correct range of resistance for the sensor is approximately 75 ohms at -40° C (-40° F) to 230 ohms at 120° C (248° F). The resistance will be approximately 140 ohms at 25° C (77° F).

Results:

- YES – The resistance of the speed sensor is within the correct resistance range. The sensor is correct. Proceed to Test Step 2.
- NO – The resistance of the speed sensor is not within the correct resistance range. The speed sensor has failed.

Repair: Replace the speed sensor for the transmission input. Verify that the new sensor corrects the problem before operating the machine.

STOP.

Test Step 2. CHECK THE SENSOR CIRCUIT FOR AN OPEN

The disconnect switch and the key start switch remain in the OFF position. The machine harness connector remains disconnected from the sensor.

- A.** At the machine harness connector for the sensor, connect a jumper wire between contact 1 (wire E908-BR(Brown)) and contact 2 (wire E909-WH(White)).
- B.** Disconnect the machine harness connectors J1 from the ECM.
- C.** At the machine harness connector J1 for the ECM, measure the resistance between contact J1-2 (wire E909-WH(White)) and contact J1-3 (wire E908-BR(Brown)).
- D.** Observe the resistance measurement and wiggle the ECM connector. Gently pull on the wires and wiggle the wires.
- E.** Observe the resistance measurement and wiggle the speed sensor connector. Gently pull on the wires and wiggle the wires. Do not disconnect the jumper wire.

Expected Result:

The resistance measurement is less than 5 ohms, all times, during the manipulation of the wires and the connectors.

Results:

- YES – The resistance measurement is less than 5 ohms. The speed sensor circuit is not open in the machine harness. Proceed to Test Step 3.
- NO – The resistance measurement is greater than 5 ohms for all of the time or for part of the time that the resistance is being measured. There is an open connection or a bad connection in one of the wires in the speed sensor circuit. Check each wire individually in order to determine whether the problem is in the signal circuit or the ground circuit.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is not connected or that a wire is open. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points or a splice in the circuit is not an open connection but not a good connection.

A resistance measurement that is greater than 5 ohms at some time during the manipulation of the machine harness indicates that there is an intermittent open or a loose connection in the machine harness.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the circuit. Ensure that all of the contacts for the circuit are in good condition, that all connectors are clean, and that all connectors are securely fastened in each of the harness connectors. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT FOR A SHORT

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors remain disconnected from the sensor and the ECM.

- A. Disconnect the jumper wire that was used in the last test step.
- B. Disconnect the machine harness connector J2 from the ECM.
- C. At the machine harness connector J1 for the ECM, measure the resistance between contact J1-2 (wire E909-WH(White)) and frame ground. Measure the resistance between contact J1-2 (wire E909-WH(White)) and all of the other contacts that are used in the J1 and J2 connectors for the ECM.
- D. Observe the resistance measurements and wiggle the ECM connectors and the speed sensor connector. Gently pull on the wires and wiggle the wires.
- E. At the machine harness connector J1 for the ECM, measure the resistance between contact J1-3 (wire E908-BR(Brown)) and frame ground. Measure the resistance between contact J1-3 (wire E908-BR(Brown)) and all of the other contacts that are used in the J1 and J2 connectors for the ECM.
- F. Observe the resistance measurements and wiggle the ECM connectors and the speed sensor connector. Gently pull on the wires and wiggle the wires.

Expected Result:

Each resistance measurement is greater than 5000 ohms at all times during the manipulation of the machine harness.

Results:

- YES – Each resistance measurement is greater than 5000 ohms. The measurements do not indicate a short circuit. Proceed to Test Step 4.

- NO – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness.

Repair: The short is between the circuit for the speed sensor that was being checked and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the faulty speed sensor circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 0669 FMI 02 diagnostic code is active.

Expected Result:

The CID 0669 FMI 02 diagnostic code is active.

Results:

- YES – The CID 0669 FMI 02 diagnostic code is active. The problem has not been corrected.

Repair: Check the relay circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0669 FMI 02 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i03740022

MID 027 - CID 0673 - FMI 02

SMCS Code: 3175-038-OJ

Conditions Which Generate This Code:

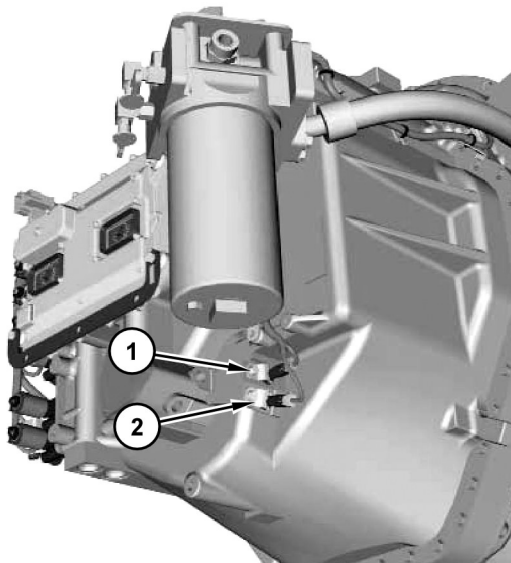


Illustration 200

g01323251

Speed sensors for transmission output are located on the right side rear of the transmission.

- (1) Transmission output speed sensor 2
(2) Transmission output speed sensor 1

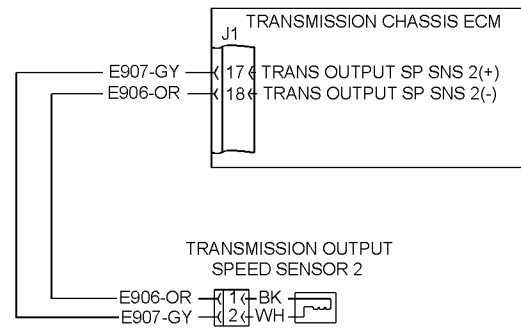


Illustration 201

g02019556

Connections of the transmission output speed sensor 2

This diagnostic code is associated with the transmission output speed sensor 2. The transmission output speed sensor 2 is located toward the rear of the transmission on the right hand side.

The ECM monitors the signals from the transmission output speed sensor 2 and the transmission output speed sensor 1. The ECM will activate the FMI 02 diagnostic code when both of the following conditions occur:

- The signal for speed sensor 2 is not within the accepted limits.
- The signal for speed sensor 1 is within the accepted limits.

The following conditions could cause the ECM to activate this diagnostic code:

- The speed sensor has failed.
- There is an intermittent short or an open connection in the speed sensor circuit.
- The speed sensor is not mounted securely.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, verify that the speed sensor is mounted securely. A loose mount could cause this diagnostic code to be activated. Ensure that this diagnostic code is active before performing this procedure.

Test Step 1. CHECK THE SENSOR

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness from the speed sensor.
- At the connector for the speed sensor, measure the resistance from contact 2 to contact 1.

Expected Result:

The correct range of resistance for the sensor is approximately 75 ohms at -40°C (-40°F) to 230 ohms at 120°C (248°F). The resistance will be approximately 140 ohms at 25°C (77°F).

Results:

- YES – The resistance of the speed sensor is within the correct resistance range. The sensor is correct. Proceed to Test Step 2.
- NO – The resistance of the speed sensor is not within the correct resistance range. The speed sensor may have failed.

Repair: In order to verify that the speed sensor has failed, switch the sensor connections and check the codes. Perform the following steps in order to perform this verification:

- A. Mark the harness connector for the transmission output speed sensor 2.
 - B. Connect the harness connector of the transmission output speed sensor 2 to the transmission output speed sensor 1.
 - C. Connect the harness connector of the transmission output speed sensor 1 to the transmission output speed sensor 2.
 - D. Turn the disconnect switch to the ON position.
 - E. Turn the key start switch to the ON position.
- If the transmission output speed sensor 2 has failed, both of the following will occur:
- The CID 0673 FMI 02 diagnostic code will no longer be active.
 - A CID 0585 FMI 02 diagnostic code for the transmission output speed sensor 1 will become active.

If diagnostic code CID 0673 FMI 02 is active and diagnostic code CID 0585 FMI 02 is not active, the sensor is operating properly. Perform the following actions:

- A. Reconnect the machine harness connectors to the correct transmission output speed sensor.
- B. Proceed to the next test step.

If diagnostic code CID 0673 FMI 02 is not active and diagnostic code CID 0585 FMI 02 is active, perform the following actions:

- A. Replace the transmission output speed sensor 2.

- B. Reconnect the machine harness connectors to the correct transmission output speed sensor.
- C. Verify that the new sensor corrects the problem before operating the machine.

STOP.

Test Step 2. CHECK THE SENSOR CIRCUIT FOR AN OPEN

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. Disconnect the machine harness connector from the sensor.
- C. Disconnect the machine harness connectors "J1" from the ECM.
- D. At the machine harness connector for the sensor, connect a jumper wire between contact 1 (wire E906-OR(Orange)) and contact 2 (wire E907-GY(Grey)).
- E. At the machine harness connector "J1" for the ECM, measure the resistance between contact "J1-17" (wire E907-GY(Grey)) and contact "J1-18" (wire E906-OR(Orange)).
- F. Observe the resistance measurement and wiggle the ECM connector. Gently pull on the wires and wiggle the wires.
- G. Observe the resistance measurement and wiggle the speed sensor connector. Gently pull on the wires and wiggle the wires. Do not disconnect the jumper wire.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the wires and connectors.

Results:

- YES – The resistance measurement is less than 5 ohms. The speed sensor circuit is not open in the machine harness. Proceed to Test Step 3.
- NO – The resistance is intermittently greater than 5 ohms or the resistance is continually greater than 5 ohms. One of the wires for the speed sensor has an open or there is a bad connection in the speed sensor wiring. Check each wire individually in order to determine whether the problem is in the signal circuit or the ground circuit.

Repair: A resistance that is greater than 5000 ohms could indicate one of the following conditions:

- A wire is not connected.
- A wire is an open.

A resistance measurement that is greater than 5 ohms, but less than 5000 ohms could indicate the following condition:

- One of the connection points or a splice in the circuit is not a completely open connection, but the connection is not good.

A resistance measurement that is greater than 5 ohms at some time during the manipulation of the machine harness could indicate one of the following conditions:

- There is an intermittent open in the machine harness.
- There is a loose connection in the machine harness.

Refer to the Electrical Schematic of the machine. Check all of the connectors that are in the circuit. Ensure that all of the contacts for the circuit are in good condition, that all of the contacts are clean, and that all of the contacts are securely fastened in each of the harness connectors. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT FOR A SHORT

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors remain disconnected from the sensor and the ECM.

- Disconnect the jumper wire that was used in the last test step.
- Disconnect the machine harness connectors "J2" from the ECM.
- At the machine harness connector "J1" for the ECM, measure the resistance between contact "J1-17" (wire E907-GY(Grey)) and frame ground. Measure the resistance between contact "J1-17" (wire E907-GY(Grey)) and all of the other contacts that are used in the "J1" and "J2" connectors for the ECM.
- Observe the resistance measurements and wiggle the ECM connectors and the speed sensor connector. Gently pull on the wires and wiggle the wires.

- At the machine harness connector "J1" for the ECM, measure the resistance between contact "J1-18" (wire E906-OR(Orange)) and frame ground. Measure the resistance between contact "J1-18" (wire E906-OR(Orange)) and all of the other contacts that are used in the "J1" and "J2" connectors for the ECM.

- Observe the resistance measurements and wiggle the ECM connectors and the speed sensor connector. Gently pull on the wires and wiggle the wires.

Expected Result:

Each resistance measurement is greater than 5000 ohms at all times during the manipulation of the machine harness.

Results:

- YES – Each resistance measurement is greater than 5000 ohms. The measurements do not indicate a short circuit. Proceed to Test Step 4.
- NO – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness.

Repair: The short is between the circuit of the speed sensor that was being checked and the circuit with the low resistance measurement.

Refer to the Electrical Schematic of the machine. Check all of the connectors that are in the faulty speed sensor circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition.

For information on testing for short circuits and finding short circuits, refer to the Testing and Adjusting, "Wiring Harness (Short Circuit) - Test" Story in this manual. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.

- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 0673 FMI 02 diagnostic code is active.

Expected Result:

The CID 0673 FMI 02 diagnostic code is active.

Results:

- YES – The CID 0673 FMI 02 diagnostic code is active. The problem has not been corrected.

Repair: Check the relay circuit again. Use the Caterpillar Electronic Technician (Cat ET) service tool in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact the technical communicator at your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to the Testing and Adjusting, "Electronic Control Module (ECM) - Replace" Story in this manual.

STOP.

- NO – The CID 0673 FMI 02 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i07088478

MID 027 - CID 0674 - FMI 02

SMCS Code: 3175-038-IMD

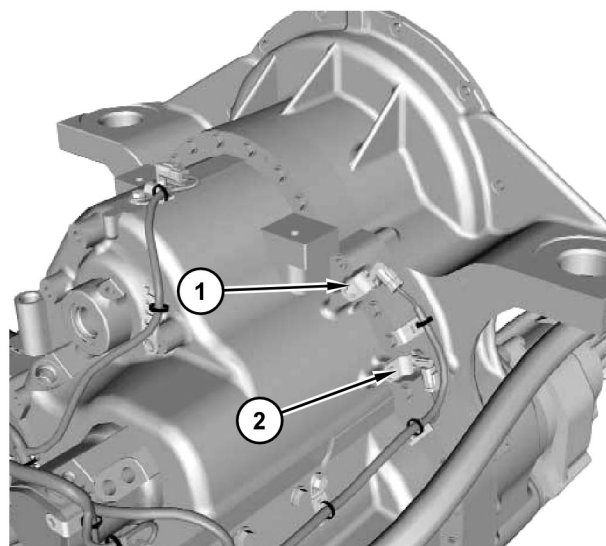
Conditions Which Generate This Code:

Illustration 202

g01323376

Transmission Intermediate Speed Sensors are on the right-hand side of the transmission.

- (1) Transmission Intermediate Speed Sensor 2
- (2) Transmission Intermediate Speed Sensor 1

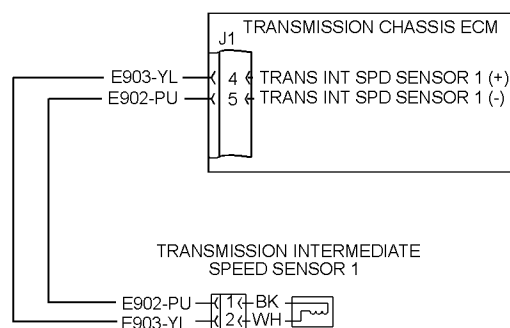


Illustration 203

g01321514

Connections of the Transmission Intermediate Speed Sensor 1

This diagnostic code is associated with the transmission intermediate speed sensor 1. The transmission intermediate speed sensor 1 is on the right-hand side of the transmission.

Diagnostic Code Procedures

The ECM monitors the signals from the transmission intermediate speed sensor 1 and the transmission intermediate speed sensor 2. When the ECM detects that the signal of speed sensor 1 is not within the accepted limits and the signal of speed sensor 2 is within the accepted limits, the ECM will activate the FMI 02 diagnostic code.

The following conditions could cause the ECM to activate this diagnostic code:

- The speed sensor has failed.
- There is an intermittent short or an open in the speed sensor circuit.
- The speed sensor is not mounted securely.
- Failure of the ECM is unlikely.

Note: Before performing this procedure, verify that the speed sensor is mounted securely. A loose mount could cause this diagnostic code to be activated. Ensure that this diagnostic code is active before performing this procedure.

Test Step 1. CHECK THE SENSOR

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness from the speed sensor.
- C. At the connector for the speed sensor, measure the resistance from contact 2 to contact 1.

Expected Result:

The correct range of resistance for the sensor is approximately 600 ohms at -40° C (-40° F) to 1800 ohms at 120° C (248° F). The resistance will be approximately 1055 ohms at 25° C (77° F).

Results:

- YES – The resistance of the speed sensor is within the correct resistance range. The sensor is correct. Proceed to Test Step 2.
- NO – The resistance of the speed sensor is not within the correct resistance range. The speed sensor has failed.

Repair: Verify that the speed sensor is causing the problem. Mark the harness connector for the transmission intermediate speed sensor 1. Connect the marked machine harness connector for transmission intermediate speed sensor 1 to the transmission intermediate speed sensor 2. Connect the machine harness connector for transmission intermediate speed

sensor 2 to the transmission intermediate speed sensor 1. Turn the disconnect switch and the key start switch to the ON position.

If the transmission intermediate speed sensor 1 has failed, the CID 0674 FMI 02 diagnostic code will no longer be active. A CID 0675 FMI 02 diagnostic code for the transmission intermediate speed sensor 2 will become active.

Replace the transmission intermediate speed sensor 1. Verify that the new sensor corrects the problem before operating the machine.

STOP.

Test Step 2. SWITCH THE SENSORS

The key start switch and the disconnect switch remain in the OFF position. The transmission intermediate speed sensor 1 remains disconnected from the machine harness.

- A. Mark the harness connector of the transmission intermediate speed sensor 1 to track the connector that is used for each sensor.
- B. Disconnect the transmission intermediate speed sensor 2 from the machine harness.
- C. Switch the speed sensor harness connectors. Connect the marked machine harness connector for transmission intermediate speed sensor 1 to the transmission intermediate speed sensor 2. Connect the machine harness connector for transmission intermediate speed sensor 2 to the transmission intermediate speed sensor 1.
- D. Turn the key start switch and the disconnect switch to the ON position.
- E. Observe the status of the active diagnostic code.

Expected Result:

The CID 0674 FMI 02 diagnostic code is no longer active. A CID 0675 FMI 02 diagnostic code for the transmission intermediate speed sensor 2 is active after the switch.

Results:

- YES – The CID 0674 FMI 02 diagnostic code is no longer active after the sensors are switched. A CID 0675 FMI 02 diagnostic code for the transmission intermediate speed sensor 2 is now active.

Repair: The transmission intermediate speed sensor 1 has failed. Replace the speed sensor. Verify that the new speed sensor corrects the problem before operating the machine.

STOP.

- NO – The CID 0674 FMI 02 diagnostic code is still active. Switching the speed sensors did not affect the status of the CID 0674 FMI 02 diagnostic code. The sensor is not causing the problem. Reconnect the machine harness connectors to the correct transmission intermediate speed sensor before proceeding to the next test step. Proceed to Test Step 3.

Test Step 3. CHECK THE SENSOR CIRCUIT FOR AN OPEN

- Turn the disconnect switch and the key start switch to the OFF position.
- Disconnect the machine harness connector from the sensor.
- Disconnect the machine harness connectors J1 from the ECM.
- At the machine harness connector for the sensor, connect a jumper wire between contact 1 (wire E902-PU(Purple)) and contact 2 (wire E903-YL(Yellow)).
- At the machine harness connector J1 for the ECM, measure the resistance between contact J1-4 (wire E903-YL(Yellow)) and contact J1-5 (wire E902-PU(Purple)).
- Observe the resistance measurement and wiggle the ECM connector. Gently pull on the wires and wiggle the wires.
- Observe the resistance measurement and wiggle the speed sensor connector. Gently pull on the wires and wiggle the wires. Do not disconnect the jumper wire.

Expected Result:

The resistance measurement is less than 5 ohms all times during the manipulation of the wires and the connectors.

Results:

- YES – The resistance measurement is less than 5 ohms. The speed sensor circuit is not open in the machine harness. Proceed to Test Step 4.
- NO – The resistance measurement is greater than 5 ohms for all the time or for part of the time that the resistance is being measured. There is an open connection or a bad connection in the one of the wires of the circuit for the speed sensor. Check each wire individually to determine whether the problem is in the signal circuit or the ground circuit.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is either not connected or that a wire is

open. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points or a splice in the circuit is not an open connection but not a good connection.

A resistance measurement that is greater than 5 ohms at some time during the manipulation of the machine harness indicates that there is an intermittent open or a loose connection in the machine harness.

Refer to the complete Electrical System Schematic of the machine. Check all the connectors that are in the circuit. Ensure that all the contacts for the circuit are in good condition, that all the contacts are clean, and that all the contacts are securely fastened in each of the harness connectors. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SIGNAL CIRCUIT FOR A SHORT

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors remain disconnected from the sensor and the ECM.

- Disconnect the jumper wire that was used in the last test step.
- Disconnect the machine harness connectors J2 from the ECM.
- At the machine harness connector J1 for the ECM, measure the resistance between contact J1-4 (wire E903-YL(Yellow)) and frame ground. Measure the resistance between contact J1-4 (wire E903-YL(Yellow)) and all the other contacts that are used in the J1 and J2 connectors for the ECM.
- Observe the resistance measurements and wiggle the ECM connectors and the speed sensor connector. Gently pull on the wires and wiggle the wires.
- At the machine harness connector J1 for the ECM, measure the resistance between contact J1-5 (wire E902-PU(Purple)) and frame ground. Measure the resistance between contact J1-5 (wire E902-PU(Purple)) and all the other contacts that are used in the J1 and J2 connectors for the ECM.
- Observe the resistance measurements and wiggle the ECM connectors and the speed sensor connector. Gently pull on the wires and wiggle the wires.

Expected Result:

Each resistance measurement is greater than 5000 ohms always during the manipulation of the machine harness.

Results:

- YES – Each resistance measurement is greater than 5000 ohms. The measurements do not indicate a short circuit. Proceed to Test Step 5.
- NO – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness.

Repair: The short is between the circuit of the speed sensor that was being checked and the circuit with the low-resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all the connectors that are in the faulty speed sensor circuit. Ensure that all connections are clean, that all connections are secure, and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Determine if the CID 0674 FMI 02 diagnostic code is active.

Expected Result:

The CID 0674 FMI 02 diagnostic code is active.

Results:

- YES – The CID 0674 FMI 02 diagnostic code is active. The problem has not been corrected.

Repair: Check the relay circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 0674 FMI 02 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i04664769

MID 027 - CID 0675 - FMI 02

SMCS Code: 3175-038-IMD

Conditions Which Generate This Code:

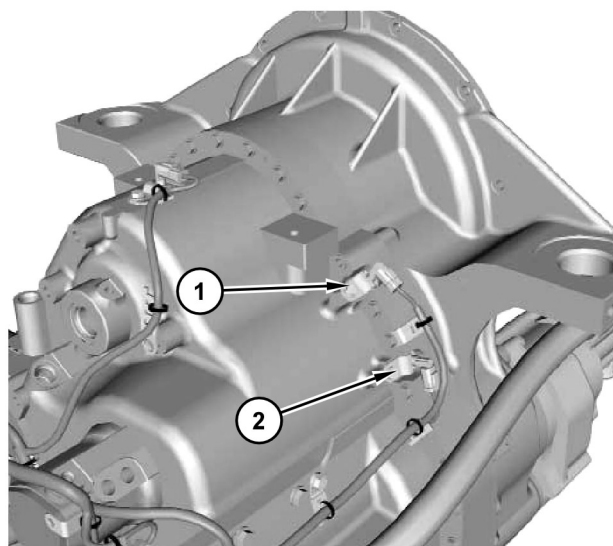


Illustration 204

g01323376

Transmission Intermediate Speed Sensors are located on the right-hand side of the transmission.

- (1) Transmission Intermediate Speed Sensor 2
(2) Transmission Intermediate Speed Sensor 1

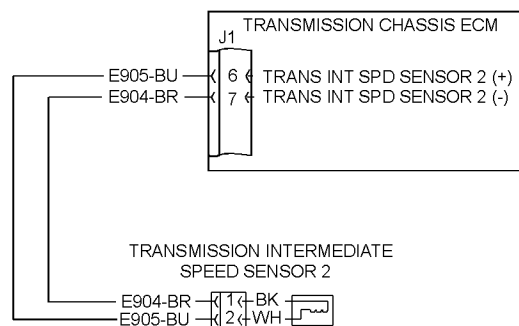


Illustration 205

g01321549

Connections of the Transmission Intermediate Speed Sensor 2.

This diagnostic code is associated with the transmission intermediate speed sensor 2. The transmission intermediate speed sensor 2 is located on the right-hand side of the transmission.

The ECM monitors the signals from the transmission intermediate speed sensor 2 and the transmission intermediate speed sensor 1. When the ECM detects that the signal of the speed sensor 2 is not within the accepted limits and the signal of the speed sensor 1 is within the accepted limits, the ECM will activate the FMI 02 diagnostic code.

The following conditions could cause the ECM to activate this diagnostic code:

- The speed sensor has failed.
- There is an intermittent short or an open in the speed sensor circuit.
- The speed sensor is not mounted securely.
- Failure of the ECM is unlikely.

Note: Before performing this procedure, verify that the speed sensor is mounted securely. A loose mount could cause this diagnostic code to be activated. Ensure that this diagnostic code is active before performing this procedure.

Test Step 1. CHECK THE SENSOR

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness from the speed sensor.
- At the connector for the speed sensor, measure the resistance from contact 2 to contact 1.

Expected Result:

The correct range of resistance for the sensor is approximately 75 ohms at -40°C (-40°F) to 230 ohms at 120°C (248°F). The resistance will be approximately 140 ohms at 25°C (77°F).

Results:

- YES – The resistance of the speed sensor is within the correct resistance range. The sensor is correct. Proceed to Test Step 2.
- NO – The resistance of the speed sensor is not within the correct resistance range. The speed sensor has failed.

Repair: Verify that the speed sensor is causing the problem. Mark the harness connector for the transmission intermediate speed sensor 2. Connect the transmission intermediate speed sensor 2 harness connector to the transmission intermediate speed sensor 1 and connect the transmission intermediate speed sensor 1 harness connector to the transmission

intermediate speed sensor 2. Turn the disconnect switch and the key start switch to the ON position.

If the transmission intermediate speed sensor 2 has failed, the CID 0675 FMI 02 diagnostic code will no longer be active. A CID 0674 FMI 02 diagnostic code for the transmission intermediate speed sensor 1 will become active.

If a CID 0674 FMI 02 diagnostic code is active after the sensors are switched, replace the transmission intermediate speed sensor 2. Verify that the new sensor corrects the problem before operating the machine.

STOP.

Test Step 2. SWITCH THE SENSORS

The key start switch and the disconnect switch remain in the OFF position. The transmission intermediate speed sensor 2 remains disconnected from the machine harness.

- A. Mark the harness connector of transmission intermediate speed sensor 2 in order to track the connector that is used for each sensor.
- B. Disconnect the transmission intermediate speed sensor 1 from the machine harness.
- C. Switch the speed sensor connectors. Connect the marked machine harness connector for transmission intermediate speed sensor 2 to the transmission intermediate speed sensor 1. Connect the machine harness connector for transmission intermediate speed sensor 1 to the transmission intermediate speed sensor 2.
- D. Turn the key start switch and the disconnect switch to the ON position.
- E. Observe the status of the active diagnostic code.

Expected Result:

The CID 0675 FMI 02 diagnostic code is no longer active. A CID 0674 FMI 02 diagnostic code for the transmission intermediate speed sensor 1 is active after the switch.

Results:

- YES – The CID 0675 FMI 02 diagnostic code is no longer active after the sensors are switched. A CID 0674 FMI 02 diagnostic code for the transmission intermediate speed sensor 1 is now active.

Repair: The transmission intermediate speed sensor 2 has failed. Replace the speed sensor. Verify that the new speed sensor corrects the problem before operating the machine.

STOP.

- NO – The CID 0675 FMI 02 diagnostic code is still active. Switching the speed sensors did not affect the status of the CID 0675 FMI 02 diagnostic code. The sensor is not causing the problem. Reconnect the machine harness connectors to the correct transmission intermediate speed sensor before proceeding to the next test step. Proceed to Test Step 3.

Test Step 3. CHECK THE SENSOR CIRCUIT FOR AN OPEN

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. Disconnect the machine harness connector from the sensor.
- C. Disconnect the machine harness connectors J1 from the ECM.
- D. At the machine harness connector for the sensor, connect a jumper wire between contact 1 (wire E904-BR(Brown)) and contact 2 (wire E905-GN(Green)).
- E. At the machine harness connector J1 for the ECM, measure the resistance between contact J1-6 (wire E905-GN(Green)) and contact J1-7 (wire E904-BR(Brown)).
- F. Observe the resistance measurement and wiggle the ECM connector. Gently pull on the wires and wiggle the wires.
- G. Observe the resistance measurement and wiggle the speed sensor connector. Gently pull on the wires and wiggle the wires. Do not disconnect the jumper wire.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the wires and connectors.

Results:

- YES – The resistance measurement is less than 5 ohms. The speed sensor circuit is not open in the machine harness. Proceed to Test Step 4.
- NO – The resistance measurement is greater than 5 ohms for all of the time or part of the time that the resistance is being measured. There is an open connection or bad connection in the one of the wires of the circuit of the speed sensor. Check each wire individually in order to determine whether the problem is in the signal circuit or the ground circuit.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is either not connected or that a wire is open. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points or a splice in the circuit is not an open connection but not a good connection.

A resistance measurement that is greater than 5 ohms at some time during the manipulation of the machine harness indicates that there is an intermittent open or a loose connection in the machine harness.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the circuit. Ensure that all of the contacts for the circuit are in good condition, that all of the contacts are clean, and that all of the contacts are securely fastened in each of the harness connectors. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SIGNAL CIRCUIT FOR A SHORT

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors remain disconnected from the sensor and the ECM.

- A. Disconnect the jumper wire that was used in the last test step.
- B. Disconnect the machine harness connectors J2 from the ECM.
- C. At the machine harness connector J1 for the ECM, measure the resistance between contact J1-6 (wire E905-BU(Blue)) and frame ground. Measure the resistance between contact J1-6 (wire E905-BU(Blue)) and all of the other contacts that are used in the J1 and J2 connectors for the ECM.
- D. Observe the resistance measurements and wiggle the ECM connectors and the speed sensor connector. Gently pull on the wires and wiggle the wires.
- E. At the machine harness connector J1 for the ECM, measure the resistance between contact J1-7 (wire E904-BR(Brown)) and frame ground. Measure the resistance between contact J1-7 (wire E904-BR(Brown)) and all of the other contacts that are used in the J1 and J2 connectors for the ECM.

- F. Observe the resistance measurements and wiggle the ECM connectors and the speed sensor connector. Gently pull on the wires and wiggle the wires.

Expected Result:

Each resistance measurement is greater than 5000 ohms at all times during the manipulation of the machine harness.

Results:

- YES – Each resistance measurement is greater than 5000 ohms. The measurements do not indicate a short circuit. Proceed to Test Step 5.
- NO – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness.

Repair: The short is between the circuit of the speed sensor that was being checked and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the faulty speed sensor circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all the harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 0675 FMI 02 diagnostic code is active.

Expected Result:

The CID 0675 FMI 02 diagnostic code is active.

i02917913

Results:

- YES – The CID 0675 FMI 02 diagnostic code is active. The problem has not been corrected.

Repair: Check the relay circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NO – The CID 0675 FMI 02 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

MID 027 - CID 0681 - FMI 03

SMCS Code: 5479-038-BRK

Conditions Which Generate This Code:

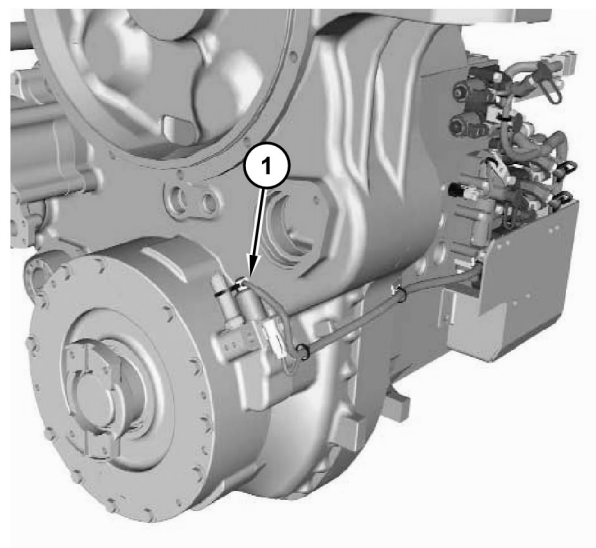


Illustration 206

g01323395

The “Park Brake” solenoid is located on the housing of the park brake of the engine side of the transmission.

(1) “Park Brake” solenoid

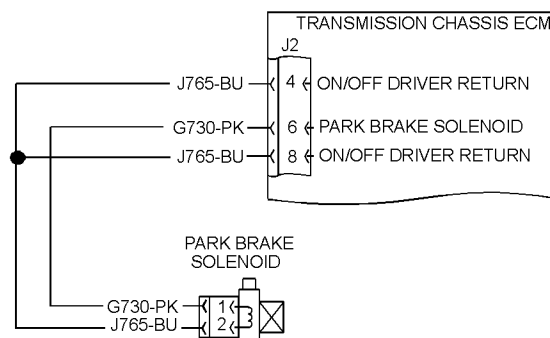


Illustration 207

g01301698

Connections of the “Park Brake” solenoid

This diagnostic code is associated with the parking brake solenoid. The solenoid is connected to an “ON/OFF” output at the Transmission/Chassis ECM. The FMI 03 diagnostic code means the ECM has detected that the voltage of the solenoid circuit is above normal or that the ECM has detected voltage in the circuit when no voltage should be present.

Conditions that could cause this diagnostic code to be activated are:

- The energize circuit of the solenoid is shorted to another voltage source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the solenoid. Disconnect the machine harness connectors J1 and J2 from the ECM.
- At the machine harness connectors for the ECM, measure the resistance from contact J2-6 (wire G730-PK(Pink)) to all of the other contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- YES – Each resistance measurement is greater than 5000 ohms. The resistance measurement does not indicate a short in the machine harness. Proceed to test step 2.
- NO – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness.

Repair: The short is between wire G730-PK(Pink) and the circuit that has a low resistance measurement.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoid and the ECM remain disconnected.

- At the machine harness connector J2 for the ECM, use a 151 - 6320 Removal Tool to remove the energize wire of the solenoid G730-PK(Pink) and the socket at contact J2-6 from the harness connector.
- Reconnect the machine harness J1 and J2 connectors to the ECM.
- Turn the disconnect switch and the key start switch to the ON position.
- Observe the status of the active CID 0681 FMI 03 diagnostic code.

Expected Result:

The CID 0681 FMI 03 diagnostic code is no longer active. A CID 0681 FMI 05 diagnostic code is now active.

Results:

- YES – The CID 0681 FMI 03 diagnostic code is no longer active. A CID 0681 FMI 05 diagnostic code is active after the energize circuit of the solenoid is disconnected. The ECM has responded correctly to the open circuit condition in the solenoid circuit. Reinstall the energize wire of the solenoid into the correct space of the connector of the ECM. Proceed to the next test step. Proceed to Test Step 3.
- NO – The CID 0681 FMI 03 diagnostic code remains active. The status of the active diagnostic code did not change when the solenoid energize wire was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 0681 FMI 03 diagnostic code is active.

Expected Result:

The CID 0681 FMI 03 diagnostic code is not active.

Results:

- YES – The diagnostic code is not active at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NO – The CID 0681 FMI 03 diagnostic code remains active. The problem has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the problem remains, the ECM may have failed. This is unlikely because the ECM detected the open circuit condition in the solenoid circuit and the ECM activated the FMI 05 diagnostic code when the solenoid energize wire was disconnected.

Verify that all possible causes of the diagnostic code have been investigated. Exit this procedure and perform this procedure again.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found and the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02917935

MID 027 - CID 0681 - FMI 05

SMCS Code: 5479-038-BRK

Conditions Which Generate This Code:

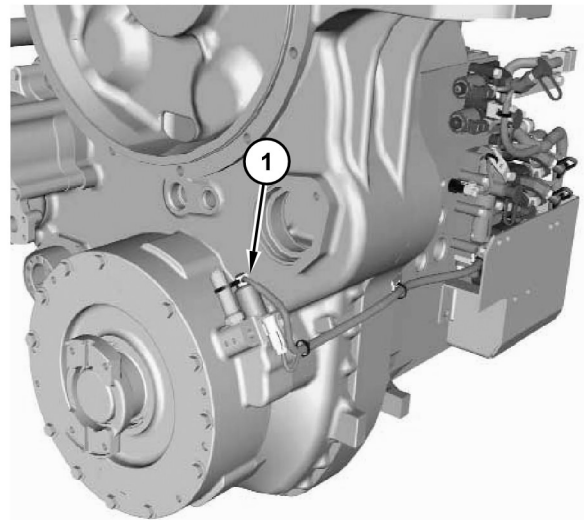


Illustration 208

g01323395

The "Park Brake" solenoid is located on the housing of the park brake on the engine side of the transmission.

(1) "Park Brake" Solenoid

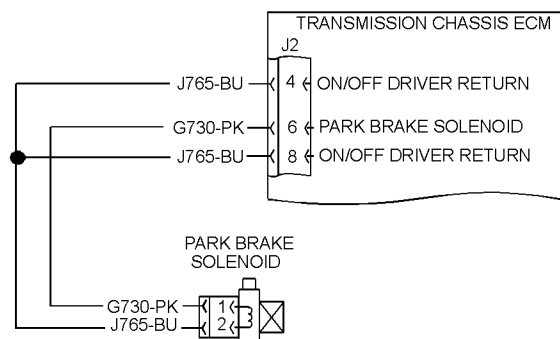


Illustration 209

g01301698

"Park Brake" Solenoid

This diagnostic code is associated with the “park brake” solenoid. The solenoid is connected to an ON/OFF output at the Transmission/Chassis ECM. The FMI 05 diagnostic code means that the ECM has detected that the current for the circuit of the solenoid is below normal.

Conditions that could cause this diagnostic code to be active are:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SOLENOID

- A. Disconnect the solenoid from the machine harness.
- B. At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire G730-PK(Pink)) to contact 2 (wire J765-BU(Blue)).
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the CID 0681 FMI 05 diagnostic code.

Expected Result:

The CID 0681 FMI 05 diagnostic code is no longer active. A CID 0681 FMI 06 diagnostic code becomes active when the jumper wire is connected.

Results:

- YES – The CID 0681 FMI 05 diagnostic code is no longer active. A CID 0681 FMI 06 diagnostic code becomes active when the jumper wire is connected. The solenoid has failed.

Repair: Repeat this Test Step “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

STOP.

- NO – The CID 0681 FMI 05 diagnostic code remains active. The jumper wire does not affect the status of the active diagnostic code. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR AN OPEN

The jumper wire that was installed in the previous Test Step remains in place.

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. Disconnect the machine harness connector of the ECM J2 from the ECM.
- C. At the machine harness connector J2 for the ECM, measure the resistance from contact J2-4 (wire J765-BU(Blue)) to contact J2-8 (wire J765-BU(Blue)).
- D. Observe the resistance measurement of the multimeter. Wiggle the machine harness connectors for the ECM. Wiggle the machine harness connector for the solenoid. Gently pull on the wires and wiggle the wires.
- E. At the machine harness connector J2 for the ECM, measure the resistance from contact J2-4 (wire J765-BU(Blue)) to contact J2-6 (wire J730-PK(Pink)).
- F. Observe the resistance measurement of the multimeter. Wiggle the machine harness connectors for the ECM. Wiggle the machine harness connector for the solenoid. Gently pull on the wires and wiggle the wires.

Expected Result:

Each resistance measurement is less than 5.0 ohms at all times during the manipulation of the harness and connectors.

Results:

- OK – The resistance measurements are less than 5.0 ohms. The resistance measurements are not indicating an open or a bad connection in the circuit. Proceed to Test Step 3.

Diagnostic Code Procedures

- NOT OK – The resistance measurement is greater than 5.0 ohms. The resistance measurement is indicating an open circuit or a bad connection in the machine harness.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is not connected or that a connection is open. A resistance measurement that is greater than 5.0 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

The open or the possible bad connection is in supply wire G730-PK(Pink) or in return wire J765-BU(Blue) of the machine harness. Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the solenoid circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connector for the solenoid and the ECM J2 connector remain disconnected.

- Remove the jumper wire that was installed in the last test step.
- At the machine harness connector J2 for the ECM, use a 151 - 6320 Removal Tool to remove the energize wire of the solenoid G730-PK(Pink) and the socket at contact J2-6 from the harness connector.
- Reconnect the machine harness J2 connector to the ECM.
- Turn the disconnect switch and the key start switch to the ON position.
- Use a 7X - 1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the ECM pin at J2-6 through the empty space in the J2 connector.
- Observe the status of the active CID 0681 FMI 05 diagnostic code and ground the other end of the 7X - 1710 Multimeter Probe to frame ground.

Expected Result:

The CID 0681 FMI 05 diagnostic code is no longer active. A CID 0681 FMI 06 diagnostic code becomes active when the ECM pin at J2-6 is grounded.

Results:

- YES – The CID 0681 FMI 05 diagnostic code is no longer active. A CID 0681 FMI 06 diagnostic code has been activated after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition in the solenoid circuit. It is unlikely that the ECM is causing the problem. Reinstall the energize wire of the solenoid into the correct spot of the ECM connector. Proceed to the next test step. Proceed to Test Step 4.
- NO – The CID 0681 FMI 05 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin for the solenoid is grounded.

Repair: The ECM has not responded correctly to the grounded condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 0681 FMI 05 diagnostic code.

Expected Result:

The CID 0681 FMI 05 diagnostic code is not active.

Results:

- OK – The CID 0681 FMI 05 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NOT OK – The CID 0681 FMI 05 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed. This is unlikely as the ECM responded correctly to the grounded condition in the previous test step.

Verify that all possible causes of the diagnostic code have been investigated. Exit this procedure and perform this procedure again.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the active diagnostic code is not found and the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02917962

MID 027 - CID 0681 - FMI 06

SMCS Code: 5479-038-BRK

Conditions Which Generate This Code:

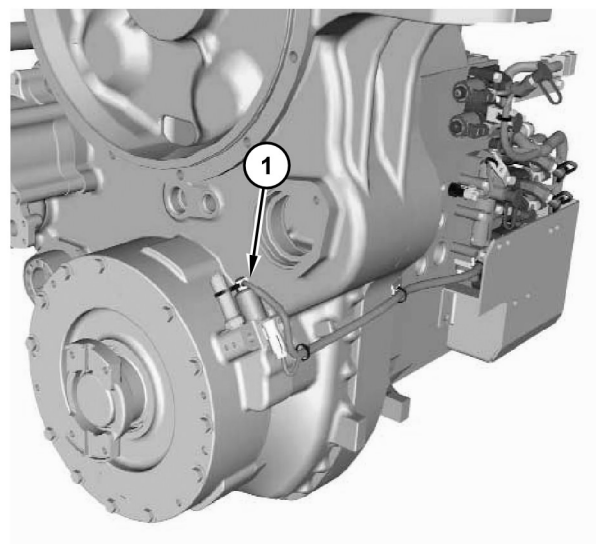


Illustration 210

g01323395

The "Park Brake" solenoid is located on the housing of the park brake on the engine side of the transmission.

(1) "Park Brake" Solenoid

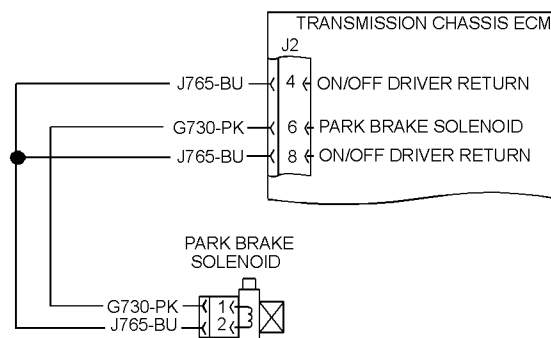


Illustration 211

g01301698

Connections of "Park Brake" solenoid

This diagnostic code is associated with the parking brake solenoid. The FMI 06 diagnostic code means that the ECM has detected that the current for the solenoid circuit is above normal.

Conditions that could cause this diagnostic code to be activated are listed below:

- The energize circuit of the solenoid is shorted to a ground source.

- The solenoid has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SOLENOID

- Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- Observe the status of the diagnostic code.
- Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

The active CID 0681 FMI 06 diagnostic code changes to a CID 0681 FMI 05 diagnostic code when the solenoid is disconnected.

Results:

- YES – The active CID 0681 FMI 06 diagnostic code changes to a CID 0681 FMI 05 diagnostic code when the solenoid is disconnected. The solenoid circuit in the machine harness is correct.

Repair: The solenoid has failed. Repeat this test "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid.

STOP.

- NO – The CID 0681 FMI 06 diagnostic code remains active. Disconnecting the solenoid did not change the status of the active diagnostic code. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND

The solenoid remains disconnected from the machine harness.

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connectors of the ECM J1 and J2 from the ECM.
- At the machine harness connectors for the ECM, measure the resistance from the signal contact J2-6 (wire G730-PK(Pink)) to frame ground. Measure the resistance from the signal contact J2-6 (wire G730-PK(Pink)) to all of the other contacts that are used in J1 and J2 ECM connectors.
- Observe the resistance measurements of the multimeter and wiggle the machine harness connectors for the ECM and the solenoid. Gently pull on the wires and wiggle the wires.

Expected Result:

Each resistance measurement is greater than 5000 ohms at all times during the manipulation of the harness and connectors.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. The resistance measurement is indicating that a short is present in the machine harness. The short is between wire G730-PK(Pink) and the frame ground or the circuit with the low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.

D. Turn the disconnect switch and the key start switch to the ON position.

E. Operate the machine.

F. Check the status of the CID 0681 FMI 06 diagnostic code.

Expected Result:

The CID 0681 FMI 06 diagnostic code not active.

Results:

- OK – The CID 0681 FMI 06 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NOT OK – The CID 0681 FMI 06 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

Verify that all possible causes of the diagnostic code have been investigated. Exit this procedure and perform this procedure again. If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found and the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02917974

MID 027 - CID 0967 - FMI 02

SMCS Code: 7610-038-DTN

Conditions Which Generate This Code:

This diagnostic code is associated with the communication between the Transmission/Chassis ECM and the Messenger that is conducted over the Cat Data Link. The machine serial number is programmed into the Messenger. The serial number is communicated to the Transmission/Chassis ECM and to the other ECM modules on the machine. The Transmission/Chassis ECM activates the CID 0967 FMI 02 diagnostic code when the machine serial number, received from the Messenger, is incorrect or the serial number has been changed.

Note: Ensure that the CID 0967 FMI 02 diagnostic code is active before performing this procedure.

Test Step 1. Check The Serial Number That Is Programmed

- Connect the Caterpillar Electronic Technician (ET) service tool to the service connector of the machine.
- Turn the key start switch and the disconnect switch to the ON position.
- Check the machine serial number that is programmed for the Messenger.

Expected Result:

The machine serial number is not correct for this machine.

Results:

- YES – The programmed machine serial number is NOT the correct serial number for this machine.

Repair: Program the complete machine serial number for this machine into the Messenger using the ET service tool. After the correct serial number has been programmed, turn the key start switch to the OFF position. Wait a minute, then turn the key start switch to the ON position. Verify that the diagnostic code has been cleared.

STOP.

- NO – The machine serial number IS correct for this machine. The complete serial number for this machine is programmed correctly for the Messenger. Proceed to Test Step 2.

Test Step 2. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. The disconnect switch and the key start switch remain in the ON position.
- B. Operate the machine.
- C. Determine if the CID 0967 FMI 02 diagnostic code is active.

Expected Result:

The CID 0967 FMI 02 diagnostic code is not active.

Results:

- OK – The CID 0967 FMI 02 diagnostic code is not active. The diagnostic code does not exist at this time. Resume normal operation.

STOP.

- NOT OK – The CID 0967 FMI 02 diagnostic code is active. The diagnostic code has not been corrected.

Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code can not be found, replace the ECM. Refer to Troubleshooting, "Electronic Control Module (ECM) - Replace".

STOP.

i02839839

MID 027 - CID 0967 - FMI 09

SMCS Code: 7610-038-DTN

Conditions Which Generate This Code:

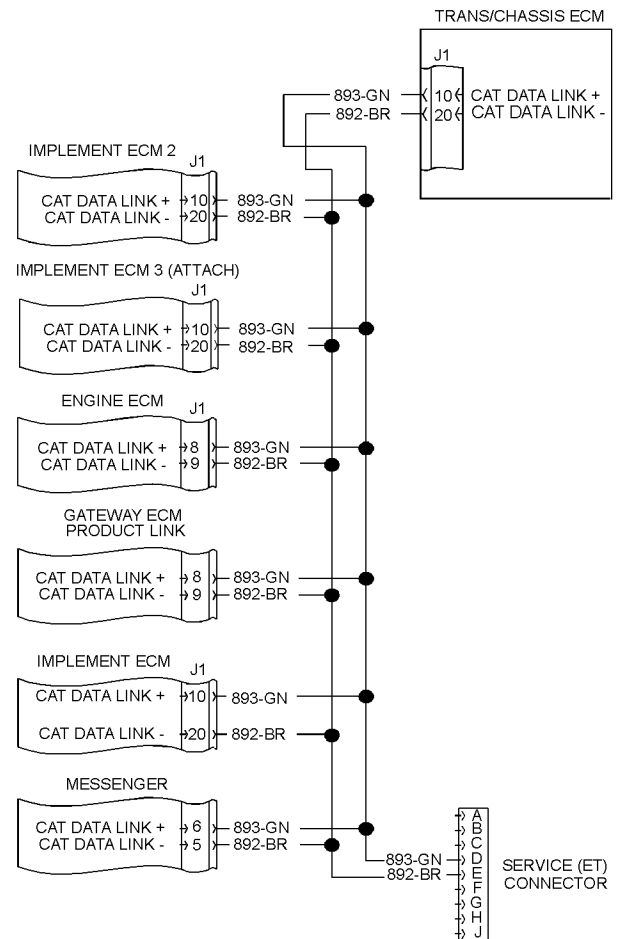


Illustration 212

g01405233

Connections of the Cat Data Link

This diagnostic code is associated with the communication between the Transmission/Chassis ECM and the Messenger that is conducted over the Cat Data Link. The FMI 09 code means that the Transmission/Chassis ECM has lost communication with the Messenger.

The possible causes of this diagnostic code are listed below:

- An open or a faulty connection in the Cat Data Link circuit.
- The Messenger has failed. This is unlikely
- The ECM has failed. This is unlikely.

Note: If the Messenger is not operating correctly, refer to Testing and Adjusting, RENR9034 for information on troubleshooting the Messenger. Ensure that CID 0967 FMI 09 diagnostic code is active before performing this procedure. Check the Messenger for correct operation before performing this procedure.

Test Step 1. CHECK THE DATA LINK CIRCUIT FOR AN OPEN

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the connector of the machine harness J1 from the Transmission/Chassis ECM. Disconnect the machine harness connector from the Messenger.
- C. Inspect the harness connectors and clean all of the contacts of the harness connectors. Refer to the illustration above in order to check the connection of the Cat Data Link on each of the machine harness connectors. Ensure that the wires are secured in the connector and in good condition.
- D. At the disconnected harness connectors, measure the resistance from the contact of ECM connector J1-10 (wire 893-GN(Green)) to contact of the Messenger 6 (wire 893-GN(Green)).
- E. At the disconnected harness connectors, measure the resistance from ECM connector contact J1-20 (wire 892-BR(Brown)) to Messenger contact 5 (wire 892-BR(Brown)).

Expected Result:

Both of the resistance measurements are less than 5 ohms.

Results:

- OK – Both of the resistance measurements are less than 5 ohms. The Cat Data Link circuit in the machine harness is not open. Proceed to Test Step
- NOT OK – At least one of the resistance measurements is more than 5 ohms.

Repair: There is an open or a bad connection in the Cat Data Link circuit in the machine harness. Refer to the complete Electrical System Schematic of the machine. Locate all the connectors and examine all of the connectors of the machine harness that are involved in the data link circuit. Check each wire section from connector to connector for an open or a bad connection. Ensure that all connections are clean, that all connections are

secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the data link circuit.
- B. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Operate the machine.
- E. Check the status of the CID 0967 FMI 09 diagnostic code.

Expected Result:

The CID 0967 FMI 09 diagnostic code is not active.

Results:

- OK – The CID 0967 FMI 09 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 0967 FMI 09 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a “wiggle” test on the machine wiring harness. The “wiggle” test can detect momentary or intermittent shorts or opens in the machine wiring harness.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. See the Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i02917979

MID 027 - CID 1326 - FMI 02

SMCS Code: 1408-038

Conditions Which Generate This Code:

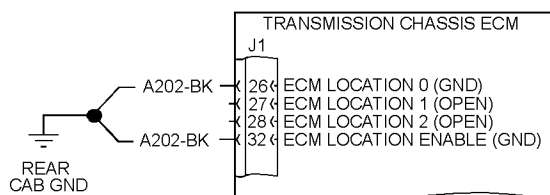


Illustration 213

g01301815

This diagnostic code is recorded when the software location code for the Implement ECM does not match the hard wired location codes.

The probable cause of this diagnostic code is software. The wrong software has been flashed into the ECM. A short to a ground source in one of the location code circuits in the machine harness could also cause this diagnostic code to activate.

Note: Do not change the hard wired location code if you have flashed the incorrect software into the control.

Note: For help with verification of correct location codes, in the Cat ET status screen, the “actual” location code and the “desired” location code for each ECM on the machine can be displayed.

Test Step 1. VERIFY HARDWARE AND SOFTWARE PART NUMBERS

A. Verify whether the part number of the software for the ECM is correct.

Expected Result:

Contact the Business Unit that is producing the product for the correct configuration for the machine.

Results:

- OK – All part numbers are correct for the ECM. Proceed to Test Step 2.
- NOT OK – All part numbers are NOT correct. The installed ECM has the wrong part number or incorrect configuration software is installed.

Repair: Replace the ECM with a module that has the correct part number or flash the correct configuration software. See Troubleshooting, “Electronic Control Module - Flash Program”.

STOP.

Test Step 2. VERIFY WHETHER THE LOCATION CODE MATCHES THE ET STATUS SCREEN

A. Check the ET status screen in order to verify the location code. The codes are listed below:

TRansmission/Chassis ECM 1

Expected Result:

The location codes in the ET are correct.

Results:

- OK – The location codes in the ET are correct. Proceed to Test Step 3.
- NOT OK – The location codes are NOT correct.

Repair: Repeat this test step in order to verify that the software and hardware part numbers are correct.

Proceed to Test Step 3 if the part numbers are correct.

Test Step 3. INSPECT HARNESS CONNECTIONS

- A.** Turn the key start switch and the disconnect switch to the OFF position.
- B.** Inspect the harness connections that are related to the location codes. Make sure that the connectors are clean. Make sure that the connectors are tight.
- C.** Check for the proper mating of the connector.
- D.** Check all wires at the connector.
- E.** Check each wire for nicks. Check each wire for signs of abrasion in the insulation.
- F.** Check for moisture at the connector.
- G.** Check for dirty contacts or corroded contacts.
- H.** Check each pin and check each socket.

Expected Result:

The machine harness connectors are tight and the machine harness connectors are free of corrosion.

Results:

- OK – The machine harness connectors are tight and the machine harness connectors are free from corrosion. Proceed to Test Step 4.
- NOT OK – One or more of the machine harness connectors are in need of repair.

Repair: Repair the connector and verify that all connections are correct before reconnecting to the mating connector. After the connector is repaired, verify that the problem has been corrected before operating the machine.

STOP.

Test Step 4. CHECK FOR SHORTS TO GROUND

- A. The disconnect switch and the key start switch remain in the OFF position.
- B. Disconnect the machine harness connector from the ECM.
- C. At the machine harness for the ECM, measure the resistance between the frame ground and the J1 location codes.

Expected Result:

The resistance that is measured is greater than 5 ohms at contacts J1-27 and J1-28. The resistance measures less than 5 ohms at contacts J1-26 and J1-32.

Results:

- OK – The resistance measurements are correct. The harness circuit is correct. Proceed to Test Step 5.
- NOT OK – One or more of the resistance measurements is NOT correct. The machine harness has failed.

Repair: Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK FOR AN OPEN HARNESS

- A. The disconnect switch and the key start switch remain in the OFF position. The ECM remains disconnected from the machine harness.
- B. At the machine harness for the ECM, measure the resistance between the frame ground and J1-27.
- C. At the machine harness for the ECM, measure the resistance between the frame ground and J1-32.

Expected Result:

The resistance measurements are less than 5 ohms.

Results:

- OK – The resistance measurements are less than 5 ohms. The location code circuit is correct. The ECM may have failed.

Repair: Check the location code circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem can not be found, The ECM may have failed. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Troubleshooting, "Electronic Control Module (ECM) - Replace".

STOP.

- NOT OK – The resistance is greater than 5 ohms. The machine harness has failed.

Repair: Repair the machine harness or replace the machine harness.

STOP.

i02917988

MID 027 - CID 1401 - FMI 03

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

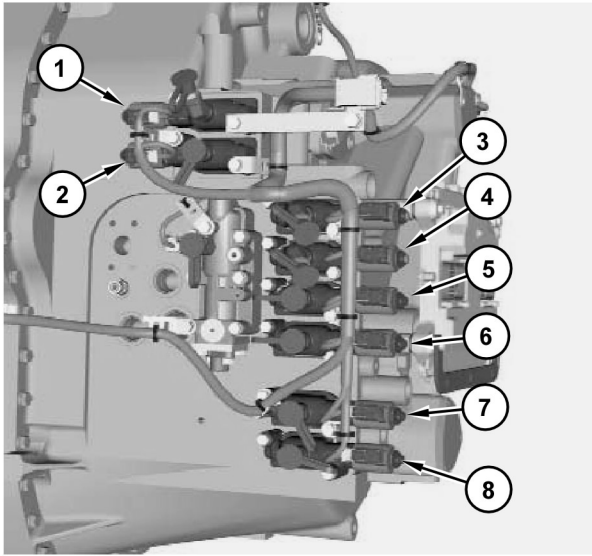


Illustration 214

g01321566

Transmission Solenoids located on the left side of the transmission

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

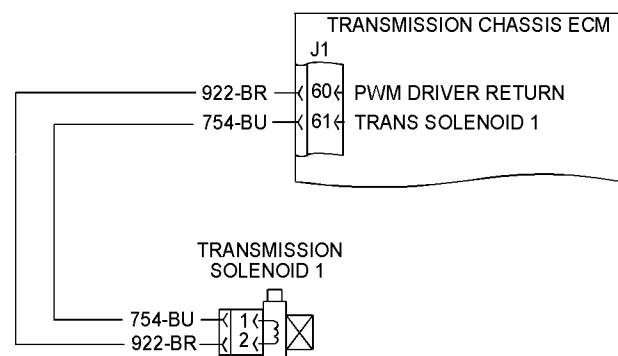


Illustration 215

g01288780

Connections for "Transmission Solenoid 1"

This diagnostic code is associated with the "transmission solenoid 1". The FMI 03 means that the Transmission/Chassis ECM has determined that the voltage of the solenoid circuit is above normal.

Conditions that can cause this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to another voltage source.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25°C (77.0°F).

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT

- A.** Turn the key start switch and the disconnect switch to the OFF position.
- B.** Disconnect the machine harness connector from the solenoid. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- C.** At the machine harness connector of the ECM J1, measure the resistance from contact J1-61 (wire 754-BU(Blue)) to all J1 and J2 contacts that are used on the connectors of the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between wire 754-BU(Blue) and the circuit that has a low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoid and the Transmission/Chassis ECM remain disconnected.

- A. At the machine harness connector J1 for the ECM, use a 151 - 6320 Removal Tool to remove the energize wire of the solenoid 754-BU(Blue) and the socket at contact J1-60 from the harness connector.
- B. Reconnect the machine harness J1 and J2 connectors to the ECM.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Observe the status of the active CID 1401 FMI 03 diagnostic code.

Expected Result:

The CID 1401 FMI 03 diagnostic code is no longer active. A CID 1401 FMI 05 diagnostic code is now active.

Results:

- YES – The CID 1401 FMI 03 diagnostic code is no longer active. A CID 1401 FMI 05 diagnostic code has been activated after the solenoid energize circuit was disconnected. The ECM has responded correctly to the open circuit condition in the solenoid circuit. Reinstall the energize wire of the solenoid into the correct space of the connector on the ECM. Proceed to the next test step. Proceed to Test Step 3.
- NO – The CID 1401 FMI 03 diagnostic code remains active. The status of the active diagnostic code did not change when the energize wire of the solenoid was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 1401 FMI 03 diagnostic code is active.

Expected Result:

The CID 1401 FMI 03 diagnostic code is active.

Results:

- YES – The CID 1401 FMI 03 diagnostic code is active.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the problem remains, the ECM may have failed. This is unlikely because the ECM detected the open circuit condition in the solenoid circuit and activated the FMI 05 diagnostic code when the energize wire of the solenoid was disconnected.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1401 FMI 03 code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02918023

MID 027 - CID 1401 - FMI 05

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

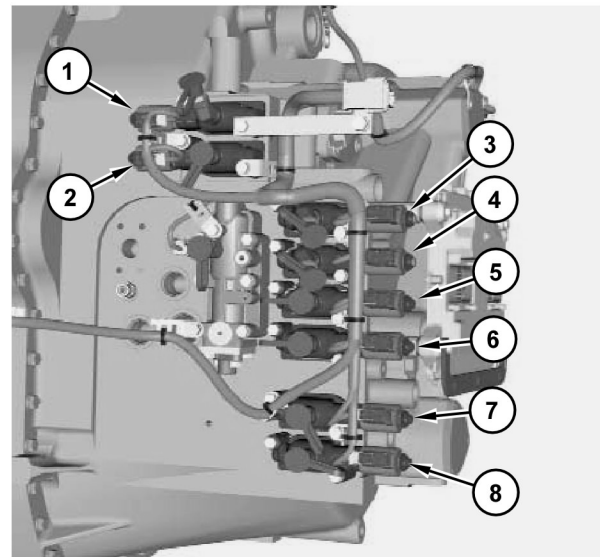


Illustration 216

g01321566

Transmission Solenoids located on the left side of the transmission

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

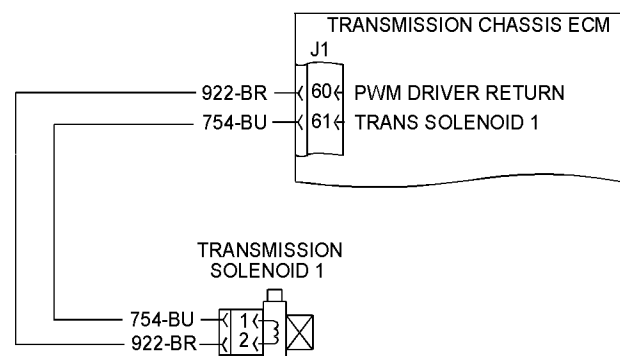


Illustration 217

g01288780

Connections of "Transmission Solenoid 1"

This diagnostic code is associated with the transmission solenoid 1. The FMI 05 means that the Transmission/Chassis ECM has determined that the current for the solenoid circuit is below normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- A. Disconnect the solenoid from the machine harness.
- B. At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire 754-BU(Blue)) to contact 2 (wire 922-BR(Brown)).
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the CID 1401 FMI 05 diagnostic code.

Expected Result:

The active diagnostic code changes from an FMI "05" to an FMI "06" diagnostic code when the jumper wire is installed.

Results:

- YES – The active diagnostic code changes from an FMI "05" to an FMI "06" diagnostic code when the jumper wire is installed. The solenoid has failed.

Repair: The solenoid has failed. Repeat this Test Step "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

STOP.

- NO – The CID 1401 FMI 05 diagnostic code remains active. The jumper wire does not affect the status of the diagnostic code. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR AN OPEN

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector J1 from the Transmission/Chassis ECM.
- C. The jumper wire that was installed in the previous Test Step remains in place.
- D. At the machine harness connector J1 for the Transmission/Chassis ECM, measure the resistance from the return contact J1-60 (wire 922-BR(Brown)) to the energize contact J1-61 (wire 754-BU(Blue)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The measurement of the resistance is less than 5 ohms. The circuit is not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5000 ohms. The resistance measurement is not correct. There is an open or a bad connection in the machine harness. A resistance measurement that is much greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

Repair: The open or the possible poor connection is in supply wire 754-BU(Blue) or in return wire 922-BR(Brown) of the machine harness. Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the solenoid circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connector for the solenoid and the ECM J1 connector remain disconnected.

- A. Remove the jumper wire that was installed in the last test step.
- B. At the machine harness connector J1 for the ECM, use a 151 - 6320 Removal Tool to remove the energize wire of the solenoid 754-BU(Blue) and the socket at contact J1-61 from the harness connector.
- C. Reconnect the machine harness J1 connector to the ECM.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Use a 7X - 1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the ECM pin at J1-61 through the empty space in the J1 connector.
- F. Observe the status of the active CID 1401 FMI 05 diagnostic code and ground the other end of the 7X - 1710 Multimeter Probe to frame ground.

Expected Result:

The CID 1401 FMI 05 diagnostic code is no longer active. A CID 1401 FMI 06 diagnostic code becomes active when the ECM pin at J1-61 is grounded.

Results:

- YES – The CID 1401 FMI 05 diagnostic code is no longer active. A CID 1401 FMI 06 diagnostic code has been activated after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition in the solenoid circuit. The problem is likely not being caused by the ECM. Reinstall the energize wire of the solenoid into the correct spot of the connector on the ECM. Proceed to the next test step. Proceed to Test Step 4.
- NO – The CID 1401 FMI 05 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin for the solenoid is grounded.

Repair: The ECM has not responded correctly to the grounded condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 1401 FMI 05 diagnostic code.

Expected Result:

The CID 1401 FMI 05 diagnostic code is active.

Results:

- YES – The CID 1401 FMI 05 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed. This is unlikely as the ECM responded correctly to the grounded condition in the previous test step.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1401 FMI 05 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02918078

MID 027 - CID 1401 - FMI 06

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

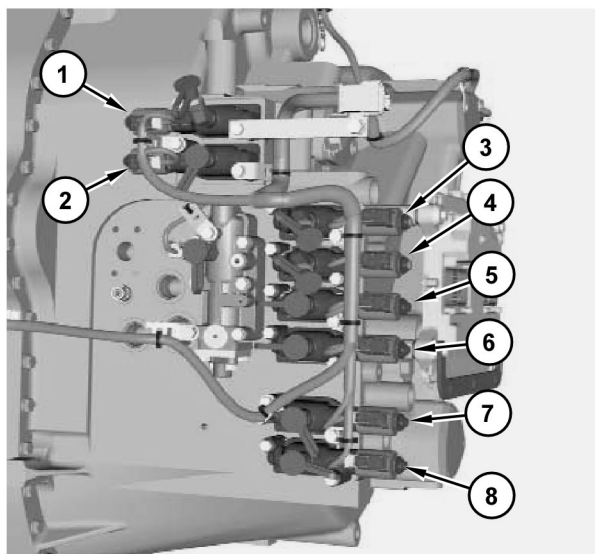


Illustration 218

g01321566

Transmission Solenoids located on the left side of the transmission

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

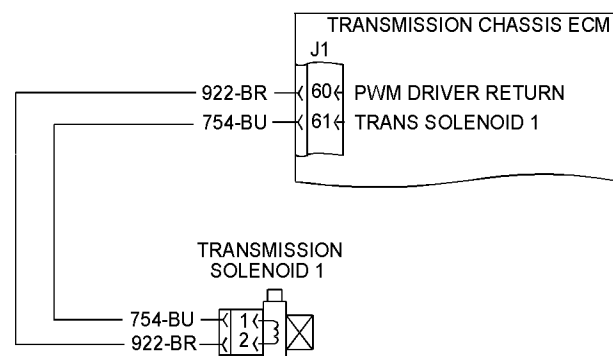


Illustration 219

g01288780

Connections for "Transmission Solenoid 1"

This diagnostic code is associated with the "transmission solenoid 1". The FMI 06 means that the Transmission/Chassis ECM has determined that the current of the solenoid circuit is above normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all the connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25°C (77.0°F).

Test Step 1. CHECK THE SOLENOID

- A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- B.** Observe the status of the diagnostic code.
- C.** Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

Diagnostic Code Procedures

The active CID 1401 FMI 06 diagnostic code changes to a CID 1401 FMI 05 diagnostic code when the solenoid is disconnected.

Results:

- YES – The active CID 1401 FMI 06 diagnostic code changes to a CID 1401 FMI 05 diagnostic code when the solenoid is disconnected. The circuit is correct.

Repair: The solenoid has failed. Repeat this test “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid.

STOP.

- NO – The CID 1401 FMI 06 remains active when the solenoid is disconnected. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND

- Turn the key start switch and the disconnect switch to the OFF position.
- The solenoid remains disconnected from the machine harness.
- Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- At the machine harness connectors of the ECM, measure the resistance from the contact J1-61 (wire 754-BU(Blue)) to frame ground. Measure the resistance from the contact J1-61 (wire 754-BU(Blue)) to all of the other J1 and J2 contacts that are used in the connectors of the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness. The short is between wire 754-BU(Blue) and the circuit with the low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to

Testing and Adjusting, “Wiring Harness (Short Circuit) - Test”. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 1401 FMI 06 diagnostic code.

Expected Result:

The CID 1401 FMI 06 diagnostic code is still active.

Results:

- YES – The CID 1401 FMI 06 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NO – The CID 1401 FMI 06 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02572896

MID 027 - CID 1401 - FMI 13

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

This diagnostic code is associated with the transmission solenoid 1. The FMI 13 diagnostic code is activated when the ECM detects that the solenoid needs calibration.

Note: Before performing this procedure, verify that no other active CID 1401 diagnostic codes exist for the solenoid. If any other diagnostic codes are active for the solenoid, correct the problem before performing this procedure.

CALIBRATION

- A.** Perform the calibration procedure for the solenoid. Refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

Expected Result:

The calibration procedure was performed successfully.

Results:

- YES – The calibration procedure was performed successfully. Resume normal machine operation.

STOP.

- NO – The calibration was not successful.

Repair: Repeat the calibration procedure for the solenoid.

If the second calibration procedure is not successful, replace the solenoid. After solenoid replacement, refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure. If the problem is still present after replacement and calibration of the new solenoid, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02918167

MID 027 - CID 1402 - FMI 03

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

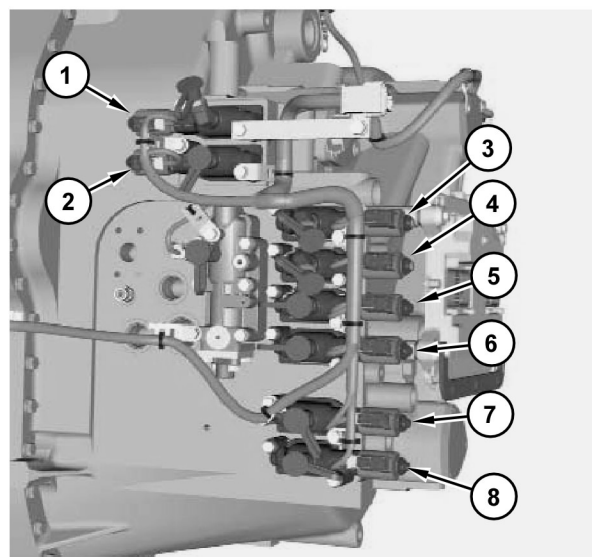


Illustration 220

g01321566

Connections of the "Transmission Solenoids" located on the left side of the transmission.

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

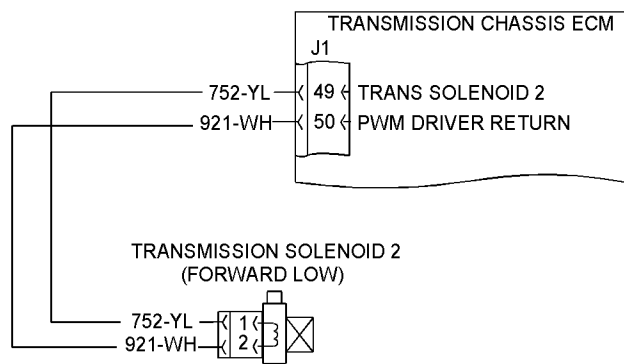


Illustration 221

g01288812

Connections of "Transmission Solenoid 2"

This diagnostic code is associated with the "transmission solenoid 2". The FMI 03 means that the Transmission/Chassis ECM has determined that the voltage of the solenoid circuit is above normal.

Conditions that can cause this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to another voltage source.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the solenoid. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.

- At the machine harness connector of the ECM J1, measure the resistance from contact J1-49 (wire 752-YL (Yellow)) to all J1 and J2 contacts that are used on the connectors of the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between wire 752-YL (Yellow) and the circuit that has a low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoid and the ECM remain disconnected.

- At the machine harness connector J1 for the ECM, use a 151-6320 Removal Tool to remove the energize wire of the solenoid 752-YL (Yellow) and the socket at contact J1-49 from the harness connector.
- Reconnect the machine harness J1 and J2 connectors to the ECM.
- Turn the disconnect switch and the key start switch to the ON position.
- Observe the status of the active CID 1402 FMI 03 diagnostic code.

Expected Result:

The CID 1402 FMI 03 diagnostic code is no longer active. A CID 1402 FMI 05 diagnostic code is now active.

Results:

- YES – The CID 1402 FMI 03 diagnostic code is no longer active. A CID 1402 FMI 05 diagnostic code has been activated after the solenoid energize circuit was disconnected. The ECM has responded correctly to the open circuit condition in the solenoid circuit. Reinstall the energize wire of the solenoid in the correct space of the connector of the ECM. Proceed to the next test step. Proceed to Test Step 3.
- NO – The CID 1402 FMI 03 diagnostic code remains active. The status of the active diagnostic code did not change when the solenoid energize wire was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Determine if the CID 1402 FMI 03 diagnostic code is active.

Expected Result:

The CID 1402 FMI 03 diagnostic code is active.

Results:

- YES – The CID 1402 FMI 03 diagnostic code is active.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service

tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the problem remains, the ECM may have failed. This is unlikely because the ECM detected the open circuit condition in the solenoid circuit and activated the FMI 05 diagnostic code when the solenoid energize wire was disconnected.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1402 FMI 03 code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02918539

MID 027 - CID 1402 - FMI 05

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

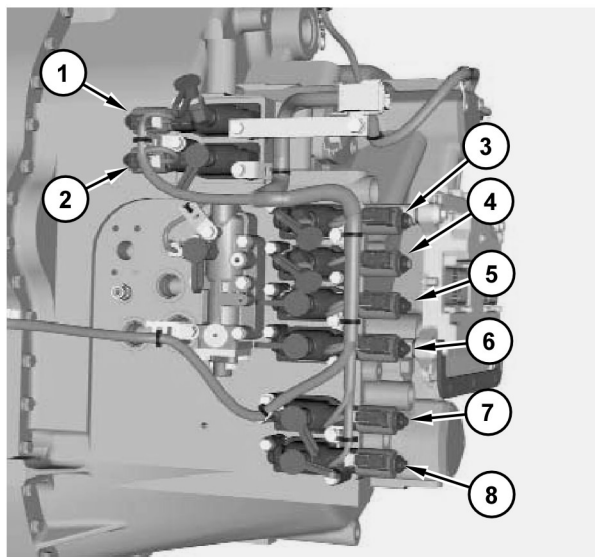


Illustration 222

g01321566

Transmission Solenoids located on the left side of the transmission

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

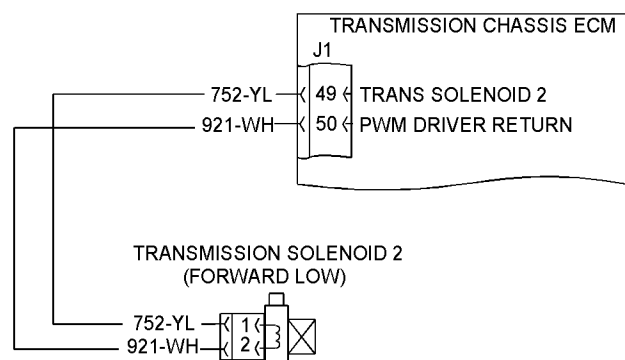


Illustration 223

g01288812

Connections for "Transmission Solenoid 2"

This diagnostic code is associated with the "transmission solenoid 2". The FMI 05 means that the Transmission/Chassis ECM has determined that the current for the solenoid circuit is below normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- A.** Disconnect the solenoid from the machine harness.
- B.** At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire 752-YL(Yellow)) to contact 2 (wire 921-WH(White)).
- C.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D.** Observe the status of the CID 1402 FMI 05 diagnostic code.

Expected Result:

The active diagnostic code changes from an FMI "05" to an FMI "06" diagnostic code when the jumper wire is installed.

Results:

- YES – The active diagnostic code changes from an FMI "05" to an FMI "06" diagnostic code when the jumper wire is installed. The solenoid has failed.

Repair: The solenoid has failed. Repeat this Test Step "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

STOP.

- NO – The CID 1402 FMI 05 diagnostic code remains active. The jumper wire does not affect the status of the diagnostic code. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR AN OPEN

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector J1 from the Transmission/Chassis ECM.
- The jumper wire that was installed in the previous Test Step remains in place.
- At the machine harness connector J1 for the Transmission/Chassis ECM, measure the resistance from the return contact J1-50 (wire 921-WH(White)) to the energize contact J1-49 (wire 752-YL(Yellow)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The measurement of the resistance is less than 5 ohms. The circuit is not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5000 ohms. The resistance measurement is not correct. There is an open or a bad connection in the machine harness. A resistance measurement that is much greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

Repair: The open connection or a possible poor connection is in supply wire 752-YL(Yellow) or in return wire 921-WH(White) of the machine harness. Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the solenoid circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connector for the solenoid and the ECM J1 connector remain disconnected.

- Remove the jumper wire that was installed in the last test step.
- At the machine harness connector J1 for the ECM, use a 151 - 6320 Removal Tool to remove the energize wire of the solenoid 752-YL(Yellow) and the socket at contact J1-49 from the harness connector.
- Reconnect the machine harness J1 connector to the ECM.
- Turn the disconnect switch and the key start switch to the ON position.
- Use a 7X - 1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the ECM pin at J1-49 through the empty space in the J1 connector.
- Observe the status of the active CID 1402 FMI 05 diagnostic code and ground the other end of the 7X - 1710 Multimeter Probe to frame ground.

Expected Result:

The CID 1402 FMI 05 diagnostic code is no longer active. A CID 1402 FMI 06 diagnostic code becomes active when the ECM pin at J1-49 is grounded.

Results:

- YES – The CID 1402 FMI 05 diagnostic code is no longer active. A CID 1402 FMI 06 diagnostic code has been activated after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition in the solenoid circuit. The problem is likely not being caused by the ECM. Reinstall the energize wire of the solenoid into the correct spot of the ECM. Proceed to the next test step. Proceed to Test Step 4.
- NO – The CID 1402 FMI 05 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin for the solenoid is grounded.

Repair: The ECM has not responded correctly to the grounded condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 1402 FMI 05 diagnostic code.

Expected Result:

The CID 1402 FMI 05 diagnostic code is active.

Results:

- YES – The CID 1402 FMI 05 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed. This is unlikely as the ECM responded correctly to the grounded condition in the previous test step.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1402 FMI 05 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02918683

MID 027 - CID 1402 - FMI 06

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

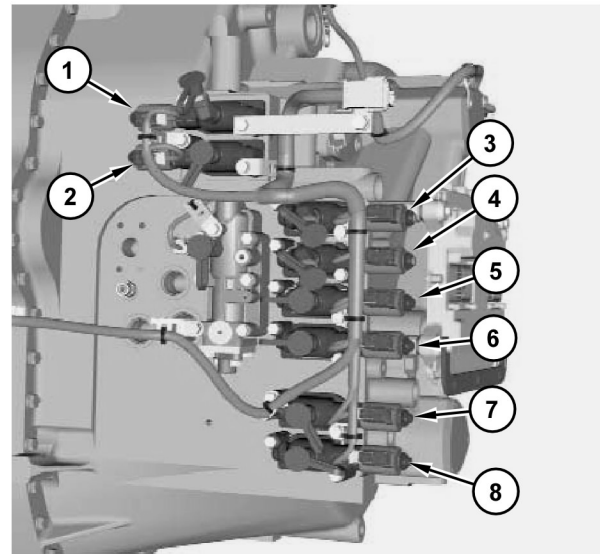


Illustration 224

g01321566

Transmission Solenoids that are located on the left side of the transmission

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

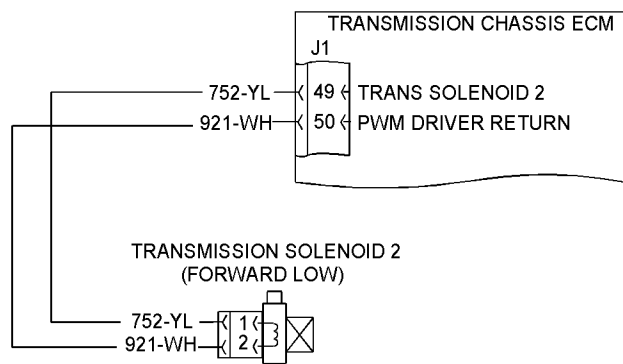


Illustration 225

g01288812

Connections for "Transmission Solenoid 2"

This diagnostic code is associated with the "transmission solenoid 2". The FMI 06 means that the Transmission/Chassis ECM has determined that the current of the solenoid circuit is above normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- Observe the status of the diagnostic code.
- Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

The active CID 1402 FMI 06 diagnostic code changes to a CID 1402 FMI 05 diagnostic code when the solenoid is disconnected.

Results:

- YES – The active CID 1402 FMI 06 diagnostic code changes to a CID 1402 FMI 05 diagnostic code when the solenoid is disconnected. The circuit is correct.

Repair: The solenoid has failed. Repeat this test in order to verify the solenoid failure. Replace the solenoid.

STOP.

- NO – The CID 1402 FMI 06 remains active when the solenoid is disconnected. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND

- Turn the key start switch and the disconnect switch to the OFF position.
- The solenoid remains disconnected from the machine harness.
- Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- At the machine harness connectors for the ECM, measure the resistance from the contact J1-49 (wire 752-YL (Yellow)) to frame ground. Measure the resistance from the contact J1-49 (wire 752-YL (Yellow)) to all of the other J1 and J2 contacts that are used in the connectors of the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness. The short is between wire 752-YL (Yellow) and the circuit with the low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to

Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 1402 FMI 06 diagnostic code.

Expected Result:

The CID 1402 FMI 06 diagnostic code is still active.

Results:

- YES – The CID 1402 FMI 06 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1402 FMI 06 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02572899

MID 027 - CID 1402 - FMI 13

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

This diagnostic code is associated with the transmission solenoid 2. The FMI 13 diagnostic code is activated when the ECM detects that the solenoid needs calibration.

Note: Before performing this procedure, verify that no other active CID 1402 diagnostic codes exist for the solenoid. If any other diagnostic codes are active for the solenoid, correct the problem before performing this procedure.

CALIBRATION

- A. Perform the calibration procedure for the solenoid. Refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

Expected Result:

The calibration procedure was performed successfully.

Results:

- YES – The calibration procedure was performed successfully. Resume normal machine operation.

STOP.

- NO – The calibration was not successful.

Repair: Repeat the calibration procedure for the solenoid.

If the second calibration procedure is not successful, replace the solenoid. After solenoid replacement, refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure. If the problem is still present after replacement and calibration of the new solenoid, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02918709

MID 027 - CID 1403 - FMI 03

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

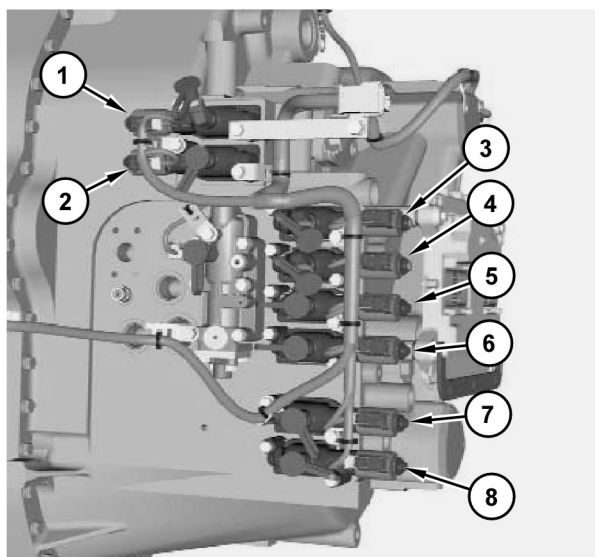


Illustration 226

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

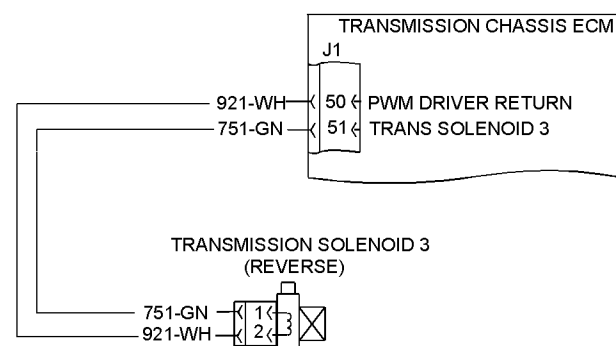


Illustration 227

g01288824

Connection of "Transmission Solenoid 3"

This diagnostic code is associated with the "transmission solenoid 3". The FMI 03 means that the Transmission/Chassis ECM has determined that the voltage of the solenoid circuit is above normal.

Conditions that can cause this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to another voltage source.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT

- A.** Turn the key start switch and the disconnect switch to the OFF position.
- B.** Disconnect the machine harness connector from the solenoid. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.

C. At the machine harness connector of the ECM J1, measure the resistance from contact J1-51 (wire 751-GN(Green)) to all J1 and J2 contacts that are used on the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between wire 751-GN(Green) and the circuit that has a low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, “Wiring Harness (Short Circuit) - Test”. Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoid and the ECM remain disconnected.

- A.** At the machine harness connector J1 for the ECM, use a 151-6320 Removal Tool to remove the energize wire of the solenoid 751-GN(Green) and the socket at contact J1-51 from the harness connector.
- B.** Reconnect the machine harness J1 and J2 connectors to the ECM.
- C.** Turn the disconnect switch and the key start switch to the ON position.
- D.** Observe the status of the active CID 1403 FMI 03 diagnostic code.

Expected Result:

The CID 1403 FMI 03 diagnostic code is no longer active. A CID 1403 FMI 05 diagnostic code is now active.

Results:

- YES – The CID 1403 FMI 03 diagnostic code is no longer active. A CID 1403 FMI 05 diagnostic code

has been activated after the energize circuit of the solenoid was disconnected. The ECM has responded correctly to the open circuit condition in the solenoid circuit. Reinstall the energize wire of the solenoid back into the correct space in the ECM connector. Proceed to the next test step. Proceed to Test Step 3.

- NO – The CID 1403 FMI 03 diagnostic code remains active. The status of the active diagnostic code did not change when the energize wire of the solenoid was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Determine if the CID 1403 FMI 03 diagnostic code is active.

Expected Result:

The CID 1403 FMI 03 diagnostic code is active.

Results:

- YES – The CID 1403 FMI 03 diagnostic code is active.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle

test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the problem remains, the ECM may have failed. This is unlikely because the ECM detected the open circuit condition in the solenoid circuit and activated the FMI 05 diagnostic code when the energize wire of the solenoid was disconnected.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1403 FMI 03 code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i03851071

MID 027 - CID 1403 - FMI 05

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

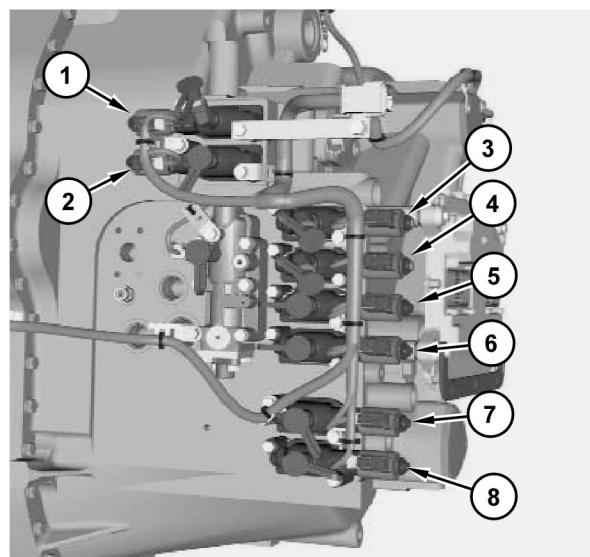


Illustration 228

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission Solenoid 1" (forward high)
- (2) "Transmission Solenoid 2" (forward low)
- (3) "Transmission Solenoid 3" (reverse)
- (4) "Transmission Solenoid 4" (2nd speed)
- (5) "Transmission Solenoid 5" (3rd speed)
- (6) "Transmission Solenoid 6" (1st speed)
- (7) "Transmission Solenoid 7" (low range)
- (8) "Transmission Solenoid 8" (high range)

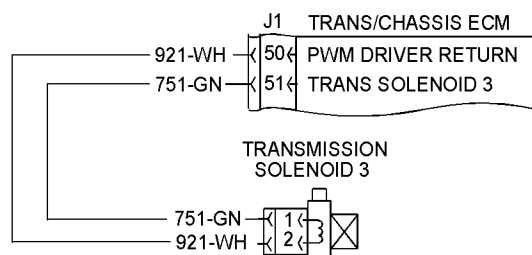


Illustration 229

g02110954

Connections of "Transmission Solenoid 3"

This diagnostic code is associated with the "Transmission Solenoid 3". The FMI05 diagnostic code means that the "Transmission/Chassis ECM" has determined that the current for the solenoid circuit is below normal.

Diagnostic Code Procedures

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- A. Disconnect the solenoid from the machine harness.
- B. At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire 751-GN(Green)) to contact 2 (wire 921-WH(White)).
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the CID 1403 FMI 05 diagnostic code.

Expected Result:

The active code changes from an FMI "05" diagnostic code to an FMI "06" diagnostic code when the jumper wire is installed.

Results:

- YES – The active diagnostic code changes from an FMI "05" to an FMI "06" diagnostic code when the jumper wire is installed. The solenoid has failed.

Repair: The solenoid has failed. Repeat this Test Step "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

STOP.

- NO – The CID 1403 FMI 05 diagnostic code remains active. The jumper wire does not affect the status of the diagnostic code. The solenoid is not the cause of the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR AN OPEN

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector J1 from the "Transmission/Chassis ECM" .
- C. The jumper wire that was installed in the previous Test Step remains in place.
- D. At the machine harness connector J1 for the "Transmission/Chassis ECM" , measure the resistance from the return wire, contact J1-50 (wire 921-WH(White)) to the energize wire, contact J1-51 (wire 751-GN(Green)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The measurement of the resistance is less than 5 ohms. The circuit is not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5000 ohms. The resistance measurement is not correct. There is an open or a bad connection in the machine harness. A resistance measurement that is much greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

Repair: The open or the possible poor connection is in supply wire 751-GN(Green) or in return wire 921-WH(White) of the machine harness. Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the solenoid circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connector for the solenoid and the ECM J1 connector remain disconnected.

- A. Remove the jumper wire that was installed in the last test step.
- B. At the machine harness connector J1 for the ECM, use a 151 - 6320 Removal Tool to remove the energize wire of the solenoid 751-GN(Green) and the socket at contact J1-51 from the harness connector.
- C. Reconnect the machine harness J1 connector to the ECM.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Use a 7X - 1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the ECM pin at J1-51 through the empty space in the J1 connector.
- F. Observe the status of the active CID 1403 FMI 05 diagnostic code and ground the other end of the 7X - 1710 Multimeter Probe to frame ground.

Expected Result:

The CID 1403 FMI 05 diagnostic code is no longer active. A CID 1403 FMI 06 diagnostic code becomes active when the ECM pin at J1-51 is grounded.

Results:

- YES – The CID 1403 FMI 05 diagnostic code is no longer active. A CID 1403 FMI 06 diagnostic code has been activated after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition in the solenoid circuit. The ECM is not the likely cause of the problem. Reinstall the energize wire of the solenoid in the correct spot of the ECM connector. Proceed to the next test step. Proceed to Test Step 4.
- NO – The CID 1403 FMI 05 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin for the solenoid is grounded.

Repair: The ECM has not responded correctly to the grounded condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 1403 FMI 05 diagnostic code.

Expected Result:

The CID 1403 FMI 05 diagnostic code is no longer active.

Results:

- YES – The CID 1403 FMI 05 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NO – The CID 1403 FMI 05 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed. This is unlikely as the ECM responded correctly to the grounded condition in the previous test step.

Diagnostic Code Procedures

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02918763

MID 027 - CID 1403 - FMI 06

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

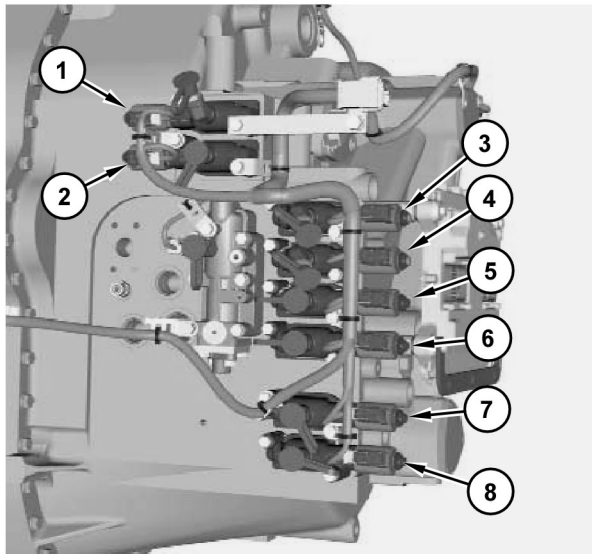


Illustration 230

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

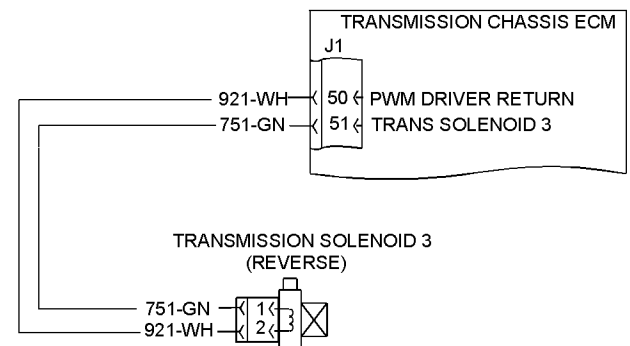


Illustration 231

g01288824

Connections of "Transmission Solenoid 3"

This diagnostic code is associated with the "transmission solenoid 3". The FMI 06 means that the Transmission/Chassis ECM has determined that the current of the solenoid circuit is above normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to ground.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- B.** Observe the status of the diagnostic code.
- C.** Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

The active CID 1403 FMI 06 diagnostic code changes to a CID 1403 FMI 05 diagnostic code when the solenoid is disconnected.

Results:

- YES – The active CID 1403 FMI 06 diagnostic code changes to a CID 1403 FMI 05 diagnostic code when the solenoid is disconnected. The circuit is correct.

Repair: The solenoid has failed. Repeat this test “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid.

STOP.

- NO – The CID 1403 FMI 06 remains active when the solenoid is disconnected. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND

- Turn the key start switch and the disconnect switch to the OFF position.
- The solenoid remains disconnected from the machine harness.
- Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- At the machine harness connectors for the ECM, measure the resistance from the contact J1-51 (wire 751-GN(Green)) to frame ground. Measure the resistance from the contact J1-51 (wire 751-GN(Green)) to all of the other J1 and J2 contacts that are used in the connectors of the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness. The short is between wire 751-GN(Green) and the circuit with the low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, “Wiring Harness (Short Circuit) - Test”. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 1403 FMI 06 diagnostic code.

Expected Result:

The CID 1403 FMI 06 diagnostic code is still active.

Results:

- YES – The CID 1403 FMI 06 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NO – The CID 1403 FMI 06 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection

or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02755564

MID 027 - CID 1403 - FMI 13

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

This diagnostic code is associated with the transmission solenoid (3). The FMI 13 diagnostic code is activated when the ECM detects that the solenoid needs calibration.

Note: Before performing this procedure, verify that no other active CID 1403 diagnostic codes exist for the solenoid. If any other diagnostic codes are active for the solenoid, correct the problem before performing this procedure.

CALIBRATION

- A. Perform the calibration procedure for the solenoid. Refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

Expected Result:

The calibration procedure was performed successfully.

Results:

- YES – The calibration procedure was performed successfully. Resume normal machine operation.

STOP.

- NO – The calibration was not successful.

Repair: Repeat the calibration procedure for the solenoid.

If the second calibration procedure is not successful, replace the solenoid. After solenoid replacement, refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure. If the problem is still present after replacement and calibration of the new solenoid, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02918775

MID 027 - CID 1404 - FMI 03

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

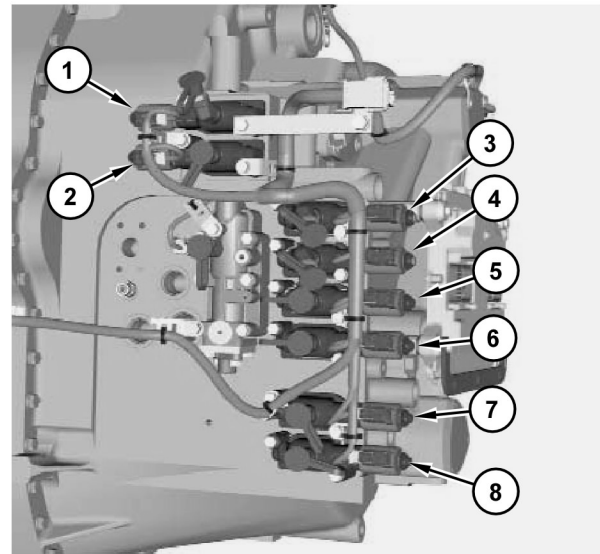


Illustration 232

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

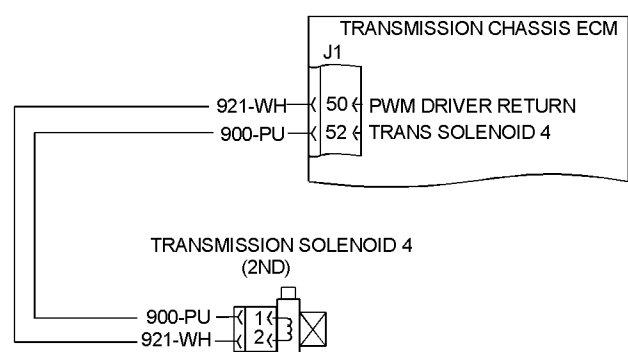


Illustration 233

g01288852

Connections of "Transmission Solenoid 4"

This diagnostic code is associated with the "transmission solenoid 4". The FMI 03 means that the Transmission/Chassis ECM has determined that the voltage of the solenoid circuit is above normal.

Conditions that can cause this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to another voltage source.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the solenoid. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.

- At the machine harness connector for the ECM, J1, measure the resistance from contact J1-52 (wire 900-PU(Purple)) to all J1 and J2 contacts that are used on the connectors of the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between wire 900-PU(Purple) and the circuit that has a low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoid and the ECM remain disconnected.

- At the machine harness connector J1 for the ECM, use a 151-6320 Removal Tool to remove the energize wire of the solenoid 900-PU(Purple) and the socket at contact J1-52 from the harness connector.
- Reconnect the machine harness J1 and J2 connectors to the ECM.
- Turn the disconnect switch and the key start switch to the ON position.
- Observe the status of the active CID 1404 FMI 03 diagnostic code.

Expected Result:

The CID 1404 FMI 03 diagnostic code is no longer active. A CID 1404 FMI 05 diagnostic code is now active.

Results:

Diagnostic Code Procedures

- YES – The CID 1404 FMI 03 diagnostic code is no longer active. A CID 1404 FMI 05 diagnostic code has been activated after the solenoid energize circuit was disconnected. The ECM has responded correctly to the open circuit condition in the solenoid circuit. Reinstall the energize wire of the solenoid into the correct space in the connector of the ECM. Proceed to the next test step. Proceed to Test Step 3.
- NO – The CID 1404 FMI 03 diagnostic code remains active. The status of the active diagnostic code did not change when the energize wire of the solenoid was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Determine if the CID 1404 FMI 03 diagnostic code is active.

Expected Result:

The CID 1404 FMI 03 diagnostic code is active.

Results:

- YES – The CID 1404 FMI 03 diagnostic code is active.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service

tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the problem remains, the ECM may have failed. This is unlikely because the ECM detected the open circuit condition in the solenoid circuit and activated the FMI 05 diagnostic code when the energize wire of the solenoid was disconnected.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1404 FMI 03 code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02918837

MID 027 - CID 1404 - FMI 05

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

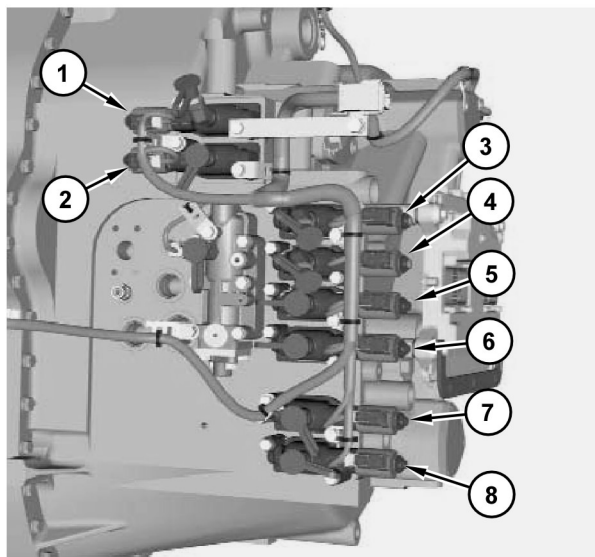


Illustration 234

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

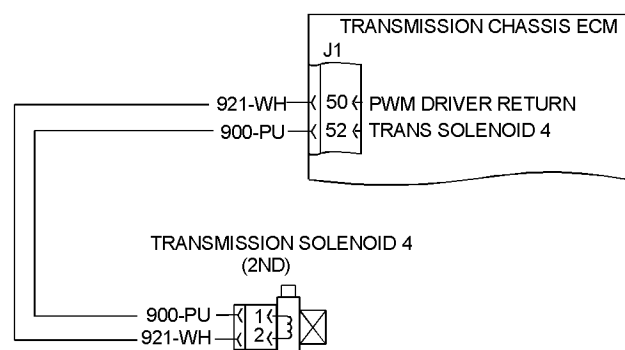


Illustration 235

g0128852

Connections for "Transmission Solenoid 4"

This diagnostic code is associated with the "transmission solenoid 4". The FMI 05 means that the Transmission/Chassis ECM has determined that the current for the solenoid circuit is below normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- A.** Disconnect the solenoid from the machine harness.
- B.** At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire 900-PU(Purple)) and contact 2 (wire 921-WH(White)).
- C.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D.** Observe the status of the CID 1404 FMI 05 diagnostic code.

Expected Result:

The active diagnostic code changes from an FMI "05" diagnostic code to an FMI "06" diagnostic code after the jumper wire is installed.

Results:

- YES – The active diagnostic code changes from an FMI "05" diagnostic code to an FMI "06" diagnostic code after the jumper wire is installed. The solenoid has failed.

Repair: The solenoid has failed. Repeat this Test Step "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

STOP.

- NO – The CID 1404 FMI 05 diagnostic code remains active. The jumper wire does not affect the status of the diagnostic code. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR AN OPEN

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector J1 from the Transmission/Chassis ECM.
- The jumper wire that was installed in the previous Test Step remains in place.
- At the machine harness connector J1 for the Transmission/Chassis ECM, measure the resistance from the return contact J1-50 (wire 921-WH(White)) and the energize contact J1-52 (wire 900-PU(Purple)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The measurement of the resistance is less than 5 ohms. The circuit is not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5000 ohms. The resistance measurement is not correct. There is an open or a bad connection in the machine harness. A resistance measurement that is much greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

Repair: The open or the possible poor connection is in supply wire 900-PU(Purple) or in return wire 921-WH(White) of the machine harness. Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the solenoid circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connector for the solenoid and the ECM J1 connector remain disconnected.

- Remove the jumper wire that was installed in the last test step.
- At the machine harness connector J1 for the ECM, use a 151 - 6320 Removal Tool to remove the energize wire of the solenoid 900-PU(Purple) and the socket at contact J1-52 from the harness connector.
- Reconnect the machine harness J1 connector to the ECM.
- Turn the disconnect switch and the key start switch to the ON position.
- Use a 7X - 1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the ECM pin at J1-52 through the empty space in the J1 connector.
- Observe the status of the active CID 1404 FMI 05 diagnostic code and ground the other end of the 7X - 1710 Multimeter Probe to frame ground.

Expected Result:

The CID 1404 FMI 05 diagnostic code is no longer active. A CID 1404 FMI 06 diagnostic code becomes active when the ECM pin at J1-52 is grounded.

Results:

- YES – The CID 1404 FMI 05 diagnostic code is no longer active. A CID 1404 FMI 06 diagnostic code has been activated after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition in the solenoid circuit. It is unlikely that the cause of the problem is the ECM. Install the energize wire of the solenoid into the correct spot in the connector of the ECM. Proceed to the next test step. Proceed to Test Step 4.
- NO – The CID 1404 FMI 05 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin for the solenoid is grounded.

Repair: The ECM has not responded correctly to the grounded condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 1404 FMI 05 diagnostic code.

Expected Result:

The CID 1404 FMI 05 diagnostic code is active.

Results:

- YES – The CID 1404 FMI 05 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed. This is unlikely as the ECM responded correctly to the grounded condition in the previous test step.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1404 FMI 05 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02918923

MID 027 - CID 1404 - FMI 06

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

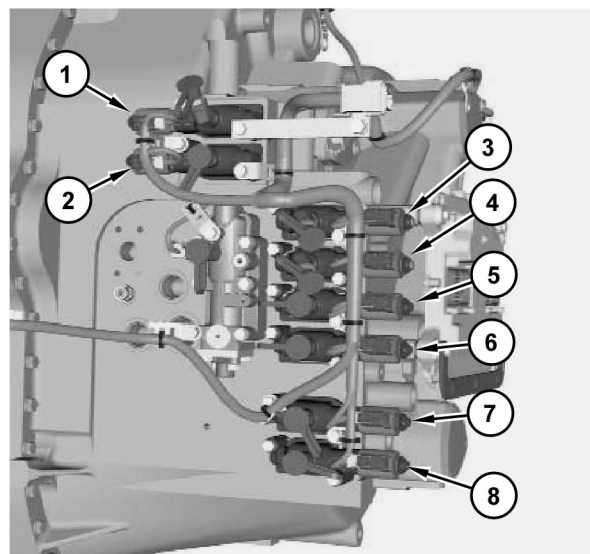


Illustration 236

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

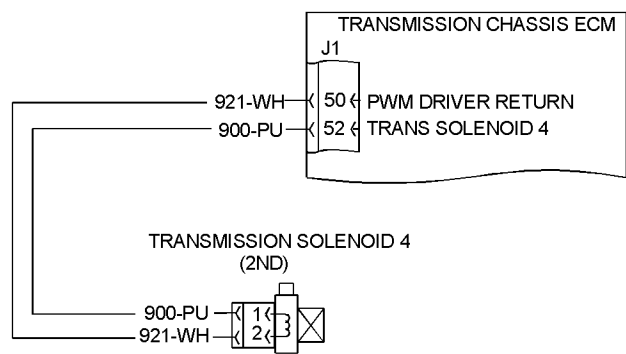


Illustration 237

g01288852

Connections for "Transmission Solenoid 4"

This diagnostic code is associated with the "transmission solenoid 4". The FMI 06 means that the Transmission/Chassis ECM has determined that the current of the solenoid circuit is above normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- Observe the status of the diagnostic code.
- Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

The active CID 1404 FMI 06 diagnostic code changes to a CID 1404 FMI 05 diagnostic code when the solenoid is disconnected.

Results:

- YES – The active CID 1404 FMI 06 diagnostic code changes to a CID 1404 FMI 05 diagnostic code when the solenoid is disconnected. The circuit is correct.

Repair: The solenoid has failed. Repeat this test "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid.

STOP.

- NO – The CID 1404 FMI 06 remains active when the solenoid is disconnected. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND

- Turn the key start switch and the disconnect switch to the OFF position.
- The solenoid remains disconnected from the machine harness.
- Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- At the machine harness connectors of the ECM, measure the resistance from the contact J1-52 (wire 900-PU(Purple)) to frame ground. Measure the resistance from the contact J1-52 (wire 900-PU(Purple)) to all of the other J1 and J2 contacts that are used in the connectors of the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness. The short is between wire 900-PU(Purple) and the circuit with the low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to

Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 1404 FMI 06 diagnostic code.

Expected Result:

The CID 1404 FMI 06 diagnostic code is still active.

Results:

- YES – The CID 1404 FMI 06 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1404 FMI 06 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02572907

MID 027 - CID 1404 - FMI 13

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

This diagnostic code is associated with the transmission solenoid 4. The FMI 13 diagnostic code is activated when the ECM detects that the solenoid needs calibration.

Note: Before performing this procedure, verify that no other active CID 1404 diagnostic codes exist for the solenoid. If any other diagnostic codes are active for the solenoid, correct the problem before performing this procedure.

CALIBRATION

- A. Perform the calibration procedure for the solenoid. Refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

Expected Result:

The calibration procedure was performed successfully.

Results:

- YES – The calibration procedure was performed successfully. Resume normal machine operation.

STOP.

- NO – The calibration was not successful.

Repair: Repeat the calibration procedure for the solenoid.

If the second calibration procedure is not successful, replace the solenoid. After solenoid replacement, refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure. If the problem is still present after replacement and calibration of the new solenoid, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02919211

MID 027 - CID 1405 - FMI 03

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

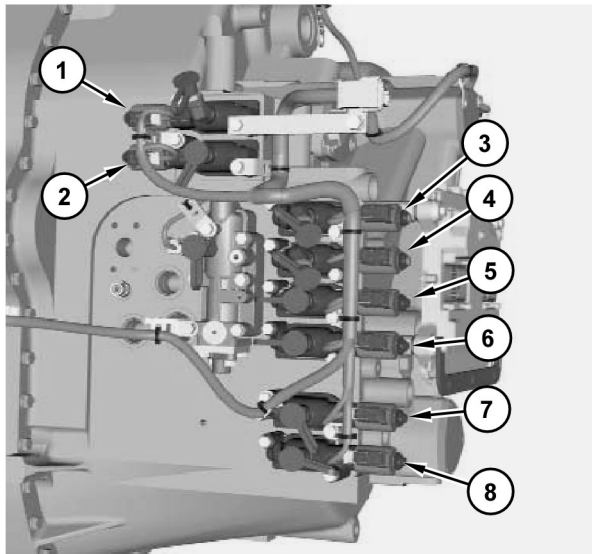


Illustration 238

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

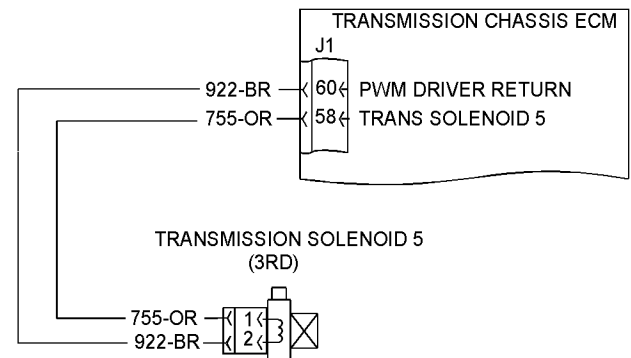


Illustration 239

g01288881

Connections of "Transmission Solenoid 5"

This diagnostic code is associated with the transmission solenoid 5. The FMI 03 means that the TRANSMISSION/Chassis ECM has determined that the voltage of the solenoid circuit is above normal.

Conditions that can cause this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to another voltage source.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT

- A.** Turn the key start switch and the disconnect switch to the OFF position.
- B.** Disconnect the machine harness connector from the solenoid. Disconnect the machine harness connectors J1 and J2 from the TRANSMISSION/Chassis ECM.

C. At the machine harness connector J1 of the ECM, measure the resistance from contact J1-58 (wire 755-OR(Orange)) to all J1 and J2 contacts that are used on the connectors of the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between wire 755-OR(Orange) and the circuit that has a low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoid and the ECM remain disconnected.

- A.** At the machine harness connector J1 for the ECM, use a 151-6320 Removal Tool to remove the energize wire of the solenoid 755-OR(Orange) and the socket at contact J1-58 from the harness connector.
- B.** Reconnect the machine harness J1 and J2 connectors to the ECM.
- C.** Turn the disconnect switch and the key start switch to the ON position.
- D.** Observe the status of the active CID 1405 FMI 03 diagnostic code.

Expected Result:

The CID 1405 FMI 03 diagnostic code is no longer active. A CID 1405 FMI 05 diagnostic code is now active.

Results:

- YES – The CID 1405 FMI 03 diagnostic code is no longer active. A CID 1405 FMI 05 diagnostic code has been activated after the solenoid energize circuit was disconnected. The ECM has responded correctly to the open circuit condition in the solenoid circuit. Reinstall the disconnected solenoid energize wire back into the correct space in the ECM connector before proceeding to the next test step. Proceed to Test Step 3.
- NO – The CID 1405 FMI 03 diagnostic code remains active. The status of the active diagnostic code did not change when the energize wire of the solenoid was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Determine if the CID 1405 FMI 03 diagnostic code is active.

Expected Result:

The CID 1405 FMI 03 diagnostic code is active.

Results:

- YES – The CID 1405 FMI 03 diagnostic code is active.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service

tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the problem remains, the ECM may have failed. This is unlikely because the ECM detected the open circuit condition in the solenoid circuit and activated the FMI 05 diagnostic code when the solenoid energize wire was disconnected.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the TRansmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1405 FMI 03 code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02919239

MID 027 - CID 1405 - FMI 05

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

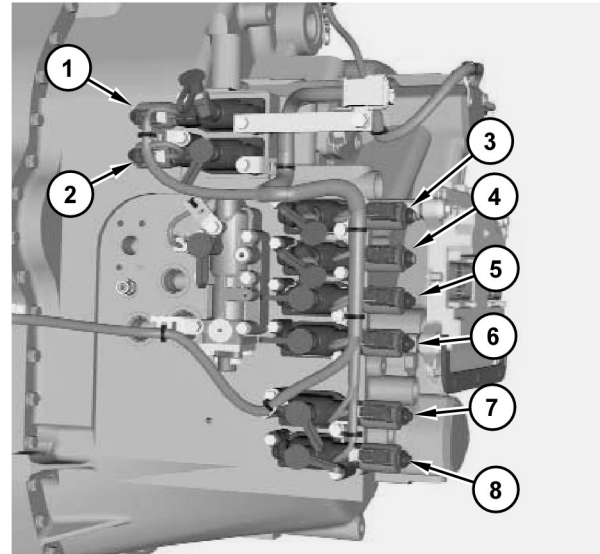


Illustration 240

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

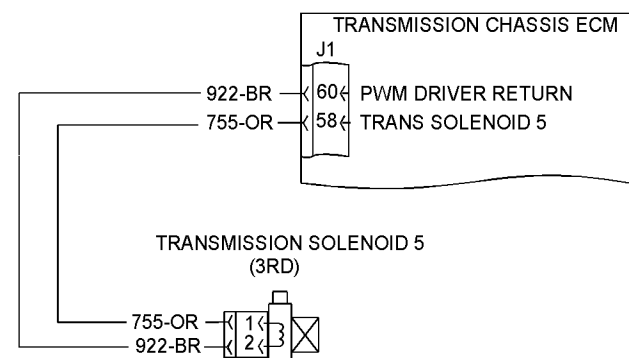


Illustration 241

g01288881

Connections of "Transmission Solenoid 5"

This diagnostic code is associated with the "transmission solenoid 5". The FMI 05 means that the Transmission/Chassis ECM has determined that the current for the solenoid circuit is below normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- Disconnect the solenoid from the machine harness.
- At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire 755-OR(Orange)) to contact 2 (wire 921-WH(White)).
- Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- Observe the status of the CID 1405 FMI 05 diagnostic code.

Expected Result:

The active diagnostic code changes from an FMI "05" to an FMI "06" diagnostic code when the jumper wire is installed.

Results:

- YES – The active diagnostic code changes from an FMI "05" to an FMI "06" diagnostic code when the jumper wire is installed. The solenoid has failed.

Repair: The solenoid has failed. Repeat this Test Step "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

STOP.

- NO – The CID 1405 FMI 05 diagnostic code remains active. The jumper wire does not affect the status of the diagnostic code. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR AN OPEN

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector J1 from the Transmission/Chassis ECM.
- The jumper wire that was installed in the previous Test Step remains in place.
- At the machine harness connector J1 for the Transmission/Chassis ECM, measure the resistance from the return, contact J1-50 (wire 921-WH(White)), to the energize contact J1-58 (wire 755-OR(Orange)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The measurement of the resistance is less than 5 ohms. The circuit is not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5000 ohms. The resistance measurement is not correct. There is an open or a bad connection in the machine harness. A measurement of resistance that is much greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

Repair: The open or a possible poor connection is in supply wire 755-OR(Orange) or in return wire 921-WH(White) of the machine harness. Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the solenoid circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connector for the solenoid and the ECM J1 connector remain disconnected.

- A. Remove the jumper wire that was installed in the last test step.
- B. At the machine harness connector J1 for the ECM, use a 151 - 6320 Removal Tool to remove the energize wire of the solenoid 755-OR(Orange) and the socket at contact J1-58 from the harness connector.
- C. Reconnect the machine harness J1 connector to the ECM.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Use a 7X - 1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the ECM pin at J1-58 through the empty space in the J1 connector.
- F. Observe the status of the active CID 1405 FMI 05 diagnostic code and ground the other end of the 7X - 1710 Multimeter Probe to frame ground.

Expected Result:

The CID 1405 FMI 05 diagnostic code is no longer active. A CID 1405 FMI 06 diagnostic code becomes active when the ECM pin at J1-58 is grounded.

Results:

- YES – The CID 1405 FMI 05 diagnostic code is no longer active. A CID 1405 FMI 06 diagnostic code has been activated after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition in the solenoid circuit. The ECM is most likely not the cause of the problem. Reinstall the energize wire of the solenoid into the correct spot in the ECM connector. Proceed to the next test step. Proceed to Test Step 4.
- NO – The CID 1405 FMI 05 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin for the solenoid is grounded.

Repair: The ECM has not responded correctly to the grounded condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 1405 FMI 05 diagnostic code.

Expected Result:

The CID 1405 FMI 05 diagnostic code is active.

Results:

- YES – The CID 1405 FMI 05 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed. This is unlikely as the ECM responded correctly to the grounded condition in the previous test step.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1405 FMI 05 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02919347

MID 027 - CID 1405 - FMI 06

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

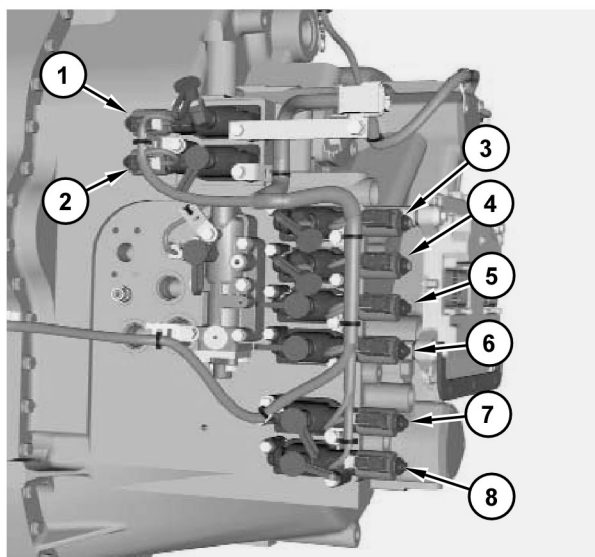


Illustration 242

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

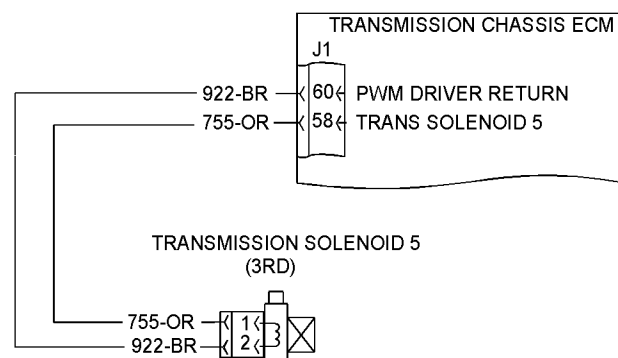


Illustration 243

g01288881

Connections of "Transmission Solenoid 5"

This diagnostic code is associated with the "transmission solenoid 5". The FMI 06 means that the Transmission/Chassis ECM has determined that the current of the solenoid circuit is above normal.

Some possible causes of this diagnostic code are listed:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that the connections are secure and that the connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- B.** Observe the status of the diagnostic code.
- C.** Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

The active CID 1405 FMI 06 diagnostic code changes to a CID 1405 FMI 05 diagnostic code when the solenoid is disconnected.

Results:

- YES – The active CID 1405 FMI 06 diagnostic code changes to a CID 1405 FMI 05 diagnostic code when the solenoid is disconnected. The circuit is correct.

Repair: The solenoid has failed. Repeat this test "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid.

STOP.

- NO – The CID 1405 FMI 06 remains active when the solenoid is disconnected. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND

- Turn the key start switch and the disconnect switch to the OFF position.
- The solenoid remains disconnected from the machine harness.
- Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- At the machine harness connectors of the ECM, measure the resistance between contact J1-58 (wire 755-OR(Orange)) and frame ground. Measure the resistance between contact J1-58 (wire 755-OR(Orange)) and all of the other J1 and J2 contacts that are used in the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness. The short is between wire 755-OR(Orange) and the circuit with the low resistance measurement.

Repair: Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 1405 FMI 06 diagnostic code.

Expected Result:

The CID 1405 FMI 06 diagnostic code is still active.

Results:

- YES – The CID 1405 FMI 06 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1405 FMI 06 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection

or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02572927

MID 027 - CID 1405 - FMI 13

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

This diagnostic code is associated with the transmission solenoid 5. The FMI 13 diagnostic code is activated when the ECM detects that the solenoid needs calibration.

Note: Before performing this procedure, verify that no other active CID 1405 diagnostic codes exist for the solenoid. If any other diagnostic codes are active for the solenoid, correct the problem before performing this procedure.

CALIBRATION

- A. Perform the calibration procedure for the solenoid. Refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

Expected Result:

The calibration procedure was performed successfully.

Results:

- YES – The calibration procedure was performed successfully. Resume normal machine operation.

STOP.

- NO – The calibration was not successful.

Repair: Repeat the calibration procedure for the solenoid.

If the second calibration procedure is not successful, replace the solenoid. After solenoid replacement, refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure. If the problem is still present after replacement and calibration of the new solenoid, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02919432

MID 027 - CID 1406 - FMI 03

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

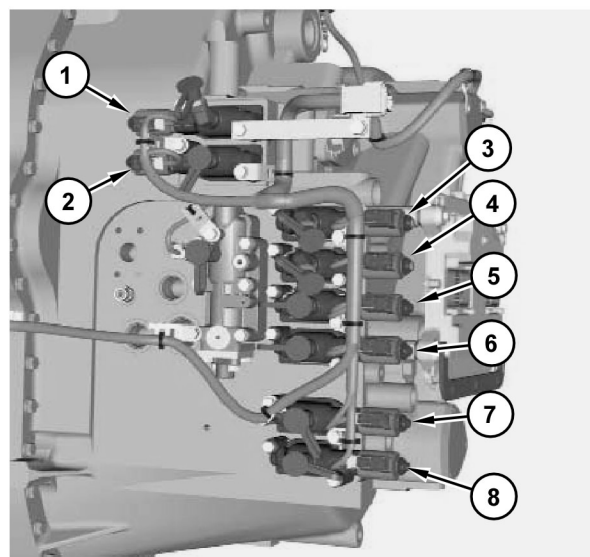


Illustration 244

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

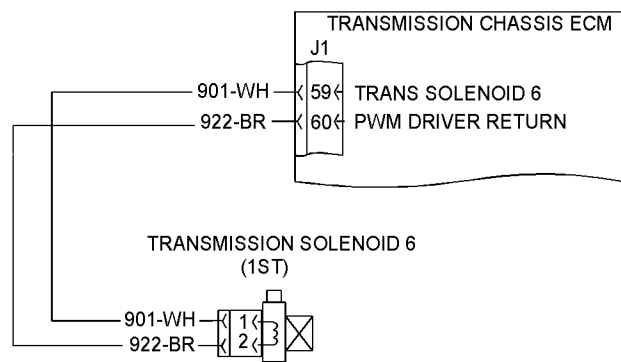


Illustration 245

g01288904

Connections for "Transmission Solenoid 6"

This diagnostic code is associated with the "transmission solenoid 6". The FMI 03 means that the Transmission/Chassis ECM has determined that the voltage of the solenoid circuit is above normal.

Conditions that can cause this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to another voltage source.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the solenoid. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.

C. At the machine harness connector J1 of the ECM, measure the resistance between contact J1-59 (wire 901-WH(White)) and all J1 and J2 contacts that are used on the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- **OK** – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- **NOT OK** – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between wire 901-WH(White) and the circuit that has a low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoid and the ECM remain disconnected.

- At the machine harness connector J1 for the ECM, use a 151-6320 Removal Tool to remove the energize wire of the solenoid 901-WH(White) and the socket at contact J1-59 from the harness connector.
- Reconnect the machine harness J1 and J2 connectors to the ECM.
- Turn the disconnect switch and the key start switch to the ON position.
- Observe the status of the active CID 1406 FMI 03 diagnostic code.

Expected Result:

The CID 1406 FMI 03 diagnostic code is no longer active. A CID 1406 FMI 05 diagnostic code is now active.

Results:

- **YES** – The CID 1406 FMI 03 diagnostic code is no longer active. A CID 1406 FMI 05 diagnostic code

has been activated after the energize circuit of the solenoid was disconnected. The ECM has responded correctly to the open circuit condition in the solenoid circuit. Install the energize wire of the solenoid into the correct space of the ECM connector. Proceed to the next test step. Proceed to Test Step 3.

- NO – The CID 1406 FMI 03 diagnostic code remains active. The status of the active diagnostic code did not change when the energize wire of the solenoid was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Determine if the CID 1406 FMI 03 diagnostic code is active.

Expected Result:

The CID 1406 FMI 03 diagnostic code is active.

Results:

- YES – The CID 1406 FMI 03 diagnostic code is active.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle

test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the problem remains, the ECM may have failed. This is unlikely because the ECM detected the open circuit condition in the solenoid circuit and activated the FMI 05 diagnostic code when the solenoid energize wire was disconnected.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1406 FMI 03 code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02919497

MID 027 - CID 1406 - FMI 05

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

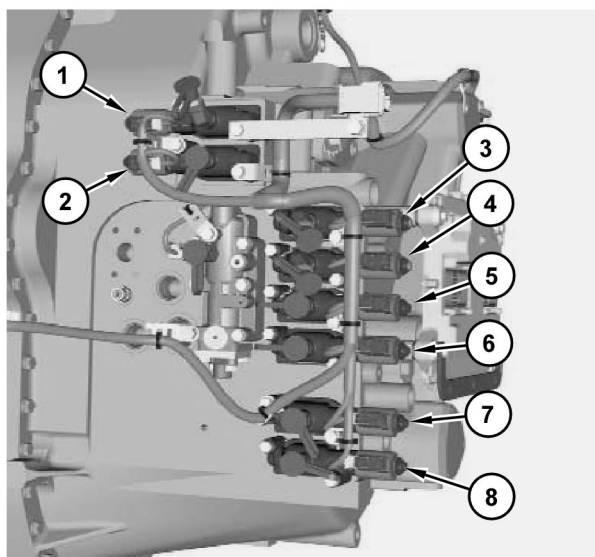


Illustration 246

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

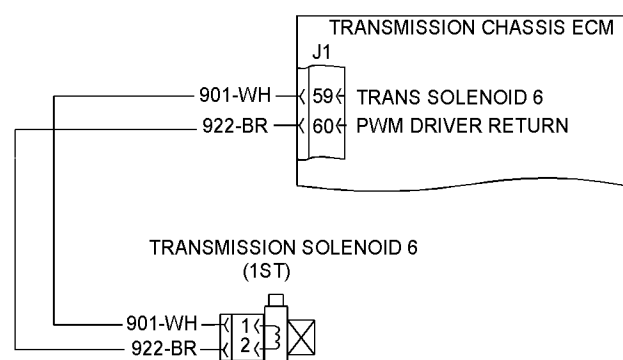


Illustration 247

g01288904

Connections of "Transmission Solenoid 6"

This diagnostic code is associated with the "transmission solenoid 6". The FMI 05 means that the Transmission/Chassis ECM has determined that the current for the solenoid circuit is below normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- A.** Disconnect the solenoid from the machine harness.
- B.** At the machine harness connector for the solenoid, place a jumper wire between contact 1 (wire 901-WH(White)) and contact 2 (wire 922-BR(Brown)).
- C.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D.** Observe the status of the CID 1406 FMI 05 diagnostic code.

Expected Result:

The active diagnostic code changes from an FMI "05" to an FMI "06" diagnostic code when the jumper wire is installed.

Results:

- YES – The active diagnostic code changes from an FMI "05" to an FMI "06" diagnostic code when the jumper wire is installed. The solenoid has failed.

Repair: The solenoid has failed. Repeat this Test Step "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

STOP.

- NO – The CID 1406 FMI 05 diagnostic code remains active. The jumper wire does not affect the status of the diagnostic code. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR AN OPEN

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector J1 from the Transmission/Chassis ECM.
- The jumper wire that was installed in the previous Test Step remains in place.
- At the machine harness connector J1 for the Transmission/Chassis ECM, measure the resistance between the contact for the return wire J1-60 (wire 922-BR(Brown)) and the contact for the energize wire J1-59 (wire 901-WH(White)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The measurement of the resistance is less than 5 ohms. The circuit is not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5000 ohms. The resistance measurement is not correct. There is an open or a bad connection in the machine harness.

Repair: A resistance measurement that is much greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

The open or a possible poor connection is in supply wire 901-WH(White) or in return wire 922-BR(Brown) of the machine harness. Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the solenoid circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connector for the solenoid and the ECM J1 connector remain disconnected.

- Remove the jumper wire that was installed in the last test step.
- At the machine harness connector J1 for the ECM, use a 151 - 6320 Removal Tool to remove the energize wire of the solenoid 901-WH(White) and the socket at contact J1-59 from the harness connector.
- Reconnect the machine harness J1 connector to the ECM.
- Turn the disconnect switch and the key start switch to the ON position.
- Use a 7X - 1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the ECM pin at J1-59 through the empty space in the J1 connector.
- Observe the status of the active CID 1406 FMI 05 diagnostic code and ground the other end of the 7X - 1710 Multimeter Probe to frame ground.

Expected Result:

The CID 1406 FMI 05 diagnostic code is no longer active. A CID 1406 FMI 06 diagnostic code becomes active when the ECM pin at J1-59 is grounded.

Results:

- YES – The CID 1406 FMI 05 diagnostic code is no longer active. A CID 1406 FMI 06 diagnostic code has been activated after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition in the solenoid circuit. The ECM is most likely not causing the problem. Reinstall the disconnected solenoid energize wire back into the correct spot in the ECM connector before proceeding to the next test step. Proceed to Test Step 4.
- NO – The CID 1406 FMI 05 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin for the solenoid is grounded.

Repair: The ECM has not responded correctly to the grounded condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 1406 FMI 05 diagnostic code.

Expected Result:

The CID 1406 FMI 05 diagnostic code is active.

Results:

- YES – The CID 1406 FMI 05 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed. This is unlikely as the ECM responded correctly to the grounded condition in the previous test step.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1406 FMI 05 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02919526

MID 027 - CID 1406 - FMI 06

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

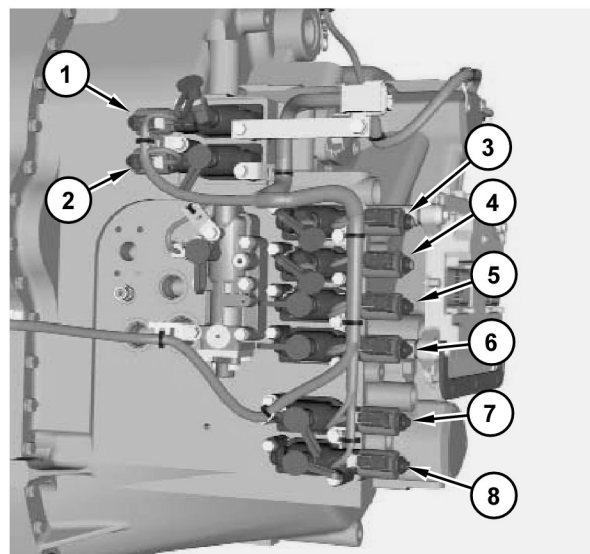


Illustration 248

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1" (forward high)
- (2) "Transmission solenoid 2" (forward low)
- (3) "Transmission solenoid 3" (reverse)
- (4) "Transmission solenoid 4" (2nd speed)
- (5) "Transmission solenoid 5" (3rd speed)
- (6) "Transmission solenoid 6" (1st speed)
- (7) "Transmission solenoid 7" (low range)
- (8) "Transmission solenoid 8" (high range)

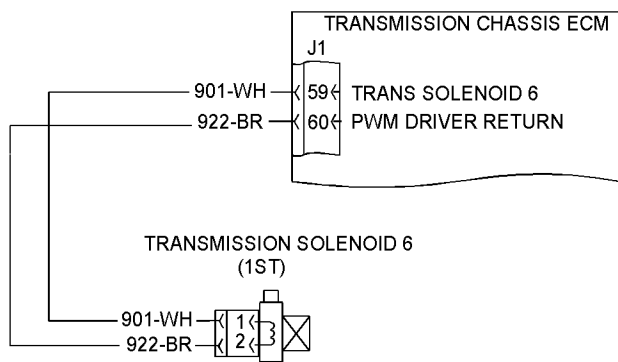


Illustration 249

g01288904

Connection for "Transmission Solenoid 6"

This diagnostic code is associated with the "transmission solenoid 6". The FMI 06 means that the Transmission/Chassis ECM has determined that the current of the solenoid circuit is above normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- Observe the status of the diagnostic code.
- Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

The active CID 1406 FMI 06 diagnostic code changes to a CID 1406 FMI 05 diagnostic code when the solenoid is disconnected.

Results:

- YES – The active CID 1406 FMI 06 diagnostic code changes to a CID 1406 FMI 05 diagnostic code when the solenoid is disconnected. The circuit is correct.

Repair: The solenoid has failed. Repeat this test "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid.

STOP.

- NO – The CID 1406 FMI 06 remains active when the solenoid is disconnected. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND

- Turn the key start switch and the disconnect switch to the OFF position.
- The solenoid remains disconnected from the machine harness.
- Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- At the machine harness connectors of the ECM, measure the resistance between the contact J1-59 (wire 901-WH(White)) and frame ground. Measure the resistance from the contact J1-59 (wire 901-WH(White)) to all of the other J1 and J2 contacts that are used in the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness. The short is between wire 901-WH(White) and the circuit with the low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to

Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 1406 FMI 06 diagnostic code.

Expected Result:

The CID 1406 FMI 06 diagnostic code is still active.

Results:

- YES – The CID 1406 FMI 06 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1406 FMI 06 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02572930

MID 027 - CID 1406 - FMI 13

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

This diagnostic code is associated with the transmission solenoid 6. The FMI 13 diagnostic code is activated when the ECM detects that the solenoid needs calibration.

Note: Before performing this procedure, verify that no other active CID 1406 diagnostic codes exist for the solenoid. If any other diagnostic codes are active for the solenoid, correct the problem before performing this procedure.

CALIBRATION

- A. Perform the calibration procedure for the solenoid. Refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

Expected Result:

The calibration procedure was performed successfully.

Results:

- YES – The calibration procedure was performed successfully. Resume normal machine operation.

STOP.

- NO – The calibration was not successful.

Repair: Repeat the calibration procedure for the solenoid.

If the second calibration procedure is not successful, replace the solenoid. After solenoid replacement, refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure. If the problem is still present after replacement and calibration of the new solenoid, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02919722

MID 027 - CID 1407 - FMI 03

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

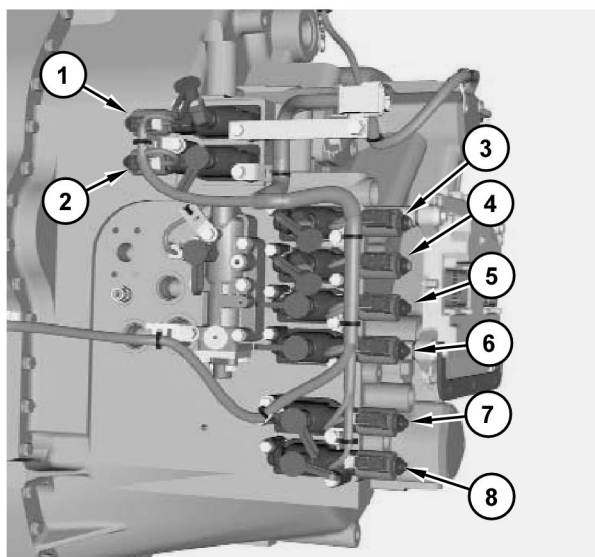


Illustration 250

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1 (forward high)"
- (2) "Transmission solenoid 2 (forward low)"
- (3) "Transmission solenoid 3 (reverse)"
- (4) "Transmission solenoid 4 (2nd speed)"
- (5) "Transmission solenoid 5 (3rd speed)"
- (6) "Transmission solenoid 6 (1st speed)"
- (7) "Transmission solenoid 7 (low range)"
- (8) "Transmission solenoid 8 (high range)"

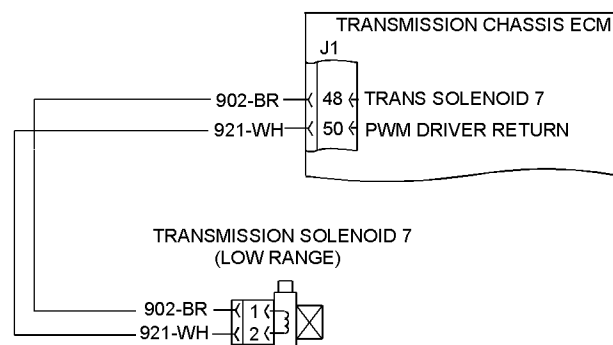


Illustration 251

g01288939

Connections for "Transmission Solenoid 7"

This diagnostic code is associated with the "transmission solenoid 7". The FMI 03 means that the Transmission/Chassis ECM has determined that the voltage of the solenoid circuit is above normal.

Conditions that can cause this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to another voltage source.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25°C (77.0°F).

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT

- A.** Turn the key start switch and the disconnect switch to the OFF position.
- B.** Disconnect the machine harness connector from the solenoid. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.

- C.** At the machine harness connector J1 of the ECM, measure the resistance between contact J1-48 (wire 902-BR(Brown)) and all of the J1 and J2 contacts that are used on the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between wire 902-BR(Brown) and the circuit that has a low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoid and the ECM remain disconnected.

- A.** At the machine harness connector J1 for the ECM, use a 151-6320 Removal Tool to remove the energize wire of the solenoid 902-BR(Brown) and the socket at contact J1-48 from the harness connector.
- B.** Reconnect the machine harness J1 and J2 connectors to the ECM.
- C.** Turn the disconnect switch and the key start switch to the ON position.
- D.** Observe the status of the active CID 1407 FMI 03 diagnostic code.

Expected Result:

The CID 1407 FMI 03 diagnostic code is no longer active. A CID 1407 FMI 05 diagnostic code is now active.

Results:

- YES – The CID 1407 FMI 03 diagnostic code is no longer active. A CID 1407 FMI 05 diagnostic code has been activated after the solenoid energize circuit was disconnected. The ECM has responded correctly to the open circuit condition in the solenoid circuit. Install the energize wire of the solenoid into the correct space of the ECM connector. Proceed to the next test step. Proceed to Test Step 3.
- NO – The CID 1407 FMI 03 diagnostic code remains active. The status of the active diagnostic code did not change when the solenoid energize wire was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Determine if the CID 1407 FMI 03 diagnostic code is active.

Expected Result:

The CID 1407 FMI 03 diagnostic code is active.

Results:

- YES – The CID 1407 FMI 03 diagnostic code is active.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service

tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the problem remains, the ECM may have failed. This is unlikely because the ECM detected the open circuit condition in the solenoid circuit and activated the FMI 05 diagnostic code when the solenoid energize wire was disconnected.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1407 FMI 03 code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02919734

MID 027 - CID 1407 - FMI 05

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

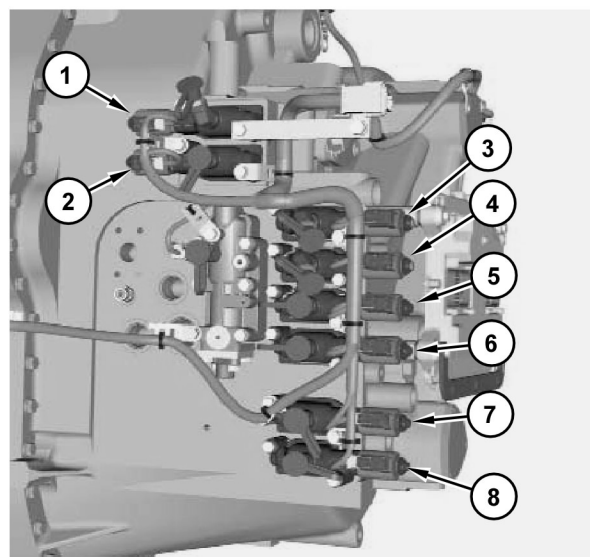


Illustration 252

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1 (forward high)"
- (2) "Transmission solenoid 2 (forward low)"
- (3) "Transmission solenoid 3 (reverse)"
- (4) "Transmission solenoid 4 (2nd speed)"
- (5) "Transmission solenoid 5 (3rd speed)"
- (6) "Transmission solenoid 6 (1st speed)"
- (7) "Transmission solenoid 7 (low range)"
- (8) "Transmission solenoid 8 (high range)"

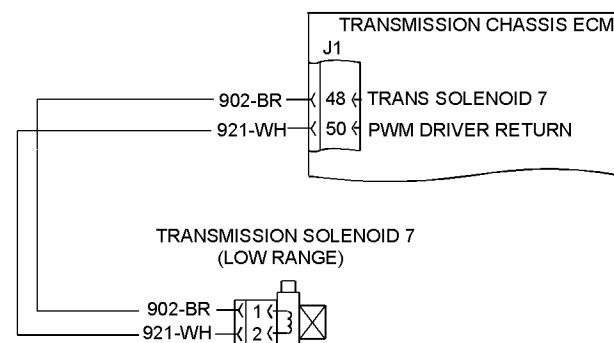


Illustration 253

g01288939

Connections of "Transmission Solenoid 7"

This diagnostic code is associated with the "transmission solenoid 7". The FMI 05 means that the Transmission/Chassis ECM has determined that the current for the solenoid circuit is below normal.

Diagnostic Code Procedures

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- A. Disconnect the solenoid from the machine harness.
- B. At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire 902-BR(Brown)) to contact 2 (wire 921-WH(White)).
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the CID 1407 FMI 05 diagnostic code.

Expected Result:

The active diagnostic code changes from an FMI "05" to an FMI "06" diagnostic code when the jumper wire is installed.

Results:

- YES – The active diagnostic code changes from an FMI "05" diagnostic code to an FMI "06" diagnostic code when the jumper wire is installed. The solenoid has failed.

Repair: The solenoid has failed. Repeat this Test Step "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

STOP.

- NO – The CID 1407 FMI 05 diagnostic code remains active. The jumper wire does not affect the status of the diagnostic code. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR AN OPEN

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector J1 from the Transmission/Chassis ECM.
- C. The jumper wire that was installed in the previous test step remains in place.
- D. At the machine harness connector J1 for the Transmission/Chassis ECM, measure the resistance from the return, contact J1-50 (wire 921-WH(White)), to the energize contact J1-48 (wire 902-BR(Brown)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The measurement of the resistance is less than 5 ohms. The circuit is not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5000 ohms. The resistance measurement is not correct. There is an open or a bad connection in the machine harness.

Repair: A resistance measurement that is much greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

The open or the possible poor connection is in supply wire 902-BR(Brown) or in return wire 921-WH(White) of the machine harness. Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the solenoid circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connector for the solenoid and the ECM J1 connector remain disconnected.

- A. Remove the jumper wire that was installed in the last test step.
- B. At the machine harness connector J1 for the ECM, use a 151 - 6320 Removal Tool to remove the energize wire of the solenoid 902-BR(Brown) and the socket at contact J1-48 from the harness connector.
- C. Reconnect the machine harness J1 connector to the ECM.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Use a 7X - 1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the ECM pin at J1-48 through the empty space in the J1 connector.
- F. Observe the status of the active CID 1407 FMI 05 diagnostic code and ground the other end of the 7X - 1710 Multimeter Probe to frame ground.

Expected Result:

The CID 1407 FMI 05 diagnostic code is no longer active. A CID 1407 FMI 06 diagnostic code becomes active when the ECM pin at J1-48 is grounded.

Results:

- YES – The CID 1407 FMI 05 diagnostic code is no longer active. A CID 1407 FMI 06 diagnostic code has been activated after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition in the solenoid circuit. The ECM is most likely not causing the problem. Reinstall the disconnected solenoid energize wire back into the correct spot in the ECM connector before proceeding to the next test step. Proceed to Test Step 4.
- NO – The CID 1407 FMI 05 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin for the solenoid is grounded.

Repair: The ECM has not responded correctly to the grounded condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 1407 FMI 05 diagnostic code.

Expected Result:

The CID 1407 FMI 05 diagnostic code is active.

Results:

- YES – The CID 1407 FMI 05 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed. This is unlikely as the ECM responded correctly to the grounded condition in the previous test step.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1407 FMI 05 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02919865

MID 027 - CID 1407 - FMI 06

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

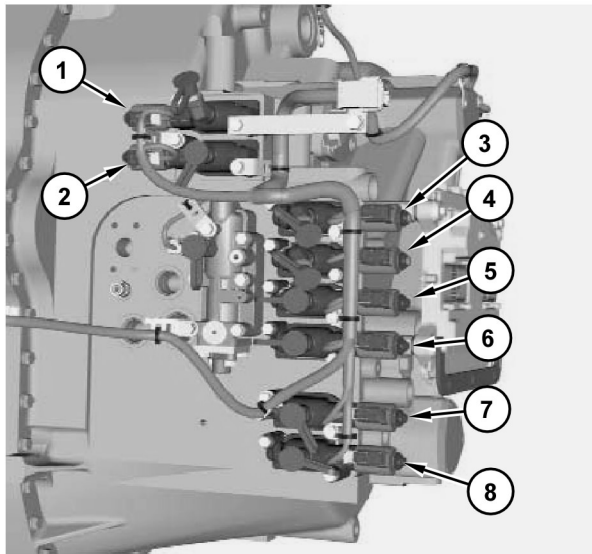


Illustration 254

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1 (forward high)"
- (2) "Transmission solenoid 2 (forward low)"
- (3) "Transmission solenoid 3 (reverse)"
- (4) "Transmission solenoid 4 (2nd speed)"
- (5) "Transmission solenoid 5 (3rd speed)"
- (6) "Transmission solenoid 6 (1st speed)"
- (7) "Transmission solenoid 7 (low range)"
- (8) "Transmission solenoid 8 (high range)"

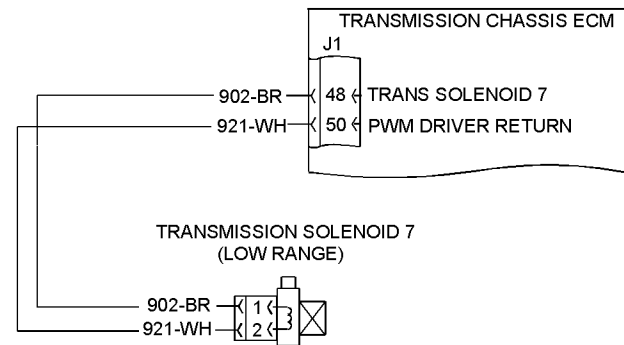


Illustration 255

g01288939

Connections for "Transmission Solenoid 7"

This diagnostic code is associated with the "transmission solenoid 7". The FMI 06 means that the Transmission/Chassis ECM has determined that the current of the solenoid circuit is above normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25°C (77.0°F).

Test Step 1. CHECK THE SOLENOID

- A.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- B.** Observe the status of the diagnostic code.
- C.** Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

The active CID 1407 FMI 06 diagnostic code changes to a CID 1407 FMI 05 diagnostic code when the solenoid is disconnected.

Results:

- YES – The active CID 1407 FMI 06 diagnostic code changes to a CID 1407 FMI 05 diagnostic code when the solenoid is disconnected. The circuit is correct.

Repair: The solenoid has failed. Repeat this test "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid.

STOP.

- NO – The CID 1407 FMI 06 remains active when the solenoid is disconnected. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND

- Turn the key start switch and the disconnect switch to the OFF position.
- The solenoid remains disconnected from the machine harness.
- Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- At the machine harness connectors of the ECM, measure the resistance from the contact J1-48 (wire 902-BR(Brown)) to frame ground. Measure the resistance from the contact J1-48 (wire 902-BR(Brown)) to all of the other J1 and J2 contacts that are used in the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness. The short is between wire 902-BR(Brown) and the circuit with the low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to

Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 1407 FMI 06 diagnostic code.

Expected Result:

The CID 1407 FMI 06 diagnostic code is still active.

Results:

- YES – The CID 1407 FMI 06 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a "wiggle test" on the wiring harness of the machine. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Diagnostic Code Procedures

- NO – The CID 1407 FMI 06 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02572933

MID 027 - CID 1407 - FMI 13

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

This diagnostic code is associated with the transmission solenoid 7. The FMI 13 diagnostic code is activated when the ECM detects that the solenoid needs calibration.

Note: Before performing this procedure, verify that no other active CID 1407 diagnostic codes exist for the solenoid. If any other diagnostic codes are active for the solenoid, correct the problem before performing this procedure.

CALIBRATION

- A.** Perform the calibration procedure for the solenoid. Refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

Expected Result:

The calibration procedure was performed successfully.

Results:

- YES – The calibration procedure was performed successfully. Resume normal machine operation.

STOP.

- NO – The calibration was not successful.

Repair: Repeat the calibration procedure for the solenoid.

If the second calibration procedure is not successful, replace the solenoid. After solenoid replacement, refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure. If the problem is still present after replacement and calibration of the new solenoid, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02919872

MID 027 - CID 1408 - FMI 03

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

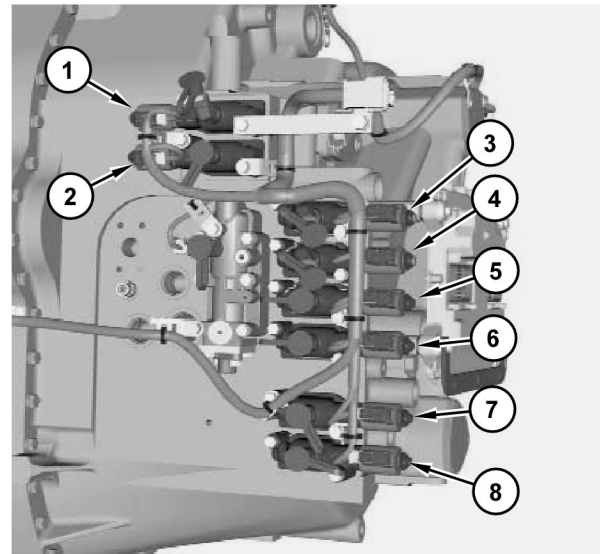


Illustration 256

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1 (forward high)"
- (2) "Transmission solenoid 2 (forward low)"
- (3) "Transmission solenoid 3 (reverse)"
- (4) "Transmission solenoid 4 (2nd speed)"
- (5) "Transmission solenoid 5 (3rd speed)"
- (6) "Transmission solenoid 6 (1st speed)"
- (7) "Transmission solenoid 7 (low range)"
- (8) "Transmission solenoid 8 (high range)"

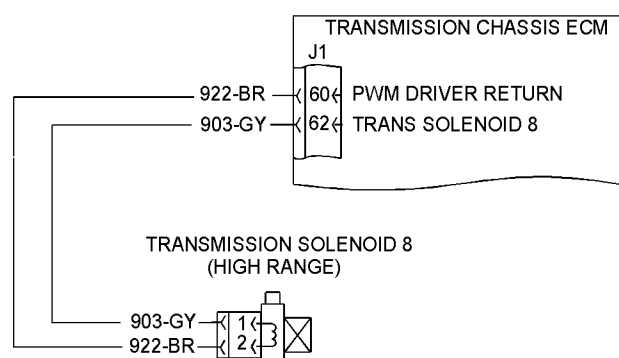


Illustration 257

g01288948

Connections for "Transmission Solenoid 8"

This diagnostic code is associated with the "transmission solenoid 8". The FMI 03 means that the Transmission/Chassis ECM has determined that the voltage of the solenoid circuit is above normal.

Conditions that can cause this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to another voltage source.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the solenoid. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.

- At the machine harness connector J1 of the ECM, measure the resistance from contact J1-62 (wire 903-GY(Grey)) to all J1 and J2 contacts that are used on the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between wire 903-GY(Grey) and the circuit that has a low resistance measurement.

Repair: Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoid and the ECM remain disconnected.

- At the machine harness connector J1 for the ECM, use a 151 - 6320 Removal Tool to remove the solenoid energize wire 903-GY(Grey) and the socket at contact J1-62 from the harness connector.
- Reconnect the machine harness J1 and J2 connectors to the ECM.
- Turn the disconnect switch and the key start switch to the ON position.
- Observe the status of the active CID 1408 FMI 03 diagnostic code.

Expected Result:

The CID 1408 FMI 03 diagnostic code is no longer active. A CID 1408 FMI 05 diagnostic code is now active.

Results:

- YES – The CID 1408 FMI 03 diagnostic code is no longer active. A CID 1408 FMI 05 diagnostic code has been activated after the solenoid energize circuit was disconnected. The ECM has responded correctly to the open circuit condition in

Diagnostic Code Procedures

the solenoid circuit. Reinstall the disconnected solenoid energize wire back into the correct space in the ECM connector before proceeding to the next test step. Proceed to Test Step 3.

- NO – The CID 1408 FMI 03 diagnostic code remains active. The status of the active diagnostic code did not change when the solenoid energize wire was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Determine if the CID 1408 FMI 03 diagnostic code is active.

Expected Result:

The CID 1408 FMI 03 diagnostic code is active.

Results:

- YES – The CID 1408 FMI 03 diagnostic code is active.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the problem remains, the ECM may have failed. This is unlikely because the ECM detected the open circuit condition in the solenoid circuit and activated the FMI 05 diagnostic code when the solenoid energize wire was disconnected.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1408 FMI 03 code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02919878

MID 027 - CID 1408 - FMI 05

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

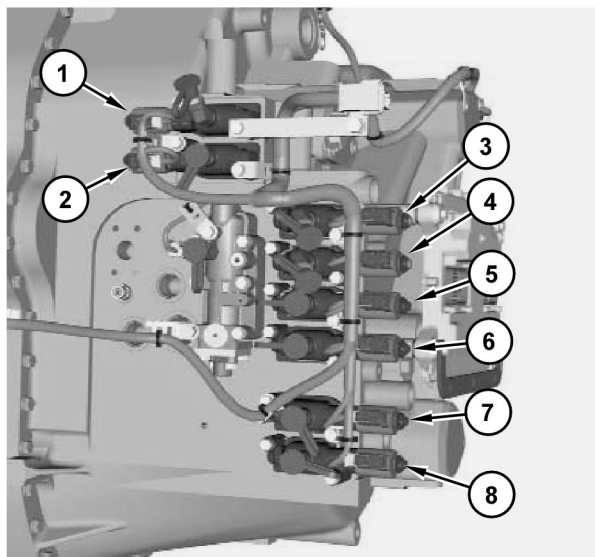


Illustration 258

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1 (forward high)"
- (2) "Transmission solenoid 2 (forward low)"
- (3) "Transmission solenoid 3 (reverse)"
- (4) "Transmission solenoid 4 (2nd speed)"
- (5) "Transmission solenoid 5 (3rd speed)"
- (6) "Transmission solenoid 6 (1st speed)"
- (7) "Transmission solenoid 7 (low range)"
- (8) "Transmission solenoid 8 (high range)"

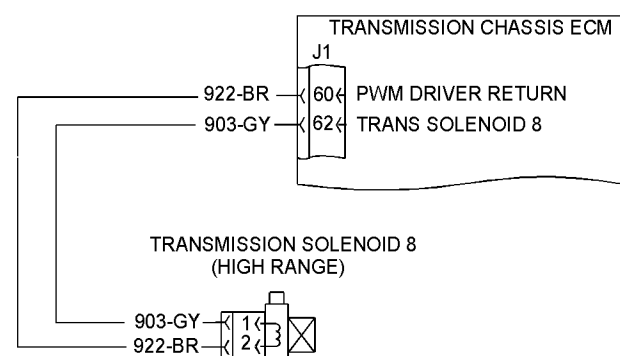


Illustration 259

g01288948

Connections for "Transmission Solenoid 8"

This diagnostic code is associated with the "transmission solenoid 8". The FMI 05 means that the Transmission/Chassis ECM has determined that the current for the solenoid circuit is below normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- A.** Disconnect the solenoid from the machine harness.
- B.** At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire 903-GY(Grey)) to contact 2 (wire 922-BR(Brown)).
- C.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D.** Observe the status of the CID 1408 FMI 05 diagnostic code.

Expected Result:

The active diagnostic code changes from an FMI "05" diagnostic code to an FMI "06" diagnostic code after the jumper wire is installed.

Results:

- YES – The active diagnostic code changes from an FMI "05" diagnostic code to an FMI "06" diagnostic code when the jumper wire is installed. The solenoid has failed.

Repair: The solenoid has failed. Repeat this Test Step "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

STOP.

- NO – The CID 1408 FMI 05 diagnostic code remains active. The jumper wire does not affect the status of the diagnostic code. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR AN OPEN

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector J1 from the Transmission/Chassis ECM.
- The jumper wire that was installed in the previous Test Step remains in place.
- At the machine harness connector J1 for the Transmission/Chassis ECM, measure the resistance from the return contact J1-60 (wire 922-BR(Brown)) to the energize contact J1-62 (wire 903-GY(Grey)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The measurement of the resistance is less than 5 ohms. The circuit is not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5000 ohms. The resistance measurement is not correct. There is an open or a bad connection in the machine harness. A resistance measurement that is much greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

Repair: The open or the possible poor connection is in supply wire 903-GY(Grey) or in return wire 922-BR(Brown) of the machine harness. Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the solenoid circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connector for the solenoid and the ECM J1 connector remain disconnected.

- Remove the jumper wire that was installed in the last test step.
- At the machine harness connector J1 for the ECM, use a 151 - 6320 Removal Tool to remove the energize wire of the solenoid 903-GY(Grey) and the socket at contact J1-62 from the harness connector.
- Reconnect the machine harness J1 connector to the ECM.
- Turn the disconnect switch and the key start switch to the ON position.
- Use a 7X - 1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the ECM pin at J1-62 through the empty space in the J1 connector.
- Observe the status of the active CID 1408 FMI 05 diagnostic code and ground the other end of the 7X - 1710 Multimeter Probe to frame ground.

Expected Result:

The CID 1408 FMI 05 diagnostic code is no longer active. A CID 1408 FMI 06 diagnostic code becomes active when the ECM pin at J1-62 is grounded.

Results:

- YES – The CID 1408 FMI 05 diagnostic code is no longer active. A CID 1408 FMI 06 diagnostic code has been activated after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition in the solenoid circuit. The cause of the problem is probably not the ECM. Reinstall the disconnected solenoid energize wire back into the correct spot in the ECM connector before proceeding to the next test step. Proceed to Test Step 4.
- NO – The CID 1408 FMI 05 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin for the solenoid is grounded.

Repair: The ECM has not responded correctly to the grounded condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 1408 FMI 05 diagnostic code.

Expected Result:

The CID 1408 FMI 05 diagnostic code is active.

Results:

- YES – The CID 1408 FMI 05 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed. This is unlikely as the ECM responded correctly to the grounded condition in the previous test step.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1408 FMI 05 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02919894

MID 027 - CID 1408 - FMI 06

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

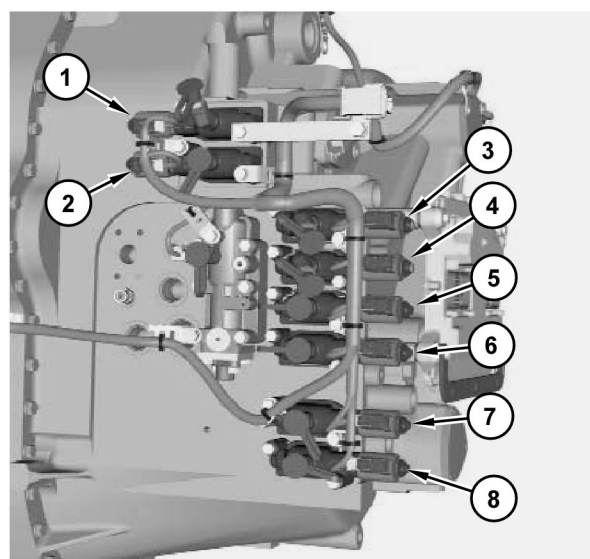


Illustration 260

g01321566

Transmission Solenoids are located on the left side of the transmission.

- (1) "Transmission solenoid 1 (forward high)"
- (2) "Transmission solenoid 2 (forward low)"
- (3) "Transmission solenoid 3 (reverse)"
- (4) "Transmission solenoid 4 (2nd speed)"
- (5) "Transmission solenoid 5 (3rd speed)"
- (6) "Transmission solenoid 6 (1st speed)"
- (7) "Transmission solenoid 7 (low range)"
- (8) "Transmission solenoid 8 (high range)"

This diagnostic code is associated with the "transmission solenoid 8". The FMI 06 means that the Transmission/Chassis ECM has determined that the current of the solenoid circuit is above normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.

- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- Observe the status of the diagnostic code.
- Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

The active CID 1408 FMI 06 diagnostic code changes to a CID 1408 FMI 05 diagnostic code when the solenoid is disconnected.

Results:

- YES – The active CID 1408 FMI 06 diagnostic code changes to a CID 1408 FMI 05 diagnostic code when the solenoid is disconnected. The circuit is correct.

Repair: The solenoid has failed. Repeat this test "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid.

STOP.

- NO – The CID 1408 FMI 06 remains active when the solenoid is disconnected. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND

- Turn the key start switch and the disconnect switch to the OFF position.
- The solenoid remains disconnected from the machine harness.

- Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.

- At the machine harness connectors of the ECM, measure the resistance from the contact J1-48 (wire 903-GY(Grey)) to frame ground. Measure the resistance from the contact J1-48 (wire 903-GY(Grey)) to all of the other J1 and J2 contacts that are used in the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness. The short is between wire 903-GY(Grey) and the circuit with the low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 1408 FMI 06 diagnostic code.

Expected Result:

The CID 1408 FMI 06 diagnostic code is still active.

Results:

- YES – The CID 1408 FMI 06 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1408 FMI 06 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- A. Perform the calibration procedure for the solenoid. Refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

Expected Result:

The calibration procedure was performed successfully.

Results:

- YES – The calibration procedure was performed successfully. Resume normal machine operation.

STOP.

- NO – The calibration was not successful.

Repair: Repeat the calibration procedure for the solenoid.

If the second calibration procedure is not successful, replace the solenoid. After solenoid replacement, refer to Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure. If the problem is still present after replacement and calibration of the new solenoid, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02572937

MID 027 - CID 1408 - FMI 13

SMCS Code: 3139-038-T3

Conditions Which Generate This Code:

This diagnostic code is associated with the transmission solenoid 8. The FMI 13 diagnostic code is activated when the ECM detects that the solenoid needs calibration.

Note: Before performing this procedure, verify that no other active CID 1408 diagnostic codes exist for the solenoid. If any other diagnostic codes are active for the solenoid, correct the problem before performing this procedure.

CALIBRATION

i02919918

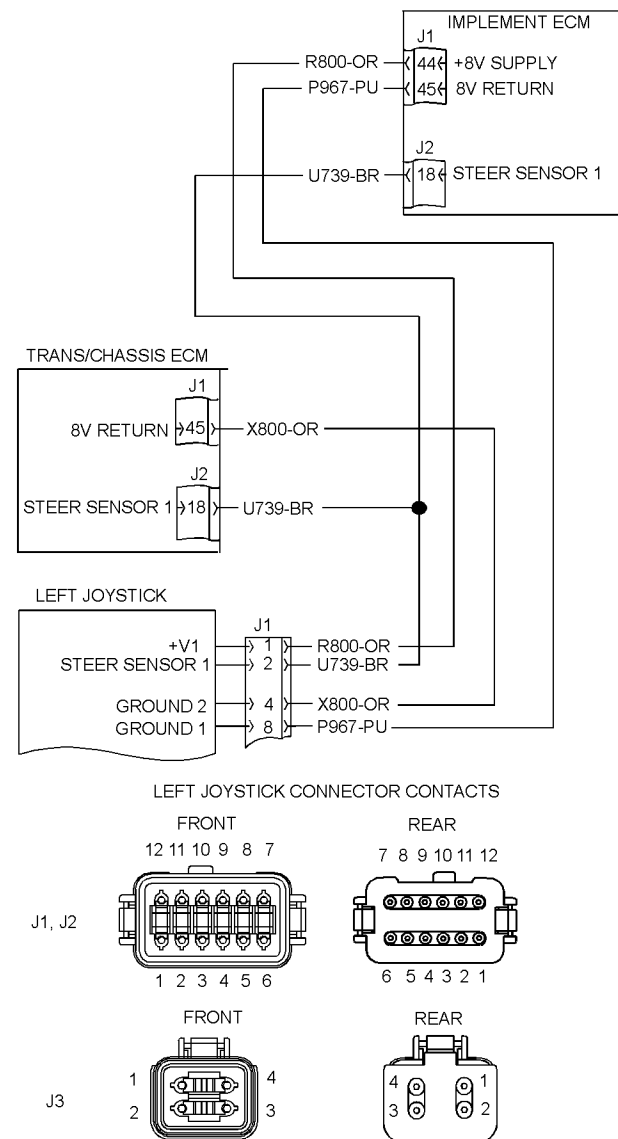
MID 027 - CID 1471 - FMI 02**SMCS Code:** 5737-038-ZH**Conditions Which Generate This Code:**

Illustration 261

g01243832

Connections for "Steer Sensor 1"

Three steering position sensors are required for correct operation of the steering control. The steering position sensors are located in the assembly of the left joystick. Each sensor provides an input signal to the Implement ECM and to the Transmission/Chassis ECM. This diagnostic code is activated when the ECM reads the input signal from the steering position sensor 1 and the signal is erratic or intermittent.

The steering position sensor 1 receives power from the 8 volt power supply of the Implement ECM. Steering position sensor 1 is internally connected to the ground that is supplied by the 8 volt sensor return of the Transmission/Chassis ECM (ground of the ECM) and to the ground that is supplied by the 8 volt sensor return of the Implement ECM (ground of the ECM). The steering sensor must lose both grounds in order to lose a ground connection. The illustration above indicates the power and ground connections for the steering sensor 1.

The position sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The position sensor sends a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The duty cycle of the signal will vary from approximately $10 \pm 5\%$ at the full left position of the joystick to approximately $90 \pm 5\%$ at the full right position of the joystick. When the joystick is in the center position, the duty cycle will be approximately 50%.

The possible causes of this diagnostic code are listed:

- The sensor has failed.
- An Intermittent connection exists in the sensor circuit.
- The signal circuit is shorted to another circuit in the machine harness.
- The ECM has failed. This is unlikely.

Consider the following points when this code is active:

- If a CID 0041 diagnostic code for the 8 volt power supply has been activated by the Implement ECM (MID 082), investigate the problem and fix the problem before proceeding with this procedure.
- The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the steering sensor 1. Both ECM modules can activate a CID 1471 FMI 02 diagnostic code when the signal is erratic or intermittent.
- When one of the ECM modules has activated a CID 1471 FMI 02 diagnostic code and the other ECM module has not, the probability is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected.
- When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause.
- If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem.

- For either condition, proceed with this procedure in order to verify the cause of the problem.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE POWER SUPPLY CIRCUIT OF THE SENSOR

- Turn the disconnect switch and the key start switch to the ON position.
- At the J1 harness connector for the left joystick, insert 7X-1710 Multimeter Probes along the contact for the power supply J1-1 (wire R800-OR(Orange)) and along ground 1 contact J1-8 (wire P967-PU(Purple)). Do not disconnect the machine harness from the J1 connector.
- Measure the DC voltage.
- At the harness connectors for the left joystick, remove the multimeter probe that is inserted along the ground 1 contact J1-8 and insert the probe along ground 2 contact J1-4 (wire X800-OR(Orange)). The other probe remains inserted along the contact for the power supply J1-1 (wire R800-OR(Orange)).
- Measure the DC voltage.

Expected Result:

Both of the voltage measurements are approximately 8.0 ± 0.4 VDC.

Results:

- OK – Both of the voltage measurements are approximately 8.0 ± 0.4 VDC. The power and ground circuits for the sensor are correct. Proceed to Test Step 2.
- NOT OK – Both of the voltage measurements are less than 8.0 ± 0.4 VDC. The power supply for the sensor is not correct.

Repair: If both of the voltage measurements are not correct, the problem is most likely in the wire of the power circuit. This condition will cause multiple diagnostic codes to activate.

Refer to the complete Electrical System Schematic for the machine. Examine all of the connectors that are in the power and ground circuits. Ensure that the connections are clean, that the connectors are secure and that the connectors are in good condition.

For troubleshooting the ECM power supply that is providing power to the sensor, refer to the CID 0041 diagnostic code procedures in the troubleshooting section of the manual for the Implement ECM.

STOP.

- NOT OK – One of the voltage measurements is not correct.

Repair: If one of the voltage measurements is correct and the other voltage measurement is not correct, there is a problem in the ground circuit that registered the bad measurement. This condition will not cause this diagnostic code to activate. There is another problem that is causing this active diagnostic code. However, the ground circuit must be repaired before proceeding with this procedure.

Do not operate the machine with only one ground connection for the left joystick.

Repair the faulty ground circuit or the supply circuit for the power before proceeding with this procedure.

After repairing the faulty ground circuit, proceed to Test Step 2.

Test Step 2. CHECK THE SIGNAL AT THE SENSOR

The key start switch and the disconnect switch remain in the OFF position.

- At the machine harness connector J1 for the left joystick, use a 151-6320 Removal Tool to remove the signal wire U739-BR(Brown) and the socket at contact J1-2 from the harness connector. The machine harness connector J1 remains connected to the connector for the left joystick.
- At the back of the connector for the joystick J1, insert 7X-1710 Multimeter Probes along the sensor signal contact J1-2 and the ground contact at J1-4.
- Turn the disconnect switch and the key start switch to the ON position.

- D.** Measure the duty cycle of the sensor at the connector contacts for the joystick J1-2 and J1-4. Move the joystick through the full range of the sensor that is described at the beginning of this procedure.

Expected Result:

The duty cycle of the steering sensor 1 is correct according to the description at the beginning of this procedure.

Results:

- OK – The duty cycle of the sensor is correct. The sensor is not the cause of the problem. Reinstall the signal wire U739-BR(Brown) and the socket back to the original location at contact J1-2 in the machine harness connector for the joystick. Verify that all of the wires of the joystick are in the correct locations and that the wires are secure in the connector before proceeding to the next step. Proceed to Test Step 3.
- NOT OK – The duty cycle of the steering sensor 1 is not correct according to the description at the beginning of this procedure. The sensor has failed.

Repair: Perform this test step again in order to verify that the sensor signal is not correct.

If the signal of the steering sensor 1 is not correct according to the description at the beginning of this procedure, replace the assembly of the left joystick. After replacement of the assembly of the joystick, verify that the operation of the new assembly of the joystick is correct before operating the machine.

STOP.

Test Step 3. CHECK THE SIGNAL AT BOTH OF THE ECM MODULES

- A.** Turn the key start switch and the disconnect switch to the OFF position.
- B.** At the machine harness connector J1 for the Transmission/Chassis ECM, insert a multimeter probe along return contact J1-45 (wire X800-OR(Orange)). At the machine harness connector J2 for the Transmission/Chassis ECM, insert a multimeter probe along signal contact J2-18 (wire U739-BR(Brown)). The machine harness connectors remain connected to the ECM.
- C.** Turn the key start switch and the disconnect switch to the ON position.

- D.** Measure the duty cycle of the sensor at the contacts of the ECM connector J1-45 and J2-18. Move the joystick through the full range of the sensor that is described at the beginning of this procedure.

- E.** At the machine harness connector J1 for the Implement ECM, insert a multimeter probe along return contact J1-45 (wire P967-PU(Purple)). At the machine harness connector J2 for the Implement ECM, insert a multimeter probe along signal contact J2-18 (wire U739-BR(Brown)). The machine harness connectors remain connected to the ECM.

- F.** Measure the duty cycle of the sensor at the contacts of the ECM connector J1-45 and J2-18. Move the joystick through the full range of the sensor that is described at the beginning of this procedure.

Expected Result:

The duty cycle of the steering sensor 1 is correct according to the description at the beginning of this procedure at both of the ECM modules.

Results:

- OK – The duty cycle of the sensor is correct at both of the ECM modules. The machine harness does not appear to be the cause of the problem. An intermittent open or a short could still be causing the problem. Proceed to Test Step 4.
- NOT OK – The duty cycle of the steering sensor 1 is NOT correct at one of the ECM modules according to the description at the beginning of this procedure. There is a problem in the machine harness.

Repair: If the sensor signal at one ECM is correct and the sensor signal at the other ECM is not correct, a poor connection in the circuit would be suspected.

The signal of the steering sensor 1 at one of the ECM modules is not correct.

Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors that are in the section of the sensor signal circuit that connects to the ECM that is not receiving a good signal. Verify that the connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

- NOT OK – The duty cycle of the steering sensor 1 is NOT correct at either of the ECM modules

according to the description at the beginning of this procedure. It is likely that there is a problem in the machine harness. Proceed to Test Step 4.

Test Step 4. CHECK THE SIGNAL CIRCUIT FOR A SHORT

Turn the key start switch and the disconnect switch to the OFF position.

- A. Disconnect the J1 connector and the J2 connector from the Implement ECM.
- B. At the J2 machine harness connector for the Implement ECM, measure the resistance from the sensor signal contact J2-18 (wire U739-BR(Brown)) to all of the other J1 and J2 contacts that are used for the Implement ECM.
- C. If any of the resistance measurements in the last test step are less than 5000 ohms, skip the next test step and proceed to the "Expected Result" step. If all of the resistance measurements in the last test step are above 5000 ohms, perform the next test step.
- D. Disconnect the J1 connector and the J2 connector from the Transmission/Chassis ECM.
- E. At the J2 machine harness connector for the Transmission/Chassis ECM, measure the resistance from the sensor signal contact J2-18 (wire U739-BR(Brown)) to all of the other J1 and J2 contacts that are used for the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The resistance checks of the signal circuit do not indicate a short in the machine harness. Proceed to Test Step 5.
- NOT OK – A resistance measurement is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the signal circuit and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 1471 FMI 02 diagnostic code is active.

Expected Result:

The CID 1471 FMI 02 diagnostic code is not active.

Results:

- OK – The CID 1471 FMI 02 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 1471 FMI 02 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar "Electronic Technician (ET)" service tool to monitor the wiring harness of the machine. Wiggling the harness while the harness is connected to the service tool will test for intermittent connections or open connections.

If the cause of the active diagnostic code is not found, an ECM that has activated this diagnostic code may have failed.

If both the Transmission/Chassis ECM and the Implement ECM have activated this diagnostic code, it is very unlikely that either ECM is causing the problem.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02919969

MID 027 - CID 1471 - FMI 03

SMCS Code: 5737-038-ZH

Conditions Which Generate This Code:

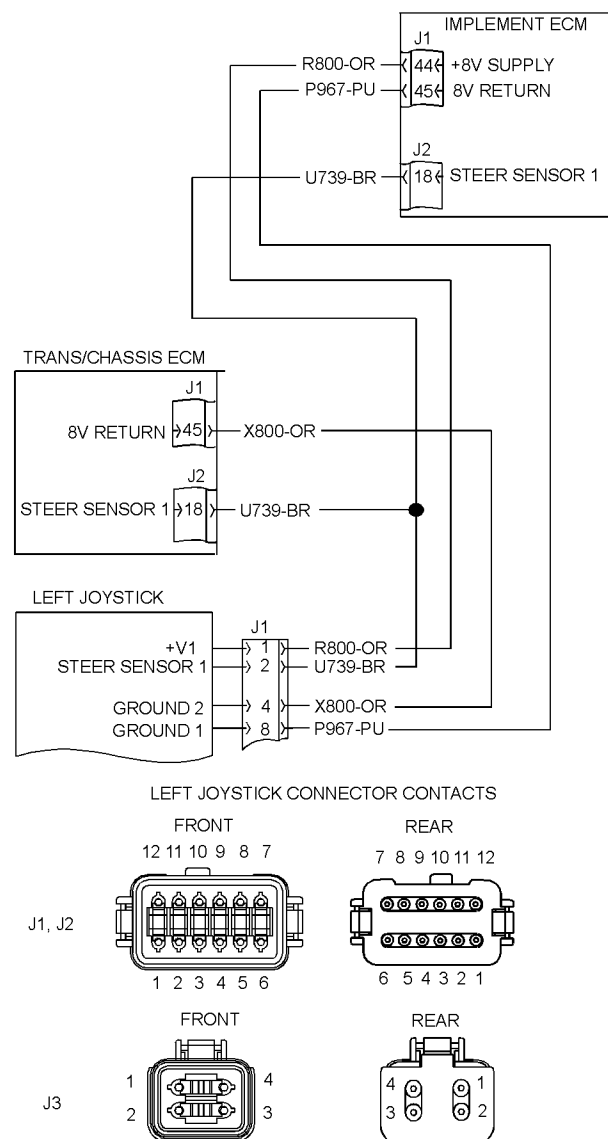


Illustration 262

g01243832

Connections of Steering Position Sensor 1

Three steering position sensors are required for correct operation of the steering control. The steering position sensors are located in the assembly of the left joystick. Each sensor provides an input signal to the Implement ECM and to the Transmission/Chassis ECM. This diagnostic code is activated when the ECM reads the input signal from the steering position sensor 1 and the voltage of the signal is above normal.

The steering position sensor 1 receives power from the 8 volt power supply of the Implement ECM. Steering position sensor 1 is internally connected to the ground that is supplied by the 8 volt sensor return of the Transmission/Chassis ECM (ground of the ECM) and to the ground that is supplied by the 8 volt sensor return of the Implement ECM (ground of the ECM). The steering sensor must lose both grounds in order to lose a ground connection. The illustration above indicates the power and ground connections for the steering sensor 1.

The position sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The position sensor sends a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The duty cycle of the signal will vary from approximately $10 \pm 5\%$ at the full left position of the joystick to approximately $90 \pm 5\%$ at the full right position of the joystick. When the joystick is in the center position, the duty cycle will be approximately 50%.

The possible causes of this diagnostic code are listed:

- The supply circuit for the sensor power is open.
- The return circuit of the sensor is open.
- The signal circuit is open.
- The signal circuit is shorted to another voltage source.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Consider the following points when this code is active:

- If a CID 0041 diagnostic code for the 8 volt power supply has been activated by the Implement ECM (MID 082), investigate the problem and fix the problem before proceeding with this procedure.
- The correct operating temperature range for the steering sensors is $-40\text{ }^{\circ}\text{C}$ ($-40.0\text{ }^{\circ}\text{F}$) to $75\text{ }^{\circ}\text{C}$ ($167.0\text{ }^{\circ}\text{F}$). If an FMI 03 diagnostic code or an FMI 08 diagnostic code become active for a steering sensor, during periods that the cab environment is at extreme temperatures, reduce the temperature of the cab environment in order to keep the steering sensors operating in the acceptable temperature range. After the temperature has been reduced, verify that the CID 1471 FMI 03 diagnostic code is active before performing this procedure.

- The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the steering sensor 1. Both ECM modules can activate a CID 1471 FMI 03 diagnostic code when the signal voltage is above normal. If one ECM activates a CID 1471 FMI 03 diagnostic code and the other ECM does not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor OR a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE POWER SUPPLY CIRCUIT FOR THE SENSOR

- A. Turn the disconnect switch and the key start switch to the ON position.
- B. At the J1 harness connector for the left joystick, insert 7X-1710 Multimeter Probes along the contact of the power supply J1-1 (wire R800-OR(Orange)) and along the ground 1 contact J1-8 (wire P967-PU(Purple)). Do not disconnect the machine harness from the J1 connector.
- C. Measure the DC voltage.
- D. At the harness connectors for the left joystick, remove the multimeter probe that is inserted along the ground 1 contact J1-8 and insert the probe along ground 2 contact J1-4 (wire X800-OR(Orange)). The other probe remains inserted along the contact of the power supply J1-1 (wire R800-OR(Orange)).
- E. Measure the DC voltage.

Expected Result:

Diagnostic Code Procedures

Both of the voltage measurements are approximately 8.0 ± 0.4 VDC.

Results:

- OK – Both of the voltage measurements are approximately 8.0 ± 0.4 VDC. The power and ground circuits for the sensor are correct. Proceed to Test Step 2.
- NOT OK – Both of the voltage measurements are less than 8.0 ± 0.4 VDC. The power supply for the sensor is not correct.

Repair: If both of the voltage measurements are not correct, the problem is most likely in the power circuit. Multiple diagnostic codes will be activated along with this diagnostic code.

Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors that are in the power and ground circuits. Ensure that the connections are clean, that all connections are secure and that all connections are in good condition.

For troubleshooting the ECM power supply that is providing power to the sensor, refer to the CID 0041 diagnostic code procedures in the troubleshooting section of the manual for the Implement ECM.

STOP.

- NOT OK – One of the voltage measurements is not correct.

Repair: If one of the voltage measurements is correct and the other voltage measurement is not correct, there is a problem in the ground circuit that registered the bad measurement. This condition will not cause this diagnostic code to activate. There is another problem that is caused by this active diagnostic code, however, the ground circuit must be repaired before proceeding with this procedure.

Do not operate the machine with only one ground connection for the left joystick.

Repair the faulty ground circuit or the circuit for the power supply before proceeding with this procedure.

After repairing the faulty ground circuit, proceed to Test Step 2.

Test Step 2. CHECK FOR AN OPEN IN THE SENSOR CIRCUITS OF BOTH ECM MODULES

- A. Turn the key start switch and the disconnect switch to the OFF position.

B. Disconnect the machine harness connector J1 from the left joystick. At harness connector J1 for the joystick, place a jumper wire between the ground 2 contact J1-4 (wire X800-OR(Orange)) and the signal contact J1-2 (wire U739-BR(Brown)).

C. Disconnect machine harness connectors J1 and J2 from the Transmission/Chassis ECM.

D. At the harness connector for the Transmission/Chassis ECM, measure the resistance from ground 2 return contact J1-45 (wire X800-OR(Orange)) to signal contact J2-18 (wire U739-BR(Brown)).

E. Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.

F. At harness connector J1 for the joystick, move the jumper wire to the ground 1 contact J1-8 (wire P967-PU(Purple)) and the signal contact J1-2 (wire U739-BR(Brown)).

G. Disconnect machine harness connectors J1 and J2 from the Implement ECM.

H. At the harness connectors for the Implement ECM, measure the resistance from ground 1 return contact J1-45 (wire P967-PU(Purple)) to signal contact J2-18 (wire U739-BR(Brown)).

I. Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.

Expected Result:

Both resistance measurements are less than 5 ohms at all times during the manipulation of the wiring harness and connectors.

Results:

- OK – Both of the resistance measurements are less than 5 ohms. The sensor circuit is not open in either of the input circuits of the ECM modules. Proceed to Test Step 3.
- NOT OK – The resistance measurement at one or both of the ECM modules is greater than 5 ohms. There is an open or a bad connection in one or both of the signal circuits.

Repair: If both of the resistance measurements are not correct, there is an open connection or a bad connection on the sensor side of the splice for the signal wire U739-BR(Brown).

If one of the measurements is correct and the other measurement is not correct, there is an open or a bad connection on the ECM side of the splice for the signal wire U739-BR(Brown).

In either case, refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the suspected section of the sensor signal circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT FOR A SHORT

The key start switch and the disconnect switch remain in the OFF position. The machine harness connectors remain disconnected from the Implement ECM and the Transmission/Chassis ECM.

- A. Remove the jumper wire that was installed in the last step at the connector of the joystick.
- B. At the J2 machine harness connector for the Implement ECM, measure the resistance from the sensor signal contact J2-18 (wire U739-BR(Brown)) to all of the other J1 and J2 contacts that are used for the Implement ECM.
- C. If any of the resistance measurements in the last test step are less than 5000 ohms, skip the next test step and proceed to the "Expected Result" step. If all of the resistance measurements in the last test step are above 5000 ohms, perform the next test step.
- D. At the J2 machine harness connector for the Transmission/Chassis ECM, measure the resistance from the sensor signal contact J2-18 (wire U739-BR(Brown)) to all of the other J1 and J2 contacts that are used for the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The resistance checks of the signal circuit do not indicate a short in the machine harness. Proceed to Test Step 4.
- NOT OK – A resistance measurement is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the signal circuit and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SIGNAL AT THE SENSOR

The key start switch and the disconnect switch remain in the OFF position.

- A. Reconnect the machine harness connectors J1 and J2 to both ECM modules.
- B. Reconnect the machine harness connectors that are disconnected to the left joystick.
- C. At the machine harness connector J1 for the left joystick, use a 151 - 6320 Removal Tool to remove the signal wire U739-BR(Brown) and the socket at contact J1-2 from the harness connector. The machine harness connector J1 remains connected to the connector of the left joystick.
- D. At the back of the connector of the joystick J1, insert 7X - 1710 Multimeter Probes along the sensor signal contact J1-2 and the ground 2 contact at J1-4.
- E. Turn the disconnect switch and the key start switch to the ON position.
- F. Measure the duty cycle of the sensor at the connector of the joystick, contacts J1-2 and J1-4. Move the joystick through the full range of the sensor that is described at the beginning of this procedure.

Expected Result:

The duty cycle of the steering sensor 1 is correct according to the description at the beginning of this procedure.

Results:

- OK – The duty cycle of the sensor is correct. The sensor is not the cause of the problem. Reinstall the signal wire U739-BR(Brown) and the socket

back to the original location at contact J1-2 in the machine harness connector for the joystick. Verify that all of the wires of the joystick are in the correct locations and that all wires are secure in the connector before proceeding to the next step. Proceed to Test Step 5.

- NOT OK – The duty cycle of the steering sensor 1 is not correct according to the description at the beginning of this procedure. The sensor has failed.

Repair: Perform this test step again in order to verify that the sensor signal is not correct.

If the signal of the steering sensor 1 is not correct according to the description at the beginning of this procedure, replace the assembly of the left joystick. After replacement of the assembly of the joystick, verify that the operation of the new assembly of the joystick is correct before operating the machine.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 1471 FMI 03 diagnostic code is active.

Expected Result:

The CID 1471 FMI 03 diagnostic code is not active.

Results:

- OK – The CID 1471 FMI 03 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 1471 FMI 03 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

If both the Transmission/Chassis ECM and the Implement ECM have activated this diagnostic code, it is very unlikely that either ECM is causing the problem.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02920127

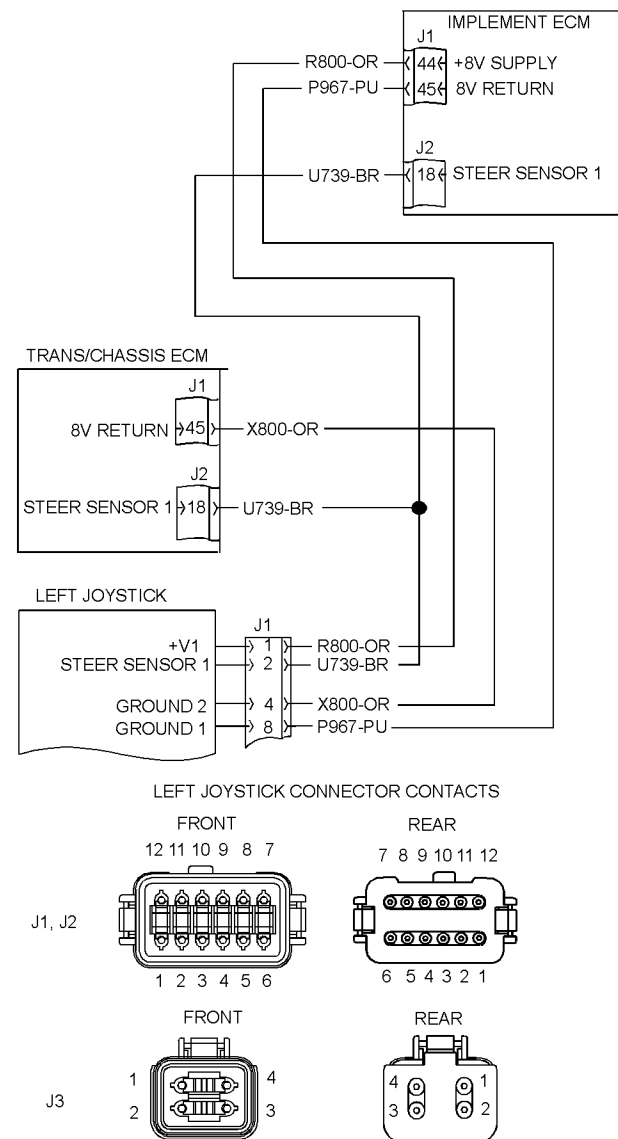
MID 027 - CID 1471 - FMI 04**SMCS Code:** 5737-038-ZH**Conditions Which Generate This Code:**

Illustration 263

g01243832

Connections for Steering Position Sensor 1

Three steering position sensors are required for correct operation of the steering control lever. The steering position sensors are located in the left assembly of the joystick. Each sensor provides an input signal to the Implement ECM and to the Transmission/Chassis ECM. This diagnostic code is activated when the ECM detects that the signal voltage from the steering position sensor 1 is below normal.

The steering position sensor 1 receives power from the 8 volt power supply of the Implement ECM. Steering position sensor 1 is internally connected to the ground that is supplied by the 8 volt sensor return of the Transmission/chassis ECM (ground of the ECM) and to the ground that is supplied by the 8 volt sensor return of the Implement ECM (ground of the ECM). The steering sensor must lose both grounds in order to lose a ground connection. The illustration above indicates the power and ground connections for the steering sensor 1.

The position sensor is a PWM sensor that operates at a frequency of approximately 500 ± 80 hertz. The position sensor sends a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The duty cycle of the signal will vary from approximately $10 \pm 5\%$ at the full left position of the joystick to approximately $90 \pm 5\%$ at the full right position of the joystick. When the joystick is in the center position, the duty cycle will be approximately 50%.

The possible causes of this diagnostic code are listed:

- The signal circuit is shorted to a ground source.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the steering sensor 1. Both ECM modules can activate a CID 1471 FMI 04 diagnostic code when the signal voltage is below normal. If one ECM has activated a CID 1471 FMI 04 diagnostic code and the other ECM has not, the sensor is probably operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor OR a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SENSOR

- A. Turn the disconnect switch and the key start switch to the ON position.
- B. Disconnect the machine harness connector J1 from the left joystick. Observe the status of the active CID 1471 FMI 04 diagnostic code.

Expected Result:

The status of the CID 1471 FMI 04 diagnostic code did not change when the connector of the joystick was disconnected. A CID 1471 FMI 03 diagnostic code has NOT been activated by either the Implement ECM or the Transmission/Chassis ECM. The CID 1471 FMI 04 diagnostic code remains active when the connector of the joystick is disconnected.

Results:

- YES – The CID 1471 FMI 04 diagnostic code remains active when the connector of the joystick is disconnected. The sensor is not causing the problem. Proceed to Test Step 2.
- NO – The CID 1471 FMI 04 diagnostic code is no longer active when the connector of the joystick is disconnected. A CID 1471 FMI 03 diagnostic code has been activated by both of the ECM modules when the connector of the joystick is disconnected. The machine harness and the ECM are operating correctly.

Repair: The steering sensor 1 is causing the problem. There is an internal short to ground in the left joystick. Replace the left assembly of the joystick. After replacement of the assembly of the joystick, verify that the operation of the new assembly of the joystick is correct before operating the machine.

STOP.

Test Step 2. CHECK THE SIGNAL CIRCUIT FOR A SHORT TO GROUND

- A. The connector of the joystick J1 remains disconnected from the machine harness.
- B. Turn the key start switch and the disconnect switch to the OFF position.
- C. Disconnect the J1 and J2 machine harness connectors from the Implement ECM.
- D. Disconnect the J1 connector and the J2 connector from the Transmission/Chassis ECM.

- E. At machine harness connector J2 for the Implement ECM, measure the resistance from contact J2-18 (wire U739-BR(Brown)) to frame ground. Measure the resistance from contact J2-18 (wire U739-BR(Brown)) to all of the other J1 and J2 contacts that are used for the Implement ECM.

- F. At the J2 machine harness connector for the Transmission/Chassis ECM, measure the resistance from the sensor signal contact J2-18 (wire U739-BR(Brown)) to all of the other J1 and J2 contacts that are used for the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The resistance checks for the signal circuit do not indicate a short in the machine harness. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the circuit for the signal and the frame ground or the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.

- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 1471 FMI 04 diagnostic code is active.

Expected Result:

The CID 1471 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 1471 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 1471 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

If both the Transmission/Chassis ECM and the Implement ECM have activated this diagnostic code, it is very unlikely that either ECM is causing the problem.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02920202

MID 027 - CID 1471 - FMI 08

SMCS Code: 5737-038-ZH

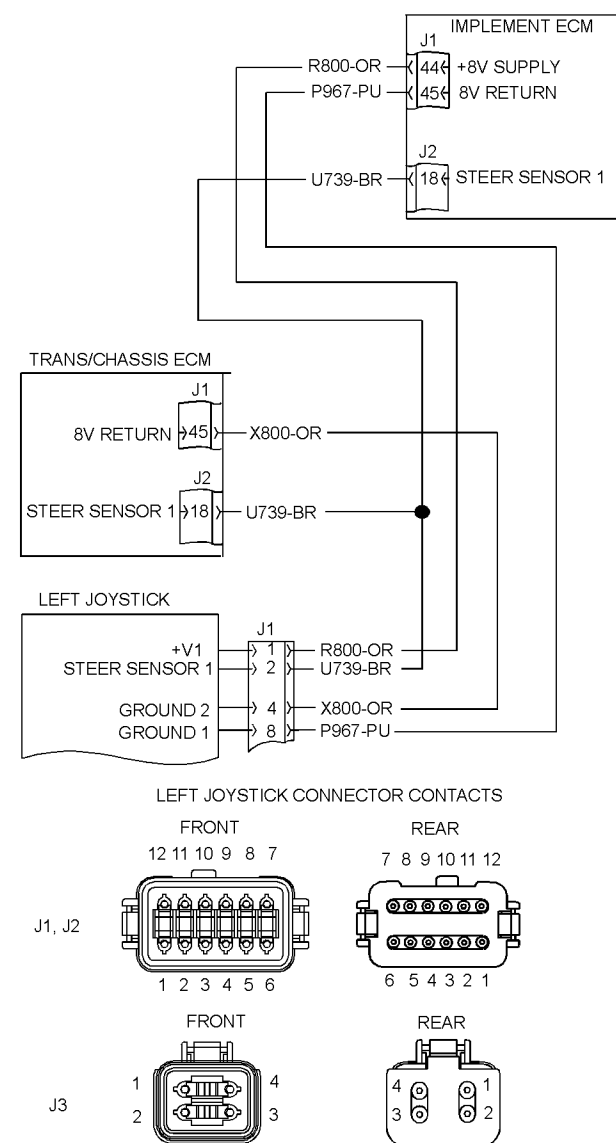
Conditions Which Generate This Code:

Illustration 264

g01243832

Connections of Steering Position Sensor 1

Three steering position sensors are required for correct operation of the steering control. The steering position sensors are located in the assembly of the left joystick. Each sensor provides an input signal to the Implement ECM and to the TRAnsmission/Chassis ECM. This diagnostic code is associated with the left hand steering lever position sensor 1. The FMI 08 means that the ECM has determined that the signal frequency or the signal pulse width is not within the expected range.

Diagnostic Code Procedures

The steering position sensor 1 receives power from the 8 volt power supply of the Implement ECM. Steering position sensor 1 is internally connected to the ground that is supplied by the 8 volt sensor return of the Transmission/Chassis ECM (ground of the ECM) and to the ground that is supplied by the Implement ECM 8 volt sensor return of the Implement ECM (ground of the ECM). The steering sensor must lose both grounds in order to lose a ground connection. The illustration above indicates the power and ground connections for the steering sensor 1.

The position sensor is a PWM sensor that operates at a frequency of 500 ± 80 Hz. The position sensor sends a PWM input signal to the Implement ECM and to the TRAnsmision/Chassis ECM. The duty cycle of the signal will vary from approximately $10 \pm 5\%$ at the full left position of the joystick to approximately $90 \pm 5\%$ at the full right position of the joystick. When the joystick is in the center position, the duty cycle will be approximately 50%.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- Intermittent connections or poor connections in the sensor circuit.
- The ECM has failed. This is unlikely.

Consider the following points when this code is active:

- If a CID 0041 diagnostic code for the 8 volt power supply has been activated by the Implement ECM (MID 082), investigate the problem and fix the problem before proceeding with this procedure.
- The correct operating temperature range for the steering sensors is -40°C (-40.0°F) to 75°C (167.0°F). If an FMI 03 diagnostic code or an FMI 08 diagnostic code becomes active for a steering sensor, when the cab environment is at extreme temperatures, reduce the temperature of the cab environment in order to keep the steering sensors operating in the acceptable temperature range. After reducing the temperature, verify that the CID 1471 FMI 08 diagnostic code is active before performing this procedure.
- The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the steering sensor 1. Both ECM modules can activate a CID 1471 FMI 08 diagnostic code when the signal frequency or the signal pulse width is not within the expected range.

- If one ECM has activated a CID 1471 FMI 08 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor OR a harness problem could be the cause.
- If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE DUTY CYCLE AND THE SIGNAL FREQUENCY AT THE SENSOR

Turn the key start switch and the disconnect switch to the OFF position.

- A.** At the machine harness connector J1 for the left joystick, use a 151 - 6320 Removal Tool to remove the signal wire (wire U739-BR(Brown)) and the socket at contact J1-2. The machine harness connector J1 remains connected to the left connector of the joystick.
- B.** At the back of the connector of the joystick J1, insert 7X - 1710 Multimeter Probes along the sensor signal contact J1-2 and the ground 2 contact at J1-4.
- C.** Turn the disconnect switch and the key start switch to the ON position.
- D.** With the joystick in a stationary position, measure the frequency of the signal from the sensor.
- E.** Observe the measurement of the resistance and wiggle the connector of the joystick. Gently pull on the wires and wiggle the wires.

- F. Measure the duty cycle of the sensor at the connector contacts of the joystick J1-2 and J1-4. Move the joystick through the full range of the sensor that is described at the beginning of this procedure.
- G. Observe the measurement of the resistance and wiggle the connector of the joystick. Gently pull on the wires and wiggle the wires.

Expected Result:

The frequency of the steering sensor 1 is 500 ± 80 Hz. The duty cycle of the steering sensor 1 is correct according to the description at the beginning of this procedure. The frequency and the duty cycle are stable during the manipulation of the harness connector and the wiring.

Results:

- OK – The frequency of the sensor and the duty cycle of the sensor are correct and did not change as the harness was manipulated. The sensor is not causing the problem. Reconnect the signal wire and the socket in the machine harness connector for the joystick. Verify that all wires of the joystick are secure in the connector before proceeding to the next step. Proceed to Test Step 2.
- NOT OK – The signal frequency and the duty cycle of the steering sensor 1 is NOT correct according to the description at the beginning of this procedure. The sensor has failed.

Repair: Perform this test step again in order to verify that the sensor signal is not correct.

If the signal of steering sensor 1 is not correct according to the description at the beginning of this procedure, replace the left assembly of the joystick. After replacement of the assembly of the joystick, verify that the operation of the new assembly of the joystick is correct before operating the machine.

STOP.

Test Step 2. CHECK FOR AN OPEN IN THE SENSOR CIRCUIT AT BOTH OF THE ECM MODULES

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector J1 from the left joystick. At harness connector J1 for the joystick, place a jumper wire between the ground 2 contact J1-4 (wire X800-OR(Orange)) and the signal contact J1-2 (wire U739-BR(Brown)).

- C. Disconnect machine harness connectors J1 and J2 from the TRansmission/Chassis ECM.
- D. At the harness connector for the TRansmission/Chassis ECM, measure the resistance from ground 2 return contact J1-45 (wire X800-OR(Orange)) to signal contact J2-18 (wire U739-BR(Brown)).
- E. Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.
- F. At harness connector J1 for the joystick, move the jumper wire to the ground 1 contact J1-8 (wire P967-PU(Purple)) and the signal contact J1-2 (wire U739-BR(Brown)).
- G. Disconnect machine harness connectors J1 and J2 from the Implement ECM.
- H. At the harness connectors for the Implement ECM, measure the resistance from ground 1 return contact J1-45 (wire P967-PU(Purple)) to signal contact J2-18 (wire U739-BR(Brown)).
- I. Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.

Expected Result:

Both resistance measurements are less than 5 ohms at all times during the manipulation of the wiring harness and connectors.

Results:

- OK – Both of the resistance measurements are less than 5 ohms. The sensor circuit is not open in the input circuit of either of the ECM modules. Proceed to Test Step 3.
- NOT OK – The resistance measurement at one or both of the ECM modules is greater than 5 ohms. There is an open or a bad connection in one or both of the signal circuits.

Repair: If both of the resistance measurements are not correct, there is an open connection or a bad connection on the sensor side of the splice for the signal wire U739-BR(Brown).

If one of the measurements is correct and the other measurement is not correct, there is an open or a bad connection on the ECM side of the splice for the signal wire U739-BR(Brown).

In either case, refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the suspected section of the signal circuit of the sensor. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C.** Reconnect all harness connectors in order to make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Check the status of the CID 1471 FMI 08.

Expected Result:

The CID 1471 FMI 08 is not active.

Results:

- OK – The CID 1471 FMI 08 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 1471 FMI 08 is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

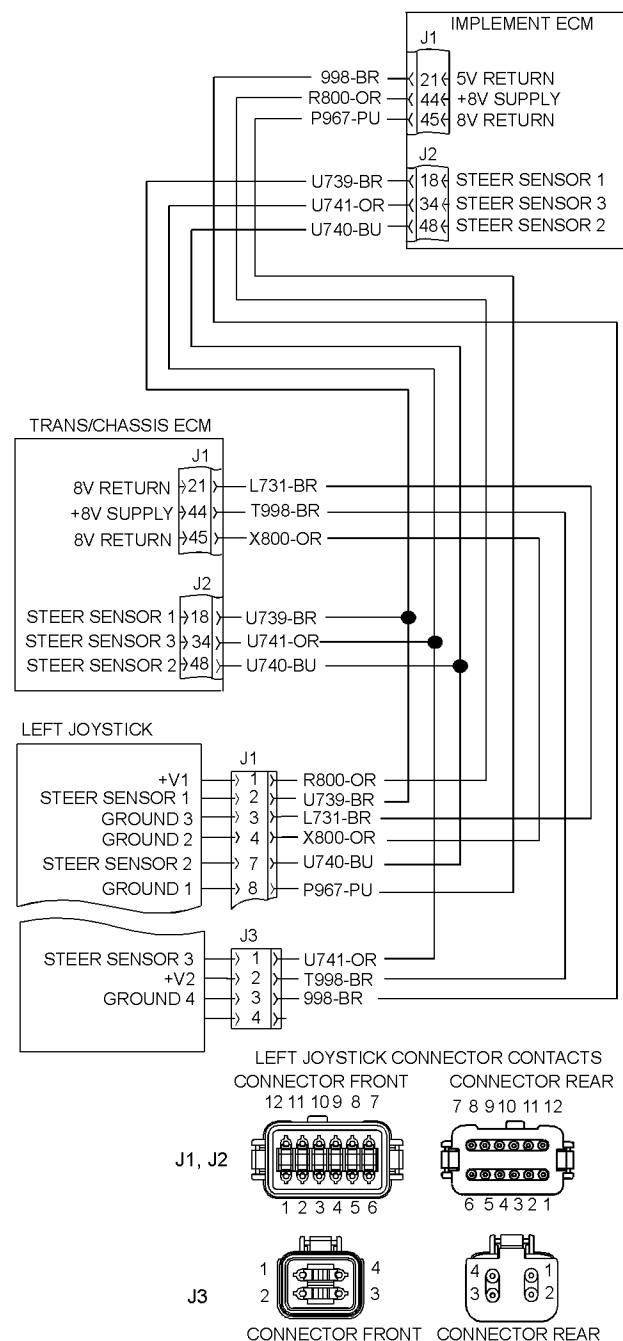
If both the TRansmission/Chassis ECM and the Implement ECM have activated this diagnostic code, it is very unlikely that either ECM is causing the problem.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02839827

MID 027 - CID 1471 - FMI 14**SMCS Code:** 5737-038-ZH**Conditions Which Generate This Code:**

Three steering position sensors are required for correct operation of the steering control. The steering position sensors are located in the left joystick assembly. Each sensor provides an input signal to the Implement ECM and to the Transmission/Chassis ECM. The ECM expects the input signals from all three steering position sensors to match very closely. The FMI 14 diagnostic code is active when the ECM determines that the PWM input signal from the steering position sensor 1 does not match the PWM input signal from one of the other steering position sensors, however, the position sensor 1 signal does match with the third sensors signal.

The steering position sensor 1 receives power from the Implement ECM 8 VDC power supply. The steering position sensor 1 is internally connected to the ground that is supplied by the Transmission/Chassis ECM 8 volt sensor return (ECM ground) and to the ground that is supplied by the Implement ECM 8 volt sensor return (ECM ground). The steering sensor must lose both grounds in order to lose a ground connection. The illustration above indicates the power and ground connections for the steer sensor 1.

The position sensor is a PWM sensor that operates at a frequency of approximately 500 ± 80 hertz. The position sensor sends a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The duty cycle of the signal will vary from approximately 10% at the lever full left position to approximately 90% at the lever full right position. When the lever is in the center position, the duty cycle will be approximately 50%.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: If a CID 0041 diagnostic code for the 8 volt power supply has been activated by the Implement ECM (MID 082), investigate the problem and fix the problem before proceeding with this procedure.

Note: The correct operating temperature range for the steering sensors is -40°C (-40.0°F) to 75°C (167.0°F). Return the temperature in the cab to a normal temperature when the temperature in the cab is extreme and a diagnostic code, an FMI 03, an FMI 08 or possibly an FMI 14, becomes active. Returning the temperature in the cab to a normal temperature will keep the steering position sensors operating in the acceptable temperature range. After stabilization of the temperature, verify that the CID 1471 FMI 14 diagnostic code is active before performing this procedure.

Illustration 265

g01291021

Left Joystick Steer Sensors connections

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the steering sensor 1. Both ECM's can activate a CID 1471 FMI 14 diagnostic code when the signal from one steer sensor does not closely match the signal from one of the other steering sensors. If one ECM has activated a CID 1471 FMI 14 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM's have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM's have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Note: The next three test steps will measure the duty cycle of each steering sensor in order to determine if one signal is not closely matching with both of the other sensor signals. Record the duty cycle of the sensor signal for each of the three sensors for comparison.

Test Step 1. CHECK THE SIGNAL AT STEER SENSOR 1

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Do not disconnect the harness connector from the sensor.
- C. At the back of the joystick connector J1, insert 7X-1710 Multimeter Probes along the sensor signal contact J1-2 and the return contact at J1-4.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Monitor the signal of the sensor with a digital multimeter.

- F. Move the joystick through the full range of operation. Record the duty cycle of the sensor at specific positions of the joystick.

- G. Repeat the process for the other two steer position sensors.

Expected Result:

The duty cycle of the three steering sensors are within 5% of each other.

Results:

- OK – The duty cycle has been recorded for comparison with the other two steering sensors. With the joystick at the same position for all three readings of the steering sensors, the duty cycle readings are within 5% of each other. Reconnect the signal wire in the machine harness connector for the joystick before proceeding to the next test step. Proceed to Test Step 2.
- NOT OK – With the joystick in the same position while reading the duty cycle of the three steering sensors one or more of the duty cycle reading varies by more than 5% from the other duty cycles. One or more of the steering sensors are not working properly.

Repair: Replace the left joystick assembly. After replacement of the assembly, verify that the new assembly is working correctly. Clear all logged codes prior to confirming the function of the new assembly.

STOP.

Test Step 2. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Operate the machine.
- E. Check the status of the CID 1471 FMI 14 diagnostic code.

Expected Result:

The CID 1471 FMI 14 diagnostic code is not active.

Results:

- OK – The CID 1471 FMI 14 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 1471 FMI 14 diagnostic code is active. The diagnostic code has not been corrected. Clear the diagnostic code. Operate the machine in order to learn if the code occurs again.

Repair: If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

If both the Transmission/Chassis ECM and the Implement ECM have activated this diagnostic code, it is very unlikely that either ECM is causing the problem.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

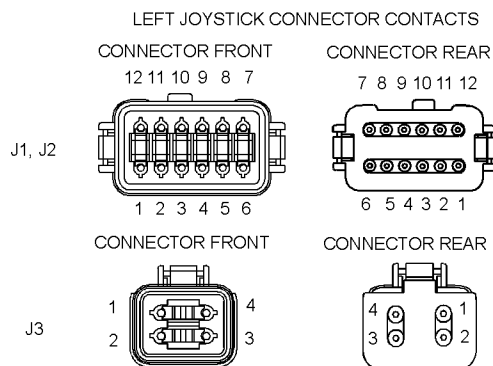
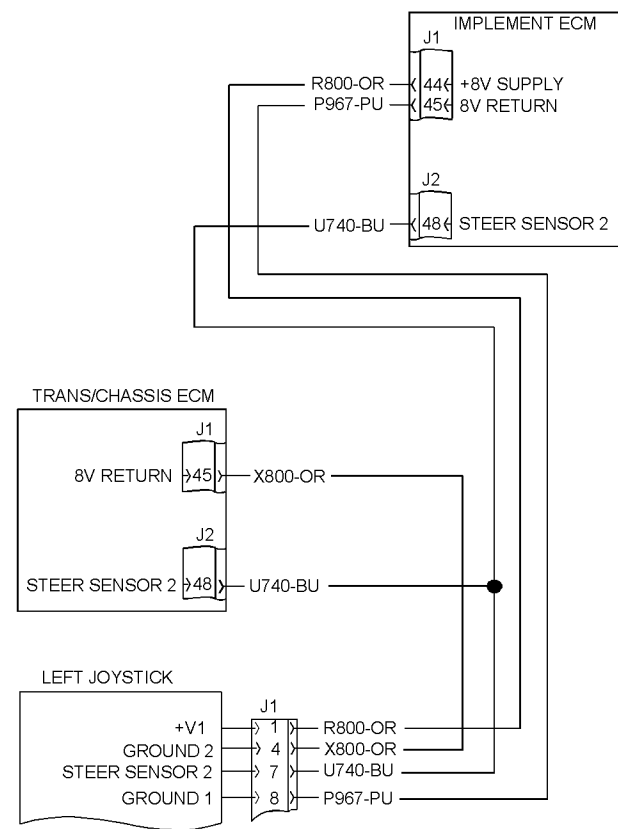
STOP.

i02920251

MID 027 - CID 1472 - FMI 02

SMCS Code: 5737-038-ZH

Conditions Which Generate This Code:



Diagnostic Code Procedures

Three steering position sensors are required for correct operation of the steering control. The steering position sensors are located in the left assembly of the joystick. Each sensor provides an input signal to the Implement ECM and to the Transmission/Chassis ECM. The FMI 02 diagnostic code is recorded when the ECM detects that the input from the "steering position sensor 2" is erratic or intermittent.

The steering position sensor 2 receives power from the 8 volt power supply of the Implement ECM. Steering position sensor 2 is connected to ground at the 8 volt sensor return of the Transmission/chassis ECM (ground of the ECM) and the 8 volt sensor return of the Implement ECM (ground of the ECM). The steering sensor must lose the 8 volt power supply or both grounds in order to lose power. The illustration above indicates the power and ground connections for steering position sensor 2.

The position sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The position sensor sends a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The duty cycle of the signal will vary from approximately $10 \pm 5\%$ at the full left position of the joystick to approximately $90 \pm 5\%$ at the full right position of the joystick. When the joystick is in the center position, the duty cycle will be approximately 50%.

The possible causes of this diagnostic code are listed:

- The sensor has failed.
- Intermittent connections or poor connections exist in the sensor circuit.
- The signal circuit is shorted to another circuit in the machine harness.
- The ECM has failed. This is unlikely.

Consider the following points when this code is active:

- Before performing this procedure, check for an active CID 0041 diagnostic code for the 8 volt sensor power supply of the Implement ECM. Correct any problem with the 8 volt power supply before performing this procedure.
- The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the steering sensor 2. Both ECM modules can activate a CID 1472 FMI 02 diagnostic code when the signal is erratic or intermittent. If one ECM has activated a CID 1472 FMI 02 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected.

- When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause.
- If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem.

For either condition, proceed with this procedure in order to verify the cause of the problem.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SENSOR POWER SUPPLY

- A.** Turn the disconnect switch and the key start switch to the ON position.
- B.** At the J1 harness connector for the left joystick, insert 7X-1710 Multimeter Probes along the contact of the power supply J1-1 (wire R800-OR(Orange)) and along ground 1 contact J1-8 (wire P967-PU(Purple)). Do not disconnect the machine harness from the J1 connector.
- C.** Measure the DC voltage of the sensor power supply.
- D.** Reposition the multimeter probe that is along ground 1 contact J1-8 (wire P967-PU(Purple)) to along ground 2 contact J1-4 (wire P967-PU(Purple)). The other multimeter probe remains positioned along the contact of the power supply J1-1 (wire R800-OR(Orange)).
- E.** Measure the DC voltage of the sensor power supply.

Expected Result:

Both of the voltage measurements are approximately 8.0 ± 0.4 VDC.

Results:

- OK – Both of the voltage measurements are approximately 8.0 ± 0.4 VDC. The power supply for the sensor is correct. Proceed to Test Step 2.

- NOT OK – The voltage measurement is less than 8.0 ± 0.4 VDC. The power supply for the sensor is not correct.

Repair: Either both of the wires for the sensor ground or the supply circuit for the sensor is faulty.

NOTE: If one of the voltage measurements is correct and the other measurement is not correct, one of the ground circuits is faulty. This condition will not cause this code to activate, however, the faulty ground circuit must be repaired prior to proceeding with this procedure.

Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors that are in the circuits. Ensure that the connections are clean, that the connections are secure and that the connections are in good condition.

For troubleshooting the power supply of the Implement ECM, refer to the CID 0041 diagnostic code procedures in the troubleshooting section of the manual for the Implement ECM.

Repair the faulty power supply circuit before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SIGNAL AT THE SENSOR

The key start switch and the disconnect switch remain in the OFF position.

- At the machine harness connector J1 for the left joystick, use a 151 - 6320 Removal Tool to remove the signal wire U740-BU(Blue) and the socket at contact J1-7 from the harness connector. The machine harness connector J1 remains connected to the left connector of the joystick.
- At the back of the connector J1 of the joystick, insert 7X - 1710 Multimeter Probes along the sensor signal contact J1-7 and the ground 1 contact at J1-8.
- Turn the disconnect switch and the key start switch to the ON position.
- Measure the duty cycle of the sensor at the connector contacts of the joystick J1-7 and J1-8. Move the joystick through the full range of the sensor that is described at the beginning of this procedure.

Expected Result:

The duty cycle of the steering sensor 2 is correct according to the description at the beginning of this procedure.

Results:

- OK – The duty cycle of the sensor is correct. The sensor is not the cause of the problem. Reinstall the signal wire U740-BU(Blue) and the socket back to the original location at contact J1-7 in the machine harness connector for the joystick. Verify that all of the wires of the joystick are in the correct locations. Secure the wires of the joystick in the connector before proceeding to the next step. Proceed to Test Step 3.
- NOT OK – The duty cycle of the steering sensor 2 is NOT correct according to the description at the beginning of this procedure. The sensor has failed.

Repair: Perform this test step again in order to verify that the sensor signal is not correct.

If the “steering sensor 2” signal is not correct according to the description at the beginning of this procedure, replace the left assembly of the joystick. After replacement of the assembly of the joystick, verify that the operation of the new assembly of the joystick is correct before operating the machine.

STOP.

Test Step 3. CHECK THE SIGNAL AT BOTH OF THE ECM MODULES

- Turn the key start switch and the disconnect switch to the OFF position.
- At the machine harness connector J1 for the Transmission/Chassis ECM, insert a multimeter probe along return contact J1-45 (wire X800-OR(Orange)). At the machine harness connector J2 for the Transmission/Chassis ECM, insert a multimeter probe along signal contact J2-48 (wire U740-BU(Blue)). The machine harness connectors remain connected to the ECM.
- Turn the key start switch and the disconnect switch to the ON position.
- Measure the duty cycle of the sensor at the contacts of the ECM J1-45 and J2-48. Move the joystick through the full range of the sensor that is described at the beginning of this procedure.

- E.** At the machine harness connector J1 for the Implement ECM, insert a multimeter probe along return contact J1-45 (wire P967-PU(Purple)). At the machine harness connector J2 for the Implement ECM, insert a multimeter probe along signal contact J2-48 (wire U740-BU(Blue)). The machine harness connectors remain connected to the ECM.
- F.** Measure the duty cycle of the sensor at the connector contacts of the ECM J1-45 and J2-48. Move the joystick through the full range of the sensor that is described at the beginning of this procedure.

Expected Result:

The duty cycle of the steering sensor 2 is correct according to the description at the beginning of this procedure at both of the ECM modules.

Results:

- OK – The duty cycle of the sensor is correct at both of the ECM modules. The machine harness does not appear to be the cause of the problem. An intermittent open or a short could still be causing the problem. Proceed to Test Step 4.
- NOT OK – The duty cycle of the steering sensor 2 is NOT correct at one of the ECM modules according to the description at the beginning of this procedure. There is a problem in the machine harness.

Repair: If the sensor signal at one ECM is correct and the sensor signal at the other ECM is not correct, a poor connection in the circuit would be suspected.

The “steering sensor 2” signal at one of the ECM modules is not correct.

Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors that are in the section of the sensor signal circuit that connects to the ECM that is not receiving a good signal. Verify that the connections are clean, that the connections are secure and that the connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

- NOT OK – The duty cycle of the steering sensor 2 is NOT correct at either of the ECM modules according to the description at the beginning of this procedure. Most likely there is a problem in the machine harness. Proceed to Test Step 4.

Test Step 4. CHECK THE SIGNAL CIRCUIT FOR A SHORT

Turn the key start switch and the disconnect switch to the OFF position.

- A.** Disconnect the J1 connection and the J2 connector from the Implement ECM.
- B.** At the J2 machine harness connector for the Implement ECM, measure the resistance from the sensor signal contact J2-48 (wire U740-BU(Blue)) to all of the other J1 and J2 contacts that are used for the Implement ECM.
- C.** If any of the resistance measurements in the last test step are less than 5000 ohms, skip the next test step and proceed to the “Expected Result” step. If all of the resistance measurements in the last test step are above 5000 ohms, perform the next test step.
- D.** Disconnect the J1 connector and the J2 connector from the Transmission/Chassis ECM.
- E.** At the J2 machine harness connector for the Transmission/Chassis ECM, measure the resistance from the sensor signal contact J2-48 (wire U740-BU(Blue)) to all of the other J1 and J2 contacts that are used for the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The resistance checks of the signal circuit do not indicate a short in the machine harness. Proceed to Test Step 5.
- NOT OK – A resistance measurement is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the signal circuit and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, “Wiring Harness (Short Circuit) - Test”. Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 1472 FMI 02 diagnostic code is active.

Expected Result:

The CID 1472 FMI 02 diagnostic code is not active.

Results:

- OK – The CID 1472 FMI 02 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 1472 FMI 02 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated the diagnostic code may have failed.

If both the Transmission/Chassis ECM and the Implement ECM have activated this diagnostic code, it is very unlikely that either ECM is causing the problem.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

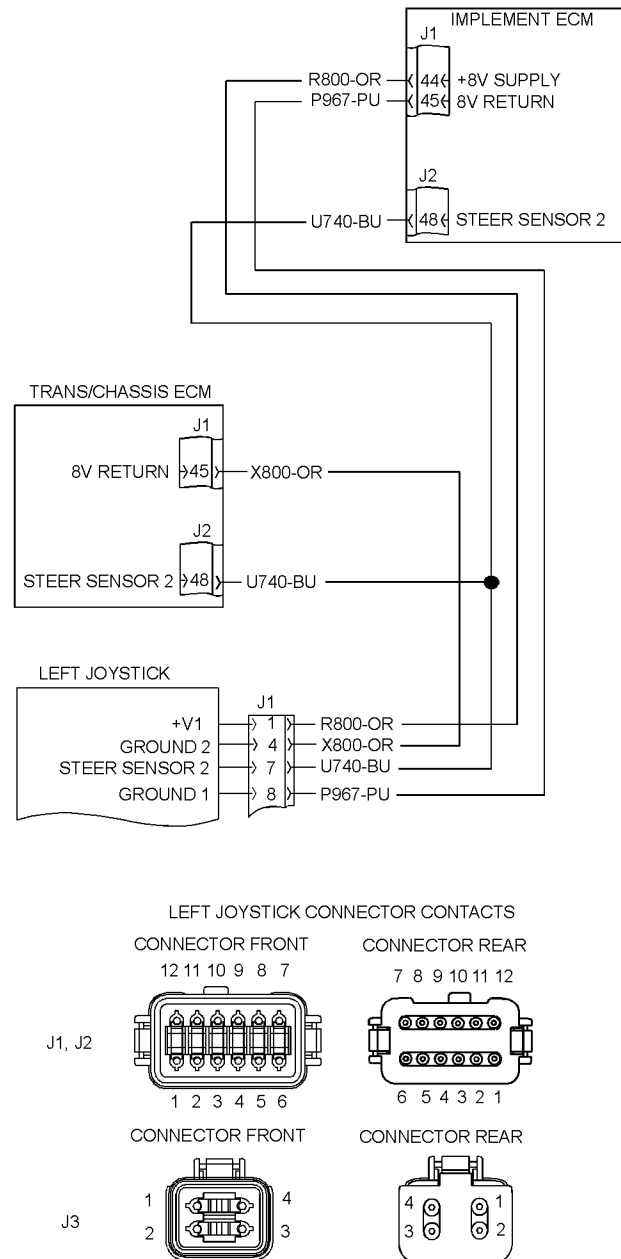
STOP.

i02920271

MID 027 - CID 1472 - FMI 03

SMCS Code: 5737-038-ZH

Conditions Which Generate This Code:



Three steering position sensors are required for correct operation of the steering control. The steering position sensors are located in the left assembly of the joystick. Each sensor provides an input signal to the Implement ECM and to the Transmission/Chassis ECM. This diagnostic code is recorded when the ECM reads the input signal from the steering position sensor 2 and the voltage of the signal is above normal.

The steering position sensor 2 receives power from the 8 volt power supply of the Implement ECM. Steering position sensor 2 is connected to ground at the 8 volt sensor return of the Transmission/chassis ECM (ground of the ECM) and the 8 volt sensor return of the Implement ECM (ground of the ECM). The steering sensor must lose the 8 volt power supply or both grounds in order to lose power. The illustration above indicates the power and ground connections for steering position sensor 2.

The position sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The position sensor sends a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The duty cycle of the signal will vary from approximately $10 \pm 5\%$ at the full left position of the joystick to approximately $90 \pm 5\%$ at the full right position of the joystick. When the joystick is in the center position, the duty cycle will be approximately 50%.

The possible causes of this diagnostic code are listed:

- The circuit of the sensor power supply is open.
- The return circuit of the sensor is open.
- The signal circuit is open.
- The signal circuit is shorted to the sensor power supply.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Consider the following points when this code is active:

- Before performing this procedure, check for an active CID 0041 diagnostic code for the 8 volt sensor power supply of the Implement ECM (MID 082). Correct any problem with the 8 volt power supply before performing this procedure.

- The correct operating temperature range for the steering sensors is -40°C (-40.0°F) to 75°C (167.0°F). If an FMI 03 diagnostic code or an FMI 08 diagnostic code become active for a steering sensor, when the cab environment is at extreme temperatures, reduce the temperature of the cab environment in order to keep the steering sensors operating. After the temperature has been reduced, verify that the CID 1472 FMI 03 diagnostic code is active before performing this procedure.
- The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the steering sensor 2. Both ECM modules can activate a CID 1472 FMI 03 diagnostic code when the signal voltage is above normal.
- If one ECM has activated a CID 1472 FMI 03 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected.
- When both ECM modules have activated the diagnostic code, either the sensor OR a harness problem could be the cause.
- If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem.

For either condition, proceed with this procedure in order to verify the cause of the problem.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SENSOR POWER SUPPLY

- A.** Turn the disconnect switch and the key start switch to the ON position.

- B.** At the J1 harness connector for the left joystick, insert 7X - 1710 Multimeter Probes along the contact of the power supply J1-1 (wire R800-OR(Orange)) and along ground 1 contact J1-8 (wire P967-PU(Purple)). Do not disconnect the machine harness from the J1 connector.

- C.** Measure the DC voltage of the sensor power supply.

- D.** Reposition the multimeter probe that is along ground 1 contact J1-8 (wire P967-PU(Purple)) and move the probe to along ground 2 contact J1-4 (wire P967-PU(Purple)). The other multimeter probe remains positioned along contact of the power supply J1-1 (wire R800-OR(Orange)).

Expected Result:

Both of the voltage measurements are approximately 8.0 ± 0.4 VDC.

Results:

- OK – Both of the voltage measurements are approximately 8.0 ± 0.4 VDC. The power supply for the sensor is correct. Proceed to Test Step 2.
- NOT OK – One or both of the voltage measurements is less than 8.0 ± 0.4 VDC. The power supply for the sensor is not correct.

Repair: Either both of the circuit for the ground of the sensor or the sensor supply circuit of the sensor is faulty.

NOTE: If one of the voltage measurements is correct and the other measurement is not correct, one of the ground circuits is faulty. This condition will not cause this code to activate. However, the faulty ground circuit must be repaired before proceeding with this procedure.

Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors that are in the circuits. Ensure that the connections are clean, that the connections are secure and that the connections are in good condition.

For troubleshooting the power supply of the Implement ECM, refer to the CID 0041 diagnostic code procedures in the troubleshooting section of the manual for the Implement ECM.

Repair the faulty power supply circuit before proceeding with this procedure.

STOP.

Test Step 2. CHECK FOR AN OPEN IN THE SENSOR CIRCUIT AT BOTH OF THE ECM MODULES

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector J1 from the left joystick. At harness connector J1 for the joystick, connect a jumper wire between ground 2 contact J1-4 (wire X800-OR(Orange)) and the signal contact J1-7 (wire U740-BU(Blue)).
- C. Disconnect machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- D. At the harness connector for the Transmission/Chassis ECM, measure the resistance from return contact J1-45 (wire X800-OR(Orange)) to signal contact J2-48 (wire U740-BU(Blue)).
- E. Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.
- F. At harness connector J1 for the joystick, move the jumper wire to the ground 1 contact J1-8 (wire P967-PU(Purple)) and the signal contact J1-7 (wire U740-BU(Blue)).
- G. Disconnect machine harness connectors J1 and J2 from the Implement ECM.
- H. At the harness connectors for the Implement ECM, measure the resistance from return contact J1-45 (wire P967-PU(Purple)) to signal contact J2-48 (wire U740-BU(Blue)).
- I. Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.

Expected Result:

Both resistance measurements are less than 5 ohms at all times during the manipulation of the wiring harness and connectors.

Results:

- OK – Both of the resistance measurements are less than 5 ohms. The sensor circuit is not open in either input circuit of the ECM. Proceed to Test Step 3.
- NOT OK – The resistance measurement at one or both of the ECM modules is greater than 5 ohms. There is an open or a bad connection in one or both of the signal circuits.

Repair: If both of the resistance measurements are not correct, there is an open or a bad connection on the sensor side of the splice for the signal wire U740-BU(Blue).

If one of the measurements is correct and the other measurement is not correct, there is an open connection or a bad connection on the ECM side of the splice for the signal wire U740-BU(Blue).

In either case, refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the suspected section of the sensor signal circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT FOR A SHORT

The key start switch and the disconnect switch remain in the OFF position. The machine harness connectors remain disconnected from the Implement ECM and the Transmission/Chassis ECM.

- A. Remove the jumper wire that was installed in the last step at the connector of the joystick.
- B. At the J2 machine harness connector for the Implement ECM, measure the resistance from the sensor signal contact J2-48 (wire U740-BU(Blue)) to all of the other J1 and J2 contacts that are used for the Implement ECM.
- C. At the J2 machine harness connector for the Transmission/Chassis ECM, measure the resistance from the sensor signal contact J2-48 (wire U740-BU(Blue)) to all of the other J1 and J2 contacts that are used for the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The resistance checks of the signal circuit do not indicate a short in the machine harness. Proceed to Test Step 4.
- NOT OK – A resistance measurement is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the signal circuit and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SIGNAL AT THE SENSOR

The key start switch and the disconnect switch remain in the OFF position.

- A. Reconnect the machine harness connectors J1 and J2 to both ECM modules.
- B. Reconnect the machine harness connectors that are disconnected to the left joystick.
- C. At the machine harness connector J1 for the left joystick, use a 151 - 6320 Removal Tool to remove the signal wire U740-BU(Blue) and the socket at contact J1-7 from the harness connector. The machine harness connector J1 remains connected to the left connector of the joystick.
- D. At the back of the connector of the joystick J1, insert 7X - 1710 Multimeter Probes along the contact of the sensor signal J1-7 and the ground contact at J1-8.
- E. Turn the disconnect switch and the key start switch to the ON position.
- F. Measure the duty cycle of the sensor at the connector contacts of the joystick J1-7 and J1-8. Move the joystick through the full range of the sensor that is described at the beginning of this procedure.

Expected Result:

The duty cycle of the steering sensor 2 is correct according to the description at the beginning of this procedure.

Results:

- OK – The duty cycle of the sensor is correct. The sensor is not the cause of the problem. Reconnect the signal wire and the socket in the machine

harness connector for the joystick. Reinstall the signal wire U740-BU(Blue) and the socket back to the original location at contact J1-7 in the machine harness connector for the joystick. Verify that all of the wires of the joystick are in the correct locations. Secure the wires of the joystick into the connector. Proceed to the next step. Proceed to Test Step 5.

- NOT OK – The duty cycle of the steering sensor 2 is NOT correct according to the description at the beginning of this procedure. The sensor has failed.

Repair: Perform this test step again in order to verify that the sensor signal is not correct.

If the "steering sensor 2" signal is not correct according to the description at the beginning of this procedure, replace the left assembly of the joystick. After replacement of the assembly of the joystick, verify that the operation of the new assembly of the joystick is correct before operating the machine.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 1472 FMI 03 diagnostic code is active.

Expected Result:

The CID 1472 FMI 03 diagnostic code is not active.

Results:

- OK – The CID 1472 FMI 03 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

Diagnostic Code Procedures

- NOT OK – The CID 1472 FMI 03 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

If both the Transmission/Chassis ECM and the Implement ECM have activated this diagnostic code, it is very unlikely that either ECM is causing the problem.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02920297

MID 027 - CID 1472 - FMI 04

SMCS Code: 5737-038-ZH

Conditions Which Generate This Code:

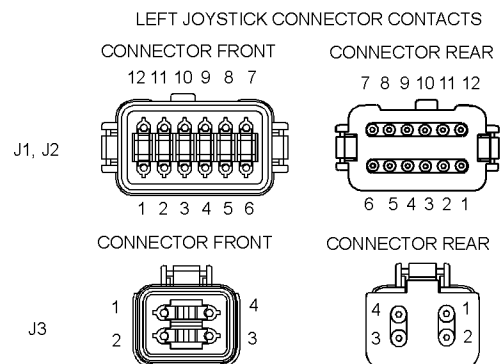
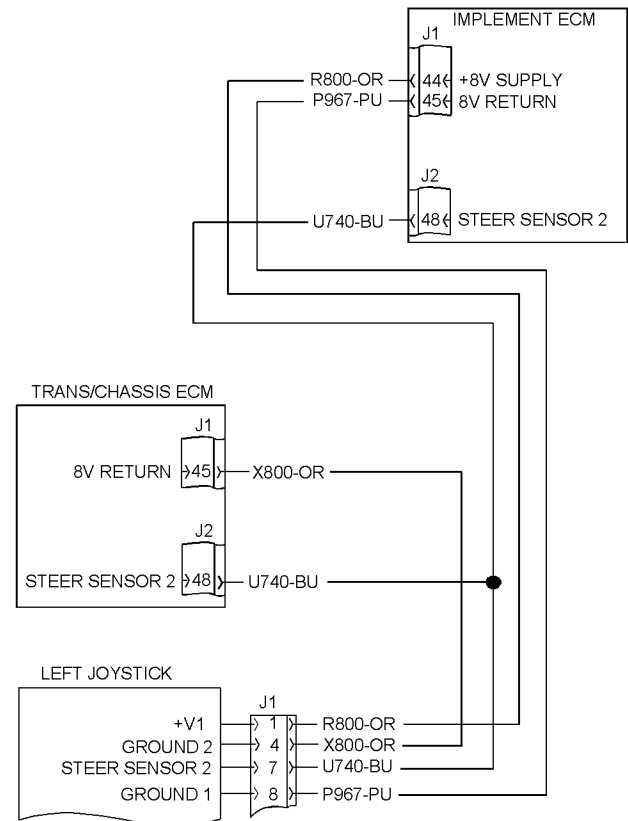


Illustration 268

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Connections of "Steering Sensor 2"

Three steering position sensors are required for correct operation of the steering control lever. The steering position sensors are located in the left assembly of the joystick. Each sensor provides an input signal to the Implement ECM and to the Transmission/Chassis ECM. This diagnostic code is recorded when the ECM reads the signal from the steering position sensor 2 and the voltage of the signal is below normal.

The steering position sensor 2 receives power from the 8 volt power supply of the Implement ECM. Steering position sensor 2 is connected to ground at the 8 volt sensor return of the Transmission/Chassis ECM (ground of the ECM) and the 8 volt sensor return of the Implement ECM (ground of the ECM). The steering sensor must lose the 8 volt power supply or both grounds in order to lose power. The illustration above indicates the power and ground connections for steering position sensor 2.

The position sensor is a PWM sensor that operates at a frequency of approximately 500 ± 80 hertz. The position sensor sends a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The duty cycle of the signal will vary from approximately $10 \pm 5\%$ at the full left position of the joystick to approximately $90 \pm 5\%$ at the full right position of the joystick. When the joystick is in the center position, the duty cycle will be approximately 50%.

The possible causes of this diagnostic code are listed:

- The signal circuit is shorted to ground.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active CID 0041 diagnostic code for the 8 volt sensor power supply of the Implement ECM (MID 082). Correct any problem with the 8 volt power supply before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the steering sensor 2. Both ECM modules can activate a CID 1472 FMI 04 diagnostic code when the signal voltage is below normal. If one ECM has activated a CID 1472 FMI 04 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor OR a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SENSOR

- A. Turn the disconnect switch and the key start switch to the ON position.
- B. Disconnect the machine harness connector J1 from the left joystick. Observe the status of the active CID 1472 FMI 04 diagnostic code.

Expected Result:

The status of the CID 1472 FMI 04 diagnostic code did not change when the connector of the joystick was disconnected. A CID 1472 FMI 03 diagnostic code has NOT been activated by either the Implement ECM or the Transmission/Chassis ECM. The CID 1472 FMI 04 diagnostic code remains active when the connector of the joystick is disconnected.

Results:

- YES – The CID 1472 FMI 04 diagnostic code remains active when the connector of the joystick is disconnected. The sensor is not causing the problem. Proceed to Test Step 2.
- NO – The CID 1472 FMI 04 diagnostic code is no longer active when the connector of the joystick is disconnected. A CID 1472 FMI 03 diagnostic code has been activated by both of the ECM modules when the connector of the joystick is disconnected. The machine harness and the ECM are operating correctly.

Repair: The steering sensor 2 is causing the problem. There is an internal short to ground in the left joystick. Replace the left assembly of the joystick. After replacement of the assembly of the joystick, verify that the operation of the new assembly of the joystick is correct before operating the machine.

STOP.

Test Step 2. CHECK THE SIGNAL CIRCUIT FOR A SHORT TO GROUND

- A. The connector of the joystick J1 remains disconnected from the machine harness.
- B. Turn the key start switch and the disconnect switch to the OFF position.
- C. Disconnect the J1 and J2 machine harness connectors from the Implement ECM.
- D. Disconnect the J1 connector and the J2 connector from the Transmission/Chassis ECM.
- E. At machine harness connector J2 for the Implement ECM, measure the resistance from contact J2-48 (wire U740-BU(Blue)) to frame ground. Measure the resistance from contact J2-48 (wire U740-BU(Blue)) to all of the other J1 and J2 contacts that are used for the Implement ECM.
- F. At the J2 machine harness connector for the Transmission/Chassis ECM, measure the resistance from the sensor signal contact J2-48 (wire U740-BU(Blue)) to frame ground and measure the resistance to all of the other J1 and J2 contacts that are used for the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The resistance checks of the signal circuit do not indicate a short in the machine harness. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the signal circuit and the frame ground or the signal circuit and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 1472 FMI 04 diagnostic code is active.

Expected Result:

The CID 1472 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 1472 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 1472 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

If both the Transmission/Chassis ECM and the Implement ECM have activated this diagnostic code, it is very unlikely that either ECM is causing the problem.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

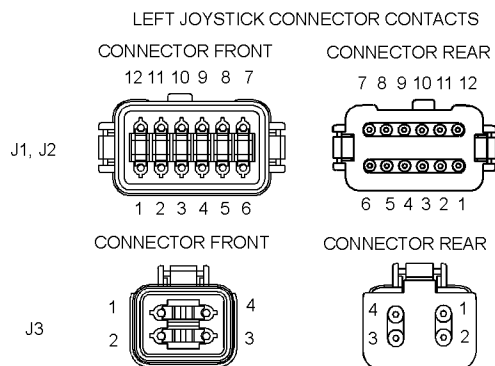
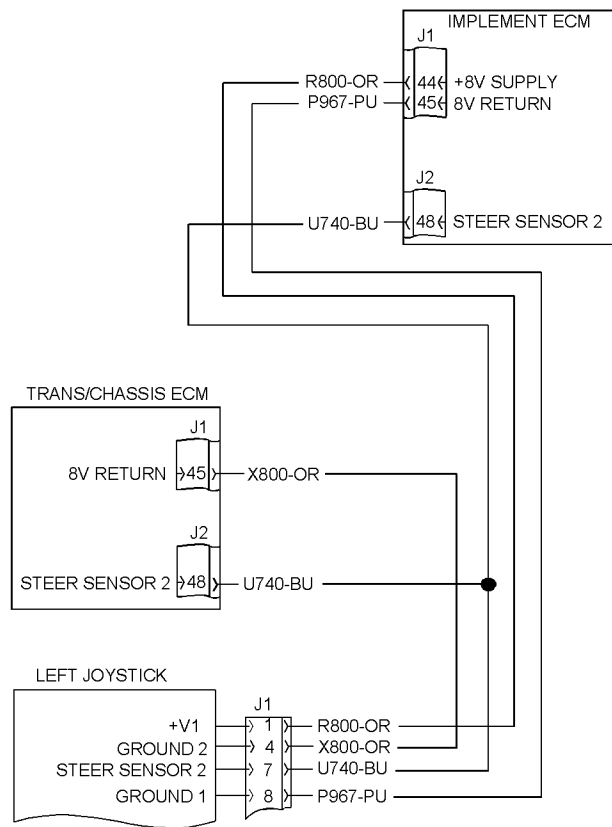
STOP.

i02920413

MID 027 - CID 1472 - FMI 08

SMCS Code: 5737-038-ZH

Conditions Which Generate This Code:



Diagnostic Code Procedures

Three steering position sensors are required for correct operation of the steering control. The steering position sensors are located in the left assembly of the joystick. Each sensor provides an input signal to the ECM. This diagnostic code is associated with the left hand steering lever position sensor 2. The FMI 08 means that the ECM has determined that the signal frequency or the signal pulse width is not within the expected range.

The "steering position sensor 2" receives power from the 8 volt power supply of the Implement ECM. "Steering position sensor 2" is connected to ground at the 8 volt sensor return of the Transmission/Chassis ECM (ground of the ECM) and the 8 volt sensor return of the Implement ECM (ground of the ECM). The steering sensor must lose the 8 volt power supply or both grounds in order to lose power. The illustration above indicates the power and ground connections for "steering position sensor 2".

The position sensor is a PWM sensor that operates at a frequency of 500 ± 80 Hz. The position sensor sends a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The duty cycle of the signal will vary from approximately $10 \pm 5\%$ at the full left position of the joystick to approximately $90 \pm 5\%$ at the full right position of the joystick. When the joystick is in the center position, the duty cycle will be approximately 50%.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- Intermittent connections or poor connections
- The ECM has failed. This is unlikely.

Consider the following points when this code is active:

- Before performing this procedure, check for an active CID 0041 diagnostic code for the 8 volt sensor power supply of the ECM. Correct any problem with the 8 volt power supply before performing this procedure.
- The correct operating temperature range for the steering sensors is -40°C (-40.0°F) to 75°C (167.0°F). If an FMI 03 diagnostic code or an FMI 08 diagnostic code is active for a steering sensor at the time that the cab environment is at extreme temperatures, reduce the temperature of the cab environment in order to keep the steering sensors operating in the acceptable temperature range. After the temperature has been reduced, verify that the CID 1472 FMI 08 diagnostic code is active before performing this procedure.

- The Transmission/Chassis ECM also receives an input from the "steering sensor 2" signal. The Transmission/Chassis ECM (MID 027) will activate a CID 1472 FMI 08 diagnostic code when an abnormal signal frequency or pulse width is detected. If one ECM has activated a CID 1472 FMI 08 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, an intermittent open in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor OR a harness problem could be the cause. For either condition, proceed with this procedure in order to verify the cause of the problem.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE DUTY CYCLE AND THE SIGNAL FREQUENCY AT THE SENSOR

Turn the key start switch and the disconnect switch to the OFF position.

- A.** At the machine harness connector J1 for the left joystick, use a 151-6320 Removal Tool to remove the signal wire (wire U740-BU(Blue)) and the socket at contact J1-7. The machine harness connector J1 remains connected to the left connector of the joystick.
- B.** At the back of the connector of the joystick J1, insert 7X-1710 Multimeter Probes along the sensor signal contact J1-7 and the ground contact at J1-4.
- C.** Turn the disconnect switch and the key start switch to the ON position.
- D.** With the joystick in a stationary position, measure the frequency of the signal from the sensor.
- E.** Observe the measurement of the resistance and wiggle the connector of the joystick. Gently pull on the wires and wiggle the wires.

- F. Measure the duty cycle of the sensor at the connector contacts for the joystick J1-7 and J1-4. Move the joystick through the full range of the sensor that is described at the beginning of this procedure.
- G. Observe the measurement and wiggle the connector of the joystick . Gently pull on the wires and wiggle the wires.

Expected Result:

The frequency of the “steering sensor 2” signal is 500 ± 80 Hz. The duty cycle of the “steering sensor 2” is correct according to the description at the beginning of this procedure. The frequency and the duty cycle are stable during the manipulation of the harness connector and the wiring.

Results:

- OK – The frequency of the signal and the duty cycle of the sensor are correct and did not change when the harness was manipulated. The sensor is not causing the problem. Reconnect the signal wire and the socket in the machine harness connector for the joystick. Verify that all wires of the joystick are secure in the connector. Proceed to the next step. Proceed to Test Step 2.
- NOT OK – The signal frequency and the duty cycle of the “steering sensor 2” is not correct according to the description at the beginning of this procedure. The sensor has failed.

Repair: Perform this test step again in order to verify that the sensor signal is not correct.

If the “steering sensor 3” signal is not correct according to the description at the beginning of this procedure, replace the left assembly of the joystick. After replacement of the assembly of the joystick, verify that the operation of the new assembly of the joystick is correct before operating the machine.

STOP.

Test Step 2. CHECK FOR AN OPEN IN THE SENSOR CIRCUIT AT BOTH OF THE ECM MODULES

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector J1 from the left joystick. At the sensor connection for the machine harness J1, place a jumper wire between the ground 1 contact J1-8 (wire P967-PU(Purple)) and the signal contact J1-7 (wire L740-BU(Blue)) .

- C. Disconnect machine harness connectors J1 and J2 from the Implement ECM.
- D. At the harness connector for the Implement ECM, measure the resistance from return contact J1-45 (wire P967-PU(Purple)) to signal contact J2-48 (wire U740-BU(Blue)).
- E. Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.
- F. At the harness connector for the joystick, move the jumper wire from the ground 1 contact and connect the jumper wire to the ground 2 contact J1-4 (wire X800-OR(Orange)). The other end of the jumper wire remains connected to the signal contact J1-7 (wire L740-BU(Blue)).
- G. Disconnect machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- H. At the harness connector for the Transmission/Chassis ECM, measure the resistance from return contact J1-45 (wire X800-OR(Orange)) to signal contact J2-48 (wire U740-BU(Blue)).
- I. Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.

Expected Result:

Both resistance measurements are less than 5 ohms at all times during the manipulation of the wiring harness and the connectors.

Results:

- OK – Both of the resistance measurements are less than 5 ohms. The sensor circuit is not open in either of the input circuits of the ECM modules. Proceed to Test Step 3.
- NOT OK – The resistance measurement at one or both of the ECM modules is greater than 5 ohms. There is an open or a bad connection in one or both of the signal circuits.

Repair: If both of the resistance measurements are not correct, there is an open connection or a bad connection on the sensor side of the splice of the machine harness for the signal wire U740-BU(Blue).

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor signal circuit. Ensure that all connections are clean, that all connectors are secure and that all connections are in good condition.

If one of the measurements is correct and the other measurement is not correct, there is an open or a bad connection on the ECM side of the splice for the machine harness for the signal wire U740-BU(Blue).

In either case, refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the suspected section of the sensor signal circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C.** Reconnect all harness connectors in order to make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Check the status of the CID 1472 FMI 08.

Expected Result:

The CID 1472 FMI 08 is not active.

Results:

- OK – The CID 1472 FMI 08 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 1473 FMI 08 is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

If both the Transmission/Chassis ECM and the Implement ECM have activated this diagnostic code, it is very unlikely that either ECM is causing the problem.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02920617

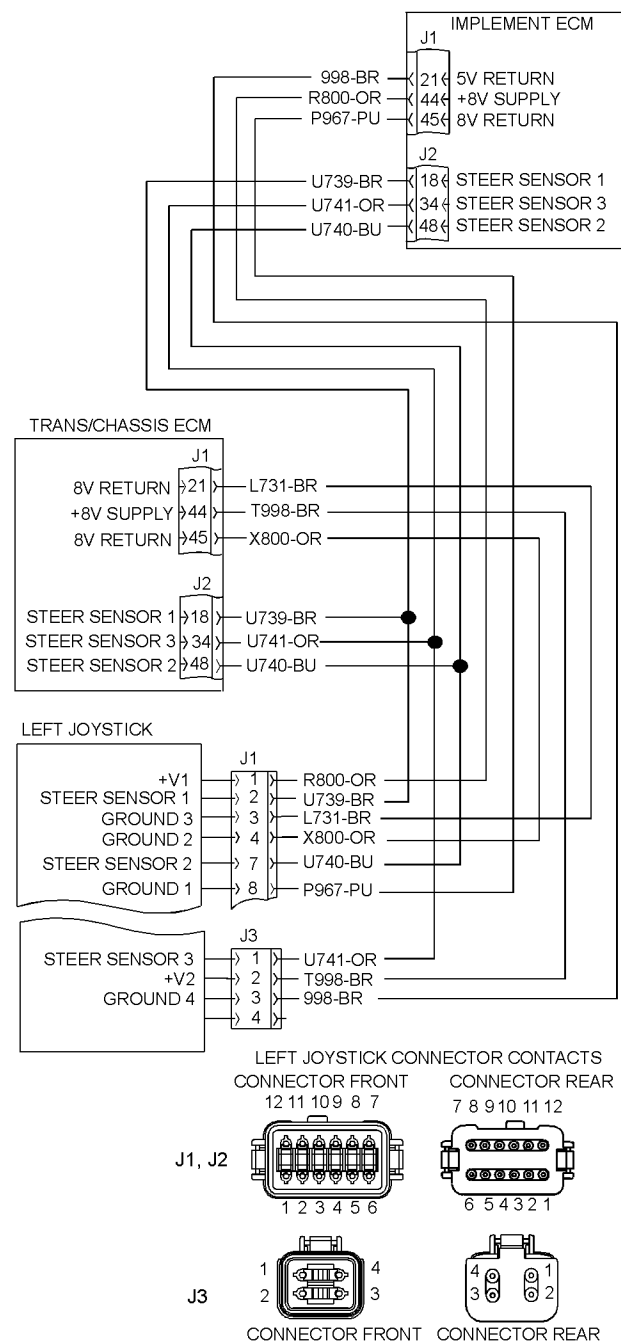
MID 027 - CID 1472 - FMI 14**SMCS Code:** 5737-038-ZH**Conditions Which Generate This Code:**

Illustration 270

g01291021

Connections of "Left Joystick Steering" Sensors

Three steering sensors are required for correct operation of the steering control. The steering sensors are located in the assembly of the left joystick. Each sensor provides an input signal to the ECM. The ECM expects the input signals from all three steering sensors to match very closely. The FMI 14 diagnostic code is active when the ECM determines that the PWM input signal from the "steering position sensor 2" does not match the PWM input signal from one of the other steering sensors. However, the signal of the "steering position sensor 2" does match with the third sensors signal.

The "steering position sensor 2" receives power from the 8 volt power supply of the Implement ECM. "Steering position sensor 2" is connected to ground at the 8 volt sensor return for the Transmission/Chassis ECM (ground of the ECM) and the 8 volt sensor return of the Implement ECM (ground of the ECM). The steering sensor must lose the 8 volt power supply or both grounds in order to lose power. The illustration above indicates the power and ground connections for "steering position sensor 2".

The position sensor is a PWM sensor that operates at a frequency of approximately 500 ± 80 hertz. The position sensor sends a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The duty cycle of the signal will vary from approximately 10% at the full left position of the lever to approximately 90% at the full right position of the lever. When the lever is in the center position, the duty cycle will be approximately 50%.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active MID 027 CID 0041 diagnostic code at the 8 volt power supply of the Transmission/Chassis ECM. Correct any problem with the 8 volt power supply before performing this procedure.

Note: The correct operating temperature range for the steering sensors is -40°C (-40.0°F) to 75°C (167.0°F). If an FMI 03, FMI 08 or FMI 14 diagnostic code becomes active for a steering sensor when the cab environment is at extreme temperatures, reduce temperature of the cab environment. Reducing the temperature of the cab will keep the steering sensors operating in the acceptable temperature range. After the temperature has returned to normal, verify that the CID 1472 FMI 14 diagnostic code is active before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the “steering sensor 1”. Both ECM modules can activate a CID 1472 FMI 14 diagnostic code when the signal from one steering sensor does not closely match the signal from one of the other steering sensors and the sensor does match the signal from the third steering sensor. If one ECM has activated a CID 1472 FMI 14 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Note: The next three test steps will measure the duty cycle of each steering sensor in order to determine if one signal is not closely matching with both of the other sensor signals. Record the duty cycle of the sensor for each of the three sensors for comparison.

Test Step 1. CHECK THE SIGNAL AT STEERING SENSOR 1

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Do not disconnect the harness connector from the sensor.
- C. At the machine harness connector J1 for the left joystick, use a 151 - 6320 Removal Tool to remove the signal wire of “steering sensor 1” (wire U739-BR(Brown)) and the socket at contact J1-2. The machine harness connector J1 remains connected to the connector of the left joystick.

- D. At the back of the connector of the joystick J1, insert 7X - 1710 Multimeter Probes along the contact of the sensor signal J1-2 and the return contact at J1-4.
- E. Turn the disconnect switch and the key start switch to the ON position.
- F. Monitor the signal of the sensor with a digital multimeter.
- G. Move the joystick through the full range of operation. Record the duty cycle of the sensor at specific positions of the joystick.

Expected Result:

The duty cycle of the “steering sensor 1” has been noted at specific positions of the joystick.

Results:

- OK – The duty cycle has been recorded for comparison with the other two steering sensors. Reconnect the signal wire and the socket in the machine harness connector for the joystick before proceeding to the next test step. Proceed to Test Step 2.

Test Step 2. CHECK THE SIGNAL AT SENSOR 2

Turn the key start switch and the disconnect switch to the OFF position.

- A. At the machine harness connector J1 for the left joystick, use a 151 - 6320 Removal Tool to remove the signal wire of “steering sensor 2” U740-BU(Blue) and the socket at contact J1-7 from the harness connector. The machine harness connector J1 remains connected to the connector of the left joystick.
- B. At the back of the connector of the joystick J1, insert 7X - 1710 Multimeter Probes along the contact of the sensor signal J1-7 and the return contact at J1-8.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Monitor the signal of the sensor with a digital multimeter.
- E. Move the joystick through the full range of operation. Record the duty cycle of the sensor at specific positions of the joystick.

Expected Result:

The duty cycle of the “steering sensor 2” has been noted at specific positions of the joystick.

Results:

- OK – The duty cycle has been recorded for comparison with the other two steering sensors. Reconnect the signal wire and the socket in the machine harness connector for the joystick before proceeding to the next test step. Proceed to Test Step 3.

Test Step 3. CHECK THE SIGNAL AT STEERING SENSOR 3

Turn the key start switch and the disconnect switch to the OFF position.

- At the machine harness connector J3 for the left joystick, use a 151 - 6320 Removal Tool to remove the "steering sensor 3" signal wire U741-OR(Orange) and the socket at contact J3-1 from the harness connector. The machine harness connector J3 remains connected to the connector of the left joystick.
- At the back of the connectors of the joystick J1 and J3, insert 7X - 1710 Multimeter Probes along the sensor signal contact J3-1 and the return contact at J3-3.
- Turn the disconnect switch and the key start switch to the ON position.
- Monitor the signal of the sensor with a digital multimeter.
- Move the joystick through the full range of operation. Record the duty cycle of the sensor at specific positions of the joystick.

Expected Result:

After comparison of the duty cycles of all three steering sensors at the same specific positions of the joystick, each duty cycle of the sensor is within 5% or less of the signals from the other sensors.

Results:

- OK – There is a 5% or less deviation between the PWM duty cycle signals for the three steering sensors with the joystick in the same position. Proceed to Test Step 4.
- NOT OK – When the joystick is the same position, one or more of the PWM duty cycle signals deviates more than 5% when compared to the signals from the other two steering sensors. There is a problem with a steering sensor.

Repair: One of the steering sensors is not operating correctly. Replace the assembly of the left joystick. After replacement of the

assembly of the joystick, verify that the new assembly is working correctly before operating the machine.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Operate the machine.
- Check the status of the CID 1472 FMI 14 diagnostic code.

Expected Result:

The CID 1472 FMI 14 diagnostic code is not active.

Results:

- OK – The CID 1472 FMI 14 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 1472 FMI 14 diagnostic code is active. The diagnostic code has not been corrected.

Repair: If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

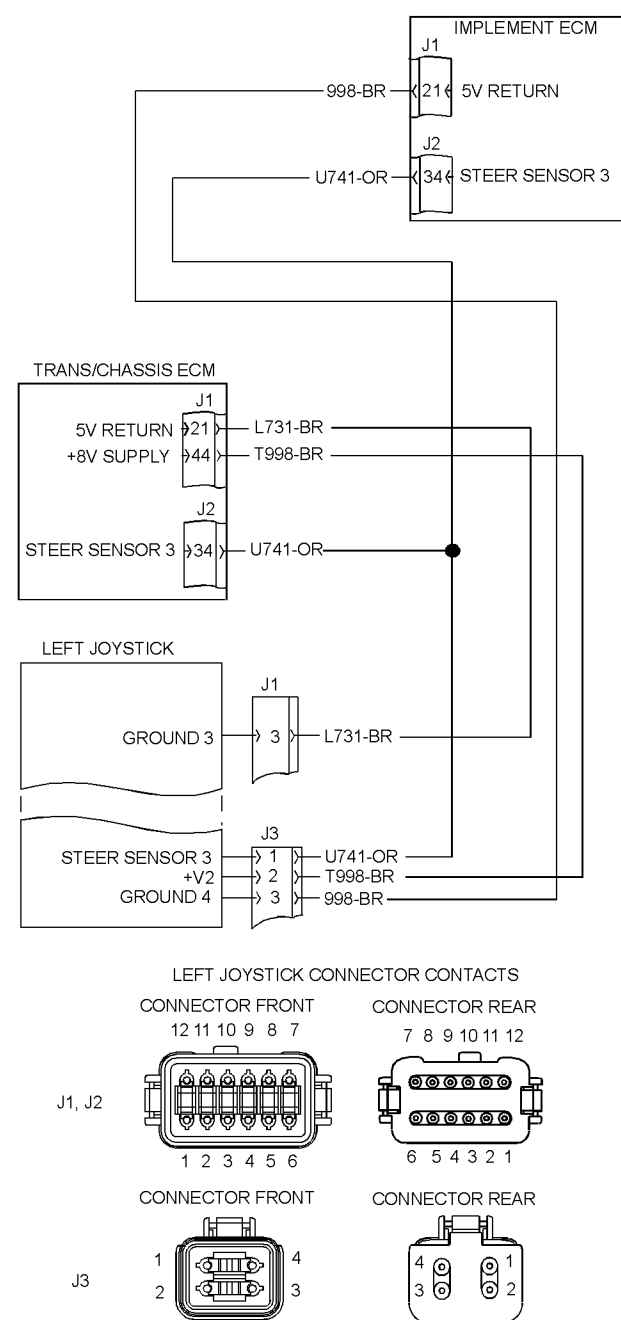
If both the Transmission/Chassis ECM and the Implement ECM have activated this diagnostic code, it is very unlikely that either ECM is causing the problem.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02921007

MID 027 - CID 1473 - FMI 02**SMCS Code:** 5737-038-ZH**Conditions Which Generate This Code:**

Three steering position sensors are required for correct operation of the steering control. The steering position sensors are located in the assembly of the left joystick. Each sensor provides an input signal to the Implement ECM and to the Transmission/Chassis ECM. This diagnostic code is recorded when the ECM reads the input signal from the "steering position sensor 3" and the signal is erratic or intermittent.

The "steering position sensor 3" receives power from the 8 volt power supply of the Transmission/Chassis ECM. The "steering sensor 3" is internally connected to the ground from the 5 volt sensor return of the Transmission/Chassis ECM (ground of the ECM) and to the ground from the 5 volt sensor return of the Transmission/Chassis ECM (ground of the ECM). The steering sensor must lose the 8 volt power supply or both grounds in order to lose power. The illustration above indicates the power and ground connections for steering position sensor 3.

The position sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The position sensor sends a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The duty cycle of the signal will vary from approximately $10 \pm 5\%$ at the full left position of the joystick to approximately $90 \pm 5\%$ at the full right position of the joystick. When the joystick is in the center position, the duty cycle will be approximately 50%.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- Intermittent connections or poor connections exist in the sensor circuit.
- The signal circuit is shorted to another circuit in the machine harness.
- The ECM has failed. This is unlikely.

Consider the following points when this code is active:

Note: Before this procedure is performed, check for an active MID 027 CID 0041 diagnostic code for the 8 volt sensor power supply of the Transmission/Chassis ECM. Correct any problem with the 8 volt power supply before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the “steering sensor 3” . Both ECM modules can activate a CID 1473 FMI 02 diagnostic code when the signal is erratic or intermittent. If one ECM has activated a CID 1473 FMI 02 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SENSOR POWER SUPPLY

- A. Turn the key start switch and the disconnect switch to the ON position.
- B. At the machine harness connectors for the left joystick, insert 7X - 1710 Multimeter Probes along the contact for the power supply J3-2 (wire T998-BR(Brown)) and along ground 3 contact J1-3 (wire L731-BR(Brown)). Do not disconnect the machine harness from the connectors of the joystick.
- C. Measure the DC voltage of the sensor power supply.
- D. Reposition the multimeter probe that is along ground 3 contact J1-3 (wire L731-BR(Brown)) to along ground 4 contact J3-3 (wire 998-BR(Brown)). The other multimeter probe remains positioned along the contact of the power supply J3-2 (wire T998-BR(Brown)).
- E. Measure the DC voltage of the sensor power supply.

Expected Result:

Both of the voltage measurements are approximately 8.0 ± 0.4 VDC.

Results:

- OK – Both of the voltage measurements are approximately 8.0 ± 0.4 VDC. The Transmission/Chassis ECM power supply for the sensor is correct. Proceed to Test Step 2.
- NOT OK – One or both of the voltage measurements is not 8.0 ± 0.4 VDC. The Transmission/Chassis ECM power supply for the sensor is not correct.

Repair: Either both of the wires for the sensor ground or the sensor supply circuit is faulty.

NOTE: If one of the voltage measurements is correct and the other measurement is not correct, one of the ground circuits is faulty. This condition will not cause this code to activate, however, the faulty ground circuit must be repaired before proceeding with this procedure.

Refer to the complete Electrical System Schematic of the machine . Examine all of the connectors that are in the circuits. Ensure that the connections are clean, that the connectors are secure and that the connectors are in good condition.

For troubleshooting the power supply of the Transmission/Chassis ECM, refer to the CID 0041 diagnostic code procedures in the troubleshooting section of the manual for the Transmission/Chassis ECM.

Repair the faulty power supply circuit before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SIGNAL AT THE SENSOR

The key start switch and the disconnect switch remain in the OFF position.

- A. At the machine harness connector J3 for the left joystick, use a 151 - 6320 Removal Tool to remove the signal wire U741-OR(Orange) and the socket at contact J3-1 from the harness connector. The machine harness connector J3 remains connected to the connector of the left joystick.
- B. At the back of the connectors for the joystick J3 and J1, insert 7X - 1710 Multimeter Probes along the sensor signal contact J3-1 and the ground 4 contact at J3-3.
- C. Turn the disconnect switch and the key start switch to the ON position.

- D.** Measure the duty cycle of the sensor at the connector contacts of the joystick J3-1 and J3-3. Move the joystick through the full range of the sensor that is described at the beginning of this procedure.

Expected Result:

The duty cycle of the steering sensor 3 is correct according to the description at the beginning of this procedure.

Results:

- OK – The duty cycle of the sensor is correct. The sensor is not the cause of the problem. Reinstall the signal wire U741-OR(Orange) and the socket back to the original location at contact J3-1 in the machine harness connector for the joystick. Verify that all of the wires of the joystick are in the correct locations. Secure the connector before proceeding to the next step. Proceed to Test Step 3.
- NOT OK – The duty cycle of the steering sensor 3 is not correct according to the description at the beginning of this procedure. The sensor has failed.

Repair: Perform this test step again in order to verify that the sensor signal is not correct.

If the steering sensor 3 signal is not correct according to the description at the beginning of this procedure, replace the assembly of the left joystick. After replacement of the assembly of the joystick, verify that the operation of the new assembly of the joystick is correct before operating the machine.

STOP.

Test Step 3. CHECK THE SIGNAL AT BOTH OF THE ECM MODULES

- A.** Turn the key start switch and the disconnect switch to the OFF position.
- B.** At the machine harness connector J1 for the Implement ECM, insert a multimeter probe along return contact J1-21 (998-BR(Brown)). At the machine harness connector J2 for the Implement ECM, insert a multimeter probe along signal contact J2-34 (wire U741-OR(Orange)). The machine harness connectors remain connected to the ECM.
- C.** Turn the key start switch and the disconnect switch to the ON position.

- D.** Measure the duty cycle of the sensor at the connector contacts of the ECM J1-21 and J2-34. Move the joystick through the full range of the sensor that is described at the beginning of this procedure.

- E.** At the machine harness connector J1 for the Transmission/Chassis ECM, insert a multimeter probe along return contact J1-21 (L731-BR(Brown)). At the machine harness connector J2 for the Implement ECM, insert a multimeter probe along the contact for the signal wire J2-34 (wire U741-OR(Orange)). The machine harness connectors remain connected to the ECM.

- F.** Measure the duty cycle of the sensor at the connector contacts of the ECM J1-21 and J2-34. Move the joystick through the full range of the sensor that is described at the beginning of this procedure.

Expected Result:

The duty cycle of the steering sensor 3 is correct according to the description at the beginning of this procedure at both of the ECM modules.

Results:

- OK – The duty cycle of the sensor is correct at both of the ECM modules. The machine harness does not appear to be the cause of the problem. An intermittent open or the short could still be causing the problem. Proceed to Test Step 4.
- NOT OK – The duty cycle of the steering sensor 3 is not correct at one or both of the ECM modules according to the description at the beginning of this procedure. There is a problem in the machine harness.

Repair: If the sensor signal at one ECM is correct and the sensor signal at the other ECM is not correct, a poor connection in the circuit would be suspected.

The steering sensor 3 signal at one of the ECM modules is not correct.

Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors that are in the section of the sensor signal circuit that connects to the ECM that is not receiving a good signal. Verify that the connections are clean, that the connections are secure and that the connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

- NOT OK – The duty cycle of the steering sensor 3 is not correct at either of the ECM modules according to the description at the beginning of this procedure. Most likely the problem is in the machine harness. Proceed to Test Step 4.

Test Step 4. CHECK THE SIGNAL CIRCUIT FOR A SHORT

Turn the key start switch and the disconnect switch to the OFF position.

- Disconnect the J1 and the J2 connectors from the Implement ECM.
- At the J2 machine harness connector for the Implement ECM, measure the resistance from the sensor signal contact J2-34 (wire U741-OR(Orange)) to all of the other J1 and J2 contacts that are used for the Implement ECM.
- If any of the resistance measurements in the last test step are less than 5000 ohms, skip the next test step and proceed to the "Expected Result" step. If all of the resistance measurements in the last test step are above 5000 ohms, perform the next test step.
- Disconnect the J1 and the J2 connectors from the Transmission/Chassis ECM.
- At the J2 machine harness connector for the Transmission/Chassis ECM, measure the resistance from the sensor signal contact J2-34 (wire U741-OR(Orange)) to all of the other J1 and J2 contacts that are used for the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The resistance checks of the signal circuit do not indicate a short in the machine harness. Proceed to Test Step 5.
- NOT OK – A resistance measurement is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the signal circuit and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Determine if the CID 1473 FMI 02 diagnostic code is active.

Expected Result:

The CID 1473 FMI 02 diagnostic code is not active.

Results:

- OK – The CID 1473 FMI 02 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 1473 FMI 02 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

Diagnostic Code Procedures

If the cause of the active diagnostic code is not found, the ECM that has activated the diagnostic code may have failed.

If both the Transmission/Chassis ECM and the Implement ECM have activated this diagnostic code, it is very unlikely that either ECM is causing the problem.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02921015

MID 027 - CID 1473 - FMI 03

SMCS Code: 5737-038-ZH

Conditions Which Generate This Code:

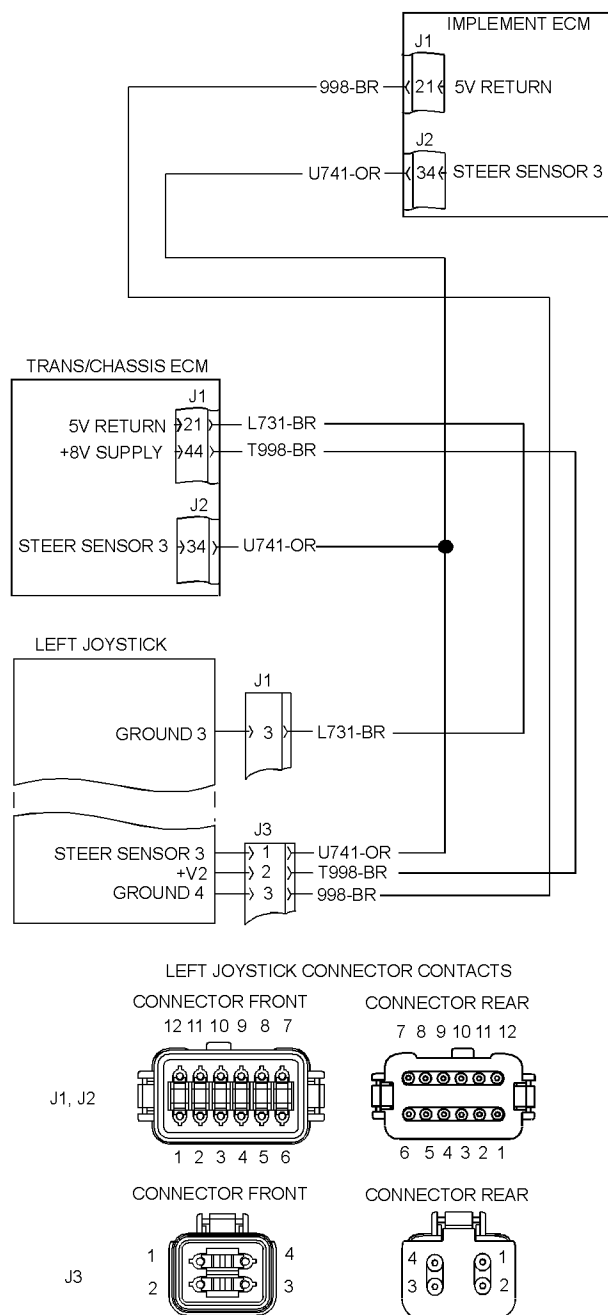


Illustration 272

g01260039

Connections of "Steering Sensor 3"

Three steering sensors are required for correct operation of the steering control. The steering sensors are located in the assembly of the left joystick. Each sensor provides an input signal to the Implement ECM and to the Transmission/Chassis ECM. This diagnostic code is recorded when the ECM reads the input signal from the "steering position sensor 3" and the voltage of the signal is above normal.

The "steering position sensor 3" receives power from the 8 volt power supply of the Transmission/Chassis ECM. The "steering sensor 3" is connected to ground at the 5 volt sensor return of the Transmission/Chassis ECM (ground of the ECM) and the 5 volt sensor return of the Transmission/Chassis ECM (ground of the ECM). The steering sensor must lose the 8 volt power supply or both grounds in order to lose power. The illustration above indicates the power and ground connections for "steering position sensor 3".

The position sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The position sensor sends a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The duty cycle of the signal will vary from approximately $10 \pm 5\%$ at the full left position of the joystick to approximately $90 \pm 5\%$ at the full right position of the joystick. When the joystick is in the center position, the duty cycle will be approximately 50%.

The possible causes of this diagnostic code are listed below:

- The power supply circuit for the sensor is faulty.
- The return circuit of the sensor is open.
- The signal circuit is open.
- The signal circuit is shorted to a voltage source.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Consider the following points when this code is active:

Perform this procedure after checking for an active MID 027 CID 0041 diagnostic code for the 8 volt sensor power supply of the Transmission/Chassis ECM. Correct any problem with the 8 volt power supply before performing this procedure.

Note: The correct operating temperature range for the steering sensors is -40°C (-40.0°F) to 75°C (167.0°F). If an FMI 03 or an FMI 08 diagnostic code becomes active for a steering sensor when the cab environment is at extreme temperatures, reduce the temperature of the cab environment in order to keep the steering sensors operating in the acceptable temperature range. After reducing the temperature, verify that the CID 1473 FMI 03 diagnostic code is active before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the "steering sensor 3". Both ECM modules can activate a CID 1473 FMI 03 diagnostic code when the signal is erratic or intermittent. If one ECM has activated a CID 1473 FMI 03 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SENSOR POWER SUPPLY

- A. Turn the key start switch and the disconnect switch to the ON position.
- B. At the J3 and J1 harness connectors for the left joystick, insert 7X - 1710 Multimeter Probes along the power supply contact J3-2 (wire T998-BR(Brown)) and along ground 2 contact J1-4 (wire X800-OR(Orange)). Do not disconnect the machine harness from the connectors of the joystick.
- C. Measure the DC voltage of the sensor power supply.
- D. Reposition the multimeter probe that is along ground 3 contact J1-3 (wire L731-BR(Brown)) to along ground 4 contact J3-3 (wire 998-BR(Brown)). The other multimeter probe remains positioned along the contact for the power supply J3-2 (wire T998-BR(Brown)).
- E. Measure the DC voltage of the sensor power supply.

Expected Result:

Both of the voltage measurements are approximately 8.0 ± 0.4 VDC.

Results:

- OK – Both of the voltage measurements are approximately 8.0 ± 0.4 VDC. The power supply for the Transmission/Chassis ECM for the sensor is correct. Proceed to Test Step 2.
- NOT OK – One or both of the voltage measurements is not 8.0 ± 0.4 VDC. The power supply for the Transmission/Chassis ECM for the sensor is not correct.

Repair: Either the circuit for the ground connection of the sensor or the circuit for the supply connection of the sensor is faulty.

NOTE: If one of the voltage measurements is correct and the other measurement is not correct, one of the ground circuits is faulty. This condition will not cause this code to activate. However, the faulty ground circuit must be repaired before proceeding with this procedure.

Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors that are in the circuits. Ensure that the connections are clean, that all connectors are secure and that all connections are good condition.

For troubleshooting the power supply of the Transmission/Chassis ECM, refer to the CID 0041 diagnostic code procedures in the troubleshooting section of the manual for the Transmission/Chassis ECM.

Repair the faulty power supply circuit before proceeding with this procedure.

STOP.

Test Step 2. CHECK FOR AN OPEN IN THE SENSOR CIRCUIT AT BOTH OF THE ECM MODULES

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connectors J3 and J1 from the left joystick. At the harness connectors for the joystick, place a jumper wire between the contact for the signal J3-1 (wire U741-OR(Orange)) and the ground 3 contact J1-3 (wire L731-BR(Brown)) .
- Disconnect machine harness connectors J1 and J2 from the Transmission/Chassis ECM.

- At the harness connector for the Transmission/Chassis ECM, measure the resistance from return contact J1-21 (wire L731-BR(Brown)) to signal contact J2-34 (wire U741-OR(Orange)).
- Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.
- At the harness connectors for the joystick, move the jumper wire from the ground 3 contact and connect the jumper wire to ground 4 contact J3-3 (wire 998-BR(Brown)). The other end of the jumper wire remains connected to the signal contact J3-1 (wire U741-OR(Orange)).
- Disconnect machine harness connectors J1 and J2 from the Implement ECM.
- At the harness connector for the Implement ECM, measure the resistance from return contact J1-21 (wire 998-BR(Brown)) to signal contact J2-34 (wire U741-OR(Orange)).
- Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.

Expected Result:

Both resistance measurements are less than 5 ohms at all times during the manipulation of the wiring harness and connectors.

Results:

- OK – Both of the resistance measurements are less than 5 ohms. The sensor circuit is not open in either input circuit of the ECM. Proceed to Test Step 3.
- NOT OK – The resistance measurement at one or both of the ECM modules is greater than 5 ohms. There is an open or a bad connection in one or both of the signal circuits.

Repair: If both of the resistance measurements are not correct, there is an open connection or a bad connection on the sensor side of the splice of the machine harness for the signal wire U741-OR(Orange).

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor signal circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

If one of the measurements is correct and the other measurement is not correct, there is an open or a bad connection on the ECM side of the splice of the machine harness for the signal wire U741-OR(Orange).

In either case, refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the suspected section of the sensor signal circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT FOR A SHORT

The key start switch and the disconnect switch remain in the OFF position. The machine harness connectors remain disconnected from the Implement ECM and the Transmission/Chassis ECM.

- A. Remove the jumper wire that was installed in the last step at the connector of the joystick.
- B. At the J2 machine harness connector for the Implement ECM, measure the resistance from the sensor signal contact J2-34 (wire U741-OR(Orange)) to all of the other J1 and J2 contacts that are used for the Implement ECM.
- C. At the J2 machine harness connector for the Transmission/Chassis ECM, measure the resistance from the sensor signal contact J2-34 (wire U741-OR(Orange)) to all of the other J1 and J2 contacts that are used for the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The resistance checks for the signal circuit do not indicate a short in the machine harness. Proceed to Test Step 4.
- NOT OK – A resistance measurement is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the signal circuit and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SIGNAL AT THE SENSOR

The key start switch and the disconnect switch remain in the OFF position.

- A. Reconnect the machine harness connectors J1 and J2 to both ECM modules.
- B. Reconnect the machine harness connectors of the left joystick that are disconnected.
- C. At the machine harness connector J3 for the left joystick, use a 151 - 6320 Removal Tool to remove the signal wire U741-OR(Orange) and the socket at contact J3-1 from the harness connector. The machine harness connector J3 remains connected to the connector of the left joystick.
- D. At the back of the connectors of the joystick J3 and J1, insert 7X - 1710 Multimeter Probes along the sensor signal contact J3-1 and the ground 3 contact at J1-3.
- E. Turn the disconnect switch and the key start switch to the ON position.
- F. Measure the duty cycle of the sensor at the connector contacts of the joystick J3-1 and J1-3. Move the joystick through the full range of the sensor that is described at the beginning of this procedure.

Expected Result:

The duty cycle of the steering sensor 3 is correct according to the description at the beginning of this procedure.

Results:

- OK – The duty cycle of the sensor is correct. The sensor is not the cause of the problem. Reinstall the signal wire U741-OR(Orange) and the socket back to the original location at contact J3-1 in the machine harness connector for the joystick. Verify that all of the wires of the joystick are in the correct locations. Secure the connector before proceeding to the next step. Proceed to Test Step 5.

- NOT OK – The duty cycle of the steering sensor 3 is not correct according to the description at the beginning of this procedure. The sensor has failed.

Repair: Perform this test step again in order to verify that the sensor signal is not correct.

If the “steering sensor 3” signal is not correct according to the description at the beginning of this procedure, replace the assembly of the left joystick. After replacement of the assembly of the joystick, verify that the operation of the new assembly of the joystick is correct before operating the machine.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 1473 FMI 03 diagnostic code is active.

Expected Result:

The CID 1473 FMI 03 diagnostic code is not active.

Results:

- OK – The CID 1473 FMI 03 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 1472 FMI 03 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle

test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

If both the Transmission/Chassis ECM and the Implement ECM have activated this diagnostic code, it is very unlikely that either ECM is causing the problem.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i02921110

MID 027 - CID 1473 - FMI 04**SMCS Code:** 5737-038-ZH**Conditions Which Generate This Code:**

Three steering position sensors are required for correct operation of the steering control lever. The steering position sensors are located in the assembly of the left joystick. Each sensor provides an input signal to the Implement ECM and to the Transmission/Chassis ECM. This diagnostic code is recorded when the ECM reads the signal from the "steering position sensor 3" and the voltage of the signal is below normal.

The "steering position sensor 3" receives power from the 8 volt power supply of the Transmission/Chassis ECM. The "steering sensor 3" is connected to ground at the 5 volt sensor return of the Transmission/Chassis ECM (ground of the ECM) and the 5 volt sensor return of the Transmission/Chassis ECM (ground of the ECM). The steering sensor must lose the 8 volt power supply or both grounds in order to lose power. The illustration above indicates the power and ground connections for "steering position sensor 3".

The "steering sensor 3" receives power from the 8 volt power supply of the Transmission/Chassis ECM. The "steering sensor 3" is connected to ground at the 5 volt sensor return of the Transmission/Chassis ECM (ground of the ECM) and the 8 volt sensor return of the Transmission/Chassis ECM (ground of the ECM). The steering sensor must lose the 8 volt power supply or both grounds in order to lose power. The illustration above indicates the power and ground connections for "steering sensor 3".

The position sensor is a PWM sensor that operates at a frequency of approximately 500 ± 80 hertz. The position sensor sends a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The duty cycle of the signal will vary from approximately $10 \pm 5\%$ at the full left position of the joystick to approximately $90 \pm 5\%$ at the full right position of the joystick. When the joystick is in the center position, the duty cycle will be approximately 50%.

The possible causes of this diagnostic code are listed below:

- The signal circuit is shorted to a ground source.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active MID 027 CID 0041 diagnostic code for the 8 volt sensor power supply of the Transmission/Chassis ECM. Correct any problem with the 8 volt power supply before performing this procedure.

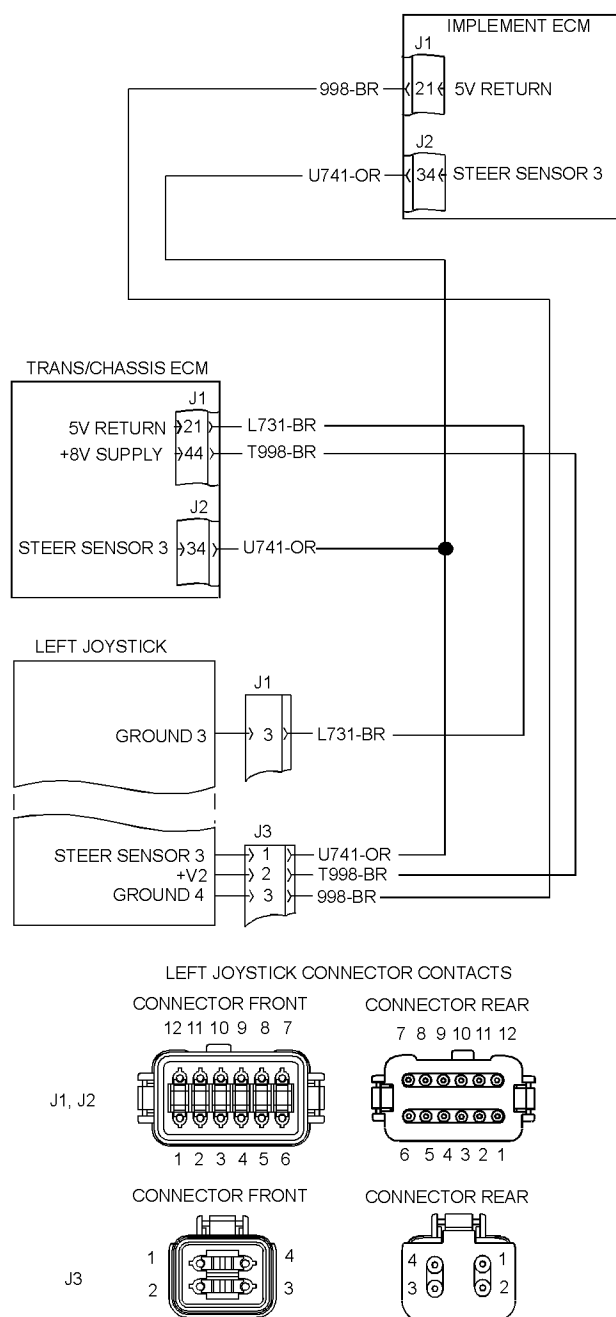


Illustration 273

g01260039

Connections of "Steering Sensor 3"

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the “steering sensor 3”. Both ECM modules can activate a CID 1473 FMI 04 diagnostic code when the signal voltage is below normal. If one ECM has activated a CID 1473 FMI 04 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SENSOR

- A. Turn the disconnect switch and the key start switch to the ON position.
- B. Disconnect the machine harness connector J3 from the left joystick. Observe the status of the active CID 1473 FMI 04 diagnostic code.

Expected Result:

The status of the CID 1473 FMI 04 diagnostic code did not change when the connector of the joystick was disconnected. A CID 1473 FMI 03 diagnostic code has not been activated by either the Implement ECM or the Transmission/Chassis ECM. The CID 1473 FMI 04 diagnostic code remains active when the connector of the joystick is disconnected.

Results:

- YES – The CID 1473 FMI 04 diagnostic code remains active when the connector of the joystick is disconnected. The sensor is not causing the problem. Proceed to Test Step 2.
- NOT OK – The CID 1473 FMI 04 diagnostic code is no longer active when the connector of the joystick is disconnected. A CID 1473 FMI 03

diagnostic code has been activated by both of the ECM modules when the connector of the joystick is disconnected. The machine harness and the ECM are operating correctly.

Repair: The “steering sensor 3” is causing the problem. There is an internal short to ground in the left joystick. Replace the assembly of the left joystick. After replacement of the assembly of the joystick, verify that the operation of the new assembly of the joystick is correct before operating the machine.

STOP.

Test Step 2. CHECK THE SIGNAL CIRCUIT FOR A SHORT TO GROUND

- A. The connector of the joystick J3 remains disconnected from the machine harness.
- B. Turn the key start switch and the disconnect switch to the OFF position.
- C. Disconnect the J1 and J2 machine harness connectors from the Implement ECM.
- D. Disconnect the J1 connector and the J2 connector from the Transmission/Chassis ECM.
- E. At machine harness connector J2 for the Implement ECM, measure the resistance from contact J2-34 (wire U741-OR(Orange)) to frame ground. Measure the resistance from contact J2-34 (wire U741-OR(Orange)) to all of the other J1 and J2 contacts that are used for the Implement ECM.
- F. At the J2 machine harness connector for the Transmission/Chassis ECM, measure the resistance from the sensor signal contact J2-34 (wire U741-OR(Orange)) to frame ground and measure the resistance to all of the other J1 and J2 contacts that are used for the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The resistance checks for the signal circuit do not indicate a short in the machine harness. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the signal circuit and the frame ground or the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 1473 FMI 04 diagnostic code is active.

Expected Result:

The CID 1473 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 1473 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 1473 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service

tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

If both the Transmission/Chassis ECM and the Implement ECM have activated this diagnostic code, it is very unlikely that either ECM is causing the problem.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02921131

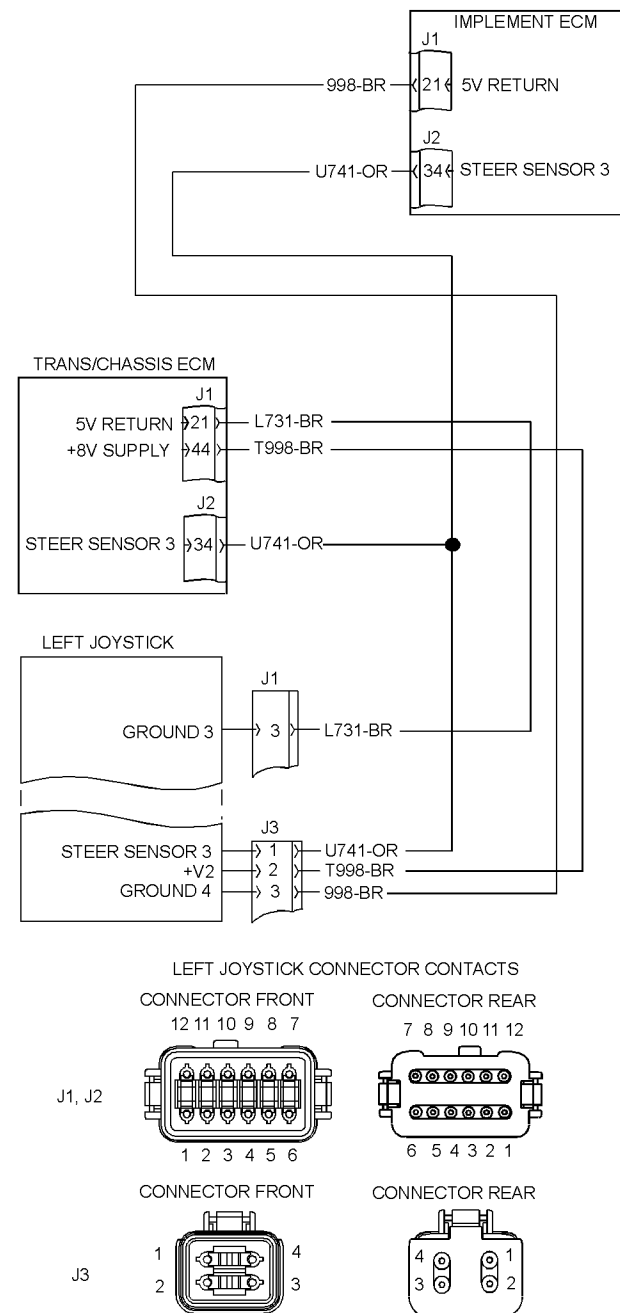
MID 027 - CID 1473 - FMI 08**SMCS Code:** 5737-038-ZH**Conditions Which Generate This Code:**

Illustration 274

g01260039

Connections for "Steering Sensor 3"

Three steering position sensors are required for correct operation of the steering control. The steering position sensors are located in the assembly of the left joystick. Each sensor provides an input signal to the Implement ECM and to the Transmission/Chassis ECM. This diagnostic code is associated with the "steering position sensor 3". The FMI 08 means that the ECM has detected that the signal frequency or that the signal pulse width is not within the expected range.

The "steering position sensor 3" receives power from the 8 volt power supply of the Transmission/Chassis ECM. The "steering sensor 3" is connected to ground at the 5 volt sensor return of the Transmission/Chassis ECM (ground of the ECM) and the 5 volt sensor return of the Transmission/Chassis ECM (ground of the ECM). The steering sensor must lose the 8 volt power supply or both grounds in order to lose power. The illustration above indicates the power and ground connections for "steering position sensor 3".

The position sensor is a PWM sensor that operates at a frequency of 500 ± 80 Hz. The position sensor sends a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The duty cycle of the signal will vary from approximately $10 \pm 5\%$ at the full left position of the joystick to approximately $90 \pm 5\%$ at the full right position of the joystick. When the joystick is in the center position, the duty cycle will be approximately 50%.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- Intermittent connections or poor connections in the sensor circuit
- The ECM has failed. This is unlikely.

Consider the following points when this code is active:

Note: Before performing this procedure, check for an active MID 027 CID 0041 diagnostic code for the 8 volt sensor power supply of the Transmission/Chassis ECM. Correct any problem with the 8 volt power supply before performing this procedure.

Note: The correct operating temperature range for the steering sensors is -40°C (-40.0°F) to 75°C (167.0°F). If an FMI 03 or an FMI 08 diagnostic code becomes active for a steering sensor when the cab environment is at extreme temperatures, reduce the temperature of the cab environment in order to keep the steering sensors operating in the acceptable temperature range. After the temperature has been reduced, verify that the CID 1473 FMI 08 diagnostic code is active before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the “steering sensor 3”. Both ECM modules can activate a CID 1473 FMI 08 diagnostic code when the ECM has detected that the signal frequency or the signal pulse width is not within the expected range. If one ECM has activated a CID 1473 FMI 08 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE DUTY CYCLE AND THE SIGNAL FREQUENCY AT THE SENSOR

Turn the key start switch and the disconnect switch to the OFF position.

- A. At the machine harness connector J3 for the left joystick, use a 151 - 6320 Removal Tool to remove the signal wire (wire U741-OR(Orange)) and the socket at contact J3-1. The machine harness connector J3 remains connected to the connector of the left joystick.
- B. At the back of the connectors for the joystick J3 and J1, insert 7X - 1710 Multimeter Probes along the sensor signal contact J3-1 and the ground 4 contact at J3-3.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. With the joystick in a stationary position, measure the frequency of the signal from the sensor.
- E. Observe the measurement and wiggle the connector of the joystick. Gently pull on the wires and wiggle the wires.

F. Measure the duty cycle of the sensor at the connector of the joystick, contacts J3-1 and J3-3. Move the joystick through the full range of the sensor that is described at the beginning of this procedure.

G. Observe the measurement and wiggle the connector of the joystick. Gently pull on the wires and wiggle the wires.

Expected Result:

The frequency of the “steering sensor 3” signal is 500 $\pm$ 80 Hz. The duty cycle of the “steering sensor 3” is correct according to the description at the beginning of this procedure. The frequency and the duty cycle are stable during the manipulation of the harness connector and the wiring.

Results:

- OK – The signal frequency and the duty cycle of the sensor are correct and the frequency and the duty cycle did not change when the harness is manipulated. The sensor is not causing the problem. Reconnect the signal wire and the socket in the machine harness connector for the joystick. Verify that all wires of the joystick are secure in the connector. Proceed to the next step. Proceed to Test Step 2.
- NOT OK – The signal frequency and the duty cycle of the “steering sensor 3” is not correct according to the description at the beginning of this procedure. The sensor has failed.

Repair: Perform this test step again in order to verify that the sensor signal is not correct.

If the “steering sensor 3” signal is not correct according to the description at the beginning of this procedure, replace the assembly of the left joystick. After replacement of the assembly of the joystick, verify that the operation of the new assembly for the joystick is correct before operating the machine.

STOP.

Test Step 2. CHECK FOR AN OPEN IN THE SENSOR CIRCUIT AT BOTH OF THE ECM MODULES

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connectors J3 and J1 from the left joystick. At the harness connectors for the joystick, place a jumper wire between the signal contact J3-1 (wire U741-OR(Orange)) and the ground 3 contact J1-3 (wire L731-BR(Brown)).

Diagnostic Code Procedures

- C. Disconnect machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- D. At the harness connector for the Transmission/Chassis ECM, measure the resistance from return contact J1-21 (wire L731-BR(Brown)) to signal contact J2-34 (wire U741-OR(Orange)).
- E. Observe the resistance measurement and wiggle the ECM connector. Observe that the sensor connector is tight. Gently pull on the wires and manipulate the wires for both connectors.
- F. At the harness connectors for the joystick, move the jumper from the ground 3 contact. Connect the jumper to ground 4 contact J3-3 (wire 998-BR(Brown)). The other end of the jumper wire remains connected to the signal contact J3-1 (wire U741-OR(Orange)).
- G. Disconnect machine harness connectors J1 and J2 from the Implement ECM.
- H. At the harness connectors for the Implement ECM, measure the resistance from return contact J1-21 (wire 998-BR(Brown)) to signal contact J2-34 (wire U741-OR(Orange)).
- I. Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and manipulate the wires for both connectors.

Expected Result:

Both resistance measurements are less than 5 ohms at all times during the manipulation of the wiring harness and connectors.

Results:

- OK – Both of the resistance measurements are less than 5 ohms. The sensor circuit is not open in either of the input circuits of the ECM. Proceed to Test Step 3.
- NOT OK – The resistance measurement at one or both of the ECM modules is greater than 5 ohms. There is an open or a bad connection in one or both of the signal circuits.

Repair: If both of the resistance measurements are not correct, there is an open or a bad connection on the sensor side of the splice for the machine harness of the signal wire U741-OR(Orange).

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor signal circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

If one of the measurements is correct and the other measurement is not correct, there is an open or a bad connection on the ECM side of the splice for the machine harness for the signal wire U741-OR(Orange).

In either case, refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the suspect section of the sensor signal circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all harness connectors in order to make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 1473 FMI 08.

Expected Result:

The CID 1473 FMI 08 is not active.

Results:

- OK – The CID 1473 FMI 08 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 1473 FMI 08 is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

If both the Transmission/Chassis ECM and the Implement ECM have activated this diagnostic code, it is very unlikely that either ECM is causing the problem.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02921179

MID 027 - CID 1473 - FMI 14

SMCS Code: 5737-038-ZH

Conditions Which Generate This Code:

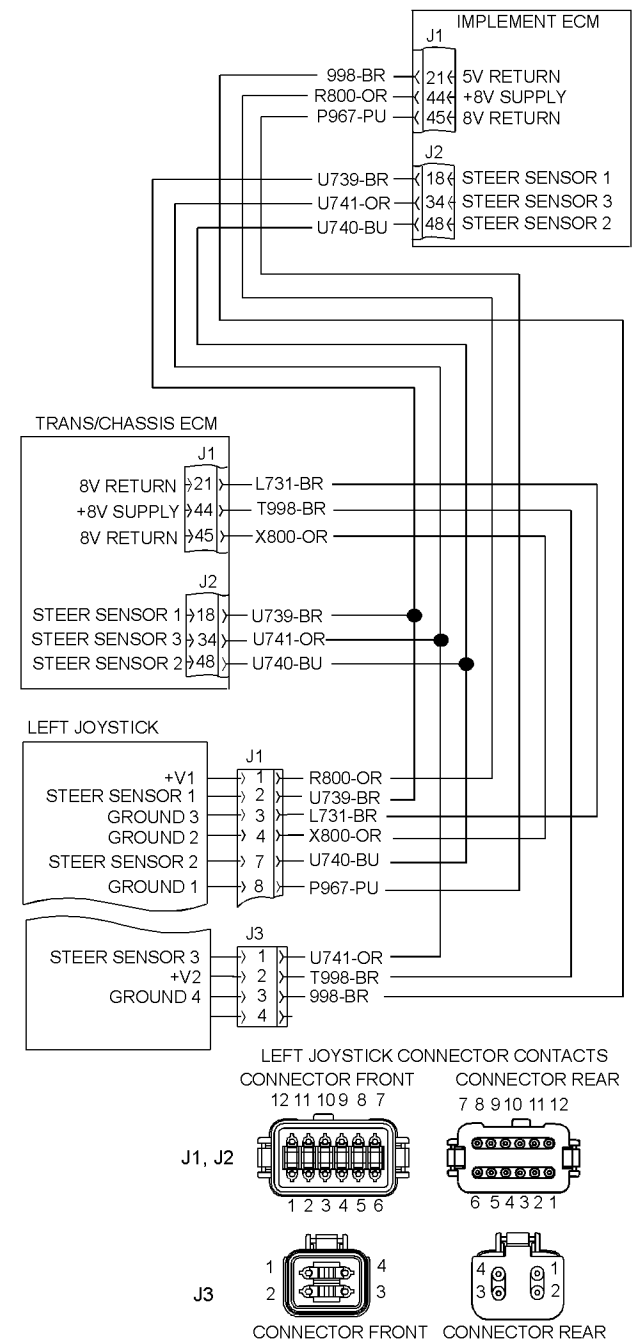


Illustration 275

g01291021

Connections of "Left Joystick steering Position Sensors"

Three steering sensors are required for correct operation of the steering control. The steering sensors are located in the assembly of the left joystick. Each sensor provides an input signal to the Implement ECM and to the Transmission/Chassis ECM. The ECM expects the input signals from all three steering sensors to match very closely. The FMI 14 diagnostic code is activated when the ECM determines that the PWM input signal from the "steering position sensor 3" does not match the PWM input signal from one of the other steering sensors, however, the "position sensor 3" signal does match with the third sensors signal.

The "steering position sensor 3" receives power from the 8 volt power supply of the Transmission/Chassis ECM. The "steering sensor 3" is connected to ground at the 5 volt sensor return of the Transmission/Chassis ECM (ground of the ECM) and the 5 volt sensor return of the Transmission/Chassis ECM (ground of the ECM). The steering sensor must lose the 8 volt power supply or both grounds in order to lose power. The illustration above indicates the power and ground connections for "steering position sensor 3" .

The position sensor is a PWM sensor that operates at a frequency of approximately 500 ± 80 hertz. The position sensor sends a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The duty cycle of the signal will vary from approximately 10% at the full left position of the joystick to approximately 90% at the full right position of the joystick. When the lever is in the center position, the duty cycle will be approximately 50%.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active MID 027 CID 0041 diagnostic code for the 8 volt sensor power supply of the Transmission/Chassis ECM. Correct any problem with the 8 volt power supply before performing this procedure.

Note: The correct operating temperature range for the steering sensors is -40°C (-40.0°F) to 75°C (167.0°F). If an FMI 03, an FMI 08 or an FMI 14 diagnostic code becomes active for a steering sensor when the cab environment is at extreme temperatures, reduce the temperature of the cab environment in order to keep the steering sensors operating in the acceptable temperature range. After reducing the temperature in the cab, verify that the CID 1473 FMI 14 diagnostic code is active before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the "steering sensor 3" . Both ECM modules can activate a CID 1473 FMI 14 diagnostic code when the signal is erratic or intermittent. If one ECM has activated a CID 1473 FMI 14 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the "steering sensor 3" . Both ECM modules can activate a CID 1473 FMI 14 diagnostic code when the signal from one steering sensor does not closely match the signal from one of the other steering sensors and the signal of the other two does match the signal from the third steering sensor. If one ECM has activated a CID 1473 FMI 14 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Note: The next three test steps will measure the duty cycle of each steering sensor in order to determine if one signal is not closely matching with both of the other sensor signals. Record the duty cycle of the sensor signal for each of the three sensors for comparison.

Test Step 1. CHECK THE SIGNAL AT STEERING SENSOR 1

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Do not disconnect the harness connector from the sensor.
- C. At the machine harness connector J1 for the left joystick, use a 151 - 6320 Removal Tool to remove the "steering sensor 1" signal wire (wire U739-BR(Brown)) and the socket at contact J1-2. The machine harness connector J1 remains connected to the connector of the left joystick.
- D. At the back of the connector of the joystick J1, insert 7X - 1710 Multimeter Probes along the sensor signal contact J1-2 and the return contact at J1-4.
- E. Turn the disconnect switch and the key start switch to the ON position.
- F. Monitor the signal of the sensor with a digital multimeter.
- G. Move the joystick through the full range of operation. Record the duty cycle of the sensor at specific positions of the joystick.

Expected Result:

The duty cycle of the "steering sensor 1" has been noted at specific positions of the joystick.

Results:

- OK – The duty cycle has been recorded for comparison with the other two steering sensors. Reconnect the signal wire and the socket in the machine harness connector for the joystick before proceeding to the next test step. Proceed to Test Step 2.

Test Step 2. CHECK THE SIGNAL AT SENSOR 2

Turn the key start switch and the disconnect switch to the OFF position.

- A. At the machine harness connector J1 for the left joystick, use a 151 - 6320 Removal Tool to remove the "steering sensor 2" signal wire U740-BU(Blue) and the socket at contact J1-7 from the harness connector. The machine harness connector J1 remains connected to the connector of the left joystick.
- B. At the back of the connector of the joystick J1, insert 7X - 1710 Multimeter Probes along the sensor signal contact J1-7 and the return contact at J1-8.

- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Monitor the signal of the sensor with a digital multimeter.
- E. Move the joystick through the full range of operation. Record the duty cycle of the sensor at specific positions of the joystick.

Expected Result:

The duty cycle of the "steering sensor 2" has been noted at specific positions of the joystick.

Results:

- OK – The duty cycle has been recorded for comparison with the other two steering sensors. Reconnect the signal wire and the socket in the machine harness connector for the joystick. Proceed to the next test step. Proceed to Test Step 3.

Test Step 3. CHECK THE SIGNAL AT "STEERING SENSOR 3"

Turn the key start switch and the disconnect switch to the OFF position.

- A. At the machine harness connector J3 for the left joystick, use a 151 - 6320 Removal Tool to remove the "steering sensor 3" signal wire U741-OR(Orange) and the socket at contact J3-1 from the harness connector. The machine harness connector J3 remains connected to the connector of the left joystick.
- B. At the back of the connectors of the joystick J1 and J3, insert 7X - 1710 Multimeter Probes along the sensor signal contact J3-1 and the return contact at J3-3.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Monitor the signal of the sensor with a digital multimeter.
- E. Move the joystick through the full range of operation. Record the duty cycle of the sensor at specific positions of the joystick.

Expected Result:

After comparison of the duty cycles of all three steering sensors at the same specific positions of the joystick, each duty cycle of the sensor is within 5% or less of the signals from the other sensors.

Results:

Diagnostic Code Procedures

- OK – There is a 5% or less deviation between the PWM duty cycle signals for the three steering sensors with the joystick in the same position. Proceed to Test Step 4.
- NOT OK – When the joystick is the same position, one or more of the PWM duty cycle signals deviates more than 5% when compared to the signals from the other two steering sensors. There is a problem with a steering sensor.

Repair: One of the steering sensors is not operating correctly. Replace the assembly of the left joystick. After replacement of the assembly of the joystick, verify that the new assembly is working correctly before operating the machine.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Operate the machine.
- Check the status of the CID 1473 FMI 14 diagnostic code.

Expected Result:

The CID 1473 FMI 14 diagnostic code is not active.

Results:

- OK – The CID 1473 FMI 14 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 1473 FMI 14 diagnostic code is active. The diagnostic code has not been corrected.

Repair: If the cause of the active diagnostic code is not found, the ECM that has activated this diagnostic code may have failed.

If both the Transmission/Chassis ECM and the Implement ECM have activated this diagnostic code, it is very unlikely that either ECM is causing the problem.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02921209

MID 027 - CID 1482 - FMI 03

SMCS Code: 1439-038

Conditions Which Generate This Code:

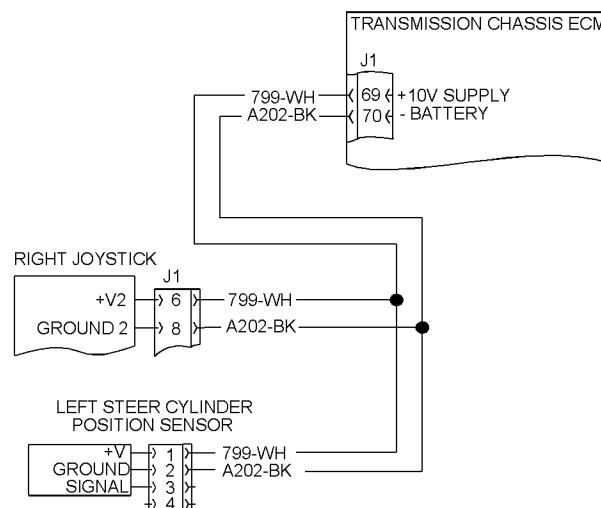


Illustration 276

g01304677

Connections of 10 VDC Power Supply for the Transmission/Chassis ECM.

This diagnostic code is associated with the 10 volt sensor power supply of the Transmission/Chassis ECM. The 10 volt sensor power supply provides a second power supply for the right joystick and the power supply supplies power for the position sensor of the left steering cylinder.

Note: The 10 volt sensor power supply of the Transmission/Chassis ECM is one of two power supplies that are used for the right joystick. The other power source for the right joystick is supplied by the 10 volt power supply of the Implement ECM.

The CID 1482 FMI 03 diagnostic code is activated when the Transmission/Chassis ECM detects that the voltage of the 10 volt power supply circuit is above normal.

The following conditions could cause this diagnostic code to be activated:

- The power supply circuit is shorted to a higher voltage source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE VOLTAGE AT THE COMPONENT

- A. Turn the disconnect switch and the key start switch to the ON position.
- B. At the position sensor for the left steering cylinder, insert a 7X - 1710 Multimeter Probe along the supply wire 799-WH(White) at contact 1. Insert a 7X - 1710 Multimeter Probe along the return wire A202-BK(Black) at contact 2.
- C. Measure the voltage between the supply, contact 1 and the return contact 2.

Expected Result:

The voltage measurement is 10.0 ± 0.4 VDC.

Results:

- OK – The voltage measurement is 10.0 ± 0.4 VDC. The voltage is correct. Proceed to Test Step 4.
- NOT OK – The voltage measurement is greater than 10.0 ± 0.4 VDC. The voltage measurement is not correct. Proceed to Test Step 2.

Test Step 2. CHECK THE POWER SUPPLY AT THE ECM

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. At the connector for the Transmission/Chassis ECM J1, use a 151 - 6320 Removal Tool or a similar tool to remove the power supply wire and the socket at contact J1-69 (wire 799-WH(White)) from the connector. The machine harness connector J1 remains connected to the ECM.
- C. At the connector for the Transmission/Chassis ECM J1, insert a 7X - 1710 Multimeter Probe along the return wire A202-BK(Black) and the socket at contact J1-70.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Use a multimeter probe in order to make contact on the connector pin of the ECM at contact J1-69. Measure the voltage at the ECM between the contact of the power supply J1-69 and the return contact J1-70.

Expected Result:

The voltage measurement is 10.0 ± 0.4 VDC.

Results:

- OK – The voltage measurement is 10.0 ± 0.4 VDC. The voltage is correct. The ECM power supply is correct. Install the wire and the socket that were removed from the J1 connector back into the original locations. Proceed to Test Step 3.
- NOT OK – The voltage measurement is greater than 10.0 ± 0.4 VDC. The ECM power supply is not correct.

Repair: Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK FOR A SHORT CIRCUIT IN THE MACHINE HARNESS

The machine harness connector remains disconnected from the position sensor.

- A. Disconnect the machine harness connector J1 from the right joystick.
- B. Turn the disconnect switch and the key start switch to the OFF position.

- C. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- D. At the harness connector of the ECM J1, measure the resistance from contact J1-69 (wire 799-WH(White)) to all of the other contacts that are used in connectors J1 and J2 for the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The supply circuit is not shorted to another circuit in the machine harness. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness.

Repair: The power supply circuit is shorted to a another circuit in the machine harness. Refer to the complete Electrical System Schematic of the machine. Examine the supply circuit in order to determine the location of the problem.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 1482 FMI 03 diagnostic code is active.

Expected Result:

The CID 1482 FMI 03 diagnostic code is active.

Results:

- YES – The CID 1482 FMI 03 diagnostic code is active. The problem has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may be activating the diagnostic code incorrectly. The ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1482 FMI 03 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02921561

MID 027 - CID 1482 - FMI 04

SMCS Code: 1439-038

Conditions Which Generate This Code:

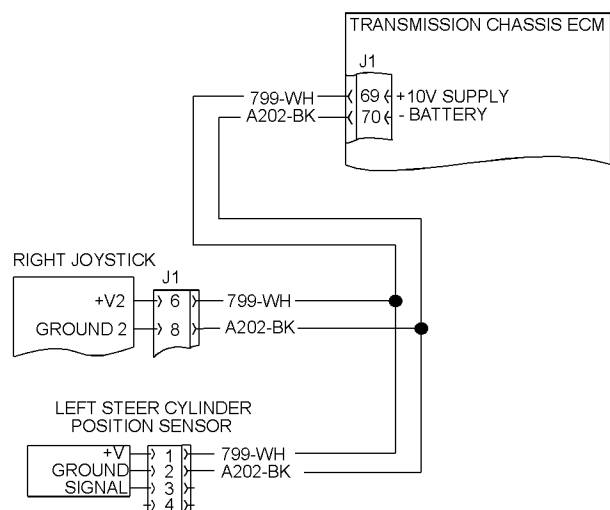


Illustration 277

g01304677

Connections of the 10 VDC Power Supply of the Transmission/Chassis ECM.

This diagnostic code is associated with the 10 volt sensor power supply of the Transmission/Chassis ECM. The 10 volt sensor power supply provides a second power supply for the right joystick and the power supply provides power for the position sensor of the left steering cylinder.

Note: The 10 volt sensor power supply of the Transmission/Chassis ECM is one of two power supplies that are used for the right joystick. The other power source for the right joystick is supplied by the 10 volt power supply of the Implement ECM.

The CID 1482 FMI 04 diagnostic code is activated when the Transmission/Chassis ECM detects that the voltage of the 10 volt power supply circuit is lower than normal.

The following conditions could cause this diagnostic code to be active:

- A component that is powered by the power supply has failed.
- The power supply circuit is shorted to a ground source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE COMPONENTS

- Turn the key start switch and the disconnect switch to the ON position.
- One at a time, disconnect a component that uses the 10 VDC power supply from the machine harness. As each component is disconnected, check the status of the CID 1482 FMI 04 diagnostic code.
- Continue disconnecting the components from the machine harness one at a time until the status of the CID 1482 FMI 04 diagnostic code changes or until all of the components that are connected to the 10 volt power supply are disconnected.

Expected Result:

When one of the components is disconnected from the machine harness, the CID 1482 FMI 04 diagnostic code is no longer active.

Results:

- OK – The CID 1482 FMI 04 diagnostic code is not active when one of the components is disconnected. The power supply circuit is correct. The component that was disconnected when the status of the CID 1482 FMI 04 diagnostic code changed has failed. Repeat this test step in order to verify the component that is causing the problem.

Repair: Once the component that is causing the problem is determined, replace the component. After the component is replaced, verify that the problem has been corrected before operating the machine.

STOP.

- NOT OK – The CID 1482 FMI 04 diagnostic code is still active. Disconnecting all of the components

that are using the 10 VDC power supply did not change the status of the diagnostic code. Proceed to Test Step 2.

Test Step 2. CHECK THE POWER SUPPLY AT THE ECM

All components that are connected to the 10 VDC power supply remain disconnected from the machine harness.

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. At the Transmission/Chassis ECM connector J1, use a 151 - 6320 Removal Tool or a similar tool to remove the power supply wire and the socket at contact J1-69 (wire 799-WH(White)) from the connector. The machine harness connector J1 remains connected to the ECM.
- C. At the connector of the Transmission/Chassis ECM J1, insert a 7X - 1710 Multimeter Probe along the return wire A202-BK(Black) and the socket at contact J1-70.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Use a multimeter probe in order to make contact on the connector pin of the ECM at contact J1-69. Measure the voltage at the ECM between the contact of the power supply J1-69 and the return contact J1-70.

Expected Result:

The voltage measurement is 10.0 ± 0.4 DCV.

Results:

- OK – The voltage measurement is 10.0 ± 0.4 DCV. The voltage is correct. The power supply of the ECM is correct. Install the wires and the sockets that were removed from the J1 connector back into the original locations. Proceed to Test Step 3.
- NOT OK – The voltage measurement is greater than 10.0 ± 0.4 DCV. The ECM power supply is not correct.

Repair: Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK FOR A SHORT TO GROUND

All components that are connected to the 10 VDC power supply remain disconnected from the machine harness.

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- C. At the harness connector for the ECM, measure the resistance between contact for the supply voltage J1-69 (wire 799-WH(White)) and frame ground. Measure the resistance between contact for the supply voltage J1-69 (wire 799-WH(White)) and all of the other contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The circuit in the machine harness is correct. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. The circuit is shorted in the machine harness.

Repair: The wire for the power supply 709-OR(Orange) is shorted in the machine harness to the circuit with the low resistance measurement. Refer to the complete Electrical System Schematic for your machine. Check all harness connectors that are in the power supply circuit. Ensure that the connectors are clean and that the connections are secure.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.

- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 1482 FMI 04 diagnostic code is active.

Expected Result:

The CID 1482 FMI 04 diagnostic code is active.

Results:

- YES – The CID 1482 FMI 04 diagnostic code is active. The problem has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may be activating the diagnostic code incorrectly. The ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 1482 FMI 04 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02921629

MID 027 - CID 1484 - FMI 03

SMCS Code: 1435-038-P9

Conditions Which Generate This Code:

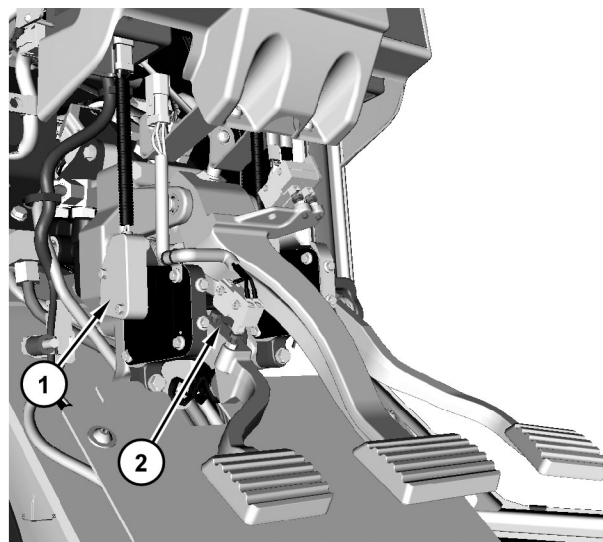


Illustration 278

g01324021

Location of "Inching Pedal" switch

- (1) "Inching Pedal" position sensor
- (2) "Inching Pedal" switch

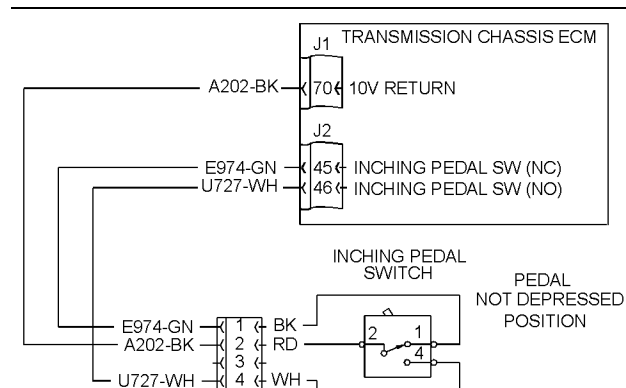


Illustration 279

g01304785

Connections of "Inching Pedal" switch

The inching pedal switch provides two switch to ground inputs to the Transmission/Chassis ECM. During normal operation, one of the inputs to the switch is connected to ground through the common contact of the switch. The other switch input is open.

The FMI 03 diagnostic code is activated when both the switch inputs to the ECM are indicating an open state at the same time.

Diagnostic Code Procedures

Conditions that can cause this diagnostic code to be active are listed below:

- The switch has failed.
- One or more of the switch circuits is open in the machine harness.
- There is a short to a voltage source in one or both of the switch circuits.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Table 28

Status of the Inching Pedal Switch		
Pedal Position	N/C Contact (Wire E974-GN(Green) - J2-45)	N/O Contact (Wire U727-WH(White) - J2-46)
Depressed	Open ⁽¹⁾	Closed ⁽²⁾
Not Depressed	Closed	Open

⁽¹⁾ Open to ECM return (Gnd) wire A202-BK - J1-70

⁽²⁾ Closed to ECM return (Gnd) wire A202-BK - J1-70

Test Step 1. CHECK THE SWITCH

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the switch.
- The inching pedal is not depressed.
- At the connector for the switch, measure the resistance from the common contact of the switch 2 (wire A202-BK(Black)) to switch contact 1 (wire E974-GN(Green)).
- At the connector for the switch, measure the resistance from the common contact of the switch 2 (wire A202-BK(Black)) to switch contact 4 (wire U727-WH(White)).
- Depress the inching pedal and repeat Steps "D" and "E".

Expected Result:

The contact status of the switch is correct according to the table at the beginning of this procedure, with the inching pedal not depressed and with the pedal depressed.

Results:

- YES – All of the resistance checks for the switch are correct according to the table at the beginning of this procedure. The switch is working correctly. Proceed to Test Step 2.
- NO – The contact states of the switch are not correct according to the table at the beginning of this procedure. The switch operation is not correct.

Repair: Examine the wiring and the connections between the switch connector and the switch for broken or for poor connections.

If a poor connection or broken wire is not found, replace the inching pedal switch. After the switch is replaced, verify that the switch operation is correct before operating the machine.

STOP.

Test Step 2. CHECK THE SWITCH CIRCUITS FOR AN OPEN CIRCUIT

The key start switch and the disconnect switch remain in the OFF position. The machine harness remains disconnected from the switch.

- At the machine harness connector for the switch, place a jumper wire between common contact 2 (wire A202-BK(Black)) and contact 4 (wire U727-WH(White)).
- Disconnect the machine harness connectors J1 and J2 from the ECM.
- At the machine harness connector J2 for the ECM, measure the resistance between common contact of the switch J1-70 (wire A202-BK(Black)) and switch input contact J2-46 (wire U727-WH(White)).
- At the machine harness connector for the switch, move the connection for the jumper wire from input contact 4 to input contact 1 (wire E974-GN(Green)). The other end of the jumper wire remains connected to common contact 2 (wire A202-BK(Black)).
- At the machine harness connector J2 for the ECM, measure the resistance between common contact of the switch J1-70 (wire A202-BK(Black)) and switch input contact J2-45 (wire E974-GN(Green)).

Expected Result:

Each resistance measurement is less than 5 ohms.

Results:

- OK – Both of the resistance measurements are less than 5 ohms. The switch circuits are not open in the machine harness. Proceed to Test Step 3.
- NOT OK – One or both of the resistance measurements is greater than 5 ohms. There is an open or a bad connection in the circuits of the switch.

Repair: Check each of the circuits of the switch individually in order to determine the circuit that has the open or the poor connection.

A resistance measurement that is greater than 5000 ohms could indicate that a wire is not connected or a wire is open. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

Refer to the complete Electrical System Schematic for your machine. Check all of the connectors that are in the sensor signal circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK FOR A SHORT TO A VOLTAGE SOURCE

The key start switch and the disconnect switch remain in the OFF position. The machine harness remains disconnected from the switch. The machine harness connectors for the ECM remain disconnected.

- At the machine harness connector for the ECM J2, measure the resistance from the input contact of the switch J2-45 (wire E974-GN(Green)) and all of the other J1 and J2 contacts that are used for the ECM.
- At the machine harness connector for the ECM J2, measure the resistance from input for the switch J2-46 (wire U727-WH(White)) and all of the other J1 and J2 contacts that are used for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is not indicating a short. Proceed to Test Step 4.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between the input wire of the switch E974-GN(Green) or the input wire of the switch U727-WH(White) and the circuit with the low resistance measurement.

Repair: Refer to the complete Electrical System Schematic for your machine. Examine all of the connectors in the faulty circuit for points in the machine harness where a short could occur.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 1484 FMI 03 diagnostic code.

Expected Result:

The CID 1484 FMI 03 diagnostic code is no longer active.

Results:

- OK – The CID 1484 FMI 03 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NOT OK – The CID 1484 FMI 03 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the input circuits of the switch again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause can not be found, the ECM may have failed. Verify that all possible causes of the diagnostic code have been investigated before replacement of the ECM.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02921903

MID 027 - CID 1484 - FMI 04

SMCS Code: 1435-038-P9

Conditions Which Generate This Code:

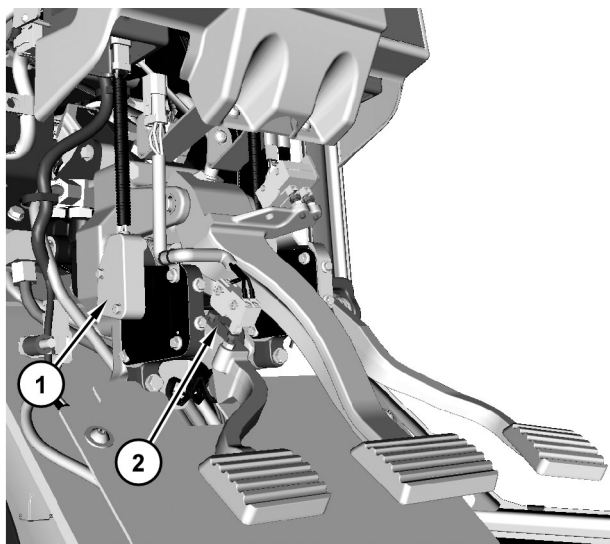


Illustration 280

g01324021

Location of "Inching Pedal" switch

- (1) "Inching Pedal" position sensor
- (2) "Inching Pedal" switch

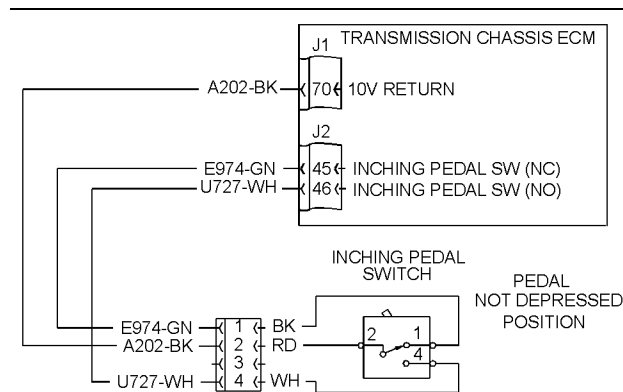


Illustration 281

g01304785

Connection of "Inching Pedal" switch connections

The inching pedal switch provides two switch to ground inputs to the Transmission/Chassis ECM. During normal operation, one of the switch inputs is connected to ground through the common contact of the switch. The other switch input is open.

The FMI 04 diagnostic code is activated when the two inputs to the switch are indicating a grounded state at the same time.

Conditions which can cause this diagnostic code to be activated are listed below:

- The switch has failed.
- One or both of the input circuits of the switch are shorted to a ground source in the machine harness.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Table 29

Contact Status of the Inching Pedal Switch		
Pedal Position	N/C Contact (Wire E974-GN(Green) - J2-45)	N/O Contact (Wire U727-WH(White) - J2-46)
Depressed	Open ⁽¹⁾	Closed ⁽²⁾
Not Depressed	Closed	Open

(1) Open to ECM return (GND) wire A202-BK - J1-70

(2) Closed to ECM return (GND) wire A202-BK - J1-70

Test Step 1. CHECK THE SWITCH

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector from the switch.
- C. The inching pedal is not depressed.
- D. At the connector for the switch, measure the resistance from common contact of the switch 2 (wire A202-BK(Black)) and switch contact 1 (wire E974-GN(Green)).
- E. At the connector for the switch, measure the resistance from common contact of the switch 2 (wire A202-BK(Black)) and switch contact 4 (wire U727-WH(White)).
- F. Depress the inching pedal and repeat Steps "D" and "E" .

Expected Result:

The contact status of the switch is correct according to the table at the beginning of this procedure with the inching pedal not depressed and with the pedal depressed.

Results:

- OK – All of the resistance checks for the switch are correct according to the table at the beginning of this procedure. The switch is working correctly. Proceed to Test Step 2.
- NOT OK – The states of contact of the switch are not correct according to the table at the beginning of this procedure. The switch operation is not correct.

Repair: Examine the wiring and the connections between the connector of the switch and the switch for broken connections or poor connections.

If a poor connection or broken wire is not found, replace the switch of the inching pedal . After the switch is replaced, verify that the switch operation is correct before operating the machine.

STOP.

Test Step 2. CHECK THE SWITCH CIRCUITS FOR A SHORT TO GROUND

The key start switch and the disconnect switch remain in the OFF position. The switch of the inching pedal remains disconnected from the machine harness.

- A. Disconnect the machine harness connectors J1 and J2 from the ECM.
- B. At the machine harness connector of the ECM J2, measure the resistance from the input contact of the switch J2-45 (wire E974-GN(Green)) and the frame ground. Measure the resistance from J2-45 (wire E974-GN(Green)) and all of the other J1 and J2 contacts that are used for the ECM.
- C. Observe the resistance measurement and wiggle the wires. Manipulate the machine harness at the ECM connectors and at the connectors of the switch.
- D. At the machine harness connector of the ECM J2, measure the resistance from the contact of the switch J2-46 (wire U727-WH(White)) and frame ground. Measure the resistance from J2-46 (wire U727-WH(White)) and all of the other J1 and J2 contacts that are used for the ECM.
- E. Observe the resistance measurement and wiggle the wires. Manipulate the machine harness at the ECM connectors and at the connectors of the switch.

Expected Result:

Each resistance measurement is greater than 5000 ohms at all times during the manipulation of the wires and connectors of the machine harness.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The measurements of the input circuit for the switch are not indicating a short to a ground source. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between the input circuit of the switch E974-GN(Green) or the input circuit of the switch U727-WH(White) and the circuit with the low resistance measurement or frame ground.

Repair: Refer to the complete Electrical System Schematic of your machine. Examine all of the connectors in the faulty circuit for locations in the machine harness that indicate a short.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 1484 FMI 04 diagnostic code.

Expected Result:

The CID 1484 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 1484 FMI 04 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NOT OK – The CID 1484 FMI 04 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the input circuits of the switch again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause can not be found, the ECM may have failed. Verify that all possible causes of the diagnostic code have been investigated before replacement of the ECM.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i06747939

MID 027 - CID 1674 - FMI 03

SMCS Code: 3139-038; 5479-038

Conditions Which Generate This Code:

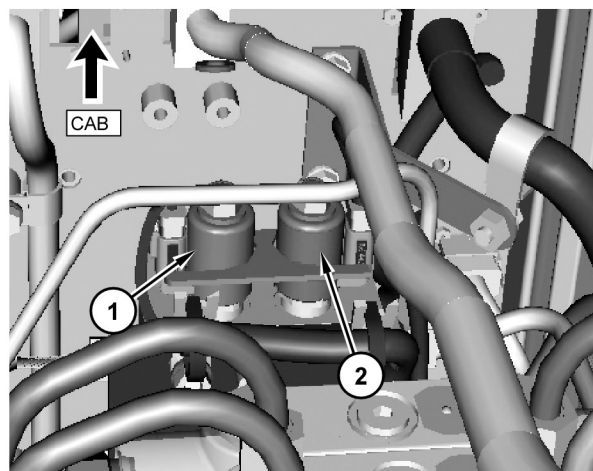


Illustration 282

g01376762

For these machines:

S/N: B921-368; B9H1-UP; R9H1-UP; B9J1-UP; R9J1-UP; B9R1-UP; R9B1-UP; B9F1-UP; B9L1-UP; B9E1-1143; B9M1-UP; B9D1-4762; B9N1-UP; R9A1-UP; B9C1-UP; B9G1-UP; D9G1-1585; B9T1-UP; D9T1-1438; B9W1-UP; R9C1-UP; D9W1-UP

Secondary steer solenoids are located in front of the cab behind the rear valve stack.

- (1) Secondary steer right solenoid
- (2) Secondary steer left solenoid

Secondary Steer Solenoids are on the Steering Valve for these machines:

S/N: B92369-UP; B9E1144-UP; B9D4763-UP; D9G1586-UP; D9T1439-UP

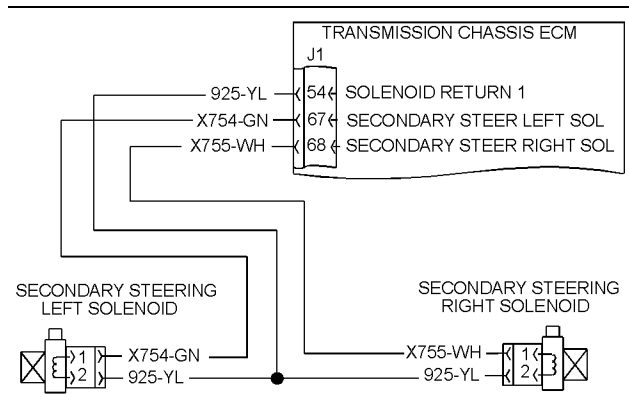


Illustration 283

g01305575

Connections for Solenoid 1 Return.

This diagnostic code is associated with the “solenoid 1 return” circuit. The FMI 03 means that the Transmission/Chassis ECM has determined that the current in the return circuit of the solenoid is above normal. This condition is likely caused by a short to another voltage source.

Conditions that could cause this diagnostic code to be activated are listed below:

- The return circuit of the solenoid is shorted to another voltage source.
- The ECM has failed. This situation is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure, and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE RETURN CIRCUIT OF THE SOLENOIDS FOR A SHORT

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connectors from both of the secondary steering solenoids. Disconnect the machine harness connectors J1 and J2 from the ECM.

C. At the machine harness connectors for the ECM, measure the resistance from the return contact of the solenoid J1-54 (wire 925-YL (Yellow)) and all the other contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- **YES** – Each resistance measurement is greater than 5000 ohms. The resistance measurement does not indicate a short in the machine harness. Proceed to test step 2.
- **NO** – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness.

Repair: The short is between wire 925-YL (Yellow) and the circuit that has a low-resistance measurement.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, “Wiring Harness (Short Circuit) - Test”. Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoids and the ECM remain disconnected.

- At the machine harness connector J1 for the ECM, use a 151 - 6320 Removal Tool to remove the return wire 925-YL (Yellow) and the socket at contact J1-54 from the harness connector.
- Reconnect the machine harness J1 and J2 connectors to the ECM.
- Turn the disconnect switch and the key start switch to the ON position.
- Observe the status of the active CID 1674 FMI 03 diagnostic code.

Expected Result:

The CID 1674 FMI 03 diagnostic code is no longer active. A CID 1674 FMI 05 diagnostic code is now active.

Results:

- YES – The CID 1674 FMI 03 diagnostic code is no longer active. A CID 1674 FMI 05 diagnostic code has been activated after the energize wire of the solenoid was disconnected. The ECM has responded correctly to the open circuit of the solenoid. Reinstall the disconnected energize wire of the solenoid into the correct connector of the ECM. Proceed to the next test step. Proceed to Test Step 3.
- NO – The CID 1674 FMI 03 diagnostic code remains active. The status of the active diagnostic code did not change when the energize wire of the solenoid was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Determine if the CID 1674 FMI 03 diagnostic code is active.

Expected Result:

The CID 1674 FMI 03 diagnostic code is not active.

Results:

- YES – The diagnostic code is not active at this time. The initial diagnostic code was probably caused by a poor electrical connection or a short

at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NO – The CID 1674 FMI 03 diagnostic code remains active. The problem has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the problem remains, the ECM may have failed. This situation is unlikely because the ECM detected the open circuit in the solenoid circuit and activated the FMI 05 diagnostic code when the energize wire of the solenoid was disconnected.

Verify that all possible causes of the diagnostic code have been investigated. Exit this procedure and perform this procedure again.

If the cause of the problem cannot be found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time.

If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace"

STOP.

i06748000

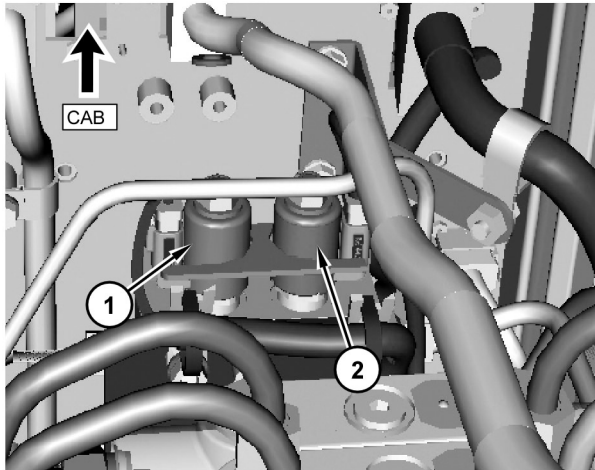
MID 027 - CID 1674 - FMI 04**SMCS Code:** 3139-038; 5479-038**Conditions Which Generate This Code:**

Illustration 284

g01376762

For these machines:

S/N: B921-368; B9H1-UP; R9H1-UP; B9J1-UP;
 R9J1-UP; B9R1-UP; R9B1-UP; B9F1-UP; B9L1-
 UP; B9E1-1143; B9M1-UP; B9D1-4762; B9N1-UP;
 R9A1-UP; B9C1-UP; B9G1-UP; D9G1-1585;
 B9T1-UP; D9T1-1438; B9W1-UP; R9C1-UP;
 D9W1-UP

Secondary steer solenoids are located in front of the cab behind the rear valve stack.

- (1) Secondary steer right solenoid
 (2) Secondary steer left solenoid

Secondary Steer Solenoids are on the Steering Valve for these machines:

S/N: B92369-UP; B9E1144-UP; B9D4763-UP;
 D9G1586-UP; D9T1439-UP

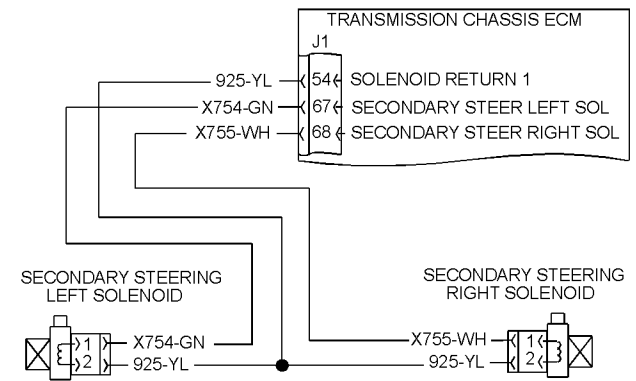


Illustration 285

g01305575

Connections for "Solenoid 1 Return"

This diagnostic code is associated with the "solenoid 1 return" circuit. The FMI 04 means that the Transmission/Chassis ECM has determined that the voltage for the "solenoid 1 return" circuit is below normal.

The "solenoid 1 return" circuit provides a return path to the ECM for the left and the right secondary steering solenoids.

Conditions that could cause this diagnostic code to be activated are listed below:

- The return circuit for one or both solenoids is shorted to a ground source.
- The ECM has failed. This situation is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure, and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE "SOLENOID 1 RETURN" CIRCUIT FOR A SHORT TO GROUND

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the left solenoid for secondary steer and the right solenoid for secondary steer from the machine harness.

Diagnostic Code Procedures

- C.** Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- D.** At the machine harness connectors for the ECM, measure the resistance from the “solenoid 1 return” contact J1-54 (wire 925-YL(Yellow)) and the frame ground location. Measure the resistance from the contact J1-54 (wire 925-YL(Yellow)) and all the other J1 and J2 contacts that are used in the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 50 ohms.

Results:

- OK – Each resistance measurement is greater than 50 ohms. The measurement is not indicating that the “solenoid 1 return” circuit is shorted to a ground source. Proceed to Test Step 2.
- NOT OK – One or more of the resistance measurements is less than 50 ohms. There is a short in the machine harness. The short is between wire 925-YL(Yellow) and the circuit with the low-resistance measurement or frame ground.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, “Wiring Harness (Short Circuit) - Test”. Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Check the status of the CID 1674 FMI 04 diagnostic code.

Expected Result:

The CID 1674 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 1674 FMI 04 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NOT OK – The CID 1674 FMI 04 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Failure of the ECM is unlikely. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i06748130

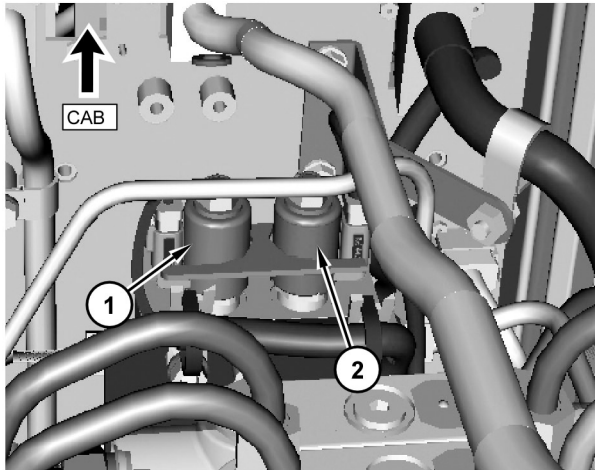
MID 027 - CID 1674 - FMI 05**SMCS Code:** 3139-038; 5479-038**Conditions Which Generate This Code:**

Illustration 286

g01376762

For these machines:

S/N: B921-368; B9H1-UP; R9H1-UP; B9J1-UP; R9J1-UP; B9R1-UP; R9B1-UP; B9F1-UP; B9L1-UP; B9E1-1143; B9M1-UP; B9D1-4762; B9N1-UP; R9A1-UP; B9C1-UP; B9G1-UP; D9G1-1585; B9T1-UP; D9T1-1438; B9W1-UP; R9C1-UP; D9W1-UP

Secondary steer solenoids are located in front of the cab behind the rear valve stack.

- (1) Secondary steer right solenoid
(2) Secondary steer left solenoid

Secondary Steer Solenoids are on the Steering Valve for these machines:

S/N: B92369-UP; B9E1144-UP; B9D4763-UP; D9G1586-UP; D9T1439-UP

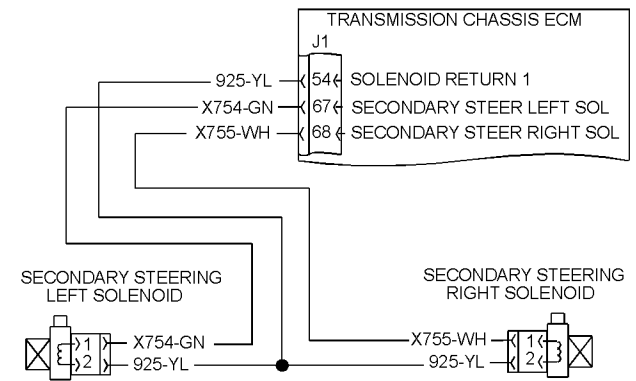


Illustration 287

g01305575

Connections of "Solenoid 1 Return"

This diagnostic code is associated with the "solenoid 1 return" circuit. The FMI 05 means that the Transmission/Chassis ECM has determined that the current for the return circuit of the solenoid is below normal.

The "solenoid 1 return" circuit provides a return path to the ECM for the left and the right secondary steering solenoids.

Conditions that can cause this diagnostic code to be activated are listed below:

- The return circuit for one or both of the solenoids is open.
- Both of the solenoids have internal open circuits at the same time. This situation is unlikely.
- The ECM has failed. This situation is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure, and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SOLENOIDS

- Turn the disconnect switch and the key start switch to the OFF position.
- Disconnect the left solenoid for secondary steer and the right solenoid for secondary steer from the machine harness.

- C. At the right solenoid for secondary steer, measure the resistance of the solenoid coil between contact 1 and contact 2.
- D. At the left solenoid for secondary steer, measure the resistance of the solenoid coil between contact 1 and contact 2.

Expected Result:

The resistance measurement for each solenoid is less than 50 ohms.

Results:

- OK – Each resistance measurement for each solenoid is less than 50 ohms. Proceed to Test Step 2.
- NOT OK – The resistance measurement for one or both of the solenoids is greater than 50 ohms. There is an open in one or both of the secondary steering solenoids.

Repair: The secondary steering solenoid with the resistance measurement that is greater than 50 ohms is faulty. Replace the faulty solenoid.

One faulty solenoid would not cause the ECM to activate the CID 1674 FMI 05 diagnostic code. After the solenoid is replaced, verify that the CID 1674 FMI 05 diagnostic code is still active. If the diagnostic code is still active, perform the next test step.

STOP.

Test Step 2. CHECK THE ENERGIZE CIRCUITS OF THE SOLENOID

Note: The purpose of this step of the test is to verify the integrity of the energize circuits. The energize circuits are used to check the condition of the return circuit in the next test step. A problem in one or the other of the energize circuits of the solenoid would most likely not cause the ECM to activate the CID 1674 FMI 05 diagnostic code. The ECM will activate either a CID 2175 (secondary steer left solenoid) diagnostic code or a CID 2176 (secondary steer right solenoid) diagnostic code for a problem in the energize circuit for either solenoid.

The disconnect switch and the key start switch remain in the OFF position. Both of the solenoids remain disconnected from the machine harness.

- A. At the machine harness connectors for both of the secondary steering solenoids, connect a jumper wire between contact 1 (wire X754-GN(Green)) for the left solenoid harness connector and contact 1 (wire X755-WH(White)) for the right solenoid harness connector.

- B. Disconnect the machine harness connector J1 from the Transmission/Chassis ECM.

- C. At the machine harness connector J1 for the ECM, measure the resistance between the energize contact of the left solenoid J1-67 (wire X754-GN(Green)) and the energize contact of the right solenoid J1-68 (wire X755-WH(White)).

Expected Result:

The resistance measurement is less than 5 ohms between the two energize circuits of the solenoid.

Results:

- OK – The resistance measurement is less than 5 ohms between the two energize circuits of the solenoid. The energize circuits for the secondary steering solenoids are correct. Proceed to Test Step 3.
- NOT OK – The resistance measurement for the energize circuits of the solenoid is greater than 5 ohms. There is a problem in one or both of the solenoid energize circuits.

Repair: A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection. A resistance measurement that is greater than 5000 ohms could indicate that an open is present in the circuit.

Check each of the energize circuits of the solenoid for continuity to determine the circuit that has an open connection or a poor connection.

Refer to the complete Electrical System Schematic of your machine. Check all the connectors that are in the suspected circuit. Ensure that all connections are clean, that all connectors are secure, and that all connectors are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE RETURN CIRCUIT FOR THE SOLENOID

The disconnect switch and the key start switch remain in the OFF position. Both of the solenoids and the ECM J1 connector remain disconnected from the machine harness.

- A. At the machine harness connector for the left solenoid for secondary steer, place a jumper wire between contact 1 (wire X754-GN(Green)) and return contact 2 (wire 925-YL(Yellow)).

- B.** At the machine harness connector J1 for the ECM, measure the resistance between the energize circuit for the left solenoid, contact J1-67 (wire X754-GN(Green)), and the return contact of the solenoid J1-54 (wire 925-YL(Yellow)).
- C.** At the machine harness connectors for the left solenoid for secondary steer and the right solenoid for secondary steer, leave one end of the jumper wire connected to the harness connector for the left solenoid, contact 1 (wire X754-GN(Green)). Connect the other end of the jumper wire to the harness connector for the right solenoid, contact 2 (wire 925-YL(Yellow)).
- D.** At the machine harness connector J1 for the ECM, measure the resistance between the energize circuit for the left solenoid, contact J1-67 (wire X754-GN(Green)), and the return contact of the solenoid J1-54 (wire 925-YL(Yellow)).

Expected Result:

Both of the resistance measurements are less than 5.0 ohms.

Results:

- OK – Both of the resistance measurements are less than 5.0 ohms. The resistance measurement is indicating that the “return 1 solenoid” circuit is not causing the problem. Proceed to Test Step 4.
- NOT OK – One or both of the resistance measurements is greater than 5.0 ohms. the “solenoid return 1” circuit is not correct.

Repair: A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection. A resistance measurement that is greater than 5000 ohms could indicate that an open is present in the circuit.

If one of the resistance measurements is OK and the other resistance measurement is not OK, the problem is in the section of the return circuit of the solenoid that is between the splice of the wiring harness and the solenoid.

If both of the resistance measurements are not correct, the problem is most likely in the section of the return circuit of the solenoid that is between the splice of the wiring harness and the ECM.

Refer to the complete Electrical System Schematic of your machine . Check all of the connectors that are in the suspected section of the “solenoid 1 return” circuit. Ensure that all connections are clean, that all connections are secure, and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Check the status of the CID 1674 FMI 05 diagnostic code.

Expected Result:

The CID 1674 FMI 05 diagnostic code is not active.

Results:

- OK – The CID 1674 FMI 05 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NOT OK – The CID 1674 FMI 05 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, to perform a wiggle test on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

Diagnostic Code Procedures

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i06748474

MID 027 - CID 1674 - FMI 06

SMCS Code: 3139-038; 5479-038

Conditions Which Generate This Code:

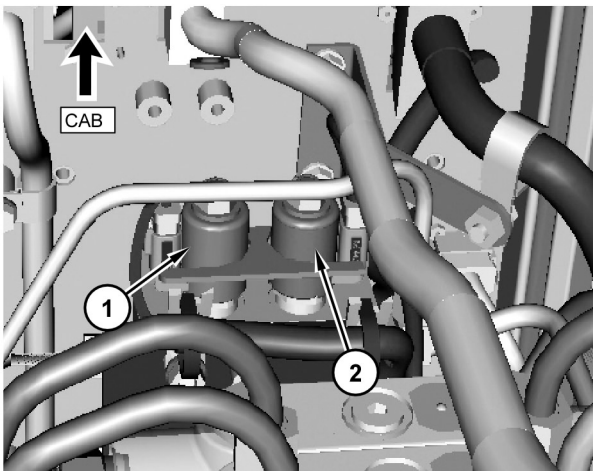


Illustration 288

g01376762

For these machines:

S/N: B921-368; B9H1-UP; R9H1-UP; B9J1-UP; R9J1-UP; B9R1-UP; R9B1-UP; B9F1-UP; B9L1-UP; B9E1-1143; B9M1-UP; B9D1-4762; B9N1-UP; R9A1-UP; B9C1-UP; B9G1-UP; D9G1-1585; B9T1-UP; D9T1-1438; B9W1-UP; R9C1-UP; D9W1-UP

Secondary steer solenoids are located in front of the cab behind the rear valve stack.

- (1) Secondary steer right solenoid
(2) Secondary steer left solenoid

Secondary Steer Solenoids are on the Steering Valve for these machines:

S/N: B92369-UP; B9E1144-UP; B9D4763-UP; D9G1586-UP; D9T1439-UP

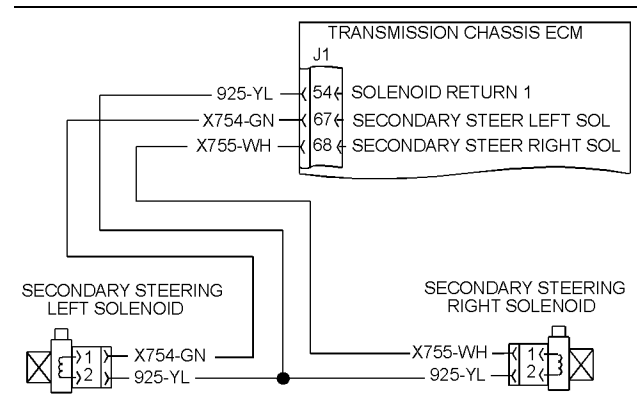


Illustration 289

g01305575

Solenoid 1 Return connections

This diagnostic code is associated with the solenoid 1 return circuit. The FMI 05 means that the Transmission Chassis ECM has determined that the current for the solenoid 1 return circuit is above normal.

The solenoid 1 return circuit provides a return path to the ECM for the left and the right secondary steering solenoids.

Conditions that could cause this diagnostic code to be activated are:

- The return circuit for one or both solenoids is shorted to a ground source.
- The ECM has failed. An ECM failure is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, secure and in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SOLENOID 1 RETURN CIRCUIT FOR A SHORT TO GROUND

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the secondary steer left solenoid and the secondary steer right solenoid from the machine harness.
- Disconnect the machine harness connectors J1 and J2 from the Transmission Chassis ECM.

D. At the machine harness connectors for the ECM, measure the resistance from the solenoid 1 return contact J1-54 (wire 925-YL(Yellow)) to frame ground. Measure the resistance from the contact J1-54 (wire 925-YL(Yellow)) to all the other J1 and J2 contacts that are used in the Transmission Chassis ECM connectors.

Expected Result:

Each resistance measurement is greater than 50 ohms.

Results:

- OK – Each resistance measurement is greater than 50 ohms. The measurement is not indicating that the solenoid 1 return circuit is shorted to a ground source. Proceed to Test Step 2.
- NOT OK – One or more of the resistance measurements are less than 50 ohms. There is a short in the machine harness. The short is between wire 925-YL(Yellow) and the circuit with the low-resistance measurement or frame ground.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace machine harness.

STOP.

Test Step 2. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors and clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated and the clips for each connector are fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Check the status of the CID 1674 FMI 06 diagnostic code.

Expected Result:

The CID 1674 FMI 06 diagnostic code is not active.

Results:

- OK – The CID 1674 FMI 06 is not active. The diagnostic code does not exist currently.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harnesses. Check the harness connectors that were disconnected and reconnected. Resume normal machine operation.

STOP.

- NOT OK – The CID 1674 FMI 06 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, to perform a "Wiggle Test" on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

An ECM failure is unlikely. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your Cat Dealer Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i06193379

MID 027 - CID 1893 - FMI 09

SMCS Code: 1439-038; 5574-038

Conditions Which Generate This Code:

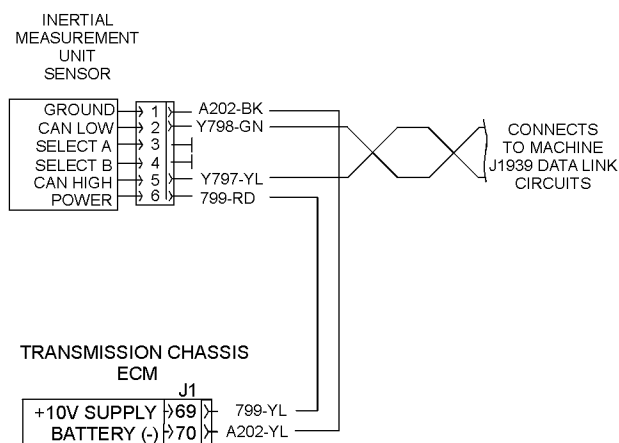


Illustration 290

g03844855

Schematic of the Inertial Measurement Sensor

This diagnostic code is associated with the Inertial Measurement Sensor. The Inertial Measurement Sensor provides J1939-CAN messages containing lateral acceleration, longitudinal acceleration, vertical acceleration, and yaw rate data to the Transmission Chassis ECM.

The diagnostic fault code activates for the following possible reasons:

- An open in the power supply circuit to the inertial sensor
- An open in the inertial sensor signal circuit (CAN + and CAN -)
- A short to battery in the inertial sensor signal circuit (CAN + and CAN -)
- A short to ground in the inertial sensor signal circuit (CAN +)

The inputs that affect the FMI 09 diagnostic codes are listed below:

- Inertial Measurement Sensor

System Response:

- ATC is not available
- ATC will automatically engage the Inter Axle Lock Clutch when throttle and retarding are available

- ATC lamp on the main cluster display will flash when the fault is active and a warning message will pop up on the CMPD

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, secure, and in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Test Step 1. INSPECT THE HARNESS CONNECTIONS.

- Turn the key start switch and the disconnect switch to the OFF position.
- Inspect the harness connections that are related to the CAN B Data Link. Make sure that the connectors are clean and tight.
- Check the mating of the connector.
- Check the wires at the connector.
- Check each wire for nicks and/or signs of abrasion in the insulation.
- Check for moisture at the connector.
- Check for dirty contacts and/or corroded contacts.
- Check each pin and check each socket.

Expected Result:

The machine harness connectors are tight and free of corrosion.

Results:

- OK – The machine harness connectors are tight and the connectors are free of corrosion. Proceed to Test Step 2.
- NOT OK – The machine harness connectors require repair.

Repair: Repair or replace the harness.

STOP.

Test Step 2. CHECK FOR ADDITIONAL RELATED DIAGNOSTIC CODES.

- Turn the disconnect switch and the key start switch to the ON position.
- Acknowledge any active diagnostic codes that are currently displayed.

- C.** Verify that there are no related diagnostic codes present.

Expected Result:

NO other diagnostic codes are present.

Results:

- OK – NO other related diagnostic codes are present. Proceed to Test Step 3.
- NOT OK – Other related diagnostic codes are present.

Repair: Exit this procedure and perform the other related diagnostic codes. Verify that the other related diagnostic codes are NOT present. Observe the status of the CID 1893 FMI 09. If the diagnostic code remains active, perform the procedure again.

STOP.

Test Step 3. CHECK FOR SHORTS

- A.** Turn the disconnect switch and the key start switch to the OFF position.
- B.** Disconnect the machine harness connector from the Inertial Measurement Sensor and the Transmission Chassis ECM.
- C.** Measure the resistance between contact J1-69 and each of the contacts that are used in the machine harness connector for the Transmission Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – The resistance is greater than 5000 ohms. The circuit is correct. Proceed to Test Step 4.
- NOT OK – The resistance is less than 5000 ohms. The CAN + signal is shorted to another circuit in the harness.

Repair: Repair or replace the machine harness

STOP.

Test Step 4. CHECK FOR AN OPEN HARNESS.

- A.** The disconnect switch remains in the OFF position.

- B.** Do not reconnect the machine harness connector to the Inertial Measurement Sensor and the Transmission Chassis ECM.

- C.** Measure the resistance between connector contact J1-69 (wire 799-YL(Yellow)) of the Transmission Chassis ECM and connector contact 6 (wire 799-RD(Red)) of the Inertial Measurement Sensor.

- D.** Measure the resistance between connector contact J1-70 (wire A202-YL(Yellow)) of the Transmission Chassis ECM and connector contact 1 (wire A202-BK(Black)) of the Inertial Measurement Sensor.

Expected Result:

The resistance measurements are less than 5 ohms.

Results:

- OK – The resistance measurements are less than 5 ohms.

Repair: The CAN Data Link circuit is correct. Exit this procedure and perform this diagnostic code again. If the cause of the diagnostic code is not found, contact the dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. See Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NOT OK – The resistance is greater than 5 ohms. The machine harness has an open circuit.

Repair: The data link circuit or the power supply circuit is open on the machine harness. Repair or replace the machine harness. Verify that the repair has corrected the problem.

STOP.

i06193384

MID 027 - CID 1893 - FMI 12

SMCS Code: 1439-038; 5574-038

Conditions Which Generate This Code:

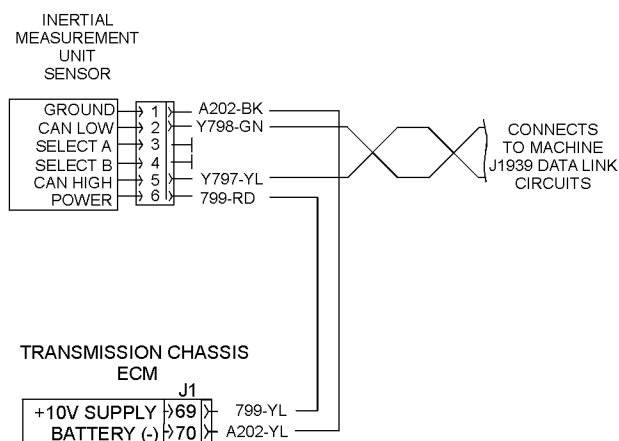


Illustration 291

g03844868

Schematic of the Inertial Measurement Unit Sensor

The CID 1893 is associated with the Inertial Measurement Sensor. The FMI 12 is recorded when the internal component or components failed.

Note: The inertial measurement sensor is directly tied to the Transmission Chassis ECM through the Auto Can data link.

Test Step 1. CHECK HARDWARE MOUNTING LOCATION

- A.** Check the inertial sensor mounting location to see if sensor is mounted loosely.

Expected Result:

The inertial sensor is mounted correctly and tightly.

Results:

- OK – The inertial sensor is mounted correctly. Proceed to Test Step 2.
- NOT OK – Inertial sensor is loosely mounted.

Repair: Tighten the inertial sensor mounting bolts.
Proceed to Test Step 2.

Test Step 2. RECHECK FOR DIAGNOSTIC CODES.

- A.** Ensure that the diagnostic code is active.
- B.** Cycle power to the Inertial Measurement Unit Sensor and the Transmission Chassis ECM.

Expected Result:

The diagnostic code is inactive.

Results:

- OK – The diagnostic code is not active.

Repair: Clear the logged diagnostic code.

STOP.

- NOT OK – The diagnostic code is still active.

Repair: Replace the Inertial Measurement Unit Sensor. Perform this procedure again after the sensor has been replaced, to ensure that the diagnostic code is no longer active.

STOP.

i02922406

MID 027 - CID 1960 - FMI 09

SMCS Code: 7631-038

Conditions Which Generate This Code:

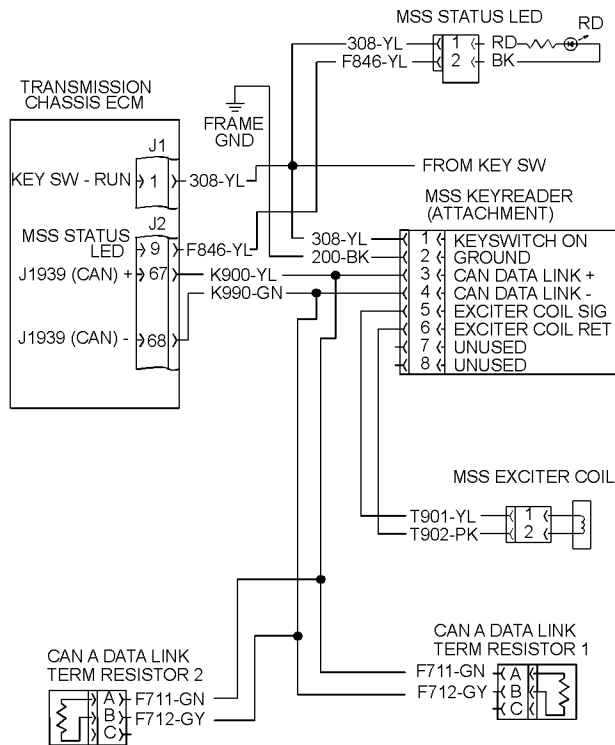


Illustration 292

g01305359

Connections of the "Machine Security System (MSS)" key reader

A record is made of the diagnostic code after the Transmission/Chassis ECM fails to receive the information that is expected. The information comes from the "MSS key reader". The information is transmitted by the "J1939 CAN data link".

Note: The Machine Security System (MSS) must be installed in order for this diagnostic code to be logged.

Test Step 1. CHECK THE ET SCREENS

- Check the active diagnostic screen and the logged diagnostic screen for a communication error between the ECM and the key reader.

Expected Result:

The ET reports CID 1960 FMI 09 as being active, or the diagnostic code has been logged.

Results:

- YES – The electronic technician reports CID 1960 FMI 09 as being active, or the diagnostic code has been logged.

Repair: Examine the connections on the CAN data link between the key reader and the Transmission/Chassis ECM. Ensure that all connections in the data link circuit are clean, that all connections are tight and that all connections are in good condition.

Proceed to Test Step 2.

- NO – The diagnostic code has not been logged or the diagnostic is not active.

Repair: The diagnostic code is not active at this time. Resume normal machine operation.

STOP.

Test Step 2. CHECK FOR POWER TO THE KEY READER

- Disconnect the machine harness connector from the "MSS key" reader.
- Turn the key start switch to the ON position. At the machine harness connector for the key reader, measure the voltage between contact 1 (wire 308-YL(Yellow)) and contact 2 (wire 200-BK(Black)). Measure the voltage between contact 1 (wire 308-YL(Yellow)) and frame ground.

Expected Result:

The voltage that is measured for each measurement is approximately 24 DCV.

Results:

- YES – The voltage that is measured for each measurement is approximately 24 DCV. The supply voltage is correct. Proceed to Test Step 3.
- NO – One of the voltage measurements is not correct. There is a problem in the wiring harness.

Repair: If the voltage measurement between contact 1 and the frame ground is less than 24 DCV, then the supply wire 308-YL(Yellow) is either an open connection or a shorted connection in the machine harness. Check the wiring harness for signs of damage. Repair the machine harness or replace the machine harness.

If the voltage measurement between contact 1 and contact 2 is less than 24 DCV and the ground measurement of the frame is OK, then the ground wire 200-BK(Black) is an open connection or a bad connection in the machine harness. Check the wiring harness. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the contacts. Clean the contacts of the harness connectors.
- B. Reconnect all harness connectors.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Enter the service mode of the Caterpillar Monitoring System. Clear all inactive diagnostic codes.
- E. Operate the machine.
- F. Determine if the CID 1960 FMI 09 is active.

Expected Result:

The CID 1960 FMI 09 is not active.

Results:

- OK – The CID 1960 FMI 09 is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NOT OK – The CID 1960 FMI 09 is still active. The problem has not been corrected.

Repair: Check the “CAN data link” circuit again. Perform a “wiggle test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” is used to detect intermittent shorts or open connections in the wiring harness of the machine. If the cause of the problem can not be found, the Transmission/Chassis ECM or the “MSS key reader” module may have failed.

Prior to replacing the ECM or the “MSS key reader”, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Troubleshooting, “Electronic Control Module (ECM) - Replace”.

STOP.

i02922407

MID 027 - CID 1961 - FMI 03

SMCS Code: 1439-038-BRK

Conditions Which Generate This Code:

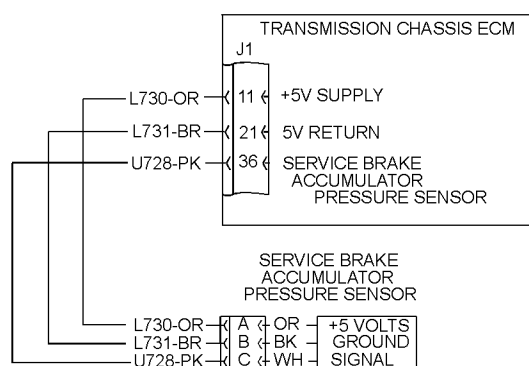


Illustration 293

g01305473

Connections of the “Service Brake Accumulator” pressure sensor

This diagnostic code is associated with the “service brake accumulator” pressure sensor. The FMI 03 diagnostic code means that the Transmission/Chassis ECM has determined that the voltage or the duty cycle of the signal circuit for the position sensor is above normal.

The position sensor is an active analog sensor that sends a 0 to 4.5 volt signal to the ECM in order to indicate the hydraulic pressure that is in the “service brake accumulator”.

Conditions that can cause this diagnostic code to be activated are listed below:

- There is a problem with the sensor power supply.
- The signal circuit for the sensor has an open or a bad connection.
- The signal circuit for the sensor is shorted to a voltage source.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: When this diagnostic code is activated, verify that there are no active CID 0262 diagnostic codes for the 5 volt power supply of the ECM. An active diagnostic code for the power supply must be cleared before proceeding with this procedure.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE POWER SUPPLY OF THE SENSOR

- A. Turn the key start switch and the disconnect switch to the ON position.
- B. Disconnect the machine harness connector from the sensor.
- C. At the machine harness connector for the sensor, measure the supply voltage between the contact for the power supply A (wire L730-OR(Orange)) and the ground contact B (wire U731-BR(Brown)).

Expected Result:

The measurement of the supply voltage is 5.0 ± 0.3 VDC.

Results:

- OK – The voltage measurement is approximately 5.0 ± 0.3 VDC. The power supply for the sensor is correct. Proceed to Test Step 2.
- NOT OK – The voltage measurement is less than 5.0 ± 0.3 VDC. The power supply for the sensor is not correct.

Repair: The wire of the return circuit U731-BR(Brown) or the wire of the supply circuit L730-OR(Orange) has a bad connection or an open in the machine harness. Examine all of the connectors that are in the circuit. Ensure that the connections are clean, that all connections are secure and that all connections are in good condition.

Refer to the CID 0262 diagnostic code procedures in this manual for troubleshooting the power supply (5 VDC). Correct the problem with the power supply of the ECM. After the power supply is correct, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK FOR AN OPEN IN THE SENSOR CIRCUIT

The connector of the machine harness remains disconnected from the sensor.

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. At the machine harness connector for the machine harness of the sensor, place a "jumper" wire between the contact of the sensor return B (wire L731-BR(Brown)) and the signal contact C (wire U728-PK(Pink)).
- C. Disconnect machine harness connectors J1 and J2 from the ECM.
- D. At the harness connectors for the ECM, measure the resistance from return contact J1-21 (wire L731-BR(Brown)) to signal contact J1-36 (wire U728-PK(Pink)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The sensor circuit is not open. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the signal circuit.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is not connected or that a wire is open. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor signal circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SIGNAL CIRCUIT OF THE SENSOR FOR A SHORT

The sensor remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors remain disconnected from the ECM.

- A. Remove the jumper wire that was used in the last test step.
- B. At the harness connector J1 for the ECM, measure the resistance from signal contact J1-36 (wire U728-PK(Pink)) to all of the other contacts that are used for the J1 and J2 connectors on the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The signal circuit is not shorted to another circuit in the machine harness. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness.

Repair: The wire of the sensor signal circuit U728-PK(Pink) is shorted to the circuit with the low resistance measurement in the machine harness.

Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors in the circuits. The technician must look for locations that indicate that a short could occur in the machine harness.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SIGNAL AT THE SENSOR

The key start switch and the disconnect switch remain in the OFF position.

- A. Reconnect the machine harness connectors to the sensor and to the ECM.

- B. At the machine harness for the sensor connector, use a 151 - 6320 Removal Tool to remove the signal wire U728-PK(Pink) and the socket at contact C from the harness connector. The machine harness connector remains connected to the "accumulator pressure" sensor connector.

- C. At the back of the sensor connector, insert 7X - 1710 Multimeter Probes along the sensor signal contact C and the return contact at B.

- D. Turn the disconnect switch and the key start switch to the ON position.

- E. Measure the voltage of the sensor at connector contacts C and B.

Expected Result:

The voltage of the sensor signal is in the range of 0.0 volts to 4.5 VDC.

Results:

- OK – The voltage of the sensor signal is in the range of 0.0 volts to 4.5 VDC. The sensor signal voltage is in the correct range. Proceed to Test Step 5.
- NOT OK – The voltage of the sensor signal is not in the range of 0.0 volts to 4.5 VDC. The sensor may have failed.

Repair: Verify that the sensor signal is not in the correct voltage range. Start the engine. Run the engine at low idle and check the sensor signal. If the sensor signal is not in the correct voltage range, the sensor has failed.

Replace the "service brake accumulator" pressure sensor. After replacement of the sensor, verify that the operation of the new sensor is correct before operating the machine.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.

E. Operate the machine.

F. Determine if the CID 1961 FMI 03 diagnostic code is active.

Expected Result:

The CID 1961 FMI 03 diagnostic code is not active.

Results:

- OK – The CID 1961 FMI 03 diagnostic code is not active. The problem has been corrected.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NOT OK – The CID 1961 FMI 03 diagnostic code is still active. The problem has not been corrected.

Repair: Perform this test step again. If the problem has not been corrected, Perform a “wiggle test” on the sensor circuit in the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” is used to detect intermittent shorts or open connections in the wiring harness of the machine.

If a problem is not found in the machine harness, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i02922408

MID 027 - CID 1961 - FMI 04

SMCS Code: 1439-038-BRK

Conditions Which Generate This Code:

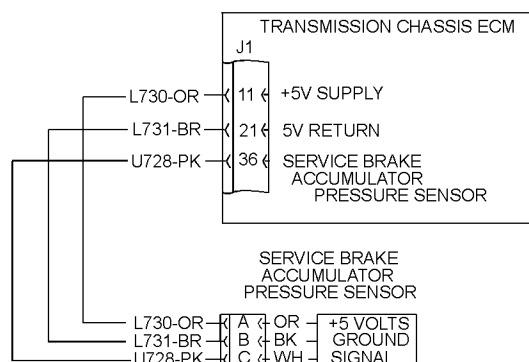


Illustration 294

g01305473

Connections of the “Service Brake Accumulator” pressure sensor

This diagnostic code is associated with the “service brake accumulator” pressure sensor. The FMI 04 diagnostic code means that the Transmission/Chassis ECM has determined that the voltage or the duty cycle of the signal circuit for the position sensor is below normal.

The position sensor is an active analog sensor that sends a 0 to 4.5 volt signal to the ECM in order to indicate the hydraulic pressure that is in the “service brake accumulator”.

Conditions that can cause this diagnostic code to be activated are listed below:

- The signal circuit for the sensor is shorted to a ground source.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SIGNAL CIRCUIT OF THE SENSOR FOR A SHORT

The sensor remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors remain disconnected from the ECM.

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the “service brake accumulator” pressure sensor from the machine harness.
- C. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- D. At the harness connector J1 for the ECM, measure the resistance between signal contact J1-36 (wire U728-PK(Pink)) and frame ground. Measure the resistance between signal contact J1-36 (wire U728-PK(Pink)) and all of the other contacts that are used on the J1 and J2 connectors on the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The measurement is not indicating that the “accumulator pressure sensor” circuit is shorted to a ground source. Proceed to Test Step 2.
- NOT OK – One or more resistance of the resistance measurements is less than 5000 ohms. There is a short in the machine harness.

Repair: The wire for the sensor signal circuit U728-PK(Pink) is shorted to frame ground or to the circuit with the low resistance measurement in the machine harness.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors in the circuits. Examine the machine harness for indications of damage. Damage to the harness connector could indicate a location for a short.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, “Wiring Harness (Short Circuit) - Test”. Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE SIGNAL AT THE SENSOR

The key start switch and the disconnect switch remain in the OFF position.

- A. Reconnect the machine harness connectors to the sensor and to the ECM.
- B. At the machine harness connector for the sensor, use a 151 - 6320 Removal Tool to remove the signal wire U728-PK(Pink) and the socket at contact C from the harness connector. The machine harness connector remains connected to the “accumulator pressure sensor” connector.
- C. At the back of the sensor connector, insert 7X - 1710 Multimeter Probes along the sensor signal contact C and the return contact at B.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Measure the voltage of the sensor at the connector contacts C and B.

Expected Result:

The voltage of the sensor signal is in the range of 0.0 volts to 4.5 VDC.

Results:

- OK – The voltage of the sensor signal is in the range of 0.0 volts to 4.5 VDC. The sensor signal voltage is in the correct range. Proceed to Test Step 3.
- NOT OK – The voltage of the sensor signal is not in the range of 0.0 volts to 4.5 VDC. The sensor may have failed.

Repair: Verify that the sensor signal is not in the correct voltage range. Start the engine. Run the engine at low idle and check the sensor signal again. If the sensor signal is not in the correct voltage range, the sensor has failed.

Replace the “service brake accumulator” pressure sensor. After replacement of the sensor, verify that the operation of the new sensor is correct before operating the machine.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 1961 FMI 03 diagnostic code is active.

Expected Result:

The CID 1961 FMI 03 diagnostic code is not active.

Results:

- OK – The CID 1961 FMI 03 diagnostic code is not active. The problem has been corrected.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NOT OK – The CID 1961 FMI 03 diagnostic code is still active. The problem has not been corrected.

Repair: Perform this test step again. If the problem has not been corrected, Perform a “wiggle test” on the sensor circuit in the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” is used to detect intermittent shorts or open connections in the wiring harness of the machine.

If a problem is not found in the machine harness, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i02839847

MID 027 - CID 2113 - FMI 03

SMCS Code: 1435-038

Conditions Which Generate This Code:

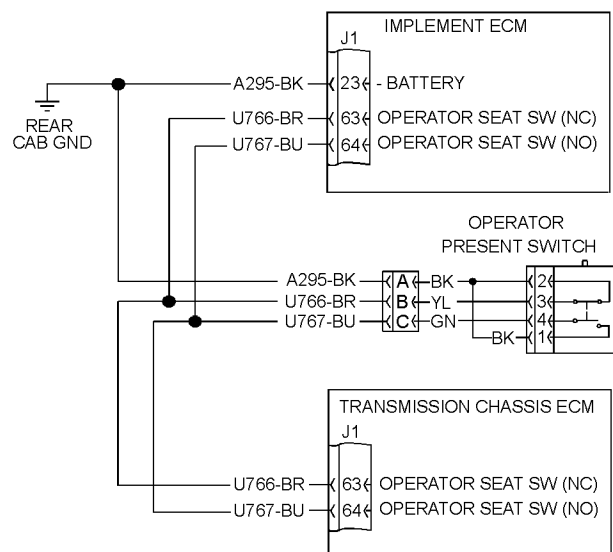


Illustration 295

g01405089

Connections for “Operator Present” Switch

This diagnostic code is associated with the “Operator Present” switch. The switch supplies two switch to “ground type” inputs to the Transmission/Chassis ECM and to the Implement ECM. The ECM expects one of the two switch inputs to be grounded at all times. When the ECM detects that neither of the switch inputs are grounded, the ECM will activate an FMI 03 diagnostic code for “voltage above normal”.

Possible conditions that can cause this diagnostic code are listed:

- One or both of the switch circuits is open in the machine harness.
- One or both of the switch inputs is shorted to a voltage source.
- The switch has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Table 30

States of "Operator Present" Switch Contact		
Operator Status	N/O Input J1-64 (wire U767-BU(Blue))	N/C Input J1-63 (wire U766-BR(Brown))
Operator Not Present	Open ⁽¹⁾	Closed ⁽²⁾
"Operator Present" Switch	Closed	Open

(1) Open to ECM return J1-23 (A295-BK(Black) - ground).

(2) Closed to ECM return J1-23 (A295-BK(Black) - ground).

Note: The "operator present" switch provides two inputs to the Implement ECM and to the Transmission/Chassis ECM. If one ECM has an active diagnostic code and the other ECM does not have an active diagnostic code, most likely the switch is operating correctly. This condition would indicate that there is a problem in the machine harness. In either case, perform this procedure in order to find the cause of the problem.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SWITCH INPUT CIRCUITS FOR AN OPEN

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. Disconnect the connector of the machine harness from the switch.
- C. At the connector of the machine harness for the switch, connect a jumper wire between the normally open (N/O) contact C (wire U767-BU(Blue)) and the normally closed (N/C) contact B (wire U766-BR(Brown)).
- D. Disconnect the connectors of the machine harness J1 and J2 from the Transmission/Chassis ECM.
- E. At the machine harness connector of the Transmission/Chassis ECM J1, measure the resistance between N/C contact J1-63 (wire U766-BR(Brown)) and N/O contact J1-64 (wire U767-BU(Blue)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The input circuits to the switch are not open in the machine harness. Proceed to Test Step 2.
- NOT OK – The resistance measurement is greater than 5 ohms. One of the input circuits to the switch is open or has a poor connection in the machine harness.

Repair: There is an open or a poor connection in input wire to the switch U766-BR(Brown) or input wire to the switch U767-BU(Blue). Check each input circuit of the switch individually in order to determine the circuit that has the problem.

If both of the ECMs have active diagnostic codes, then there is most likely an open or a bad connection on the switch side of the splice connection of the machine harness for the signal wire.

If only one ECM has activated this diagnostic code, there is most likely an open or a bad connection on the ECM side of the splice connection of the machine harness for the circuit wire to the switch.

Refer to the complete Electrical System Schematic of the machine. Verify that all connection points in the suspected part of the circuits are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE SWITCH GROUND CIRCUIT FOR AN OPEN

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors remain disconnected from the Transmission/Chassis ECM and the switch.

- A. Disconnect the machine harness connector J1 from the Implement ECM.
- B. At the connector for the machine harness for the switch, connect the jumper wire that was used in the last test step between the common ground contact A (wire A295-BK(Black)) and the normally closed (N/C) contact B (wire U766-BR(Brown)).
- C. At the machine harness connector for the Implement ECM J1, measure the resistance between the contact of the common ground J1-23 (wire A295-BK(Black)) and N/C contact J1-63 (wire U766-BR(Brown)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The circuit for the common ground is not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. The circuit of the common ground is open or has a poor connection in the machine harness.

Repair: There is an open or a poor connection in ground wire of the switch A295-BK(Black). Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the common connection to the ground circuit. Verify that all connection points for the circuit are clean, that all connection points are secure and that all connection points are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE HARNESS FOR A SHORT

The key start switch and the disconnect switch remain in the OFF position.

The switch for both ECMs and the connectors for both ECMs remain disconnected from the machine harness.

- Disconnect the jumper wire that was used in the last test step.
- At the machine harness connector of the Transmission/Chassis ECM J1, measure the resistance between contact J1-63 (wire U766-BR(Brown)) and all of the other contacts that are used in the J1 and J2 connectors for the ECM.
- At the machine harness connector of the Transmission/Chassis ECM J1, measure the resistance between contact J1-64 (wire U767-BU(Blue)) and all of the other contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The input circuits to the switch are not shorted in the machine harness. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms.

Repair: There is a short circuit in a input circuit to the switch. The short is between the input circuit that revealed the low resistance measurement and another circuit. Refer to the complete Electrical System Schematic of the machine. Check the connectors that are in the involved circuits. Verify that all connection points for the circuit are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SWITCH OPERATION

The switch remains disconnected from the machine harness. The disconnect switch and the key start switch remain in the OFF position.

- At the connector for the switch, measure the resistance (continuity) between common contact A and the switch N/C contact B when an operator is present in the operator seat and when no operator is present in the operator seat.
- At the connector for the switch, measure the resistance (continuity) between common contact A and the switch N/O contact C when an operator is present in the operator seat and when no operator is present in the operator seat.

Expected Result:

The continuity checks of the switch are correct according to the table at the beginning of this procedure.

Results:

- OK – The continuity checks between common contact A and the switch contacts are correct. The switch is operating correctly. Proceed to Test Step 5.
- NOT OK – The continuity checks between the common contact A and the contacts of the switch are not correct. The switch is not working correctly.

Repair: The “operator present” switch has failed. Replace the switch. After replacement of the switch, verify that the operation of the new switch is correct before operating the machine.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2113 FMI 03 diagnostic code is active.

Expected Result:

The CID 2113 FMI 03 diagnostic code is active.

Results:

- YES – The CID 2113 FMI 03 diagnostic code is active. The problem has not been corrected.

Repair: Repeat this procedure. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a “wiggle test” on the switch circuits in the machine wiring harness. The “wiggle test” can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NO – The CID 2113 FMI 03 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02839845

MID 027 - CID 2113 - FMI 04

SMCS Code: 1435-038

Conditions Which Generate This Code:

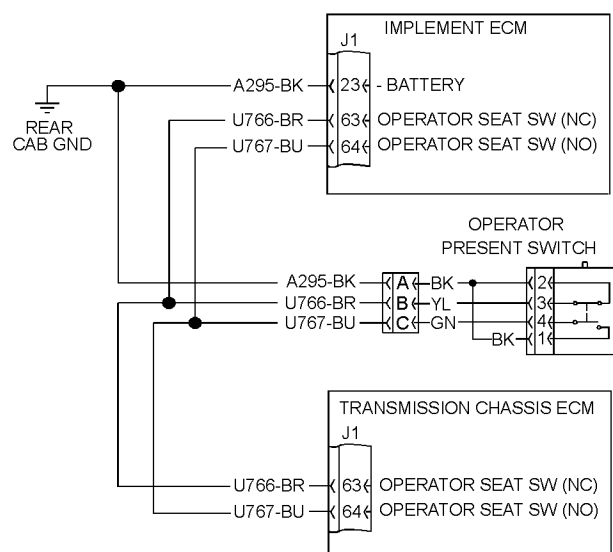


Illustration 296

g01405089

Connections for “Operator Present” Switch

This diagnostic code is associated with the “Operator Present” switch. The switch supplies two switch to ground types of inputs to the Transmission/Chassis ECM and to the Implement ECM. The ECM expects one of the two inputs of the switch to be grounded at all times. When the ECM detects that both of the inputs of the switch are grounded at the same time, the ECM will activate an FMI 04 diagnostic code for “voltage below normal”.

Some conditions that can cause this diagnostic code are listed below:

- One or both of the switch inputs is shorted to a ground source.
- The switch has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Table 31

States of Contact for "Operator Present" Switch		
Operator Status	N/O Input J1-64 (wire U767-BU(Blue))	N/C Input J1-63 (wire U766-BR(Brown))
Operator Not Present	Open ⁽¹⁾	Closed ⁽²⁾
"Operator Present"	Closed	Open

⁽¹⁾ Open to ECM return J1-23 (A295-BK(Black) - ground).

⁽²⁾ Closed to ECM return J1-23 (A295-BK(Black) - ground).

Note: The "Operator Present" switch provides two inputs to the Transmission/Chassis ECM and to the Implement ECM. If one ECM has an active diagnostic code and the other ECM does not have an active diagnostic code, the switch is probably operating correctly. This condition would indicate that there is a problem in the machine harness. In either case, perform this procedure in order to find the cause of the problem.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SWITCH

- A. Turn the disconnect switch and the key start switch to the ON position.
- B. Ensure that the diagnostic code is active.
- C. Observe the status of the diagnostic code while the connector of the switch is disconnected from the machine harness.

Expected Result:

The CID 2113 FMI 04 diagnostic code will remain active if the switch is not the cause of the diagnostic code. The switch is the cause of the diagnostic code if the CID 2113 FMI 04 diagnostic code is NO longer active and a CID 2113 FMI 03 diagnostic code becomes active.

Results:

- OK – The CID 2113 FMI 04 diagnostic code remains active. The switch has not failed. Proceed to Test Step 2.
- NOT OK – The CID 2113 FMI 04 diagnostic code is NO longer active. A CID 2113 FMI 03 diagnostic code becomes active when the connector of the switch is disconnected. The machine harness and the ECM are operating correctly. The switch has failed.

Repair: Replace the "Operator Present" switch. After replacement of the switch, verify that the operation of the new switch is correct before operating the machine.

STOP.

Test Step 2. CHECK THE HARNESS FOR A SHORT

The switch remains disconnected from the machine harness.

- A. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- B. At the machine harness connector of the ECM J1, measure the resistance between contact J1-63 (wire U766-BR(Brown)) and frame ground. Measure the resistance between contact J1-63 (wire U766-BR(Brown)) to all of the other contacts that are used in the J1 and J2 connectors for the ECM.
- C. At the machine harness connector for the ECM J1, measure the resistance between contact J1-64 (wire U767-BU(Blue)) and frame ground. Measure the resistance between contact J1-64 (wire U767-BU(Blue)) to all of the other contacts that are used in the J1 and J2 connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The input circuits of the switch are not shorted in the machine harness. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms.

Repair: The input circuit of the switch is shorted to the circuit with the low resistance measurement. Refer to the complete Electrical System Schematic of the machine. Check the connectors that are in the involved circuits. Verify that all connection points for the circuit are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

i02922455

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the switch circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2113 FMI 04 diagnostic code is active.

Expected Result:

The CID 2113 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 2113 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2113 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a “wiggle test” on the machine wiring harness. The “wiggle test” can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

MID 027 - CID 2175 - FMI 03

SMCS Code: 5479-038-ZH

Conditions Which Generate This Code:

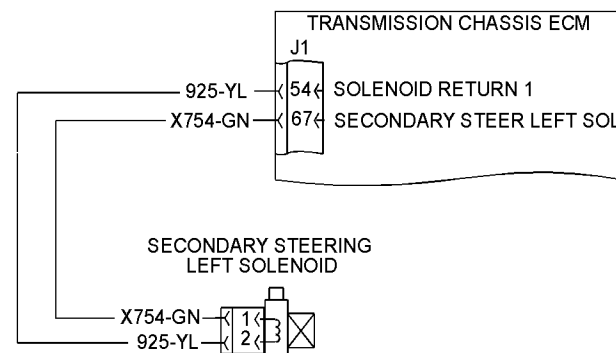


Illustration 297

g01289122

Connections of “Secondary Steer Left” solenoid

This diagnostic code is associated with the “secondary steer left” solenoid. The FMI 03 means that the Transmission/Chassis ECM has determined that the voltage of the solenoid circuit is above normal.

Conditions that can cause this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to another voltage source.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $2.2 \pm .2$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector from the solenoid. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- C. At the machine harness connector J1 for the ECM, measure the resistance between contact J1-67 (wire X754-GN(Green)) and all of the J1 and J2 contacts that are used on the ECM connectors.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the wire for the energize circuit X754-GN(Green) and the circuit that has a low resistance measurement.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoid and the ECM remain disconnected.

- A. At the connector of the machine harness J1, use a 151 - 6320 Removal Tool to remove the energize wire of the solenoid X754-GN(Green) and the socket at contact J1-67 from the harness connector.
- B. Reconnect the machine harness J1 and J2 connectors to the ECM.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Observe the status of the active CID 2175 FMI 03 diagnostic code.

Expected Result:

The CID 2175 FMI 03 diagnostic code is no longer active. A CID 2175 FMI 05 diagnostic code is now active.

Results:

- YES – The CID 2175 FMI 03 diagnostic code is no longer active. A CID 2175 FMI 05 diagnostic code is active after the wire for the energize circuit of the solenoid was disconnected. The ECM has responded correctly to the open circuit condition in the solenoid circuit. Reinstall the energize wire of the solenoid into the correct space of the ECM connector. Proceed to the next test step. Proceed to Test Step 3.
- NO – The CID 2175 FMI 03 diagnostic code remains active. The status of the active diagnostic code did not change when the energize wire of the solenoid was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2175 FMI 03 diagnostic code is active.

Expected Result:

The CID 2175 FMI 03 diagnostic code is active.

Results:

i02922465

- YES – The CID 2175 FMI 03 diagnostic code is active.

Repair: Check the circuit again. Perform a “wiggle test” on the solenoid circuit in the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” is used to detect intermittent shorts or open connections in the wiring harness of the machine.

If the problem remains, the ECM may have failed. This is unlikely because the ECM detected the open circuit condition in the solenoid circuit and activated the FMI 05 diagnostic code when the solenoid energize wire was disconnected.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NO – The CID 2175 FMI 03 code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

MID 027 - CID 2175 - FMI 05

SMCS Code: 5479-038-ZH

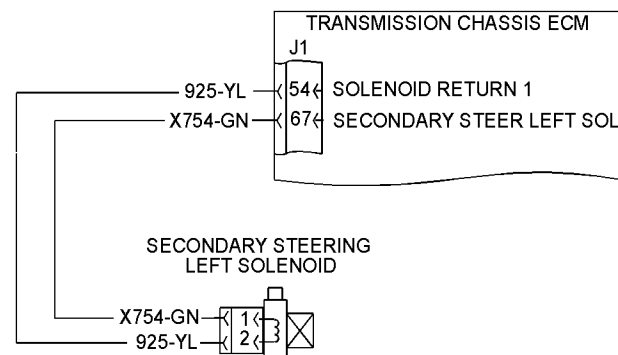
Conditions Which Generate This Code:

Illustration 298

g01289122

Connection of “Secondary Steer Left” Solenoid

This diagnostic code is associated with the “secondary steer left” solenoid. The FMI 05 means that the Transmission/Chassis ECM has determined that the current for the solenoid circuit is below normal.

Conditions that could cause this diagnostic code to be activated are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $2.2 \pm .2$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- A.** Disconnect the solenoid from the machine harness.
- B.** At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire X754-GN(Green)) to contact 2 (wire 925-YL(Yellow)).
- C.** Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D.** Observe the status of the CID 2175 FMI 05 diagnostic code.

Expected Result:

The CID 2175 FMI 05 diagnostic code is no longer active. A CID 2175 FMI 06 diagnostic code becomes active when the jumper wire is connected.

Results:

- YES – The CID 2175 FMI 05 diagnostic code is no longer active. A CID 2175 FMI 06 diagnostic code becomes active when the jumper wire is connected. The solenoid has failed.

Repair: The solenoid has failed. Repeat this Test Step “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

STOP.

- NO – The CID 2175 FMI 05 diagnostic code remains active. The jumper wire does not affect the status of the diagnostic code. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR AN OPEN

- A.** Turn the key start switch and the disconnect switch to the OFF position.
- B.** Disconnect the machine harness connector J1 from the Transmission/Chassis ECM.
- C.** The jumper wire that was installed in the previous test step remains in place.
- D.** At the harness connector J1 for the Transmission/Chassis ECM, measure the resistance between the return wire, contact J1-54 (wire 925-YL(Yellow)) and the energize wire, contact J1-67 (wire X754-GN(Green)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The measurement of the resistance is less than 5 ohms. The circuit is not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5000 ohms. The resistance measurement is not correct. There is an open or a bad connection in the machine harness.

Repair: A resistance measurement that is much greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

The open or the possible poor connection is in the supply wire X754-GN(Green) or in the return wire 925-YL(Yellow) of the machine harness. Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the solenoid circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connector for the solenoid and the ECM J1 connector remain disconnected.

- A.** Remove the jumper wire that was installed in the last test step.
- B.** At the machine harness connector J1 for the ECM, use a 151 - 6320 Removal Tool to remove the energize wire of the solenoid X754-GN(Green) and the socket at contact J1-65 from the harness connector.
- C.** Reconnect the machine harness J1 connector to the ECM.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Use a 7X - 1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the ECM pin at J1-65 through the empty space in the J1 connector.
- F.** Observe the status of the active CID 2175 FMI 05 diagnostic code and ground the other end of the 7X - 1710 Multimeter Probe to frame ground.

Expected Result:

Diagnostic Code Procedures

The CID 2175 FMI 05 diagnostic code is no longer active. A CID 2175 FMI 06 diagnostic code becomes active when the ECM pin at J1-67 is grounded.

Results:

- YES – The CID 2175 FMI 05 diagnostic code is no longer active. A CID 2175 FMI 06 diagnostic code has been activated after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition in the solenoid circuit. The ECM is most likely not causing the problem. Reinstall the disconnected solenoid energize wire back into the correct spot in the ECM connector. Proceed to the next test step. Proceed to Test Step 4.
- NO – The CID 2175 FMI 05 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin for the solenoid is grounded.

Repair: The ECM has not responded correctly to the grounded condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 2175 FMI 05 diagnostic code.

Expected Result:

The CID 2175 FMI 05 diagnostic code is active.

Results:

- YES – The CID 2175 FMI 05 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the circuit again. Perform a "wiggle test" on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The "wiggle test" is used to detect intermittent shorts or open connections in the wiring harness of the machine.

If the cause of the problem is not found in the machine harness, the ECM may have failed. This is unlikely as the ECM responded correctly to the grounded condition in the previous test step.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 2175 FMI 05 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02922480

MID 027 - CID 2175 - FMI 06

SMCS Code: 5479-038-ZH

Conditions Which Generate This Code:

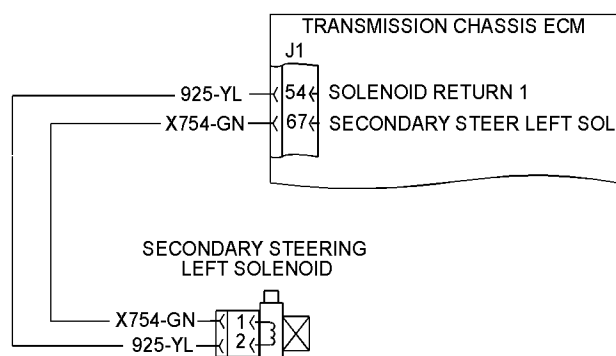


Illustration 299

g01289122

Connections of "Secondary Steer Left" solenoid

This diagnostic code is associated with the "secondary steer left" solenoid. The FMI 06 means that the Transmission/Chassis ECM has determined that the current of the solenoid circuit is above normal.

Conditions that could cause this diagnostic code to be activated are listed below:

- The energize circuit of the solenoid is shorted to a ground source.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $2.2 \pm .2$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

- Observe the status of the diagnostic code.

- Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

The active CID 2175 FMI 06 diagnostic code changes to a CID 2175 FMI 05 diagnostic code when the solenoid is disconnected.

Results:

- YES – The active CID 2175 FMI 06 diagnostic code changes to a CID 2175 FMI 05 diagnostic code when the solenoid is disconnected. The circuit is correct.

Repair: The solenoid has failed. Repeat this test "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid.

STOP.

- NO – The CID 2175 FMI 06 remains active when the solenoid is disconnected. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND

- Turn the key start switch and the disconnect switch to the OFF position.
- The solenoid remains disconnected from the machine harness.
- Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- At the machine harness connectors of the ECM, measure the resistance from the contact J1-67 (wire X754-GN(Green)) to frame ground. Measure the resistance between the contact J1-67 (wire X754-GN(Green)) and all of the other J1 and J2 contacts that are used in the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a

short in the machine harness. The short is between wire X754-GN(Green) and the circuit with the low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoid and the ECM remain disconnected.

- A. At the machine harness connector J1 for the ECM, use a 151 - 6320 Removal Tool to remove the energize wire of the solenoid at contact X754-GN(Green) and the socket at contact J1-67 from the harness connector.
- B. Reconnect the machine harness J1 and J2 connectors to the ECM.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Observe the status of the active CID 2175 FMI 06 diagnostic code.

Expected Result:

The CID 2175 FMI 06 diagnostic code is no longer active. A CID 2175 FMI 05 diagnostic code is now active.

Results:

- YES – The CID 2175 FMI 06 diagnostic code is no longer active. A CID 2175 FMI 05 diagnostic code has been activated after the solenoid energize circuit was disconnected. The ECM has responded correctly to the open circuit condition in the solenoid circuit. Reinstall the energize wire of the solenoid into the correct space of the ECM connector. Proceed to the next test step. Proceed to Test Step 4.
- NO – The CID 2175 FMI 06 diagnostic code remains active. The status of the active diagnostic code did not change when the energize wire of the solenoid was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 2175 FMI 06 diagnostic code.

Expected Result:

The CID 2175 FMI 06 diagnostic code is still active.

Results:

- YES – The CID 2175 FMI 06 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a "wiggle test" on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The "wiggle test" is used to detect intermittent shorts or open connections in the wiring harness of the machine.

If the cause of the problem is not found, the ECM may have failed.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 2175 FMI 06 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02922511

MID 027 - CID 2176 - FMI 03

SMCS Code: 5479-038-ZH

Conditions Which Generate This Code:

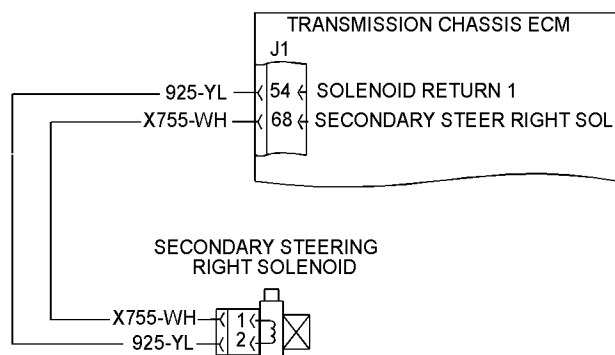


Illustration 300

g01289178

Connections of "Secondary Steer Right" solenoid

This diagnostic code is associated with the "secondary steer right" solenoid. The FMI 03 means that the Transmission/Chassis ECM has determined that the voltage of the solenoid circuit is above normal or that a voltage is present in the solenoid circuit when no voltage should be present.

Conditions that can cause this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to another voltage source.
- The solenoid has failed.

- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $2.2 \pm .2$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the solenoid. Disconnect the connectors of the machine harness J1 and J2 from the Transmission/Chassis ECM.
- At the machine harness connector for the ECM J1, measure the resistance from contact J1-68 (wire X755-WH(White)) and all the J1 and J2 contacts that are used on the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms.

Repair: There is a short in the machine harness. The short is between wire X755-WH(White) and the circuit that has a low resistance measurement.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoid and the ECM remain disconnected.

- A. At the machine harness connector J1 for the ECM, use a 151 - 6320 Removal Tool to remove the wire X755-WH(White) and the socket at contact J1-68 from the harness connector.
- B. Reconnect the machine harness J1 and J2 connectors to the ECM.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Observe the status of the active CID 2176 FMI 03 diagnostic code.

Expected Result:

The CID 2176 FMI 03 diagnostic code is no longer active. A CID 2176 FMI 05 diagnostic code is now active.

Results:

- YES – The CID 2176 FMI 03 diagnostic code is no longer active. A CID 2176 FMI 05 diagnostic code is active after the energize circuit of the solenoid is disconnected. The ECM has responded correctly to the open circuit condition in the solenoid circuit. Install the wire for the energize circuit of the solenoid in the correct space of the ECM. Proceed to the next test step. Proceed to Test Step 3.
- NO – The CID 2176 FMI 03 diagnostic code remains active. The status of the active diagnostic code does not change after the wire for the energize circuit of the solenoid is disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2176 FMI 03 diagnostic code is active.

Expected Result:

The CID 2176 FMI 03 diagnostic code is active.

Results:

- YES – The CID 2176 FMI 03 diagnostic code is active.

Repair: Check the circuit again. Perform a "wiggle test" on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The "wiggle test" can detect intermittent shorts or open connections in the wiring harness of the machine .

If the problem remains, the ECM may have failed. The failure of the ECM is unlikely. The Transmission/Chassis ECM was able to active the FMI 05 diagnostic code when the energize wire of the solenoid was removed from the circuit.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 2176 FMI 03 code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02922567

MID 027 - CID 2176 - FMI 05

SMCS Code: 5479-038-ZH

Conditions Which Generate This Code:

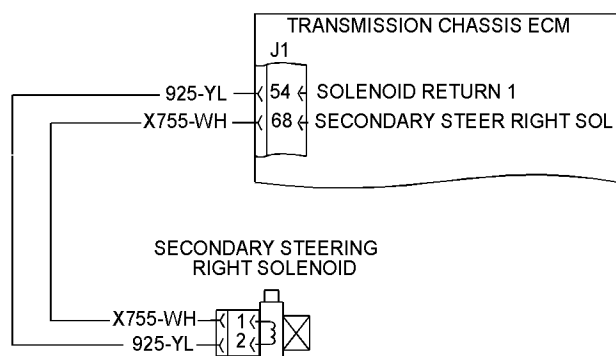


Illustration 301

g01289178

Connections of "Secondary Steer Right" solenoid

This diagnostic code is associated with the "secondary steer right" solenoid. The FMI 05 means that the Transmission/Chassis ECM has determined that the current for the solenoid circuit is below normal.

Conditions that could cause this diagnostic code to be activated are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $2.2 \pm .2$ ohms at 25 °C (77.0 °F).

Test Step 1. CHECK THE SOLENOID

- Disconnect the solenoid from the machine harness.
- At the machine harness connector for the solenoid, place a jumper wire from contact 1 (wire X755-WH(White)) to contact 2 (wire 925-YL(Yellow)).
- Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- Observe the status of the CID 2176 FMI 05 diagnostic code.

Expected Result:

The CID 2176 FMI 05 diagnostic code is no longer active. A CID 2176 FMI 06 diagnostic code becomes active when the jumper wire is connected.

Results:

- YES – The CID 2176 FMI 05 diagnostic code is no longer active. A CID 2176 FMI 06 diagnostic code becomes active when the jumper wire is connected. The solenoid has failed.

Repair: The solenoid has failed. Repeat this Test Step "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

STOP.

- NO – The CID 2176 FMI 05 diagnostic code remains active. The jumper wire does not affect the status of the diagnostic code. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR AN OPEN

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector J1 from the Transmission/Chassis ECM.
- The jumper wire that was installed in the previous Test Step remains in place.
- At the machine harness connector J1 for the Transmission/Chassis ECM, measure the resistance from contact J1-54 (wire 925-YL(Yellow)) to the contact J1-68 (wire X755-WH(White)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

Diagnostic Code Procedures

- OK – The measurement of the resistance is less than 5 ohms. The circuit is not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5000 ohms. The resistance measurement is not correct. There is an open or a bad connection in the machine harness.

Repair: A resistance measurement that is much greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

The open or the possible poor connection is in supply wire X755-WH(White) or in the return wire 925-YL(Yellow) of the machine harness. Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the solenoid circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connector for the solenoid and the ECM J1 connector remain disconnected.

- Remove the jumper wire that was installed in the last test step.
- At the harness connector J1 for the ECM, use a 151 - 6320 Removal Tool to remove the energize wire of the solenoid X755-WH(White) and the socket at contact J1-68 from the harness connector.
- Reconnect the machine harness J1 connector to the ECM.
- Turn the disconnect switch and the key start switch to the ON position.
- Use a 7X - 1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the ECM pin at J1-68 through the empty space in the J1 connector.
- Observe the status of the active CID 2176 FMI 05 diagnostic code and ground the other end of the 7X - 1710 Multimeter Probe to the frame ground.

Expected Result:

The CID 2176 FMI 05 diagnostic code is no longer active. A CID 2176 FMI 06 diagnostic code becomes active when the ECM pin at J1-68 is grounded.

Results:

- YES – The CID 2176 FMI 05 diagnostic code is no longer active. A CID 2176 FMI 06 diagnostic code has become active after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition in the solenoid circuit. It is likely that the ECM is the cause of the problem. Reconnect the energize wire of the solenoid. Proceed to the next test step. Proceed to Test Step 4.
- NO – The CID 2176 FMI 05 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin for the solenoid is grounded.

Repair: The ECM has not responded correctly to the grounded condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 2176 FMI 05 diagnostic code.

Expected Result:

The CID 2176 FMI 05 diagnostic code is active.

Results:

- YES – The CID 2176 FMI 05 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

i02922574

Repair: Check the circuit again. Perform a “wiggle test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed. This is unlikely as the ECM response was correct for the grounded condition in the previous test step.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the Transmission/Chassis ECM. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NO – The CID 2176 FMI 05 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

MID 027 - CID 2176 - FMI 06

SMCS Code: 5479-038-ZH

Conditions Which Generate This Code:

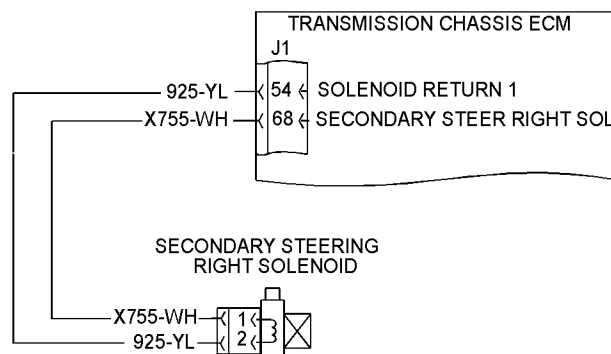


Illustration 302

g01289178

Connections of “Secondary Steer Right” solenoid

This diagnostic code is associated with the “secondary steer right” solenoid. The FMI 06 means that the Transmission/Chassis ECM has determined that the current of the solenoid circuit is above normal.

Conditions that could cause this diagnostic code to be activated are listed below:

- The energize circuit of the solenoid is shorted to a ground source.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Note: The resistance of the solenoid coil should be $2.2 \pm .2$ ohms at 25°C (77.0°F).

Test Step 1. CHECK THE SOLENOID

- Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

Diagnostic Code Procedures

- B.** Observe the status of the diagnostic code.
- C.** Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

The active CID 2176 FMI 06 diagnostic code changes to a CID 2176 FMI 05 diagnostic code when the solenoid is disconnected.

Results:

- YES – The active CID 2176 FMI 06 diagnostic code changes to a CID 2176 FMI 05 diagnostic code when the solenoid is disconnected. The circuit is correct.

Repair: The solenoid has failed. Repeat this test "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid.

STOP.

- NO – The CID 2176 FMI 06 remains active when the solenoid is disconnected. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND

- A.** Turn the key start switch and the disconnect switch to the OFF position.
- B.** The solenoid remains disconnected from the machine harness.
- C.** Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- D.** At the machine harness connectors for the ECM, measure the resistance from the contact J1-68 (wire X755-WH(White)) to frame ground. Measure the resistance from the contact J1-68 (wire X755-WH(White)) to all of the other J1 and J2 contacts that are used in the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a

short in the machine harness. The short is between wire X755-WH(White) and the circuit with the low resistance measurement.

Repair: Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the relay circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoid and the ECM remain disconnected.

- A.** At the machine harness connector J1 for the ECM, use a 151-6320 Removal Tool to remove the energize wire of the solenoid X755-WH(White) and the socket at contact J1-68 from the harness connector.
- B.** Reconnect the machine harness J1 and J2 connectors to the ECM.
- C.** Turn the disconnect switch and the key start switch to the ON position.
- D.** Observe the status of the active CID 2176 FMI 06 diagnostic code.

Expected Result:

The CID 2176 FMI 06 diagnostic code is no longer active. A CID 2176 FMI 05 diagnostic code is now active.

Results:

- YES – The CID 2176 FMI 06 diagnostic code is no longer active. A CID 2176 FMI 05 diagnostic code has been activated after the solenoid energize circuit was disconnected. The ECM has responded correctly to the open circuit condition in the solenoid circuit. Reconnect the energize wire of the solenoid into the correct space of the ECM connector. Proceed to the next test step. Proceed to Test Step 4.

- NO – The CID 2176 FMI 06 diagnostic code remains active. The status of the active diagnostic code did not change when the energize wire of the solenoid was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 2176 FMI 06 diagnostic code.

Expected Result:

The CID 2176 FMI 06 diagnostic code is still active.

Results:

- YES – The CID 2176 FMI 06 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a "wiggle test" on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The "wiggle test" can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 2176 FMI 06 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02922616

MID 027 - CID 2199 - FMI 03

SMCS Code: 7610-038-II

Conditions Which Generate This Code:

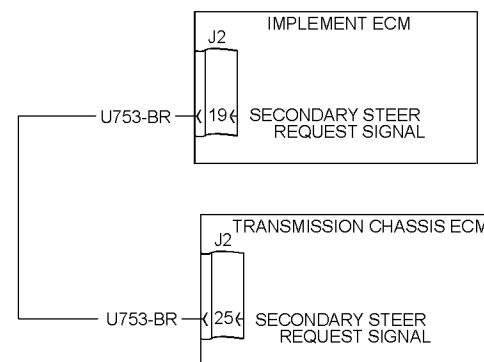


Illustration 303

g01305868

Connections of "Secondary Steer Request" signal circuit

This diagnostic code is associated with the "secondary steer request" signal circuit. This circuit enables the Implement ECM to request that the Transmission/Chassis ECM activate specific components of the secondary steering system or to active the complete secondary steering system during times that certain machine conditions require it.

The FMI 03 diagnostic code means that the Transmission/Chassis ECM has determined that the voltage of the circuit is above normal.

When a CID 2199 diagnostic code is activated by the Transmission/Chassis ECM, the ECM will activate the secondary steering system without input from the Implement ECM. This is the only condition that will cause the Transmission/Chassis ECM to activate the secondary steering system without input from the Implement ECM.

During normal operation, when the Implement ECM detects a problem in the primary steering system, the Implement ECM will send a pulse width modulated (PWM) signal to the Transmission/Chassis ECM on the secondary steering request circuit that is connected between the two controls.

When the Implement ECM sends a PWM secondary steer request signal to the Transmission/Chassis ECM, the duty cycle of the PWM signal will determine which specific secondary steer system components will be activated. During normal operation, the Implement ECM maintains a 20 percent duty cycle on the request circuit. When a secondary steering test is requested or when the Implement ECM has detected a problem in the primary steering system, the secondary steering signal will be one of the following duty cycle signals:

20 percent PWM duty cycle – Normal operation, no request to activate.

40 percent PWM duty cycle – Request to activate the secondary steering pump motor only.

60 percent PWM duty cycle – Request to activate the secondary steering pilot solenoid valves only.

80 percent PWM duty cycle – Request to activate the secondary steering pump and the secondary steering pilot solenoid valves.

Conditions that can cause this diagnostic code to be activated are listed below:

- There is an open in the circuit.
- The circuit is shorted to another voltage source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE CIRCUIT FOR AN OPEN

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connectors J1 and J2 from the Implement ECM and from the Transmission/Chassis ECM.
- C. Obtain a spare length of wire that will reach from the connectors for the Implement ECM to the connectors for the Transmission/Chassis ECM .
- D. At the Implement ECM connector J2 connect one end of the spare wire to the request circuit contact J2-19 (wire U753-BR(Brown)).
- E. At the Transmission/Chassis ECM connector J2, measure the resistance between the other end of the spare wire and the request circuit contact J2-25 (wire U753-BR(Brown)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The resistance measurement is not indicating that the secondary steering request circuit is open in the machine harness. Proceed to Test Step 2.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the circuit for the secondary steering request.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is not connected or that a wire is open. A resistance measurement that is greater 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

A poor connection can cause the problem. A connector may be loose, dirty or corroded. Inspect the connectors that are in the circuit. Ensure that all connectors are clean, that all connectors are tight and that all connectors are in good condition.

The open or the possible bad connection is in wire U753-BR(Brown). Refer to the complete Electrical System Schematic of the machine . Check all of the connectors that are in the circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE CIRCUIT FOR A SHORT

The key start switch and the disconnect switch remain in the OFF position. The machine harness connectors for both ECM modules remain disconnected.

- A. Remove the spare wire that was used in the last test step.
- B. At the J2 machine harness connector for the Transmission/Chassis ECM, measure the resistance from the contact J2-25 (wire U753-BR(Brown)) to all of the other J1 and J2 contacts that are used on the connectors of the Transmission/Chassis ECM.
- C. At the J2 machine harness connector for the Implement ECM, measure the resistance from the contact J2-19 (wire U753-BR(Brown)) to all of the other J1 and J2 contacts that are used on the connectors of the Implement ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The measurement does not indicate that the request signal circuit is shorted in the machine harness. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the request signal circuit wire U753-BR(Brown) and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors in circuits for points in the machine harness that indicate the circuits could be shorted. For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position.

- A. Reconnect the J1 and J2 machine harness connectors to the Implement ECM and to the Transmission/Chassis ECM.
- B. At the machine harness connector J2 for the Transmission/Chassis ECM, use a 151 - 6320 Removal Tool to remove the request signal wire U753-BR(Brown) and the socket at contact J2-25 from the harness connector. The machine harness connector J2 remains connected to the ECM.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Use a 7X - 1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the pin of the Transmission/Chassis ECM at J2-25 through the empty space in the J2 connector.
- E. Observe the status of the active CID 2199 FMI 03 diagnostic code and ground the other end of the 7X - 1710 Multimeter Probe to frame ground.

Expected Result:

The CID 2199 FMI 03 diagnostic code is no longer active. A CID 2199 FMI 04 diagnostic code becomes active when the ECM pin at J2-25 is grounded.

Results:

- YES – The CID 2199 FMI 03 diagnostic code is no longer active. A CID 2199 FMI 04 diagnostic code has been activated after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition. It is unlikely that the ECM is the cause of the problem. Reconnect the wire into the correct spot of the ECM connector. Proceed to the next test step. Proceed to Test Step 4.
- NO – The CID 2199 FMI 03 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin is grounded.

Repair: The ECM has not responded correctly to the ground condition of the circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2199 FMI 03 diagnostic code is active.

Expected Result:

The CID 2199 FMI 03 diagnostic code is not active.

Results:

- OK – The CID 2199 FMI 03 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2199 FMI 03 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a “wobble test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wobble test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed. It is unlikely as the ECM response was correct to the ground condition of the previous test step.

Verify that all possible causes of the diagnostic code have been investigated. Exit this procedure and perform this procedure again.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the active diagnostic code is not found and the ECM must be replaced, refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i02922876

MID 027 - CID 2199 - FMI 04

SMCS Code: 7610-038-II

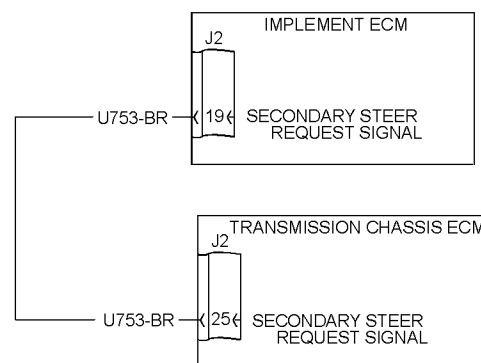
Conditions Which Generate This Code:

Illustration 304

g01305868

Connections of “Secondary Steer Request” signal circuit

This diagnostic code is associated with the “secondary steer request” signal circuit. This circuit enables the Implement ECM to request that the Transmission/Chassis ECM activate the secondary steering system when certain machine conditions require it.

The FMI 04 means that the Transmission/Chassis ECM has detected that a lower than normal voltage is present in the circuit.

When a CID 2199 diagnostic code is activated by the Transmission/Chassis ECM, the ECM will activate the secondary steering system without input from the Implement ECM. This is the only condition that will cause the Transmission/Chassis ECM to activate the secondary steering system without input from the Implement ECM.

During normal operation, when the Implement ECM detects a problem in the primary steering system, the Implement ECM will send a pulse width modulated (PWM) signal to the Transmission/Chassis ECM on the circuit for the secondary steering request that is connected between the two controls.

When the Implement ECM sends a PWM secondary steering request signal to the Transmission/Chassis ECM, the duty cycle of the PWM signal will determine the specific secondary steering system components that will be activated. During normal operation, the Implement ECM maintains a 20 percent duty cycle on the request circuit. When a secondary steer test is requested or when the Implement ECM has detected a problem in the primary steering system, the secondary steering request signal will be one of the following duty cycle signals:

20 percent PWM duty cycle – Normal operation, no request to activate.

40 percent PWM duty cycle – Request to activate the secondary steer pump motor only.

60 percent PWM duty cycle – Request to activate the secondary steer pilot solenoid valves only.

80 percent PWM duty cycle – Request to activate the secondary steer pump and the secondary steer pilot solenoid valves.

Conditions that can cause this diagnostic code to be activated are listed below:

- The circuit is shorted to a ground source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE CIRCUIT FOR A SHORT TO GROUND

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connectors J1 and J2 from the Implement ECM and from the Transmission/Chassis ECM.
- C. At the J2 machine harness connector for the Transmission/Chassis ECM, measure the resistance from contact J2-25 (wire U753-BR(Brown)) to frame ground. Measure the resistance from contact J2-25 (wire U753-BR(Brown)) to all of the other J1 and J2 contacts that are used on the connectors of the Transmission/Chassis ECM.
- D. At the J2 machine harness connector for the Implement ECM, measure the resistance from the contact J2-19 (wire U753-BR(Brown)) to frame ground. Measure the resistance from contact J2-19 (wire U753-BR(Brown)) to all of the other J1 and J2 contacts that are used on the connectors of the Implement ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The measurement does not indicate that the request signal circuit is shorted to ground in the machine harness. Proceed to Test Step 2.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the request signal circuit wire U753-BR(Brown) and the circuit with the low resistance measurement or the frame ground.

Refer to the complete Electrical System Schematic of the machine. Examine all of the connectors in the circuit. In the machine harness, look for points that indicate the circuits could be shorted. For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position.

- A. Reconnect the machine harness connectors J1 and J2 to the Implement ECM and to the Transmission/Chassis ECM.
- B. Turn the disconnect switch and the key start switch to the ON position.
- C. At the machine harness connector J2 for the Transmission/Chassis ECM, use a 151 - 6320 Removal Tool to remove the request signal wire U753-BR(Brown) and the socket at contact J2-25 from the harness connector. The machine harness connector J2 remains connected to the ECM.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Observe the status of the active CID 2199 FMI 04 diagnostic code.

Expected Result:

Diagnostic Code Procedures

The CID 2199 FMI 04 diagnostic code is no longer active. A CID 2199 FMI 03 diagnostic code is now active.

Results:

- YES – The CID 2199 FMI 04 diagnostic code is no longer active. A CID 2199 FMI 03 diagnostic code has been activated after the request signal circuit was disconnected. The ECM has responded correctly to the open circuit condition in the circuit. Reconnect the wire for the request signal into the correct spot of the ECM connector. Proceed to the next test step. Proceed to Test Step 3.
- NO – The CID 2199 FMI 04 diagnostic code remains active. The status of the active diagnostic code did not change when the wire of the signal request was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Determine if the CID 2199 FMI 04 diagnostic code is active.

Expected Result:

The CID 2199 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 2199 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2199 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a "wiggle test" on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The "wiggle test" can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed. It is unlikely as the ECM response was correct for the ground condition in the previous test step.

Verify that all possible causes of the diagnostic code have been investigated. Exit this procedure and perform this procedure again.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the active diagnostic code is not found and the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02923053

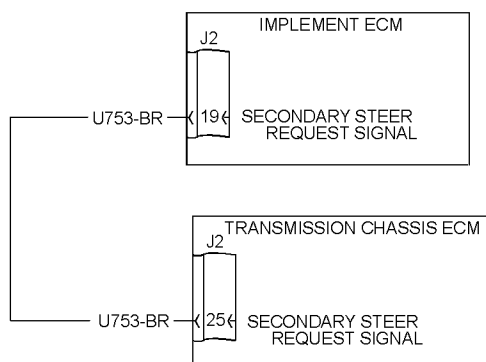
MID 027 - CID 2199 - FMI 08**SMCS Code:** 7610-038-II**Conditions Which Generate This Code:**

Illustration 305

g01305868

Connections of "Secondary Steer Request" signal circuit

This diagnostic code is associated with the "secondary steer request" signal circuit. This circuit enables the Implement ECM to request that the Transmission/Chassis ECM activate the "secondary steering system" at times that certain machine conditions require it.

The FMI 08 means that the Transmission/Chassis ECM has detected that the signal circuit has an abnormal frequency or pulse width.

When a CID 2199 diagnostic code is activated by the Transmission/Chassis ECM, the ECM will activate the "secondary steer system" without input from the Implement ECM. This is the only condition that will cause the Transmission/Chassis ECM to activate the "secondary steer system" without input from the Implement ECM.

During normal operation, when the Implement ECM detects a problem in the primary steering system, the Implement ECM will send a pulse width modulated (PWM) signal to the Transmission/Chassis ECM on the "secondary steer request circuit" that is connected between the two controls.

When the Implement ECM sends a PWM "secondary steer request signal" to the Transmission/Chassis ECM, the duty cycle of the PWM signal will determine the specific "secondary steer system" components that will be activated. During normal operation, the Implement ECM maintains a 20 percent duty cycle on the request circuit. When a "secondary steering test" is requested or when the Implement ECM has detected a problem in the primary steering system, the "secondary steer request" signal will be one of the following duty cycle signals:

20 percent PWM duty cycle – Normal operation, no request to activate.

40 percent PWM duty cycle – Request to activate the "secondary steer pump" motor only.

60 percent PWM duty cycle – Request to activate the "secondary steer pilot" solenoid valves only.

80 percent PWM duty cycle – Request to activate the "secondary steer pump" and the "secondary steer pilot" solenoid valves.

Conditions that can cause this diagnostic code to be activated are listed below:

- Intermittent connections or poor connections in the signal circuit.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE CIRCUIT FOR AN OPEN

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connectors J1 and J2 from the Implement ECM and from the Transmission/Chassis ECM.
- Obtain a spare length of wire that will reach from the connectors of the Implement ECM to the connectors of the Transmission/Chassis ECM.
- At the Implement ECM connector J2 connect one end of the spare wire to the contact for the request circuit J2-19 (wire U753-BR(Brown)).
- At the Transmission/Chassis ECM connector J2, measure the resistance between the other end of the spare wire and the request circuit contact J2-25 (wire U753-BR(Brown)).

- F.** Observe the resistance measurement and wiggle the connector of the Implement ECM and the connector of the Transmission/Chassis ECM. Gently pull on the wires and wiggle the wires for both connectors.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the wiring harness and connectors.

Results:

- OK – The resistance measurement is less than 5 ohms. The resistance measurement is not indicating that the “secondary steer request” circuit is open in the machine harness. Proceed to Test Step 2.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the “secondary steer request” circuit.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is not connected or that a wire is open. A resistance measurement that is greater 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

A poor connection could be causing the problem. A connector may be loose, dirty or corroded. Inspect the connectors that are in the circuit. Ensure that all connectors are clean, that all connectors are tight and that all connectors are in good condition.

The open or the possible bad connection is in wire U753-BR(Brown). Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position.

- A.** Reconnect the machine harness connectors J1 and J2 to the Implement ECM and to the Transmission/Chassis ECM.
- B.** Turn the disconnect switch and the key start switch to the ON position.

- C.** At the machine harness connector J2 for the Transmission/Chassis ECM, use a 151 - 6320 Removal Tool to remove the wire for the request signal U753-BR(Brown) and the socket at contact J2-25 from the harness connector. The machine harness connector J2 remains connected to the ECM.

- D.** Turn the disconnect switch and the key start switch to the ON position.

- E.** Observe the status of the active CID 2199 FMI 08 diagnostic code.

Expected Result:

The CID 2199 FMI 08 diagnostic code is no longer active. A CID 2199 FMI 03 diagnostic code is now active.

Results:

- YES – The CID 2199 FMI 08 diagnostic code is no longer active. A CID 2199 FMI 03 diagnostic code has been activated after the request signal circuit was disconnected. The ECM has responded correctly to the open circuit condition in the circuit. Reconnect the “request signal” wire into the correct spot of the ECM connector. Proceed to the next test step. Proceed to Test Step 3.
- NO – The CID 2199 FMI 08 diagnostic code remains active. The status of the active diagnostic code did not change when the wire for the request signal was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with “Caterpillar”. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.

- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2199 FMI 03 diagnostic code is active.

Expected Result:

The CID 2199 FMI 03 diagnostic code is not active.

Results:

- OK – The CID 2199 FMI 03 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.
- STOP.
- NOT OK – The CID 2199 FMI 03 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a “wiggle test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed. This is unlikely as the ECM response was correct for the open condition in the previous test step.

Verify that all possible causes of the diagnostic code have been investigated. Exit this procedure and perform this procedure again.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the active diagnostic code is not found and the ECM must be replaced, refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i02923324

MID 027 - CID 2200 - FMI 00

SMCS Code: 1439-038-CD

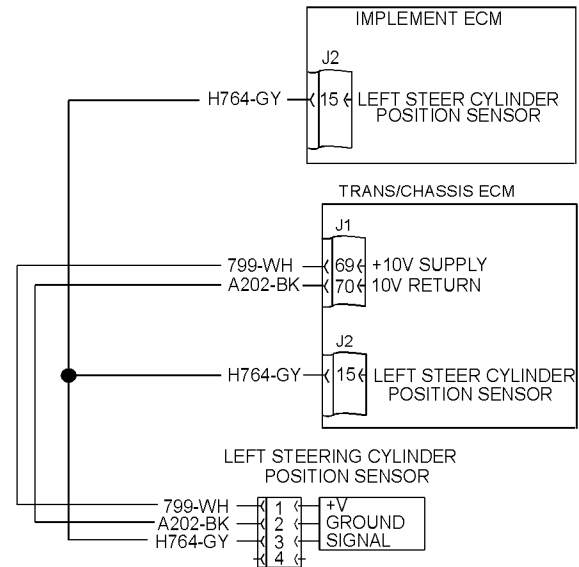
Conditions Which Generate This Code:

Illustration 306

g01254277

Connections of “Left Steering Cylinder” position sensor

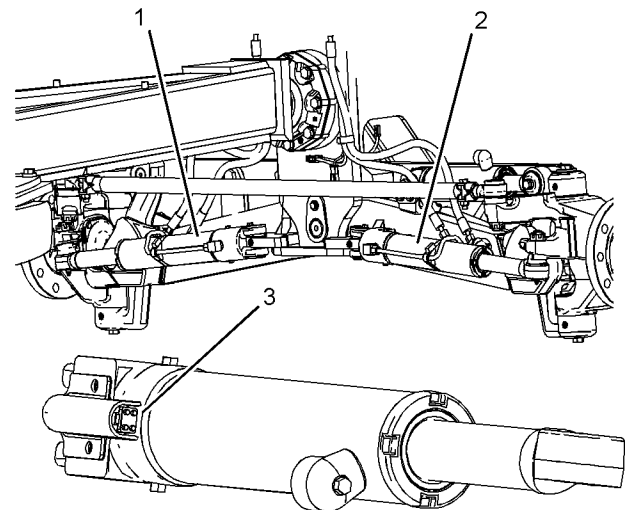


Illustration 307

g01254278

- (1) Left Steering Cylinder
- (2) Right Steering Cylinder
- (3) “Steering Position” Sensor Connector on the Back Side of the Cylinders

This diagnostic code is associated with the “left steering cylinder” position sensor. The position sensor provides a PWM input signal to the Transmission/Chassis ECM and to the Implement ECM. The FMI 00 means that the ECM is receiving a valid signal from the sensor, however, the signal is above the high limit for the expected signal range.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. The changes in the duty cycle of the sensor can not be measured with a digital multimeter.

The possible causes of this diagnostic code are listed below:

- Mechanical devices are broken or loose.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active CID 1482 diagnostic code for the 10 volt sensor power supply of the Transmission/Chassis ECM. Correct any problem with the 10 volt power supply before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the “left steer cylinder” position sensor. Both ECM modules can activate a CID 2200 FMI 00 diagnostic code when the signal is above the normal range. If one ECM has activated a CID 2200 FMI 00 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections are often the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL CONNECTIONS

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Visually inspect the mechanical connections for the left steering cylinder. Verify that all mechanical connections and adjustments for the steering cylinder are in good condition. Verify that none of the mechanical connections are loose.

Expected Result:

All mechanical connections for the steering cylinder are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical connections for the steering cylinder are correct. Proceed to Test Step 2.
- NOT OK – All mechanical connections for the steering cylinder are not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the steering cylinder. After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SENSOR

Turn the key start switch and the disconnect switch to the OFF position.

- A. Disconnect the machine harness connector from the “left steering cylinder” position sensor and disconnect the machine harness connector from the “right steering cylinder” position sensor. Mark the harness connector for the “left steering sensor” .
- B. Connect the marked connector for the “left steering sensor” to the “right steering sensor” connector. Connect the unmarked connector for the right steering sensor to the left steering sensor connector.
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the active diagnostic code for the left steering sensor.

Expected Result:

When the harness connectors are switched, the CID 2200 FMI 00 diagnostic code for the left steering sensor is not active. A CID 2201 FMI 00 diagnostic code for the right steering sensor is now active.

Results:

- YES – The CID 2200 FMI 00 diagnostic code is no longer active. A CID 2201 FMI 00 diagnostic code is now active. The sensor has failed.

Repair: The “left steering cylinder” position sensor is the cause of the problem. Replace the “left steering cylinder” position sensor.

BEFORE REPLACING THE STEERING POSITION SENSOR, RECONNECT THE HARNESS CONNECTORS TO THE CORRECT CONNECTORS OF THE STEERING SENSOR.

For removal of the position sensor from the steering cylinder, refer to Disassembly and Assembly, RENR9704, “Clevis Style Cylinder Sensor - Remove and Install”.

After the replacement of the sensor, the new position parameters of the sensor must be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, RENR9013, “Implement Electronic Control System” “Position Sensor (Steering Cylinder) - Set” for the correct procedure.

STOP.

- NO – The status of the CID 2200 FMI 00 diagnostic code did not change when the sensor connectors were switched. The CID 2200 FMI 00 diagnostic code is still active. The sensor does not appear to be the cause of the problem. It is unlikely that a harness condition is the cause for this code to be active. ENSURE THAT THE MACHINE HARNESS CONNECTORS ARE CONNECTED TO THE CORRECT POSITION SENSOR. THE MARKED HARNESS CONNECTOR IS CONNECTED TO THE LEFT STEERING SENSOR. THE UNMARKED HARNESS CONNECTOR IS CONNECTED TO THE RIGHT STEERING SENSOR. Proceed to Test Step 3.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.

C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.

D. Turn the disconnect switch and the key start switch to the ON position.

E. Operate the machine.

F. Check the status of the CID 2200 FMI 00 diagnostic code.

Expected Result:

The CID 2200 FMI 00 diagnostic code is not active.

Results:

- OK – The CID 2200 FMI 00 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2200 FMI 00 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a “wobble test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wobble test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the active diagnostic code is not found, the Implement ECM may have failed.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i02923419

MID 027 - CID 2200 - FMI 01

SMCS Code: 1439-038-CD

Conditions Which Generate This Code:

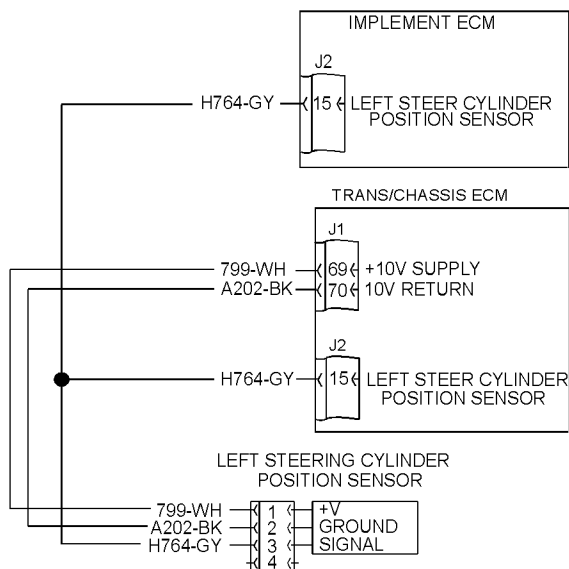


Illustration 308

g01254277

Connections of "Left Steering Cylinder" position sensor

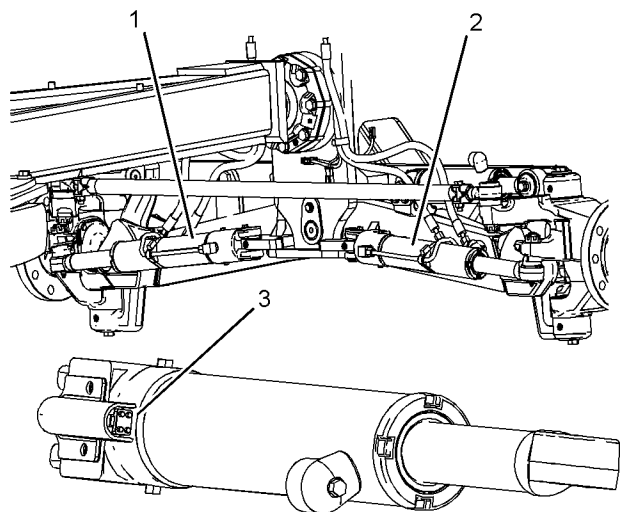


Illustration 309

g01254278

- (1) Left Steering Cylinder
- (2) Right Steering Cylinder
- (3) "Steering Position Sensor" connector on the back side of the cylinders

This diagnostic code is associated with the "left steering cylinder" position sensor. The position sensor provides a PWM input signal to the Transmission/Chassis ECM and to the Implement ECM.

The FMI 01 means that the ECM receives a valid signal from the sensor, however, the signal is below the low limit of the expected signal range.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. The changes in the duty cycle of the sensor can not be measured with a digital multimeter.

The possible causes of this diagnostic code are listed below:

- Mechanical devices are broken or loose.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the "left steer cylinder" position sensor. Both ECM modules can activate a CID 2200 FMI 01 diagnostic code when the signal is below the normal range. If one ECM has activated a CID 2200 FMI 01 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections are often the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL CONNECTIONS

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Visually inspect the mechanical connections for the "left steering cylinder" . Verify that all mechanical connections and adjustments for the steering cylinder are in good condition and verify that none of the mechanical connections are loose.

Expected Result:

All mechanical connections for the steering cylinder are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical connections for the steering cylinder are correct. Proceed to Test Step 2.
- NOT OK – All mechanical connections for the steering cylinder are not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the steering cylinder. After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SENSOR

Turn the key start switch and the disconnect switch to the OFF position.

- A. Disconnect the machine harness connector from the "left steering cylinder" position sensor and disconnect the machine harness connector from the "right steering cylinder" position sensor. Mark the harness connector for the left steering sensor.
- B. Connect the marked connector for the "left steering sensor" to the connector for the "right steering sensor" . Connect the unmarked connector for the "right steering sensor" to the connector for the "left steering sensor" .
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the active diagnostic code for the "left steering sensor" .

Expected Result:

When the harness connectors are switched, the CID 2200 FMI 01 diagnostic code for the "left steering sensor" is not active. A CID 2201 FMI 01 diagnostic code for the "right steering sensor" is now active.

Results:

- YES – The CID 2200 FMI 01 diagnostic code is no longer active. A CID 2201 FMI 01 diagnostic code is now active. The sensor has failed.

Repair: The "left steering cylinder" position sensor is the cause of the problem. Replace the "left steering cylinder" position sensor.

BEFORE REPLACING THE "STEERING POSITION SENSOR", RECONNECT THE HARNESS CONNECTORS TO THE CORRECT "STEERING SENSOR" CONNECTORS.

For removal of the position sensor from the steering cylinder, refer to Disassembly and Assembly, RENR 9704, "Clevis Style Cylinder Sensor - Remove and Install".

After replacement of the sensor, the new parameters of the position sensor MUST be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, RENR9013, "Implement Electronic Control System" "Position Sensor (Steering Cylinder) - Set" for the correct procedure.

STOP.

- NO – The status of the CID 2200 FMI 01 diagnostic code did not change when the sensor connectors were switched. The CID 2200 FMI 01 diagnostic code is still active. The sensor does not appear to be causing the problem. It is unlikely that a harness condition is the cause for this code to be active. ENSURE THAT THE MACHINE HARNESS CONNECTORS ARE CONNECTED TO THE CORRECT POSITION SENSOR. THE MARKED HARNESS CONNECTOR IS CONNECTED TO THE LEFT STEERING SENSOR. THE UNMARKED HARNESS CONNECTOR IS CONNECTED TO THE RIGHT STEERING SENSOR. Proceed to Test Step 3.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.

Diagnostic Code Procedures

E. Operate the machine.

i04801070

F. Check the status of the CID 2200 FMI 01 diagnostic code.

Expected Result:

The CID 2200 FMI 01 diagnostic code is not active.

Results:

- OK – The CID 2200 FMI 01 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2200 FMI 01 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a “wiggle test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the active diagnostic code is not found, the Implement ECM may have failed.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

MID 027 - CID 2200 - FMI 02

SMCS Code: 1439-038-CD

Conditions Which Generate This Code:

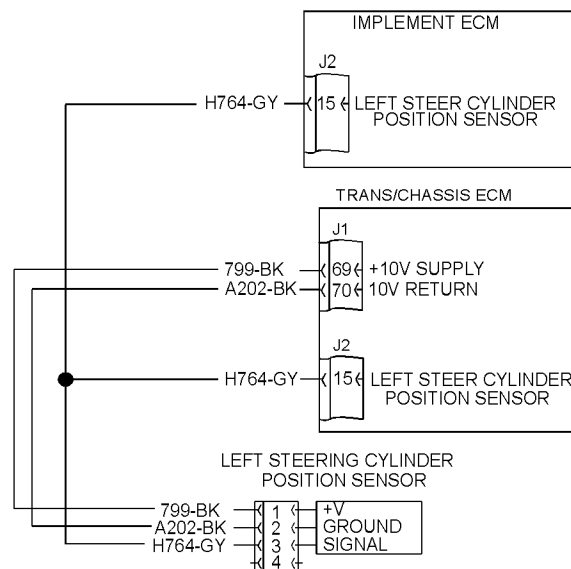


Illustration 310

g02919377

Connections of left steering cylinder position sensor

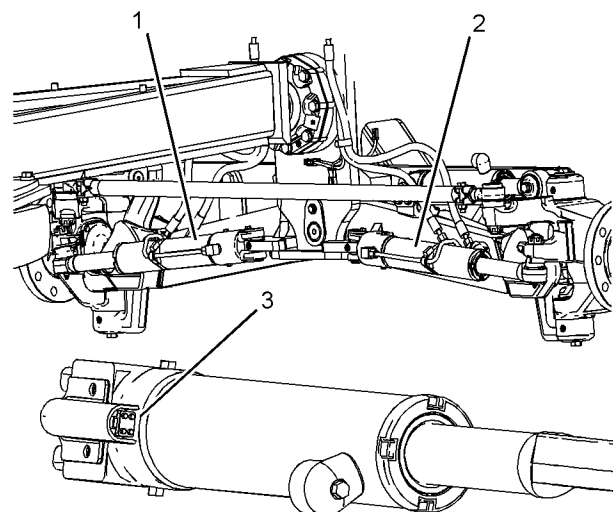


Illustration 311

g01254278

- (1) Left steering cylinder
- (2) Right steering cylinder
- (3) Connector for steering position sensor on the back side of the cylinders

This diagnostic code is associated with the left steering cylinder position sensor. The position sensor provides a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The FMI 02 diagnostic code is activated when the ECM detects an input signal that is erratic, intermittent, or incorrect from the sensor.

The sensor is a PWM sensor that operates at a frequency of approximately 500 Hz. The duty cycle of the PWM signal that is supplied to the ECM is measured in small increments. The changes in the duty cycle of the sensor cannot be measured with a digital multimeter.

The following conditions could cause this diagnostic code to be activated:

- Mechanical devices are loose.
- Mechanical devices are not adjusted correctly.
- There is an intermittent connection in the sensor circuit.
- Opens in the sensor circuit
- The sensor has failed.
- Failure of the ECM is unlikely.

Note: Before performing this procedure, check for an active CID 1482 diagnostic code for the 10 V sensor power supply of the Transmission/Chassis ECM (MID 027). Correct any problem with the 10 V power supply before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) will also activate a CID 2200 FMI 02 diagnostic code when a signal that is erratic or intermittent is detected. If one ECM has activated a CID 2200 FMI 02 diagnostic code and the other ECM has not activated the diagnostic code, it is likely that the sensor is operating correctly. When this occurs, a poor connection or an open in the machine harness would be suspected. When both of the electronic control modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. For either condition, proceed with this procedure in order to verify the cause of the problem.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections are often the cause of a problem in an electrical circuit. Inspect the connections for the following:

- Connections are clean.
- Connections are secure.
- Connections are in good condition.

If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL CONNECTIONS

- Turn the disconnect switch to the OFF position.
- Turn the key start switch to the OFF position.
- Visually inspect the mechanical connections for the left steering cylinder. Verify the following:
 - All mechanical connections and adjustments for the steering cylinder are in good condition.
 - None of the mechanical connections are loose.

Expected Result:

All mechanical connections for the steering cylinder are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical connections for the steering cylinder are correct. Proceed to Test Step 2.
- NOT OK – All mechanical connections for the steering cylinder are not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the steering cylinder. After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK FOR POWER AT THE SENSOR

- The disconnect switch and the key start switch remain in the OFF position.
- Do not disconnect the harness connector from the sensor.
- At the back of the harness connector for the sensor, insert 7X - 1710 Multimeter Probes along the contact of the supply 1 (wire 799-BK(Black)). Insert a multimeter probe along return contact 2 (wire A202-BK(Black)).
- Turn the disconnect switch to the ON position.
- Turn the key start switch to the ON position.
- Measure the voltage from contact 1 to contact 2.

Expected Result:

The voltage measurement is 10 ± 0.5 DCV.

Results:

- OK – The voltage measurement is 10 ± 0.5 DCV. The power supply circuit is correct. Proceed to Test Step 3.
- NOT OK – The voltage measurement is not 10 ± 0.5 DCV. The power supply circuit is not correct.

Repair: There is a problem with the power supply circuit for the sensor. Refer to the Electrical Schematic of the machine. Check all of the connections that are in the power supply circuit and the return circuit. Inspect the connections for the following:

- Connections are clean.
- Connections are secure.
- Connections are in good condition.

Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SENSOR

- Turn the disconnect switch to the OFF position.
- Turn the key start switch to the OFF position.
- Mark the harness connector for the left steering sensor.
- Disconnect the machine harness connector from the position sensor of the left steering cylinder.
- Disconnect the machine harness connector from the position sensor of the right steering cylinder.
- Connect the marked connector for the left steering sensor to the connector for the right steering sensor.
- Connect the unmarked connector for the right steering sensor to the connector for the left steering sensor.
- Turn the disconnect switch to the ON position.
- Turn the key start switch to the ON position.

Note: Do not start the engine.

- Observe the status of the active diagnostic code for the left steering sensor.

Expected Result:

When the harness connectors are switched, the CID 2200 FMI 02 diagnostic code for the left steering sensor is not active. A CID 2201 FMI 02 diagnostic code for the right steering sensor is now active.

Results:

- OK – The CID 2200 FMI 02 diagnostic code is no longer active. A CID 2201 FMI 02 diagnostic code is now active. The sensor has failed.

Repair: The position sensor of the left steering cylinder is the cause of the problem. Replace the position sensor of the left steering cylinder.

BEFORE REPLACING THE STEERING POSITION SENSOR, RECONNECT THE HARNESS CONNECTORS TO THE CORRECT CONNECTORS FOR THE STEERING SENSOR.

For removal of the position sensor from the steering cylinder, refer to the Disassembly and Assembly, RENR 9704, "Clevis Style Cylinder Sensor - Remove and Install" Story.

After the replacement of the sensor, the parameters of the new position sensor MUST be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, "Position Sensor (Steering Cylinder) - Set" Story in this manual for the correct procedure.

STOP.

- NOT OK – The status of the CID 2200 FMI 02 diagnostic code did not change when the sensor connectors were switched. The CID 2200 FMI 02 diagnostic code is still active. There is a problem in the machine harness. ENSURE THAT THE MACHINE HARNESS CONNECTORS ARE CONNECTED TO THE CORRECT POSITION SENSOR. THE MARKED HARNESS CONNECTOR IS CONNECTED TO THE LEFT STEERING SENSOR. THE UNMARKED HARNESS CONNECTOR IS CONNECTED TO THE RIGHT STEERING SENSOR. Proceed to Test Step 4.

Test Step 4. CHECK FOR AN OPEN IN THE SIGNAL CIRCUIT

Before performing this Test Step, verify that the machine harness connectors are properly connected in the original positions.

- Turn the disconnect switch to the OFF position.
- Turn the key start switch to the OFF position.
- Disconnect the machine harness connector from the position sensor of the left steering cylinder.

- D. At the machine harness connector for the left steering sensor, place a jumper wire between return contact 2 (wire A202-BK(Black)) and signal contact 3 (wire H764-GY(Grey)).
- E. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM and from the Implement ECM.
- F. At the Transmission/Chassis ECM, measure the resistance from return contact J1-70 (wire A202-BK(Black)) to signal contact J2-15 (wire H764-GY(Grey)).
- G. Obtain a spare length of wire that will reach from the connectors for the Implement ECM to the connector for the position sensor of the steer cylinder.
- H. At the connector for the position sensor of the steer cylinder, connect one end of the spare wire to the signal contact 3 (wire H764-GY(Grey)).
- I. At the connector for the Implement ECM J2, measure the resistance between the other end of the spare wire and the signal contact J2-15 (wire H764-GY(Grey)).

Expected Result:

Each of the resistance measurements is less than 5 ohms.

Results:

- OK – Both of the resistance measurements are less than 5 ohms. The signal circuit is not open. Proceed to Test Step 5.
- NOT OK – One or both of the resistance measurements is greater than 5 ohms. There is an open or a bad connection in the signal circuit.

Repair: A resistance that is greater than 5000 ohms could indicate that a wire is not connected or the wire is open. A resistance that is in the range between 5 ohms and 5000 ohms could indicate that one of the connection points in the circuit is not open. There is a problem in the machine harness on the ECM side of the splice. This is likely due to the following:

- The circuit at one of the electronic control modules indicates a correct connection.
- The circuit at the other ECM indicates an open or a bad connection.

A problem in the sensor side of the splice in the machine harness is causing the problem, if the resistance measurement indicates an open or a bad connection.

Refer to the Electrical Schematic of the machine. Verify all connection points in the suspected part of the circuit for the following:

- Connections are clean.
- Connections are secure.
- Connections are in good condition.

Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE**A. Perform the following:**

- Visually inspect the harness connectors.
- Clean the contacts of the harness connectors.
- Visually inspect the insulation of the wires for damage that is caused by excessive heat, battery acid, or chafing.

B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.**C. Reconnect all harness connectors. Verify the following:**

- Connectors are fully seated.
- The clips for each connector are fastened.

D. Turn the disconnect switch to the ON position.**E. Turn the key start switch to the ON position.****F. Operate the machine.****G. Check the status of the CID 2200 FMI 02 diagnostic code.****Expected Result:**

The CID 2200 FMI 02 diagnostic code is not active.

Results:

- OK – The CID 2200 FMI 02 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2200 FMI 02 diagnostic code is active. The diagnostic code has not been corrected.

i04801072

Repair: Check the circuit again. Perform a Wiggle Test on the machine wiring harness with the Caterpillar Electronic Technician (Cat ET) service tool. The Wiggle Test can detect the following in the machine wiring harness:

- Momentary shorts
- Intermittent shorts
- Opens

If the cause of the active diagnostic code is not found, the Implement ECM may have failed.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to the Testing and Adjusting, "Electronic Control Module (ECM) - Replace" Story in this manual for additional information.

STOP.

MID 027 - CID 2200 - FMI 03

SMCS Code: 1439-038-CD

Conditions Which Generate This Code:

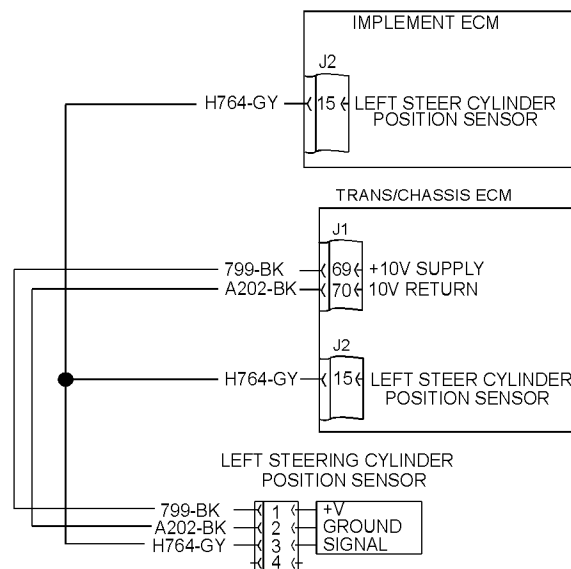


Illustration 312

g02919377

Connections of left steering cylinder position sensor

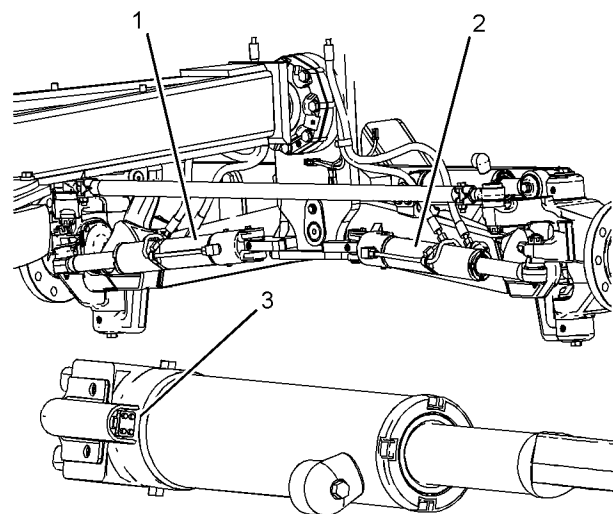


Illustration 313

g01254278

- (1) Left steering cylinder
- (2) Right steering cylinder
- (3) Connector for steering position sensor on the back side of the cylinders

This diagnostic code is associated with the left steering cylinder position sensor. The position sensor provides a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The FMI 03 diagnostic code is activated when the ECM reads the input signal from the sensor and the voltage of the signal is above normal.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. The changes in the duty cycle of the sensor cannot be measured with a digital multimeter.

The following conditions could cause this diagnostic code to be activated:

- The power supply circuit of the sensor is open.
- The return circuit is open.
- The signal circuit is open or the sensor is disconnected.
- The signal circuit is shorted to the sensor power supply.
- The sensor has failed.
- Failure of the ECM is unlikely.

Note: Before performing this procedure, check for an active CID 1482 diagnostic code for the 10 V sensor power supply of the Transmission/Chassis ECM (MID 027). Correct any problem with the 10 V power supply before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) will also activate a CID 2200 FMI 03 diagnostic code when an above normal signal voltage is detected. If one ECM has activated a CID 2200 FMI 03 diagnostic code and the other ECM has not activated the diagnostic code, it is likely that the sensor is operating correctly. When this occurs, a poor connection or an open in the machine harness would be suspected. When both of the electronic control modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. For either condition, proceed with this procedure in order to verify the cause of the problem.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections are often the cause of a problem in an electrical circuit. Inspect the connections for the following:

- Connections are clean.
- Connections are secure.
- Connections are in good condition.

If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SUPPLY VOLTAGE AT THE SENSOR

- A. Turn the disconnect switch to the OFF position.
- B. Turn the key start switch to the OFF position.
- C. Do not disconnect the harness connector from the sensor.
- D. At the back of the harness connector for the sensor, insert 7X - 1710 Multimeter Probes along the contact of the supply 1 (wire 799-BK(Black)). Insert a multimeter probe along return contact 2 (wire A202-BK(Black)).
- E. Turn the disconnect switch to the ON position.
- F. Turn the key start switch to the ON position.
- G. Measure the voltage from contact 1 to contact 2.

Expected Result:

The voltage measurement is 10 ± 0.5 DCV.

Results:

- OK – The voltage measurement is 10 ± 0.5 DCV. The power supply circuit of the Transmission/Chassis ECM is correct. Proceed to Test Step 2.
- NOT OK – The voltage measurement is not 10 ± 0.5 DCV. The power supply circuit that is coming from the Transmission/Chassis ECM is not correct.

Repair: Verify that the Transmission/Chassis ECM has not lost the power of the machine system. Loss of power to the Transmission/Chassis ECM can cause this code to activate.

If the Transmission/Chassis ECM is powered up, check the wire of the return circuit for the sensor A202-BK(Black) or the supply wire 799-BK(Black) in the machine harness for an open circuit or a bad connection.

Refer to the Electrical Schematic of the machine. Examine all of the connectors that are in the circuit. Inspect the connections for the following:

- Connections are clean.
- Connections are secure.

- Connections are in good condition.

Repair the machine harness or replace the machine harness in order to restore the power supply to the sensor.

STOP.

Test Step 2. CHECK THE SENSOR

- Turn the disconnect switch to the OFF position.
- Turn the key start switch to the OFF position.
- Mark the harness connector for the left steering sensor.
- Disconnect the machine harness connector from the position sensor of the left steering cylinder.
- Disconnect the machine harness connector from the position sensor of the right steering cylinder.
- Connect the marked connector for the left steering sensor to the connector for the right steering sensor.
- Connect the unmarked connector for the right steering sensor to the connector for the left steering sensor.
- Turn the disconnect switch to the ON position.
- Turn the key start switch to the ON position.

Note: Do not start the engine.

- Observe the status of the active diagnostic code for the left steering sensor.

Expected Result:

When the harness connectors are switched, the CID 2200 FMI 03 diagnostic code for the left steering sensor is not active. A CID 2201 FMI 03 diagnostic code for the right steering sensor is now active.

Results:

- OK – The CID 2200 FMI 03 diagnostic code is no longer active. A CID 2201 FMI 03 diagnostic code is now active. The sensor has failed.

Repair: The position sensor of the left steering cylinder is the cause of the problem. Replace the position sensor of the left steering cylinder.

BEFORE REPLACING THE STEERING POSITION SENSOR, RECONNECT THE HARNESS CONNECTORS TO THE CORRECT CONNECTORS FOR THE STEERING SENSOR.

For removal of the position sensor from the steering cylinder, refer to the Disassembly and Assembly, RENR 9704, "Cleviss Style Cylinder Sensor - Remove and Install" Story.

After the replacement of the sensor, the parameters of the new position sensor MUST be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, "Position Sensor (Steering Cylinder) - Set" Story in this manual for the correct procedure.

STOP.

- NOT OK – The status of the CID 2200 FMI 03 diagnostic code did not change when the sensor connectors were switched. The CID 2200 FMI 03 diagnostic code is still active. There is a problem in the machine harness. DISCONNECT THE SENSORS THAT WERE SWITCHED AND RECONNECT THE HARNESS CONNECTORS TO THE CORRECT CONNECTORS FOR THE STEERING SENSOR. THE MARKED HARNESS CONNECTOR IS CONNECTED TO THE LEFT STEERING SENSOR. THE UNMARKED HARNESS CONNECTOR IS CONNECTED TO THE RIGHT STEERING SENSOR. Proceed to Test Step 3.

Test Step 3. CHECK FOR AN OPEN IN THE SIGNAL CIRCUIT

Before performing this Test Step, verify that the machine harness connectors are properly connected in the original positions.

- Turn the disconnect switch to the OFF position.
- Turn the key start switch to the OFF position.
- Disconnect the machine harness connector from the position sensor of the left steering cylinder.
- At the machine harness connector for the left steering sensor, place a jumper wire between return contact 2 (wire A202-BK(Black)) and signal contact 3 (wire H764-GY(Grey)).
- Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM and from the Implement ECM.
- At the Transmission/Chassis ECM, measure the resistance from return contact J1-70 (wire A202-BK(Black)) to signal contact J2-15 (wire H764-GY(Grey)).
- Obtain a spare length of wire that will reach from the connectors for the Implement ECM to the connector for the position sensor of the steer cylinder.

H. At the connector for the position sensor of the steer cylinder, connect one end of the spare wire to the signal contact 3 (wire H764-GY(Grey)).

I. At the connector for the Implement ECM J2, measure the resistance between the other end of the spare wire and the signal contact J2-15 (wire H764-GY(Grey)).

Expected Result:

Each of the resistance measurements is less than 5 ohms.

Results:

- OK – Both of the resistance measurements are less than 5 ohms. The signal circuit is not open. Proceed to Test Step 4.
- NOT OK – One or both of the resistance measurements is greater than 5 ohms. There is an open or a bad connection in the signal circuit.

Repair: A resistance that is greater than 5000 ohms could indicate that a wire is not connected or the wire is open. A resistance that is in the range between 5 ohms and 5000 ohms could indicate that one of the connection points in the circuit is not open. There is a problem in the machine harness on the ECM side of the splice. This is likely due to the following:

- The circuit at one of the electronic control modules indicates a correct connection.
- The circuit at the other ECM indicates an open or a bad connection.

If the resistance measurement indicates an open or a bad connection, a problem in the sensor side of the splice in the machine harness is causing the problem.

Refer to the Electrical Schematic of the machine. Verify all connection points in the suspected part of the circuit for the following:

- Connections are clean.
- Connections are secure.
- Connections are in good condition.

Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SIGNAL CIRCUIT FOR A SHORT

A. The key start switch and the disconnect switch remain in the OFF position.

B. The harness connectors for the Transmission/Chassis ECM and the connectors for the Implement ECM remain disconnected from the machine harness.

C. Remove the jumper wire that was installed in the last step.

D. At the J1 and J2 machine harness connectors for the Implement ECM, measure the resistance from the sensor signal contact J2-15 (wire H764-GY(Grey)) to all of the other J1 and J2 contacts that are used for the Implement ECM.

E. If any of the resistance measurements in the last test step are less than 5000 ohms, skip the next test step and proceed to the "Expected Result" step. If all of the resistance measurements in the last test step are above 5000 ohms, perform the next test step.

F. At the disconnected J1 and J2 machine harness connectors for the Transmission/Chassis ECM, measure the resistance from the sensor signal contact J2-15 (wire H764-GY(Grey)) to all of the other J1 and J2 contacts that are used for the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The signal circuit is not shorted. Proceed to Test Step 5.
- NOT OK – A resistance measurement is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the signal circuit and the circuit with the low resistance measurement. Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

A. Perform the following:

- Visually inspect the harness connectors.
- Clean the contacts of the harness connectors.

Diagnostic Code Procedures

- Visually inspect the insulation of the wires for damage that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Verify the following:
- Connectors are fully seated.
 - Clips for each connector are completely fastened.
- D.** Turn the disconnect switch to the ON position.
- E.** Turn the key start switch to the ON position.
- F.** Operate the machine.
- G.** Determine if the CID 2200 FMI 03 diagnostic code is active.

Expected Result:

The CID 2200 FMI 03 diagnostic code is not active.

Results:

- OK – The CID 2200 FMI 03 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2200 FMI 03 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a Wiggle Test on the machine wiring harness with the Caterpillar Electronic Technician (Cat ET) service tool. The Wiggle Test can detect the following in the machine wiring harness:

- Momentary shorts
- Intermittent shorts
- Opens

If the cause of the active diagnostic code is not found, the Implement ECM may have failed.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to the Testing and Adjusting, "Electronic Control Module (ECM) - Replace" Story in this manual for additional information.

STOP.

i02924260

MID 027 - CID 2200 - FMI 04

SMCS Code: 1439-038-CD

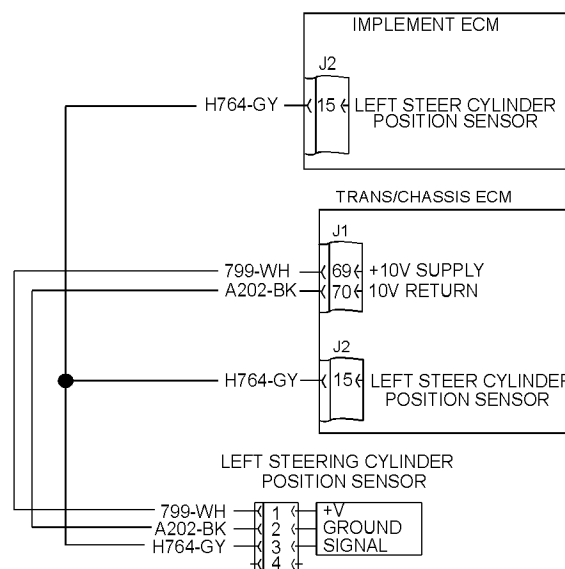
Conditions Which Generate This Code:

Illustration 314

g01254277

Connections of "Left Steering Cylinder" position sensor

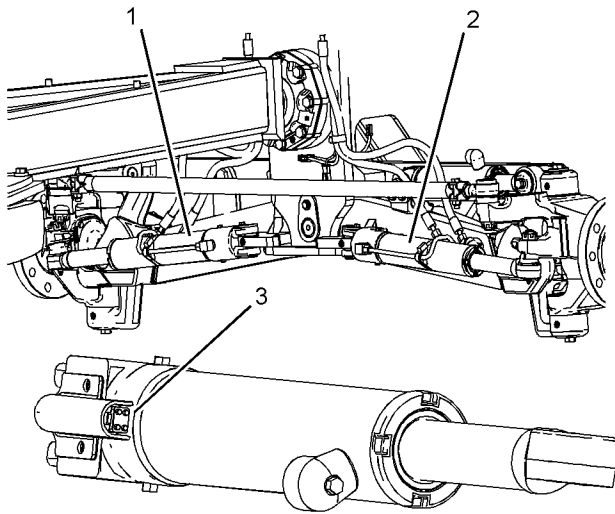


Illustration 315

g01254278

- (1) Left Steering Cylinder
- (2) Right Steering Cylinder
- (3) "Steering Position Sensor" connector on the back side of the cylinders

This diagnostic code is associated with the "left steering cylinder" position sensor. The position sensor provides a PWM input signal to the Transmission/Chassis ECM and to the Implement ECM. The FMI 04 diagnostic code is activated when the ECM reads the input signal from the sensor and the voltage of the signal is below normal.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. The changes in the duty cycle of the sensor can not be measured with a digital multimeter.

The possible causes of this diagnostic code are listed below:

- The signal circuit is shorted to a ground source.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active CID 1482 diagnostic code for the 10 volt sensor power supply of the Transmission/Chassis ECM. Correct any problem with the 10 volt power supply before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the "left steer cylinder" position sensor. Both ECM modules can activate a CID 2200 FMI 04 diagnostic code when the signal is below normal. If one ECM is communicating an active CID 2200 FMI 04 diagnostic code and the other ECM is not, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections are often the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SENSOR

Turn the key start switch and the disconnect switch to the OFF position.

- A. Disconnect the machine harness connector from the "left steering cylinder" position sensor and disconnect the machine harness connector from the "right steering cylinder" position sensor. Mark the harness connector for the "left steering sensor".
- B. Connect the marked connector for the "left steering sensor" to the connector for the "right steering sensor". Connect the unmarked connector for the "right steering sensor" to the connector for the "left steering sensor".
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the active diagnostic code for the "left steering sensor".

Expected Result:

When the harness connectors are switched, the CID 2200 FMI 04 diagnostic code for the "left steering sensor" is not active. A CID 2201 FMI 04 diagnostic code for the "right steering sensor" is now active.

Results:

- YES – The CID 2200 FMI 04 diagnostic code is no longer active. A CID 2201 FMI 04 diagnostic code is now active. The sensor has failed.

Repair: The "left steering cylinder" position sensor is the cause of the problem. Replace the "left steering cylinder" position sensor.

BEFORE REPLACING THE STEERING POSITION SENSOR, RECONNECT THE HARNESS CONNECTORS TO THE CORRECT "STEERING SENSOR" CONNECTORS.

For removal of the position sensor from the steering cylinder, refer to Disassembly and Assembly, REN9704, "Clevis Style Cylinder Sensor - Remove and Install".

After replacement of the sensor, the new parameters of the position sensor MUST be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, REN9013, "Implement Electronic Control System" "Position Sensor (Steering Cylinder) - Set" for the correct procedure.

STOP.

- NO – The status of the CID 2200 FMI 04 diagnostic code did not change when the sensor connectors were switched. The CID 2200 FMI 04 diagnostic code is still active. There is a problem in the machine harness. ENSURE THAT THE MACHINE HARNESS CONNECTORS ARE CONNECTED TO THE CORRECT POSITION SENSOR. THE MARKED HARNESS CONNECTOR IS CONNECTED TO THE "LEFT STEERING SENSOR". THE UNMARKED HARNESS CONNECTOR IS CONNECTED TO THE "RIGHT STEERING SENSOR". Proceed to Test Step 2.

Test Step 2. CHECK THE SIGNAL CIRCUIT FOR A SHORT TO GROUND

Before performing this Test Step, verify that the machine harness connectors are connected to the original "left and right steering cylinder position" sensor connectors.

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the "left steering cylinder" position sensor.

- Disconnect the J1 and J2 machine harness connectors from the Transmission/Chassis ECM and from the Implement ECM.

- At machine harness connector J2 for the Transmission/Chassis ECM, measure the resistance between the signal, contact J2-15 (wire H764-GY(Grey)), and to the frame ground. Next, measure the resistance between the signal and all of the contacts that are used in the machine harness connectors for the Transmission/Chassis ECM.

- At machine harness connector J2 for the Implement ECM, measure the resistance from the signal, contact J2-15 (wire H764-GY(Grey)), to frame ground and measure the resistance to all of the contacts that are used in the machine harness connectors for the Implement ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. The resistance measurement is indicating a short in the machine harness.

Repair: There is a short in the machine harness between the signal circuit and the circuit with the low resistance measurement.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.

- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2200 FMI 04 diagnostic code is active.

Expected Result:

The CID 2200 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 2200 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2200 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a “wobble test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wobble test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i02924441

MID 027 - CID 2200 - FMI 08

SMCS Code: 1439-038-CD

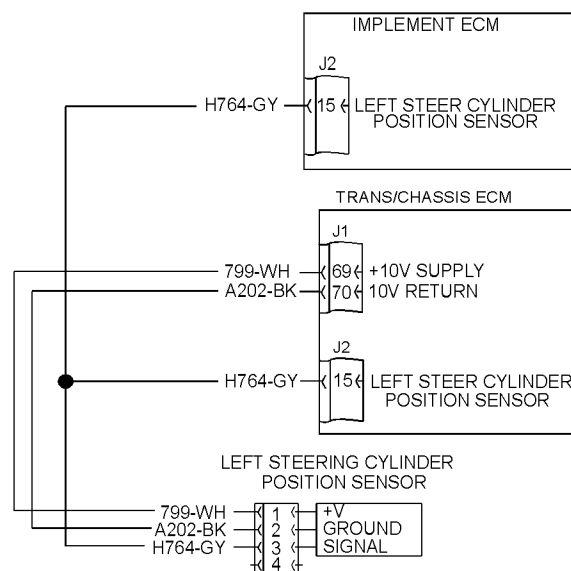
Conditions Which Generate This Code:

Illustration 316

g01254277

Connections of “Left Steering Cylinder” position sensor

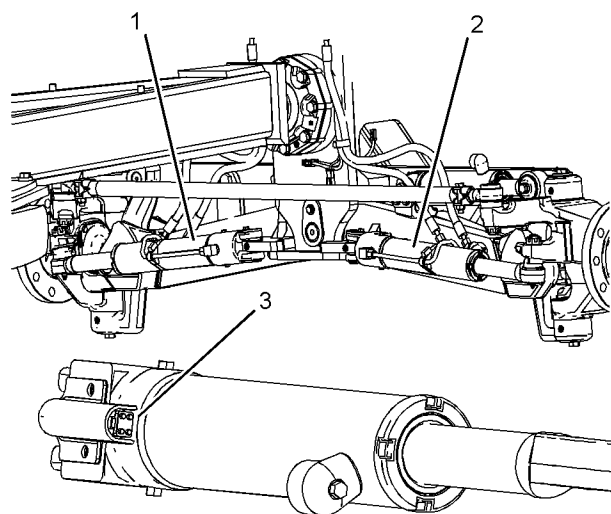


Illustration 317

g01254278

- (1) Left Steering Cylinder
- (2) Right Steering Cylinder
- (3) “Steering Position Sensor” connector on the back side of the cylinders

This diagnostic code is associated with the “left steering cylinder” position sensor. The position sensor provides a PWM input signal to the Transmission/Chassis ECM and to the Implement ECM. The FMI 08 diagnostic code is active when the ECM detects that the input signal from the sensor has an abnormal frequency or pulse width.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. The changes in the duty cycle of the sensor can not be measured with a digital multimeter.

The possible causes of this diagnostic code are listed below:

- Mechanical devices in the cylinder assembly are loose.
- The sensor has failed.
- Intermittent connections or poor connections in the signal circuit
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active CID 1482 diagnostic code for the 10 volt sensor power supply of the Transmission/Chassis ECM. Correct any problem with the 10 volt power supply before performing this procedure.

Note: The Implement ECM (MID 082) will also activate a CID 2200 FMI 08 diagnostic code when an above normal signal frequency or pulse width is detected. If one ECM has an active CID 2200 FMI 08 diagnostic code and the other ECM has not, it is likely that the sensor is operating correctly. When this occurs, an intermittent open or a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections are often the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL CONNECTIONS

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Visually inspect the mechanical connections for the “left steering cylinder” . Verify that all mechanical connections and adjustments for the steering cylinder are in good condition and verify that none of the mechanical connections are loose.

Expected Result:

All mechanical connections for the steering cylinder are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical connections for the steering cylinder are correct. Proceed to Test Step 2.
- NOT OK – All mechanical connections for the steering cylinder are not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the steering cylinder. After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SENSOR

The key start switch and the disconnect switch remain in the OFF position.

- A. Disconnect the machine harness connector from the “left steering cylinder” position sensor and disconnect the machine harness connector from the “right steering cylinder” position sensor. Mark the harness connector for the “left steering sensor” .
- B. Connect the marked connector for the “left steering sensor” to the connector for the “right steering sensor” . Connect the connector that is not marked for the “right steering sensor” to the connector for the “left steering sensor” .
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the active diagnostic code for the left steering sensor.

Expected Result:

When the harness connectors are switched, the CID 2200 FMI 08 diagnostic code for the "left steering sensor" is not active. A CID 2201 FMI 08 diagnostic code for the "right steering sensor" is now active.

Results:

- YES – The CID 2200 FMI 08 diagnostic code is no longer active. A CID 2201 FMI 08 diagnostic code is now active. The sensor has failed.

Repair: The "left steering cylinder" position sensor is the cause of the problem. Replace the "left steering cylinder" position sensor.

BEFORE REPLACING THE "STEERING POSITION SENSOR", RECONNECT THE HARNESS CONNECTORS TO THE CORRECT "STEERING SENSOR" CONNECTORS.

For removal of the position sensor from the steering cylinder, refer to Disassembly and Assembly, RENR9704, "Clevis Style Cylinder Sensor - Remove and Install".

After replacement of the sensor, the new parameters for the position sensor MUST be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, RENR9013, "Implement Electronic Control System" "Position Sensor (Steering Cylinder) - Set" for the correct procedure.

STOP.

- NO – The status of the CID 2200 FMI 08 diagnostic code did not change when the sensor connectors were switched. The CID 2200 FMI 08 diagnostic code is still active. There is a problem in the machine harness. ENSURE THAT THE MACHINE HARNESS CONNECTORS ARE CONNECTED TO THE CORRECT POSITION SENSOR. THE MARKED HARNESS CONNECTOR IS CONNECTED TO THE "LEFT STEERING SENSOR". THE HARNESS CONNECTOR THAT IS NOT MARKED IS CONNECTED TO THE "RIGHT STEERING SENSOR". Proceed to Test Step 3.

Test Step 3. CHECK FOR AN OPEN IN THE SIGNAL CIRCUIT

Before performing this Test Step, verify that the machine harness connectors are connected to the original "left and right steering cylinder position" sensor connectors.

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the "left steering cylinder" position sensor.

- At the machine harness connector for the "left steering sensor", place a jumper wire between return contact 2 (wire A202-BK(Black)) and signal contact 3 (wire H764-GY(Grey)).

- Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM and from the Implement ECM.

- At the Transmission/Chassis ECM, measure the resistance from return contact J1-70 (wire A202-BK(Black)) to signal contact J2-15 (wire H764-GY(Grey)).

- Obtain a spare length of wire that will reach from the connectors of the Implement ECM to the "steer cylinder position" sensor connector.

- At the "steer cylinder position" sensor connector, connect one end of the spare wire to the signal contact 3 (wire H764-GY(Grey)).

- At the connector for the Implement ECM J2, measure the resistance between the other end of the spare wire and the signal contact J2-15 (wire H764-GY(Grey)).

Expected Result:

Each of the resistance measurements is less than 5 ohms.

Results:

- OK – Both of the measurements for the resistance are less than 5 ohms. The signal circuit is not open. Proceed to Test Step 4.
- NOT OK – One or both of the measurements of the resistance is greater than 5 ohms. There is an open or a bad connection in the signal circuit.

Repair: A measurement of resistance that is greater than 5000 ohms could indicate that a wire is not connected or that a wire is open. A resistance measurement that is greater 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

If the circuit at one of the ECM modules checks correctly and the circuit at the other ECM indicates an open or a bad connection, most likely there is a problem in the machine harness on the ECM side of the splice.

If the both of the resistance checks indicate an open or a bad connection, a problem in the sensor side of the splice in the machine harness is most likely causing the problem.

Refer to the complete Electrical System Schematic of the machine. Verify that all connection points in the suspected part of the circuit are clean, that all connection points are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2200 FMI 08 diagnostic code is active.

Expected Result:

The CID 2200 FMI 08 diagnostic code is not active.

Results:

- OK – The CID 2200 FMI 08 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2200 FMI 08 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a “wiggle test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i02924717

MID 027 - CID 2200 - FMI 13

SMCS Code: 1439-038-CD

Conditions Which Generate This Code:

This diagnostic code is associated with the “left steering cylinder” position sensor. The position sensor provides a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The FMI 13 diagnostic code is active in order to indicate that the sensor needs calibration.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. The changes in the duty cycle of the sensor can not be measured with a digital multimeter.

CALIBRATION

- A. Perform the calibration procedure for the sensor. Refer to the Testing and Adjusting, RENR9013, “Implement Electronic Control System” “Calibration” for the information on the method to access the calibration procedure.

Expected Result:

The calibration procedure was performed successfully.

Results:

- YES – The calibration procedure was performed successfully. Resume normal machine operation.

STOP.

- NO – The calibration was not successful.

Repair: Repeat the calibration procedure for the sensor.

If the second calibration procedure is not successful, replace the “steer cylinder position” sensor.

For removal of the position sensor from the steering cylinder, refer to Disassembly and Assembly, RENR 9704, "Clevis Style Cylinder Sensor - Remove and Install".

After replacement of the sensor, the parameters of the new position sensor MUST be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, RENR9013, "Implement Electronic Control System" "Position Sensor (Steering Cylinder) - Set" for the correct procedure.

After cylinder replacement, refer to the Testing and Adjusting, RENR9013, "Implement Electronic Control System" "Calibration" for the information on the method to access the calibration procedure. If the problem is still present after replacement and calibration of the new sensor, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02924831

MID 027 - CID 2200 - FMI 14

SMCS Code: 1439-038-CD

Conditions Which Generate This Code:

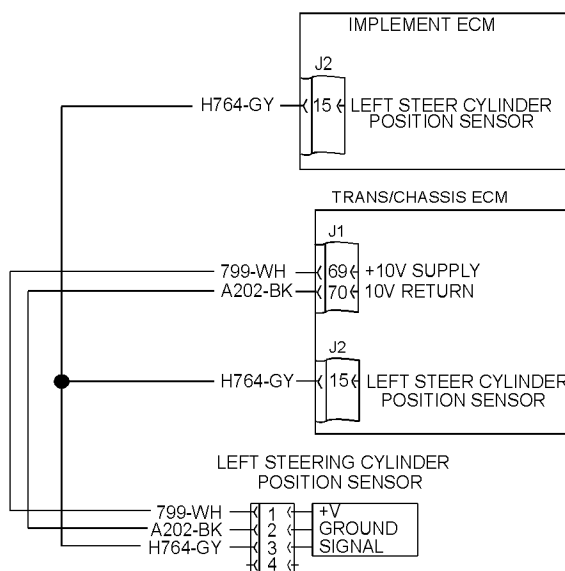


Illustration 318

g01254277

Connections of "Left Steering Cylinder" position sensor

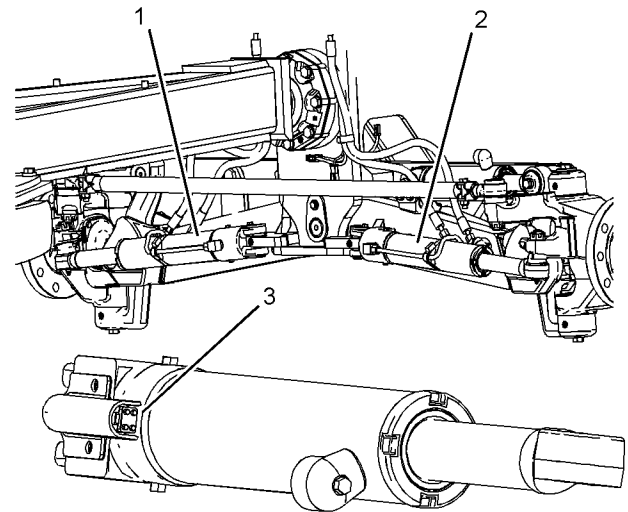


Illustration 319

g01254278

- (1) Left Steering Cylinder
- (2) Right Steering Cylinder
- (3) "Steering Position Sensor" connector on the back side of the cylinders

This diagnostic code is associated with the "left steering cylinder" position sensor. The position sensor provides a PWM input signal to the Transmission/Chassis ECM and to the Implement ECM. The FMI 14 diagnostic code is active during times that the sensor is not responding as expected. And no external conditions that could cause this problem have been detected by the ECM.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. The changes in the duty cycle of the sensor can not be measured with a digital multimeter.

The possible causes of this diagnostic code are listed below:

- Mechanical devices are broken or loose.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active CID 1482 diagnostic code for the 10 volt sensor power supply of the Transmission/Chassis ECM. Correct any problem with the 10 volt power supply before performing this procedure.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections are often the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL CONNECTIONS

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Visually inspect the mechanical connections for the left steering cylinder. Verify that all mechanical connections and adjustments for the "steering cylinder" are in good condition and verify that none of the mechanical connections are loose.

Expected Result:

All mechanical connections for the steering cylinder are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical connections for the steering cylinder are correct. Proceed to Test Step 2.
- NOT OK – All mechanical connections for the steering cylinder are not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the steering cylinder. After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SENSOR

The key start switch and the disconnect switch remain in the OFF position.

- A. Disconnect the machine harness connector from the "left steering cylinder" position sensor and disconnect the machine harness connector from the "right steering cylinder" position sensor. Mark the harness connector for the "left steering sensor".
- B. Connect the marked connector for the "left steering sensor" to the connector for the "right steering sensor". Connect the connector that is not marked for the "right steering sensor" to the connector for the "left steering sensor".
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the active diagnostic code for the "left steering sensor".

Expected Result:

When the harness connectors are switched, the CID 2200 FMI 14 diagnostic code for the "left steering sensor" is not active. A CID 2201 FMI 14 diagnostic code for the "right steering sensor" is now active.

Results:

- YES – The CID 2200 FMI 14 diagnostic code is no longer active. A CID 2201 FMI 14 diagnostic code is now active. The sensor has failed.

Repair: The "left steering cylinder" position sensor is the cause of the problem. Replace the "left steering cylinder" position sensor.

BEFORE REPLACING THE STEERING POSITION SENSOR, RECONNECT THE HARNESS CONNECTORS TO THE CORRECT "STEERING SENSOR" CONNECTORS.

For removal of the position sensor from the steering cylinder, refer to Disassembly and Assembly, RENR 9704, "Clevis Style Cylinder Sensor - Remove and Install".

After replacement of the sensor, the parameters for the new position sensor MUST be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, RENR9013, "Implement Electronic Control System" "Position Sensor (Steering Cylinder) - Set" for the correct procedure.

STOP.

- NO – The status of the CID 2200 FMI 14 diagnostic code did not change when the sensor connectors were switched. The CID 2200 FMI 14 diagnostic code is still active. There is a problem in the machine harness. ENSURE THAT THE MACHINE HARNESS CONNECTORS ARE CONNECTED TO THE CORRECT POSITION

SENSOR. THE MARKED HARNESS CONNECTOR IS CONNECTED TO THE "LEFT STEERING SENSOR". THE HARNESS CONNECTOR THAT IS NOT MARKED IS CONNECTED TO THE "RIGHT STEERING SENSOR". Proceed to Test Step 3.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

Before performing this Test Step, verify that the machine harness connectors are connected to the original "left and right steering cylinder position" sensor connectors.

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2200 FMI 14 diagnostic code is active.

Expected Result:

The CID 2200 FMI 14 diagnostic code is not active.

Results:

- OK – The CID 2200 FMI 14 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2200 FMI 14 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a "wiggle test" on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The "wiggle test" can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02925351

MID 027 - CID 2201 - FMI 00

SMCS Code: 1439-038-CD

Conditions Which Generate This Code:

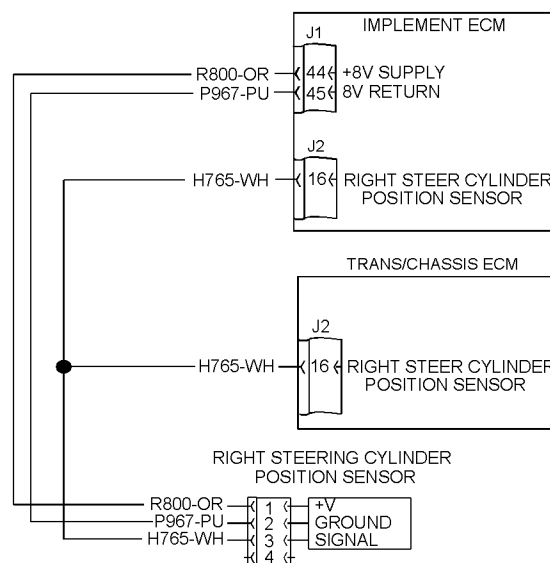


Illustration 320

g01254393

Connections of "Right Steering Cylinder" position sensor

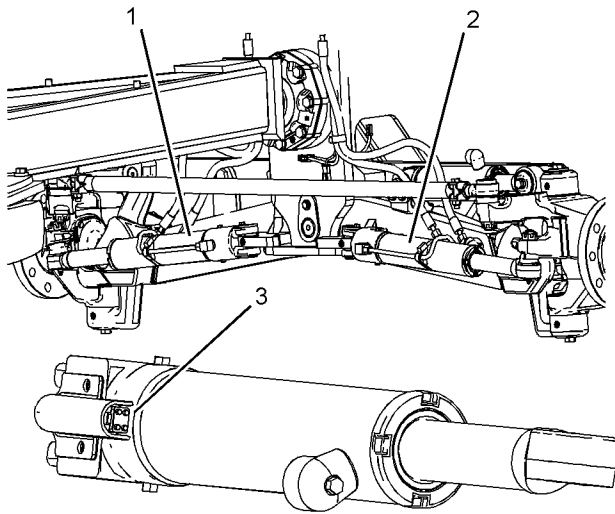


Illustration 321

g01254278

- (1) Left Steering Cylinder
- (2) Right Steering Cylinder
- (3) "Steering Position Sensor" connector on the back side of the cylinders

This diagnostic code is associated with the "left steering cylinder" position sensor. The position sensor provides a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The FMI 00 means that the ECM is receiving a valid signal from the sensor that is above the high limit for the expected signal range.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. The changes in the duty cycle of the sensor can not be measured with a digital multimeter.

The possible causes of this diagnostic code are listed below:

- Mechanical devices are broken or loose.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active CID 0041 diagnostic code for the 8 volt sensor power supply of the Implement ECM (082). Correct any problem with the 8 volt power supply before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the "left steer cylinder" position sensor. Both ECM modules can activate a CID 2201 FMI 00 diagnostic code when the signal is above the normal range. When one of the ECM modules has an active CID 2201 FMI 00 diagnostic code and the other ECM does not have an active diagnostic code, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections are often the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL CONNECTIONS

- A.** Turn the key start switch and the disconnect switch to the OFF position.
- B.** Visually inspect the mechanical connections for the "left steering cylinder". Verify that all mechanical connections and adjustments for the steering cylinder are in good condition and verify that none of the mechanical connections are loose.

Expected Result:

All mechanical connections for the "steering cylinder" are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical connections for the steering cylinder are correct. Proceed to Test Step 2.
- NOT OK – All mechanical connections for the steering cylinder are not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the steering cylinder. After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SENSOR

Turn the key start switch and the disconnect switch to the OFF position.

- A. Disconnect the machine harness connector from the "right steering cylinder" position sensor and disconnect the machine harness connector from the "left steering cylinder" position sensor. Mark the harness connector for the "right steering sensor".
- B. Connect the marked connector for the "right steering sensor" to the connector for the "left steering sensor". Connect the connector that is not marked for the "left steering sensor" to the connector for the "right steering sensor".
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the active diagnostic code for the "right steering sensor".

Expected Result:

When the harness connectors are switched, the CID 2201 FMI 00 diagnostic code for the "right steering sensor" is not active. A CID 2200 FMI 00 diagnostic code for the "left steering sensor" is now active.

Results:

- YES – The CID 2201 FMI 00 diagnostic code is no longer active. A CID 2200 FMI 00 diagnostic code is now active. The sensor has failed.

Repair: The "right steering cylinder" position sensor is the cause of the problem. Replace the "right steering cylinder" position sensor.

BEFORE REPLACING THE "STEERING POSITION SENSOR", RECONNECT THE HARNESS CONNECTORS TO THE CORRECT "STEERING SENSOR" CONNECTORS.

For removal of the position sensor from the steering cylinder, refer to Disassembly and Assembly, RENR 9704, "Clevis Style Cylinder Sensor - Remove and Install".

After replacement of the sensor, the new parameters for the position sensor MUST be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, RENR9013, "Implement Electronic Control System" "Position Sensor (Steering Cylinder) - Set" for the correct procedure.

STOP.

- NO – The status of the CID 2201 FMI 00 diagnostic code did not change when the sensor connectors were switched. The CID 2201 FMI 00 diagnostic code is still active. The sensor does not appear to be causing the problem. It is unlikely that a harness problem is causing this code to be active. ENSURE THAT THE MACHINE HARNESS CONNECTORS ARE CONNECTED TO THE CORRECT POSITION SENSOR. THE MARKED HARNESS CONNECTOR IS CONNECTED TO THE "RIGHT STEERING SENSOR". THE HARNESS CONNECTOR THAT IS NOT MARKED IS CONNECTED TO THE "LEFT STEERING SENSOR". Proceed to Test Step 3.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 2201 FMI 00 diagnostic code.

Expected Result:

The CID 2201 FMI 00 diagnostic code is not active.

Results:

- OK – The CID 2201 FMI 00 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

Diagnostic Code Procedures

- NOT OK – The CID 2201 FMI 00 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a “wiggle test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the active diagnostic code is not found, the Implement ECM may have failed.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i02925530

MID 027 - CID 2201 - FMI 01

SMCS Code: 1439-038-CD

Conditions Which Generate This Code:

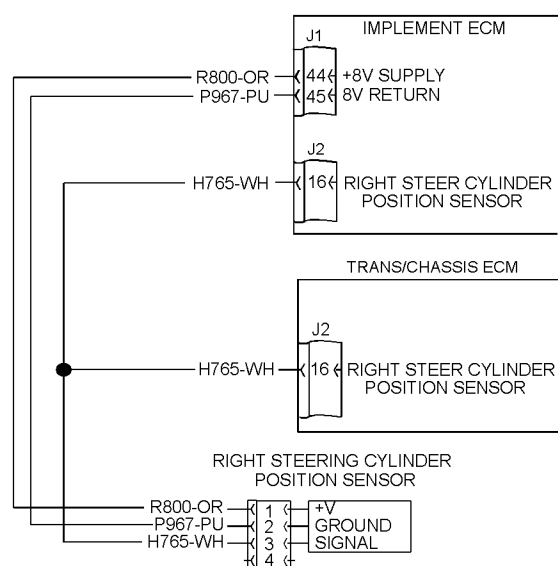


Illustration 322

g01254393

Connections of “Right Steering Cylinder” Position Sensor

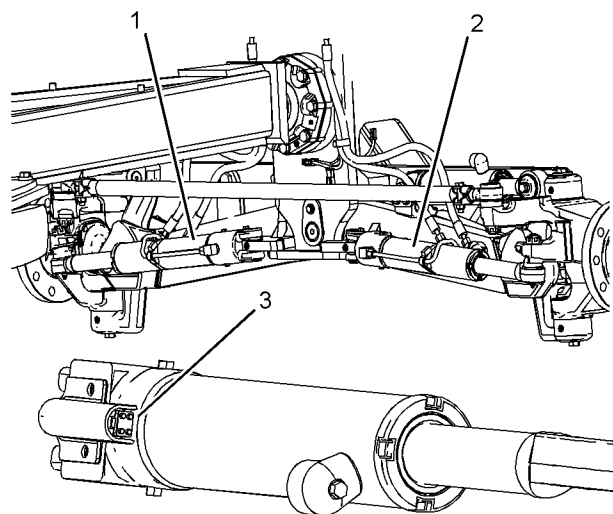


Illustration 323

g01254278

- (1) Left Steering Cylinder
- (2) Right Steering Cylinder
- (3) “Steering Position Sensor” connector on the back side of the cylinders

This diagnostic code is associated with the “right steering cylinder” position sensor. The position sensor provides a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The FMI 01 diagnostic code means that the ECM is receiving a valid signal from the sensor. However, the signal is below the level for the expected signal range.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. The changes in the duty cycle of the sensor can not be measured with a digital multimeter.

The possible causes of this diagnostic code are listed below:

- Mechanical devices are broken or loose.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active CID 0041 diagnostic code for the 8 volt sensor power supply of the Implement ECM (MID 082). Correct any problem with the 8 volt power supply before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the “left steer cylinder” position sensor. Both ECM modules can activate a CID 2201 FMI 01 diagnostic code when the signal is below the normal range. If one ECM has activated a CID 2201 FMI 01 diagnostic code and the other ECM does not have an active diagnostic code, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections are often the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL CONNECTIONS

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Visually inspect the mechanical connections for the “left steering cylinder”. Verify that all mechanical connections and adjustments for the steering cylinder are in good condition and verify that none of the mechanical connections are loose.

Expected Result:

All mechanical connections for the steering cylinder are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical connections for the steering cylinder are correct. Proceed to Test Step 2.
- NOT OK – All mechanical connections for the steering cylinder are not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the steering cylinder. After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SENSOR

Turn the key start switch and the disconnect switch to the OFF position.

- A. Disconnect the machine harness connector from the “right steering cylinder” position sensor and disconnect the machine harness connector from the “left steering cylinder” position sensor. Mark the harness connector for the “right steering sensor”.
- B. Connect the marked connector for the “right steering sensor” to the connector for the “left steering sensor”. Connect the connector that is not marked for the “left steering sensor” to the connector for the “right steering sensor”.
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the active diagnostic code for the “right steering sensor”.

Expected Result:

When the harness connectors are switched, the CID 2201 FMI 01 diagnostic code for the “right steering sensor” is not active. A CID 2200 FMI 01 diagnostic code for the “left steering sensor” is now active.

Results:

- YES – The CID 2201 FMI 01 diagnostic code is no longer active. A CID 2200 FMI 01 diagnostic code is now active. The sensor has failed.

Repair: The “right steering cylinder” position sensor is the cause of the problem. Replace the “right steering cylinder” position sensor.

BEFORE REPLACING THE “STEERING POSITION” SENSOR, RECONNECT THE HARNESS CONNECTORS TO THE CORRECT “STEERING SENSOR” CONNECTORS.

For removal of the position sensor from the steering cylinder, refer to Disassembly and Assembly, REN9704, “Clevis Style Cylinder Sensor - Remove and Install”.

After replacement of the sensor, the new parameters for the position sensor MUST be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, RENR9013, "Implement Electronic Control System" "Position Sensor (Steering Cylinder) - Set" for the correct procedure.

STOP.

- NO – The status of the CID 2201 FMI 01 diagnostic code did not change when the sensor connectors were switched. The CID 2201 FMI 01 diagnostic code is still active. The sensor does not appear to be causing the problem. It is unlikely that a harness problem is the cause for this code to be active. ENSURE THAT THE MACHINE HARNESS CONNECTORS ARE CONNECTED TO THE CORRECT POSITION SENSOR. THE MARKED HARNESS CONNECTOR IS CONNECTED TO THE "RIGHT STEERING" SENSOR. THE HARNESS CONNECTOR THAT IS NOT MARKED IS CONNECTED TO THE "LEFT STEERING" SENSOR. Proceed to Test Step 3.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 2201 FMI 01 diagnostic code.

Expected Result:

The CID 2201 FMI 01 diagnostic code is not active.

Results:

- OK – The CID 2201 FMI 01 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2201 FMI 01 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a "wiggle test" on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The "wiggle test" can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the active diagnostic code is not found, the Implement ECM may have failed.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02925679

MID 027 - CID 2201 - FMI 02

SMCS Code: 1439-038-CD

Conditions Which Generate This Code:

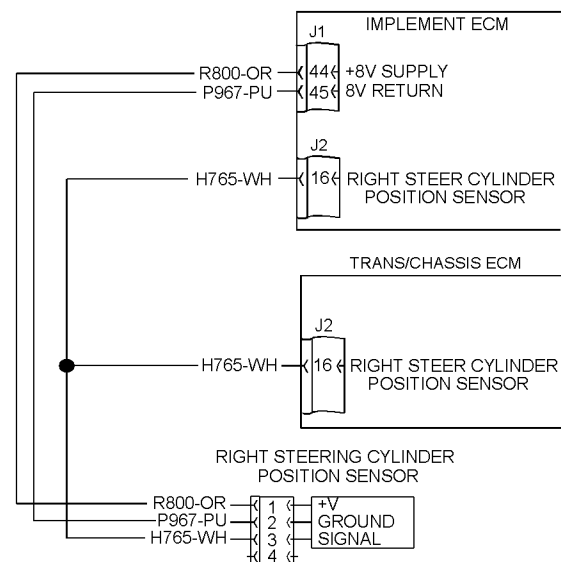


Illustration 324

g01254393

Connections of "Right Steering Cylinder" Position Sensor

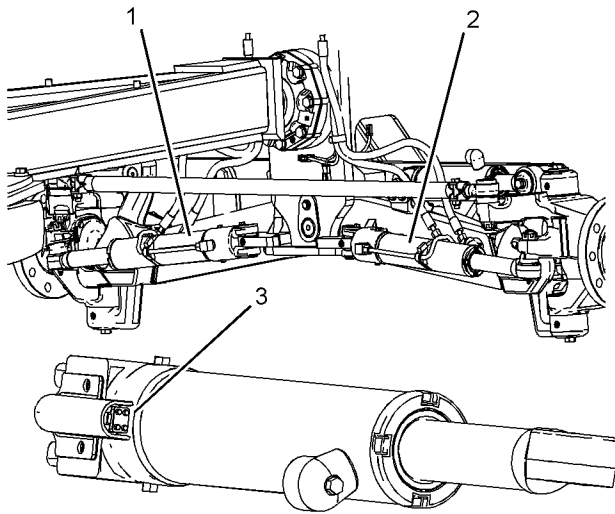


Illustration 325

g01254278

- (1) Left Steering Cylinder
- (2) Right Steering Cylinder
- (3) "Steering Position Sensor" connector on the back side of the cylinders

This diagnostic code is associated with the "right steering cylinder" position sensor. The position sensor provides a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The FMI 02 means that the ECM has determined that the input signal from the sensor is erratic, intermittent, or incorrect.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. The changes in the duty cycle of the sensor can not be measured with a digital multimeter.

The possible causes of this diagnostic code are listed below:

- Mechanical devices are loose or mechanical devices not adjusted correctly.
- Intermittent connections or open locations in the sensor circuit
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active CID 0041 diagnostic code for the 8 volt sensor power supply of the Implement ECM. Correct any problem with the 8 volt power supply before performing this procedure.

Note: The Implement ECM (MID 082) will also activate a CID 2201 FMI 02 diagnostic code if an erratic signal or an intermittent signal is detected. If one ECM has activated a CID 2201 FMI 02 diagnostic code and the other ECM has not activated a diagnostic code, it is likely that the sensor is operating correctly. When this occurs, a poor connection or an open in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, the sensor or a harness problem could be the cause. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections are often the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL CONNECTIONS

- A.** Turn the key start switch and the disconnect switch to the OFF position.
- B.** Visually inspect the mechanical connections for the "right steering" cylinder. Verify that all mechanical connections and adjustments for the steering cylinder are in good condition and verify that no mechanical connections are loose.

Expected Result:

All mechanical connections for the steering cylinder are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical connections for the steering cylinder are correct. Proceed to Test Step 2.
- NOT OK – All mechanical connections for the steering cylinder are not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the steering

Diagnostic Code Procedures

cylinder. After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK FOR POWER AT THE SENSOR

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Do not disconnect the harness connector from the sensor.
- C. At the back of the harness connector for the sensor, insert 7X - 1710 Multimeter Probes along the voltage input A (wire R800-OR(Orange)) and along the return contact B (wire P967-PU(Purple)).
- D. Turn the key start switch and the disconnect switch to the ON position.
- E. Measure the voltage from contact A to contact B.

Expected Result:

The voltage measurement is 8 ± 0.3 DCV.

Results:

- OK – The voltage measurement is 8 ± 0.3 DCV. The power supply circuit is correct. Proceed to Test Step 3.
- NOT OK – The voltage measurement is not 8 ± 0.3 DCV. The power supply circuit is not correct.

Repair: There is a problem with the power supply circuit for the sensor. Refer to the complete Electrical System Schematic of the machine. Check all of the connections that are in the power supply circuit and the return circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SENSOR

Turn the key start switch and the disconnect switch to the OFF position.

- A. Disconnect the machine harness connector from the "right steering cylinder" position sensor and disconnect the machine harness connector from the "left steering cylinder" position sensor. Mark the harness connector for the "right steering sensor".

- B. Connect the marked connector for the "right steering" sensor to the connector for the "left steering" sensor. Connect the connector that is not marked for the "left steering" sensor to the connector for the "right steering" sensor.

- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.

- D. Observe the status of the active diagnostic code for the "right steering" sensor.

Expected Result:

When the harness connectors are switched, the CID 2201 FMI 02 diagnostic code for the "right steering" sensor is not active. A CID 2200 FMI 02 diagnostic code for the "left steering" sensor is now active.

Results:

- YES – The CID 2201 FMI 02 diagnostic code is no longer active. A CID 2200 FMI 02 diagnostic code is now active. The sensor has failed.

Repair: The "right steering cylinder" position sensor is the cause of the problem. Replace the "right steering cylinder" position sensor.

BEFORE REPLACING THE "STEERING POSITION SENSOR", RECONNECT THE HARNESS CONNECTORS TO THE CORRECT "STEERING SENSOR" CONNECTORS.

For removal of the position sensor from the steering cylinder, refer to Disassembly and Assembly, RENR 9704, "Clevis Style Cylinder Sensor - Remove and Install".

After the replacement of the sensor, the new parameters for the position sensor MUST be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, RENR9013, "Implement Electronic Control System" "Position Sensor (Steering Cylinder) - Set" for the correct procedure.

STOP.

- NO – The status of the CID 2201 FMI 02 diagnostic code did not change when the sensor connectors were switched. The CID 2201 FMI 02 diagnostic code is still active. There is a problem in the machine harness. ENSURE THAT THE MACHINE HARNESS CONNECTORS ARE CONNECTED TO THE CORRECT POSITION SENSOR. THE MARKED HARNESS CONNECTOR IS CONNECTED TO THE "RIGHT STEERING" SENSOR. THE HARNESS CONNECTOR THAT IS NOT MARKED IS CONNECTED TO THE "LEFT STEERING" SENSOR. Proceed to Test Step 4.

Test Step 4. CHECK FOR AN OPEN IN THE SIGNAL CIRCUIT

Before performing this Test Step, verify that the machine harness connectors are connected to the original “right and left steering cylinder position” sensor connectors.

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector from the “right steering cylinder” position sensor.
- C. At the machine harness connector for the “right steering sensor”, place a jumper wire between return contact 2 (wire P967-PU(Purple)) and signal contact 3 (wire H765-WH(White)).
- D. Disconnect the machine harness connectors J1 and J2 from the Implement ECM and the Transmission/Chassis ECM.
- E. At the Implement ECM, measure the resistance from return contact J1-45 (wire P967-PU(Purple)) to signal contact J2-16 (wire H765-WH(White)).
- F. Obtain a spare length of wire that will reach from the connectors of the Transmission/Chassis ECM to the “steer cylinder position” sensor connector.
- G. At the “steer cylinder position” sensor connector, connect one end of the spare wire to the signal contact 3 (wire H765-WH(White)).
- H. At the connector for the Transmission/Chassis ECM J2, measure the resistance between the other end of the spare wire and the signal contact J2-16 (wire H765-WH(White)).

Expected Result:

Each of the resistance measurements is less than 5 ohms.

Results:

- OK – Both of the resistance measurements are less than 5 ohms. The signal circuit is not open. Proceed to Test Step 5.
- NOT OK – One or both of the resistance measurements is greater than 5 ohms. There is an open or a bad connection in the signal circuit.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is not connected or that a wire is open. A resistance measurement that is greater 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

If the circuit at one of the ECM modules is correct and the circuit at the other ECM indicates a bad connection this condition likely indicates a problem in the machine harness on the ECM side of the splice.

If the resistance checks both indicate a bad connection, a problem in the sensor side of the splice in the machine harness is most likely the cause of the problem.

Refer to the complete Electrical System Schematic of the machine. Verify that all connection points in the suspected part of the circuit are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 2201 FMI 02 diagnostic code.

Expected Result:

The CID 2201 FMI 02 diagnostic code is not active.

Results:

- OK – The CID 2201 FMI 02 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2201 FMI 02 diagnostic code is active. The diagnostic code has not been corrected.

Diagnostic Code Procedures

Repair: Check the circuit again. Perform a “wiggle test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the active diagnostic code is not found, the Implement ECM may have failed.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i02925867

MID 027 - CID 2201 - FMI 03

SMCS Code: 1439-038-CD

Conditions Which Generate This Code:

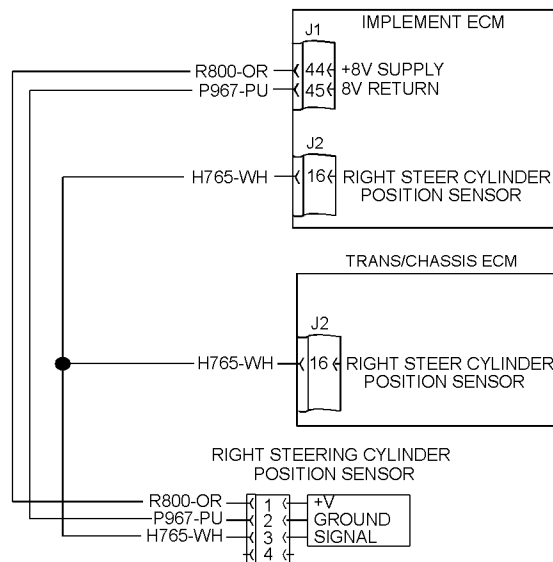


Illustration 326

g01254393

Connections of “Right Steering Cylinder” Position Sensor

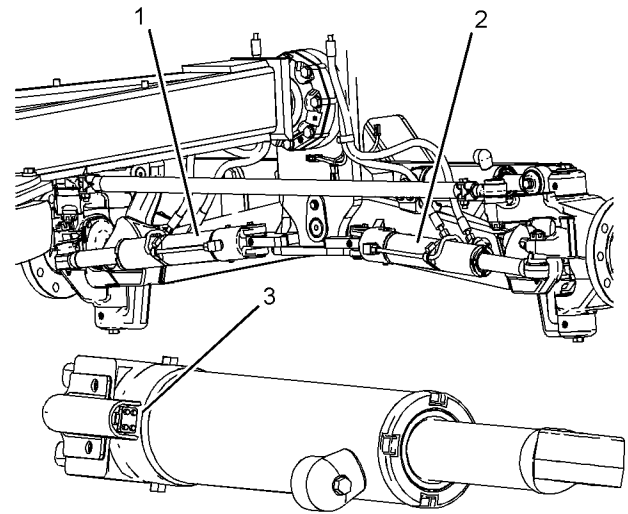


Illustration 327

g01254278

- (1) Left Steering Cylinder
- (2) Right Steering Cylinder
- (3) “Steering Position Sensor” connector on the back side of the cylinders

This diagnostic code is associated with the “right steering cylinder” position sensor. The position sensor provides a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The FMI 03 diagnostic code is activated when the ECM reads the input signal from the sensor and the voltage of the signal is above normal.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. The changes in the duty cycle of the sensor can not be measured with a digital multimeter.

The possible causes of this diagnostic code are listed below:

- The supply circuit for the power supply is open.
- The return circuit is open.
- The signal circuit is open or the sensor is disconnected.
- The signal circuit is shorted to the sensor power supply.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active CID 0041 diagnostic code for the 8 volt sensor power supply of the Implement ECM (MID 082). Correct any problem with the 8 volt power supply before performing this procedure.

Note: The Implement ECM (MID 082) will also activate a CID 2201 FMI 03 diagnostic code when an above normal signal voltage is detected. If one ECM has activated a CID 2201 FMI 03 diagnostic code and the other ECM has not activated a diagnostic code, it is likely that the sensor is operating correctly. When this occurs, a poor connection or an open in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. Verify that the CID 2201 FMI 03 diagnostic code is active before performing this procedure.

Test Step 1. CHECK FOR POWER AT THE SENSOR

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Do not disconnect the harness connector from the sensor.
- C. At the back of the harness connector for the sensor, insert 7X - 1710 Multimeter Probes along voltage supply A (wire R800-OR(Orange)) and along return contact B (wire P967-PU(Purple)).
- D. Turn the key start switch and the disconnect switch to the ON position.
- E. Measure the voltage from contact A to contact B.

Expected Result:

The voltage measurement is 8.0 ± 0.5 DCV.

Results:

- OK – The voltage measurement is 8.0 ± 0.5 DCV. The power supply circuit is correct. Proceed to Test Step 2.
- NOT OK – The voltage measurement is not 8.0 ± 0.5 DCV. The power supply circuit is not correct.

Repair: There is a problem with the power supply circuit for the sensor. Refer to the complete Electrical System Schematic of the machine. Check all of the connections that are in the power supply circuit and the return circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE SENSOR

Turn the key start switch and the disconnect switch to the OFF position.

- A. Disconnect the machine harness connector from the "right steering cylinder" position sensor and disconnect the machine harness connector from the "left steering cylinder" position sensor. Mark the harness connector for the "right steering sensor".
- B. Connect the marked connector for the "right steering sensor" to the connector for the "left steering sensor". Connect the connector that is not marked for the "left steering sensor" to the connector for the "right steering sensor".
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the active diagnostic code for the right steering sensor.

Expected Result:

When the harness connectors are switched, the CID 2201 FMI 03 diagnostic code for the "right steering sensor" is not active. A CID 2200 FMI 03 diagnostic code for the "left steering sensor" is now active.

Results:

- YES – The CID 2201 FMI 03 diagnostic code is no longer active. A CID 2200 FMI 03 diagnostic code is now active. The sensor has failed.

Repair: The "right steering cylinder" position sensor is the cause of the problem. Replace the "right steering cylinder" position sensor.

BEFORE REPLACING THE "STEERING POSITION" SENSOR, RECONNECT THE HARNESS CONNECTORS TO THE CORRECT "STEERING SENSOR" CONNECTORS.

For removal of the position sensor from the steering cylinder, refer to Disassembly and Assembly, RENR 9704, "Clevis Style Cylinder Sensor - Remove and Install".

After the replacement of the sensor, the new parameters of the position sensor MUST be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, RENR9013, "Implement Electronic Control System" "Position Sensor (Steering Cylinder) - Set" for the correct procedure.

STOP.

Diagnostic Code Procedures

- NO – The status of the CID 2201 FMI 03 diagnostic code did not change when the sensor connectors were switched. The CID 2201 FMI 03 diagnostic code is still active. There is a problem in the machine harness. ENSURE THAT THE MACHINE HARNESS CONNECTORS ARE CONNECTED TO THE CORRECT POSITION SENSOR. THE MARKED HARNESS CONNECTOR IS CONNECTED TO THE “RIGHT STEERING SENSOR”. THE HARNESS CONNECTOR THAT IS NOT MARKED IS CONNECTED TO THE “LEFT STEERING SENSOR”. Proceed to Test Step 3.

Test Step 3. CHECK FOR AN OPEN IN THE SIGNAL CIRCUIT

Before performing this Test Step, verify that the machine harness connectors are connected to the original “right and left steering cylinder position” sensor connectors.

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the “right steering cylinder” position sensor.
- At the machine harness connector for the “right steering sensor”, place a jumper wire between return contact 2 (wire P967-PU(Purple)) and signal contact 3 (wire H765-WH(White)).
- Disconnect the machine harness connectors J1 and J2 from the Implement ECM and the Transmission/Chassis ECM.
- At the Implement ECM, measure the resistance from return contact J1-45 (wire P967-PU(Purple)) to signal contact J2-16 (wire H765-WH(White)).
- Obtain a spare length of wire that will reach from the connectors of the Transmission/Chassis ECM to the connector of the “steer cylinder position” sensor.
- At the connector of the “steer cylinder position” sensor, connect one end of the spare wire to the signal contact 3 (wire H765-WH(White)).
- At the connector for the Transmission/Chassis ECM J2, measure the resistance between the other end of the spare wire and the signal contact J2-16 (wire H765-WH(White)).

Expected Result:

Each of the resistance measurements is less than 5 ohms.

Results:

- OK – Both of the resistance measurements are less than 5 ohms. The signal circuit is not open. Proceed to Test Step 4.
- NOT OK – One or both of the resistance measurements is greater than 5 ohms. There is an open or a bad connection in the signal circuit.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is not connected or that a wire is open. A resistance measurement that is greater 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

If the circuit at one of the ECM modules checks correctly and the circuit at the other ECM indicates a bad connection, a problem may exist in the machine harness on the ECM side of the splice.

If both of the resistance checks indicate a bad connection, a problem may exist in the sensor side of the splice of the machine harness.

Refer to the complete Electrical System Schematic of the machine. Verify that all connection points in the suspected part of the circuit are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SIGNAL CIRCUIT FOR A SHORT

The key start switch and the disconnect switch remain in the OFF position. The harness connectors of the Transmission/Chassis ECM and the connectors for the Implement ECM remain disconnected from the machine harness.

- Remove the spare wire that was installed in the last step.
- At the J1 and J2 machine harness connectors for the Implement ECM, measure the resistance from the sensor signal contact J2-16 (wire H765-WH(White)) to all of the other J1 and J2 contacts that are used for the Implement ECM.
- If any of the resistance measurements in the last test step are less than 3000 ohms, skip the next test step and proceed to the “Expected Result” step. If all of the resistance measurements in the last test step are above 3000 ohms, perform the next test step.

D. At the disconnected J1 and J2 machine harness connectors for the Transmission/Chassis ECM, measure the resistance from the sensor signal contact J2-16 (wire H765-WH(White)) to all of the other J1 and J2 contacts that are used for the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The signal circuit is not shorted. Proceed to Test Step 5.
- NOT OK – A resistance measurement is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the signal circuit and the circuit with the low resistance measurement.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Determine if the CID 2201 FMI 03 diagnostic code is active.

Expected Result:

The CID 2201 FMI 03 diagnostic code is not active.

Results:

- OK – The CID 2201 FMI 03 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2201 FMI 03 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a "wiggle test" on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The "wiggle test" can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02926424

MID 027 - CID 2201 - FMI 04

SMCS Code: 1439-038-CD

Conditions Which Generate This Code:

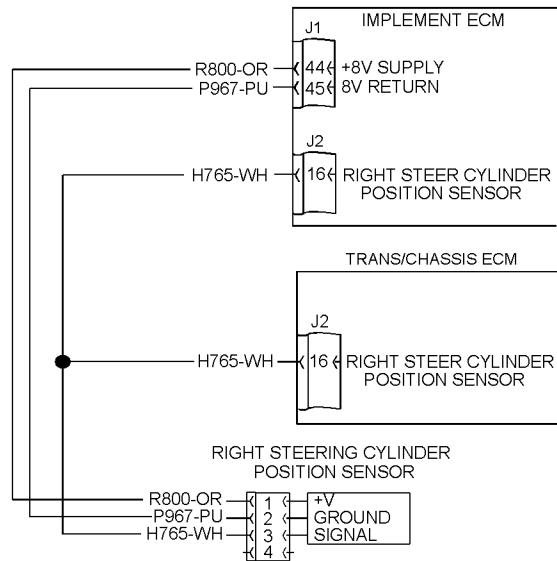


Illustration 328

g01254393

Connections of "Right Steering Cylinder" position sensor

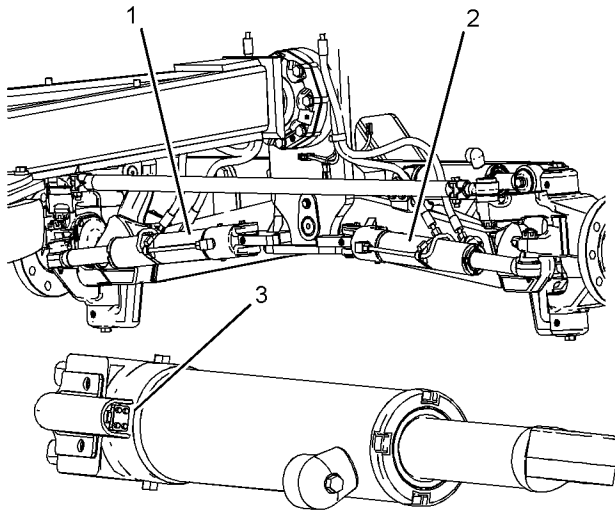


Illustration 329

g01254278

- (1) Left Steering Cylinder
- (2) Right Steering Cylinder
- (3) "Steering Position Sensor" connector on the back side of the cylinders

This diagnostic code is associated with the "right steering cylinder" position sensor. The position sensor provides a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The FMI 04 diagnostic code is activated when the ECM reads the input signal from the sensor and the voltage of the signal is below normal.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. The changes in the duty cycle of the sensor can not be measured with a digital multimeter.

The possible causes of this diagnostic code are listed below:

- The signal circuit is shorted to a ground source.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, check for an active CID 0041 diagnostic code for the 8 volt sensor power supply of the Implement ECM (MID 082). Correct any problem with the 8 volt power supply before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the "left steer cylinder" position sensor. Both ECM modules can activate a CID 2201 FMI 04 diagnostic code when the signal is below normal. If one ECM has activated a CID 2201 FMI 04 diagnostic code and the other ECM has not activated a diagnostic code, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections are often the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SENSOR

Turn the key start switch and the disconnect switch to the OFF position.

- A. Disconnect the machine harness connector from the "right steering cylinder" position sensor and disconnect the machine harness connector from the "left steering cylinder" position sensor. Mark the harness connector for the "right steering sensor".
- B. Connect the marked connector for the "right steering sensor" to the connector for the "left steering sensor". Connect the connector that is not marked for the "left steering sensor" to the connector for the "right steering sensor".
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the active diagnostic code for the "right steering sensor".

Expected Result:

When the harness connectors are switched, the CID 2201 FMI 04 diagnostic code for the "right steering sensor" is not active. A CID 2200 FMI 04 diagnostic code for the "left steering sensor" is now active.

Results:

- YES – The CID 2201 FMI 04 diagnostic code is no longer active. A CID 2200 FMI 04 diagnostic code is now active. The sensor has failed.

Repair: The "right steering cylinder" position sensor is the cause of the problem. Replace the "right steering cylinder" position sensor.

BEFORE REPLACING THE STEERING POSITION SENSOR, RECONNECT THE HARNESS CONNECTORS TO THE CORRECT "STEERING SENSOR" CONNECTORS.

For removal of the position sensor from the steering cylinder, refer to Disassembly and Assembly, RENR 9704, "Clevis Style Cylinder Sensor - Remove and Install".

After replacement of the sensor, the new parameters of the position sensor MUST be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, RENR9013, "Implement Electronic Control System" "Position Sensor (Steering Cylinder) - Set" for the correct procedure.

STOP.

- NO – The status of the CID 2201 FMI 04 diagnostic code did not change when the sensor connectors were switched. The CID 2201 FMI 04

diagnostic code is still active. There is a problem in the machine harness. ENSURE THAT THE MACHINE HARNESS CONNECTORS ARE CONNECTED TO THE CORRECT POSITION SENSOR. THE MARKED HARNESS CONNECTOR IS CONNECTED TO THE "RIGHT STEERING SENSOR". THE HARNESS CONNECTOR THAT IS NOT MARKED IS CONNECTED TO THE "LEFT STEERING SENSOR". Proceed to Test Step 2.

Test Step 2. CHECK THE SIGNAL CIRCUIT FOR A SHORT TO GROUND

Before performing this Test Step, verify that the machine harness connectors are connected to the original "right and left steering cylinder position" sensor connectors.

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector from the "right steering cylinder" position sensor.
- C. Disconnect the J1 and J2 machine harness connectors from the Implement ECM and from the Transmission/Chassis ECM.
- D. At the J1 and J2 machine harness connectors for the Implement ECM, measure the resistance from the sensor signal contact J2-16 (wire H765-WH(White)) to frame ground and measure the resistance to all of the other contacts that are used in the machine harness connectors of the Implement ECM.
- E. At machine harness connector J2 for the Transmission/Chassis ECM, measure the resistance from signal contact J2-16 (wire H765-WH(White)) to frame ground and measure the resistance to all of the contacts that are used in the machine harness connectors for the Transmission/Chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. The resistance measurement is indicating a short in the machine harness.

Diagnostic Code Procedures

Repair: There is a short in the machine harness between the signal circuit and the circuit with the low resistance measurement.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2201 FMI 04 diagnostic code is active.

Expected Result:

The CID 2201 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 2201 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2201 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a "wiggle test" on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The "wiggle test" can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02926428

MID 027 - CID 2201 - FMI 08

SMCS Code: 1439-038-CD

Conditions Which Generate This Code:

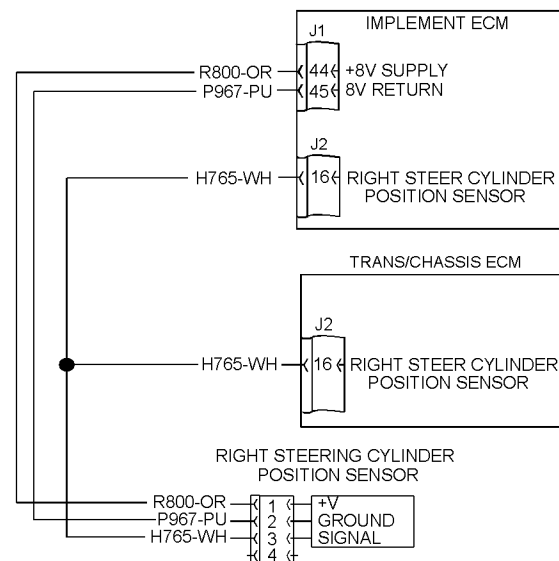


Illustration 330

g01254393

Connections of "Right Steering Cylinder" position sensor

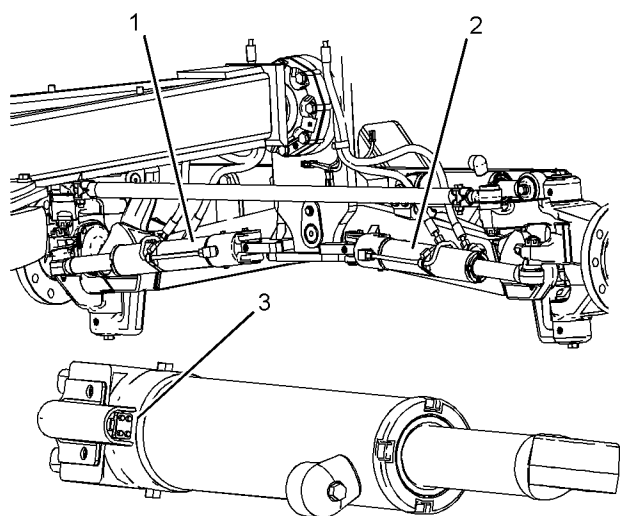


Illustration 331

g01254278

- (1) Left Steering Cylinder
- (2) Right Steering Cylinder
- (3) "Steering Position Sensor" connector on the back side of the cylinders

This diagnostic code is associated with the "right steering cylinder" position sensor. The position sensor provides a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The FMI 08 diagnostic code is active during times that the ECM detects the input signal from the sensor has an abnormal frequency or pulse width.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. The changes in the duty cycle of the sensor can not be measured with a digital multimeter.

The possible causes of this diagnostic code are listed below:

- Mechanical devices in the cylinder assembly are loose.
- The sensor has failed.
- Intermittent connections or poor connections in the signal circuit of the sensor
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active CID 0041 diagnostic code for the 8 volt sensor power supply of the Implement ECM (MID 082). Correct any problem with the 8 volt power supply before performing this procedure.

Note: The Implement ECM (MID 082) will also activate a CID 2201 FMI 08 diagnostic code when an above normal signal voltage is detected. If one ECM has activated a CID 2201 FMI 08 diagnostic code and the other ECM has not activated a diagnostic code, it is likely that the sensor is operating correctly. When this occurs, an intermittent open or a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections are often the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL CONNECTIONS

- A.** Turn the key start switch and the disconnect switch to the OFF position.
- B.** Visually inspect the mechanical connections for the "right steering cylinder". Verify that all mechanical connections and adjustments for the steering cylinder are in good condition and verify that none of the mechanical connections are loose.

Expected Result:

All mechanical connections for the steering cylinder are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical connections for the steering cylinder are correct. Proceed to Test Step 2.
- NOT OK – All mechanical connections for the steering cylinder are not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the steering

cylinder. After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SENSOR

The key start switch and the disconnect switch remain in the OFF position.

- A. Disconnect the machine harness connector from the "right steering cylinder" position sensor and disconnect the machine harness connector from the "left steering cylinder" position sensor. Mark the harness connector for the "right steering sensor" .
- B. Connect the marked connector for the "right steering sensor" to the connector for the "left steering sensor" . Connect the connector that is not marked for the "left steering sensor" to the connector for the "right steering sensor" .
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the active diagnostic code for the "right steering sensor" .

Expected Result:

When the harness connectors are switched, the CID 2201 FMI 08 diagnostic code for the "right steering sensor" is not active. A CID 2200 FMI 08 diagnostic code for the "left steering sensor" is now active.

Results:

- YES – The CID 2201 FMI 08 diagnostic code is no longer active. A CID 2200 FMI 08 diagnostic code is now active. The sensor has failed.

Repair: The "right steering cylinder" position sensor is the cause of the problem. Replace the "right steering cylinder" position sensor.

BEFORE REPLACING THE STEERING POSITION SENSOR, RECONNECT THE HARNESS CONNECTORS TO THE CORRECT "STEERING SENSOR" CONNECTORS.

For removal of the position sensor from the steering cylinder, refer to Disassembly and Assembly, RENR 9704, "Clevis Style Cylinder Sensor - Remove and Install".

After the replacement of the sensor, the new parameters for the position sensor MUST be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, RENR9013, "Implement Electronic Control System" "Position Sensor (Steering Cylinder) - Set" for the correct procedure.

STOP.

- NO – The status of the CID 2201 FMI 08 diagnostic code did not change when the sensor connectors were switched. The CID 2201 FMI 08 diagnostic code is still active. There is a problem in the machine harness. ENSURE THAT THE MACHINE HARNESS CONNECTORS ARE CONNECTED TO THE CORRECT POSITION SENSOR. THE MARKED HARNESS CONNECTOR IS CONNECTED TO THE "RIGHT STEERING SENSOR" . THE HARNESS CONNECTOR THAT IS NOT MARKED IS CONNECTED TO THE "LEFT STEERING SENSOR" . Proceed to Test Step 3.

Test Step 3. CHECK FOR AN OPEN IN THE SIGNAL CIRCUIT

Before performing this Test Step, verify that the machine harness connectors are connected to the original "right and left steering cylinder position" sensor connectors.

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector from the "right steering cylinder" position sensor.
- C. At the machine harness connector for the "right steering sensor" , place a jumper wire between return contact 2 (wire P967-PU(Purple)) and signal contact 3 (wire H765-WH(White)).
- D. Disconnect the machine harness connectors J1 and J2 from the Implement ECM and from the Transmission/Chassis ECM.
- E. At the Implement ECM, measure the resistance from return contact J1-45 (wire P967-PU(Purple)) to signal contact J2-16 (wire H765-WH(White)).
- F. Obtain a spare length of wire that will reach from the connectors of the Transmission/Chassis ECM to the "steer cylinder position" sensor connector.
- G. At the "steer cylinder position" sensor connector, connect one end of the spare wire to the signal contact 3 (wire H765-WH(White)).
- H. At the connector for the Transmission/Chassis ECM J2, measure the resistance between the other end of the spare wire and the signal contact J2-16 (wire H765-WH(White)).

Expected Result:

Each of the resistance measurements is less than 5 ohms.

Results:

- OK – Both of the resistance measurements are less than 5 ohms. The signal circuit is not open. Proceed to Test Step 4.
- NOT OK – One or both of the resistance measurements is greater than 5 ohms. There is an open or a bad connection in the signal circuit.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is not connected or that a wire is open. A resistance measurement that is greater 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

If the circuit at one of the ECM modules checks correctly and the circuit at the other ECM indicates a bad connection, most likely there is a problem in the machine harness on the ECM side of the splice.

If the resistance checks both indicate an open or a bad connection, a problem in the sensor side of the splice in the machine harness is most likely the cause of the problem.

Refer to the complete Electrical System Schematic of the machine. Verify that all connection points in the suspected part of the circuit are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Determine if the CID 2201 FMI 08 diagnostic code is active.

Expected Result:

The CID 2201 FMI 08 diagnostic code is not active.

Results:

- OK – The CID 2201 FMI 08 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2201 FMI 08 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a “wiggle test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i02926447

MID 027 - CID 2201 - FMI 13

SMCS Code: 1439-038-CD

Conditions Which Generate This Code:

This diagnostic code is associated with the “right steering cylinder” position sensor. The position sensor provides a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The FMI 13 diagnostic code is active. The ECM determines that the sensor is in need of calibration.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. The changes in the duty cycle of the sensor can not be measured with a digital multimeter.

CALIBRATION

- A.** Perform the calibration procedure for the sensor.
 Refer to the Testing and Adjusting, RENR9013, "Implement Electronic Control System" "Calibration" for the information on the method to access the calibration procedure.

i02926451

Expected Result:

The calibration procedure was performed successfully.

Results:

- YES – The calibration procedure was performed successfully. Resume normal machine operation.

STOP.

- NO – The calibration was not successful.

Repair: Repeat the calibration procedure for the sensor.

If the second calibration procedure is not successful, replace the "steer cylinder" position sensor.

For removal of the position sensor from the steering cylinder, refer to Disassembly and Assembly, RENR 9704, "Clevis Style Cylinder Sensor - Remove and Install".

After the replacement of the sensor, the new parameters of the position sensor MUST be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, "Position Sensor (Steering Cylinder) - Set" section of this manual for the correct procedure.

After cylinder replacement, refer to the Testing and Adjusting, RENR9013, "Implement Electronic Control System" "Calibration" for the information on the method to access the calibration procedure. If the problem is still present after replacement and calibration of the new sensor, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

MID 027 - CID 2201 - FMI 14

SMCS Code: 1439-038-CD

Conditions Which Generate This Code:

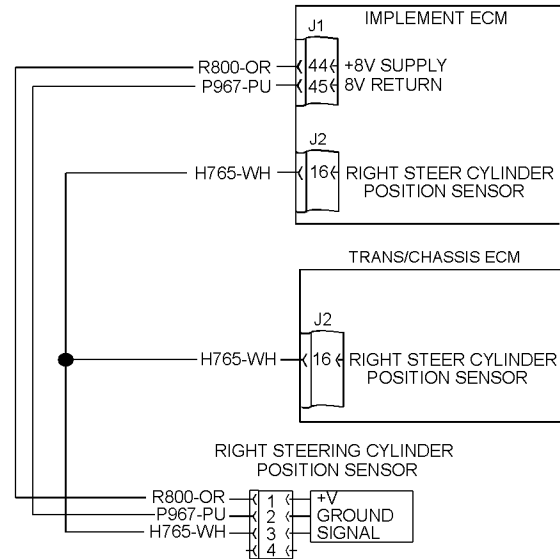


Illustration 332

g01254393

Connections of "Right Steering Cylinder" position sensor

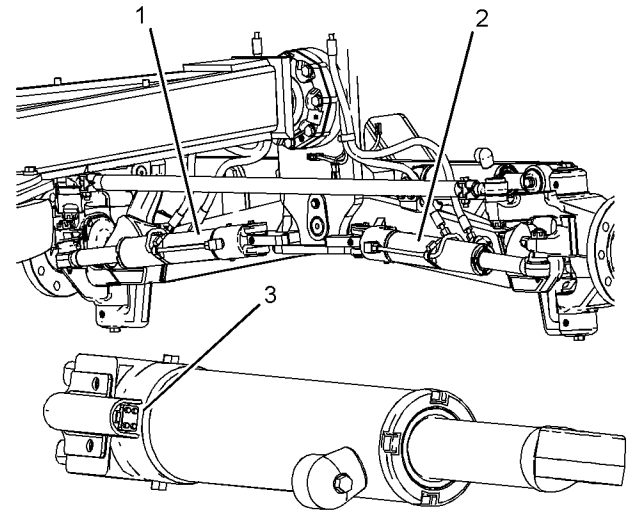


Illustration 333

g01254278

- (1) Left Steering Cylinder
- (2) Right Steering Cylinder
- (3) "Steering Position Sensor" connector on the back side of the cylinders

This diagnostic code is associated with the “right steering cylinder” position sensor. The position sensor provides a PWM input signal to the Implement ECM and to the Transmission/Chassis ECM. The FMI 14 diagnostic code is active. The ECM determines that the sensor is not responding as expected. No external conditions that could cause this problem have been detected.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. The duty cycle of the PWM signal that is supplied to the ECM is measured in very small increments. The changes in the duty cycle of the sensor can not be measured with a digital multimeter.

The possible causes of this diagnostic code are listed below:

- Mechanical devices are loose or not adjusted correctly.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active CID 0041 diagnostic code for the 8 volt sensor power supply of the Implement ECM (MID 082). Correct any problem with the 8 volt power supply before performing this procedure.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections are often the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL CONNECTIONS

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Visually inspect the mechanical connections for the “right steering cylinder”. Verify that all mechanical connections and adjustments for the steering cylinder are in good condition and verify that none of the mechanical connections are loose.

Expected Result:

All mechanical connections for the steering cylinder are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical connections for the steering cylinder are correct. Proceed to Test Step 2.
- NOT OK – All mechanical connections for the steering cylinder are not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the steering cylinder. After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SENSOR

The key start switch and the disconnect switch remain in the OFF position.

- A. Disconnect the machine harness connector from the “right steering cylinder” position sensor and disconnect the machine harness connector from the “left steering cylinder” position sensor. Mark the harness connector for the “right steering sensor”.
- B. Connect the marked connector for the “right steering sensor” to the connector for the “left steering sensor”. Connect the connector that is not marked for the “left steering sensor” to the connector for the “right steering sensor”.
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the active diagnostic code for the “right steering sensor”.

Expected Result:

When the harness connectors are switched, the CID 2201 FMI 14 diagnostic code for the “right steering sensor” is not active. A CID 2200 FMI 14 diagnostic code for the “left steering sensor” is now active.

Results:

- YES – The CID 2201 FMI 14 diagnostic code is no longer active. A CID 2200 FMI 14 diagnostic code is now active. The sensor has failed.

Repair: The “right steering cylinder” position sensor is the cause of the problem. Replace the “right steering cylinder” position sensor.

BEFORE REPLACING THE “STEERING POSITION” SENSOR, RECONNECT THE HARNESS CONNECTORS TO THE CORRECT “STEERING SENSOR” CONNECTORS.

For removal of the position sensor from the steering cylinder, refer to Disassembly and Assembly, RENR 9704, “Clevis Style Cylinder Sensor - Remove and Install”.

After the replacement of the sensor, the new parameters of the position sensor MUST be entered in Cat ET before the machine can be operated. Refer to the Testing and Adjusting, RENR9013, “Implement Electronic Control System” “Position Sensor (Steering Cylinder) - Set” for the correct procedure.

STOP.

- NO – The status of the CID 2201 FMI 14 diagnostic code did not change when the sensor connectors were switched. The CID 2201 FMI 14 diagnostic code is still active. There is a problem in the machine harness. ENSURE THAT THE MACHINE HARNESS CONNECTORS ARE CONNECTED TO THE CORRECT POSITION SENSOR. THE MARKED HARNESS CONNECTOR IS CONNECTED TO THE “RIGHT STEERING SENSOR”. THE HARNESS CONNECTOR THAT IS NOT MARKED IS CONNECTED TO THE “LEFT STEERING SENSOR”. Proceed to Test Step 3.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

Before performing this Test Step, verify that the machine harness connectors are connected to the original “left and right steering cylinder position” sensor connectors.

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2201 FMI 14 diagnostic code is active.

Expected Result:

The CID 2201 FMI 14 diagnostic code is not active.

Results:

- OK – The CID 2201 FMI 14 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2201 FMI 14 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a “wiggle test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed.

It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM. Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that has activated the diagnostic code. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i05758244

MID 027 - CID 2252 - FMI 02

SMCS Code: 4806-038

Conditions Which Generate This Code:

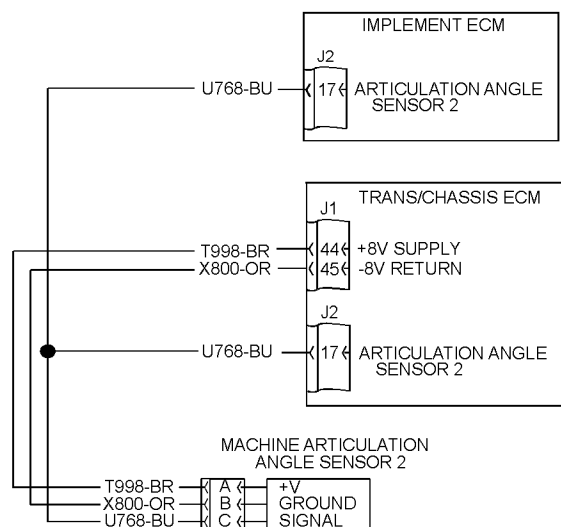


Illustration 334

g03664637

Connections of the Machine Articulation Angle Sensor 2

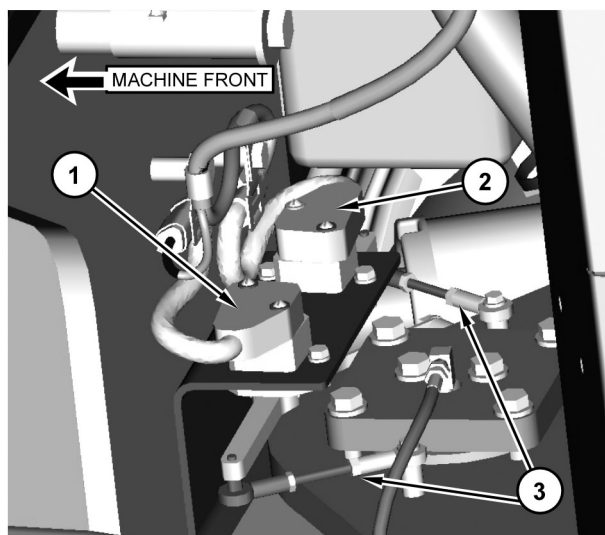


Illustration 335

g03663349

Locations of Articulation Angle Sensors

- (1) Articulation angle sensor 1
- (2) Articulation angle sensor 2
- (3) Mechanical linkage

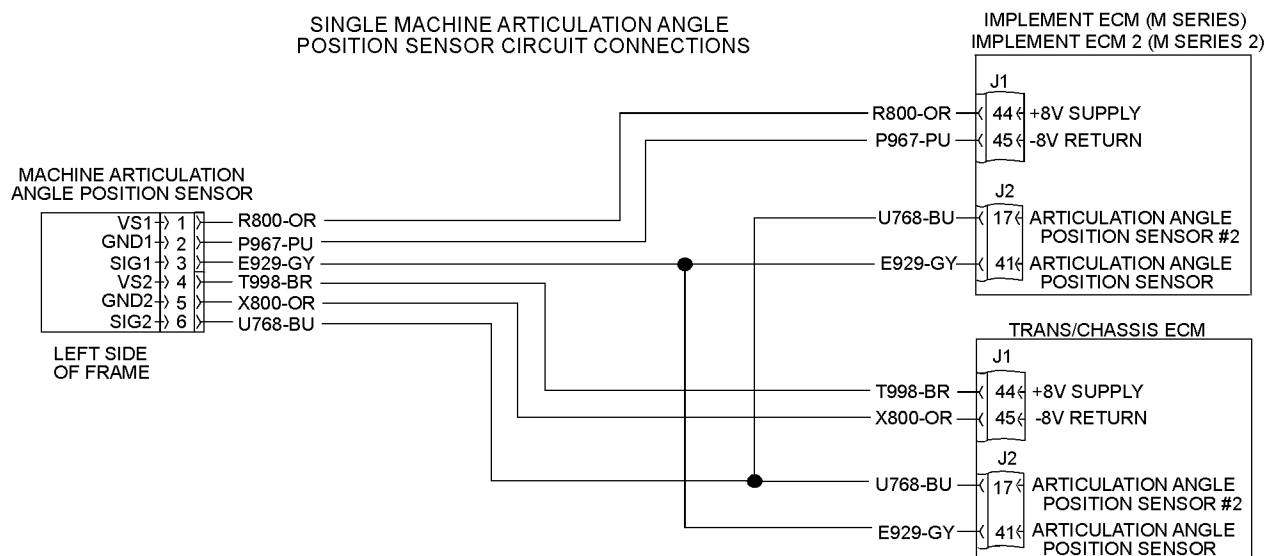


Illustration 336

g03655165

Single Sensor with two outputs

This single sensor sends a signal 1 to J2-41 and signal 2 to J2-17.

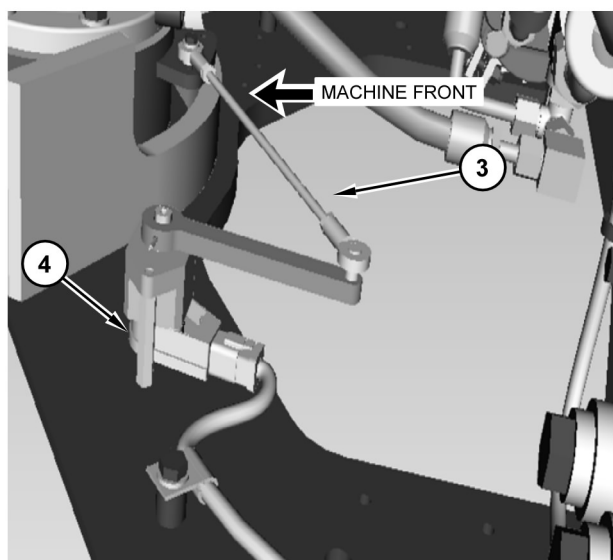


Illustration 337

g03655166

“Machine Articulation Angle Position Sensor” location (View from the left side of the machine at the articulation hitch)

(3) Mechanical linkage

(4) “Machine articulation angle sensor”

Two articulation angle signals are required for correct operation of the articulation on the machine. Either the two separate sensors or the dual output sensor will provide a PWM input to the Implement ECM and the Transmission/Chassis ECM.

This diagnostic code is associated with the number two sensor signal for the angle of machine articulation connected to each ECM at J2-17. The FMI 02 means that the ECM has determined that the input data from the sensor is erratic, intermittent, or incorrect. The Implement ECM, the Transmission/Chassis ECM or both ECM modules can activate this diagnostic code.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. When the machine is in the neutral position, the input of the duty cycle from the sensor to the ECM is approximately 55%. When the machine is articulated to the full left position, the duty cycle will be approximately 33%. When the machine is articulated to the full right position, the duty cycle will be approximately 74%.

The possible causes of this diagnostic code are listed below:

- Mechanical devices are loose or mechanical devices are not adjusted correctly.
- Intermittent connections or poor connections
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the "articulation sensor signal 2". Both ECM modules will activate a CID 2252 FMI 02 diagnostic code when an intermittent signal is detected. If one ECM has activated a CID 2252 FMI 02 diagnostic code and the other ECM has not activated a diagnostic code, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Note: Use a digital multimeter for the measurements in this procedure.

Test Step 1. CHECK THE MECHANICAL LINKAGE

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Remove any guards or shielding for the articulation sensors.
- C. Check the mounting bolts for the articulation sensors. Ensure that the sensors are securely mounted.
- D. Visually inspect the mechanical linkage for the articulation sensors. Verify that all mechanical components are tight and that all mechanical components are in good condition. Verify that the adjustment of the linkage is correct.

Expected Result:

All mechanical linkage and adjustable components for the articulation sensor(s) are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical linkage and adjustment for the articulation sensor is correct. Proceed to Test Step 2.
- NOT OK – All mechanical linkage and adjustment for the articulation sensors is not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the articulation sensor(s). After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK FOR POWER AT THE SENSOR

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Do not disconnect the harness connector from the sensor.
- C. At the back of the harness connector for the sensor, insert 7X - 1710 Multimeter Probes along supply voltage A (wire T998-BR(Brown)) and along return contact B (wire X800-OR(Orange)).
- D. Turn the key start switch and the disconnect switch to the ON position.
- E. Measure the voltage from contact A to contact B.

Expected Result:

The voltage measurement is 8.0 ± 0.5 VDC.

Results:

- OK – The voltage measurement is 8.0 ± 0.5 VDC. The power supply circuit is correct. Proceed to Test Step 3.
- NOT OK – The voltage measurement is not 8.0 ± 0.5 VDC. The 8 VDC power supply of the Transmission/Chassis ECM is not correct.

Repair: There is a problem with the power supply circuit for the sensor. Refer to the complete Electrical System Schematic of the machine. Check all of the connections that are in the power supply circuit and the return circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE SIGNAL OF THE SENSOR

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. At the back of the harness connector for the sensor, remove the multimeter probe from contact A (wire T998-BR(Brown)) and insert the probe along the signal contact C (wire U768-BU(Blue)).
- C. The multimeter probe along return contact B (wire X800-OR(Orange)) remains in place.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Monitor the signal of the sensor with a digital multimeter.
- F. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 4.
- NOT OK – The sensor's signal does not respond correctly. The sensor is NOT operating correctly.

Repair: Replace the “articulation angle 2” sensor. After the replacement of the sensor, the sensor must be calibrated. Refer to Testing and Adjusting, REN9013, “Implement Electronic Control System” “Calibrations” for information on the method to access the articulation sensor calibration procedure.

STOP.

Test Step 4. CHECK FOR AN OPEN IN THE SIGNAL CIRCUIT

The key start switch and the disconnect switch remain in the OFF position.

- A. Disconnect the machine harness connector from the sensor.
- B. At the machine harness connector for the sensor, place the jumper wire between return contact B (wire X800-OR(Orange)) and signal contact C (wire U768-BU(Blue)).

- C. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.

- D. At the machine harness connectors for the Transmission/Chassis ECM, measure the resistance from return contact J1-45 (wire X800-OR(Orange)) to signal contact J2-17 (wire U768-BU(Blue)).

- E. Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the wiring harness.

Results:

- OK – The resistance measures less than 5 ohms. The signal circuit is not open. Proceed to Test Step 5.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the signal circuit.

Repair: If both of the ECM modules have activated this diagnostic code, there is most likely an open or a bad connection on the sensor side of the machine harness splice connection for the signal wire.

If only the Transmission/Chassis ECM has activated this diagnostic code, there is most likely an open or a bad connection on the ECM side of the machine harness splice connection for the signal wire.

In either case, refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the suspected section of the sensor signal circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE OPERATION OF THE ECM

The key start switch and the disconnect switch remain in the OFF position. The machine harness connectors for the sensor and the Transmission/Chassis ECM remain disconnected.

Note: This check should be performed on the ECM that has activated the diagnostic code. If both of the ECM modules have activated the diagnostic code, perform this check on both of the ECM modules.

- A. At the machine harness connector J2 for the ECM, use a 151 - 6320 Removal Tool to remove the sensor signal wire U768-BU(Blue) and the socket at contact J2-17 from the harness connector.
- B. Reconnect the machine harness J1 and J2 connectors to the ECM.
- C. Turn the key start switch and the disconnect switch to the ON position.
- D. Observe the status of the active CID 2252 FMI 02 diagnostic code.

Expected Result:

The CID 2252 FMI 02 diagnostic code is no longer active. A CID 2252 FMI 03 diagnostic code is now active.

Results:

- YES – The CID 2252 FMI 02 diagnostic code is no longer active. A CID 2252 FMI 03 diagnostic code is active after the wire for the sensor signal is disconnected. The ECM has responded correctly to the open circuit condition in the sensor circuit. Reinstall the disconnected sensor signal wire back into the correct spot in the ECM connector. Proceed to the next test step. Proceed to Test Step 6.
- NO – The CID 2252 FMI 03 diagnostic code remains active. The status of the active diagnostic code does not change when the sensor signal wire is disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the sensor circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 6. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 2252 FMI 02 diagnostic code.

Expected Result:

The CID 2252 FMI 02 diagnostic code is not active.

Results:

- OK – The CID 2252 FMI 02 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2252 FMI 02 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a "wiggle test" on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The "wiggle test" can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the active diagnostic code is not found, replace the sensor. After the replacement of the sensor, the sensor must be calibrated. Refer to the Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

If the problem is still present after the replacement of the sensor and calibration, the ECM may have failed. This is unlikely as the ECM responded correctly to the condition in the previous test step.

Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM that activated the diagnostic code.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, and the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i05758246

MID 027 - CID 2252 - FMI 03

SMCS Code: 4806-038

Conditions Which Generate This Code:

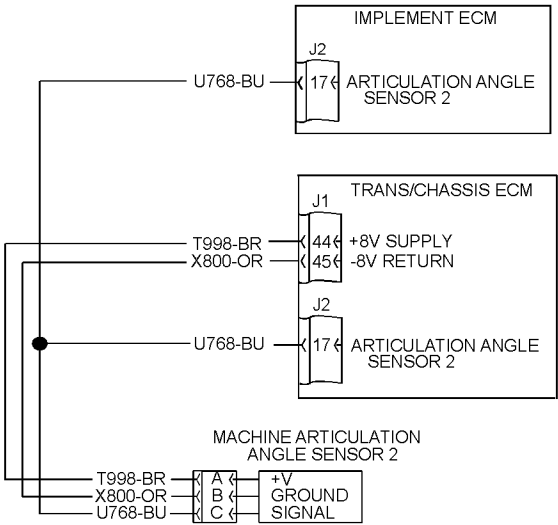


Illustration 338

g03664637

Connections of the Machine Articulation Angle Sensor 2

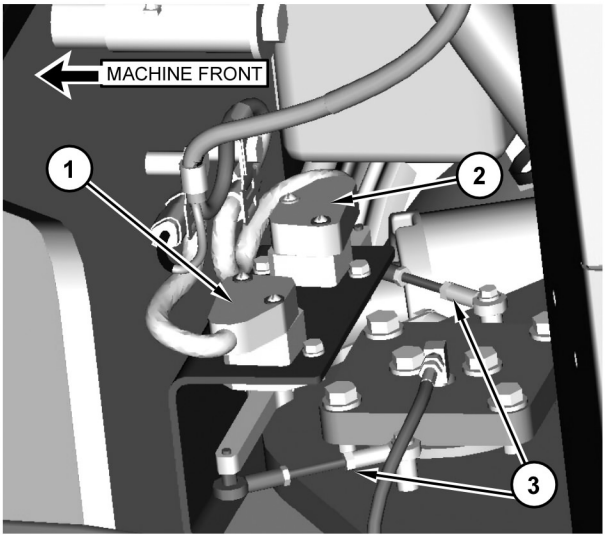


Illustration 339

g03663349

Locations of Articulation Angle Sensors

- (1) Articulation angle sensor 1
- (2) Articulation angle sensor 2
- (3) Mechanical linkage

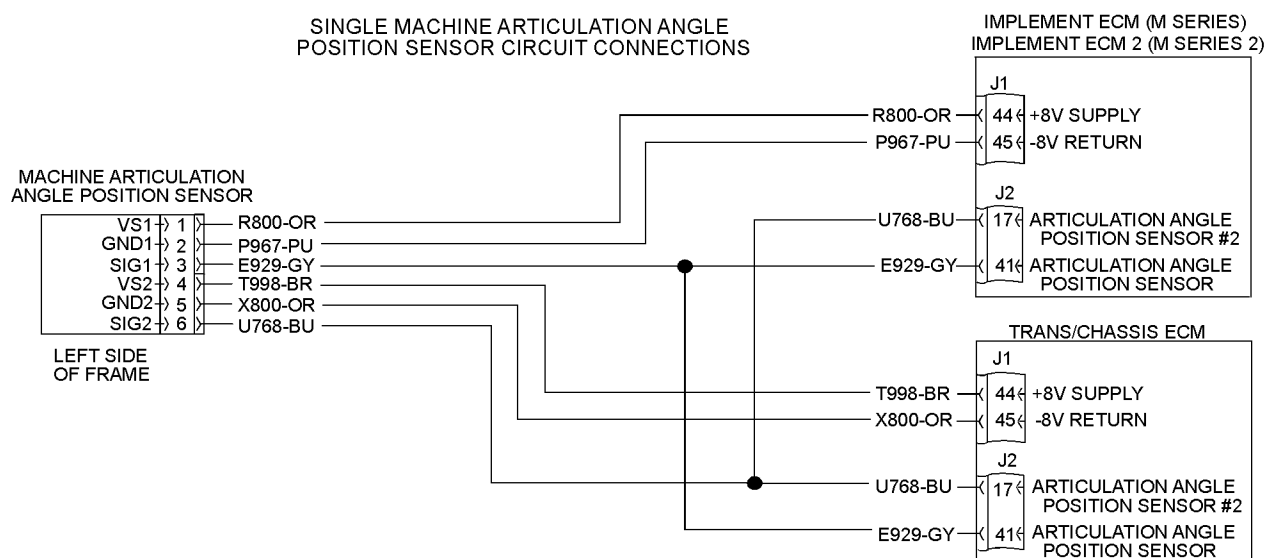


Illustration 340

g03655165

Single Sensor with two outputs

This single sensor sends a signal 1 to J2-41 and signal 2 to J2-17

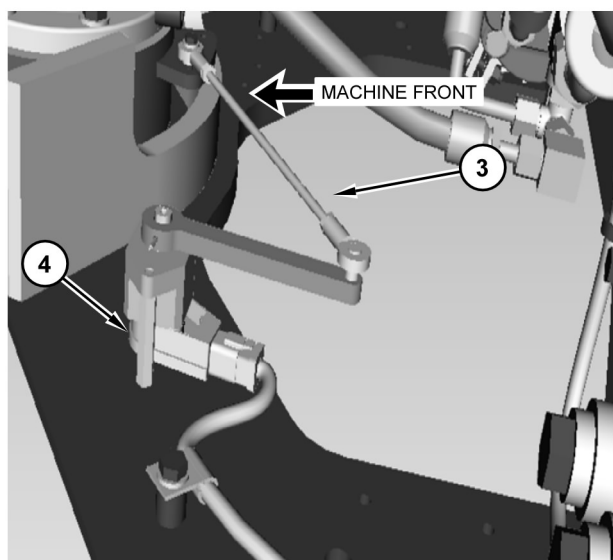


Illustration 341

g03655166

"Machine Articulation Angle Position Sensor" location
 (View from the left side of the machine at the articulation hitch)

- (3) Mechanical linkage
 (4) "Articulation angle sensor"

Two articulation angle sensor signals are required for correct operation of the articulation of the machine. Either the two separate sensors or the dual output sensor will provide a PWM signal to the Implement ECM and the Transmission/Chassis ECM.

This diagnostic code is associated with the number two sensor signal for the angle of machine articulation connected to each ECM at J2-17. The FMI 03 diagnostic code is activated when the ECM reads the input signal from the machine "articulation angle sensor signal 2" and the voltage of the signal is above normal. The Implement ECM, the Transmission/Chassis ECM or both ECM modules can activate this diagnostic code.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. When the machine is in the neutral position, the input of the duty cycle from the sensor to the ECM is approximately 55%. When the machine is articulated to the full left position, the duty cycle will be approximately 33%. When the machine is articulated to the full right position, the duty cycle will be approximately 74%.

The possible causes of this diagnostic code are listed below:

- The power supply circuit of the sensor is open.
- The return circuit is open.
- The signal circuit is open or the sensor is disconnected.
- The signal circuit is shorted to the sensor power supply.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, check for an active CID 0041 diagnostic code for the 8 volt power supply of the ECM. Correct any problem with the 8 volt power supply before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID "082") receive an input signal from the "articulation sensor signal 1" . Both ECM modules can activate a CID 2252 FMI 03 diagnostic code when an above normal signal is detected. If one ECM has activated a CID 2252 FMI 03 diagnostic code and the other ECM has not activated a diagnostic code, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that the ECM is the cause of the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL LINKAGE

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Remove any guards or shielding for the articulation sensors.
- C. Check the mounting bolts for the articulation sensors. Ensure that the sensors are securely mounted.
- D. Visually inspect the mechanical linkage for the articulation sensors. Verify that all mechanical components are tight and that all mechanical components are in good condition. Verify that the adjustable linkage is correct.

Expected Result:

All mechanical linkage and adjustable components for the articulation sensor(s) are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical linkage and adjustment for the articulation sensor is correct. Proceed to Test Step 2.
- NOT OK – All mechanical linkage and adjustment for the articulation sensors is not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the articulation sensor(s). After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SUPPLY VOLTAGE AT THE SENSOR

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Do not disconnect the harness connector from the sensor.
- C. At the back of the harness connector for the sensor, insert 7X - 1710 Multimeter Probes along supply voltage A (wire T998-BR(Brown)). Insert a multimeter probe along return contact B (wire X800-OR(Orange)).
- D. Turn the key start switch and the disconnect switch to the ON position.
- E. Measure the voltage from contact A to contact B.

Expected Result:

The voltage measurement is 8.0 ± 0.5 VDC.

Results:

- OK – The voltage measurement is 8.0 ± 0.5 VDC. The power supply circuit is correct. Proceed to Test Step 3.
- NOT OK – The voltage measurement is not 8.0 ± 0.5 VDC. The power supply circuit is not correct.

Repair: There is a problem with the 8 VDC power supply of the Transmission/Chassis ECM for the sensor. Refer to the complete Electrical System Schematic of the machine. Check all of the connections that are in the power supply circuit and the return circuit. Ensure that all connections are clean, that all connections are

secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK FOR AN OPEN IN THE SIGNAL CIRCUIT

The key start switch and the disconnect switch remain in the OFF position.

- A. Disconnect the machine harness connector from the sensor.
- B. At the machine harness connector for the sensor, place the jumper wire between return contact B (wire X800-OR(Orange)) and signal contact C (wire U768-BU(Blue)).
- C. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- D. At the machine harness connectors for the Transmission/Chassis ECM, measure the resistance from return contact J1-45 (wire X800-OR(Orange)) to signal contact J2-17 (wire U768-BU(Blue)).
- E. Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the wiring harness.

Results:

- OK – The resistance measures less than 5 ohms. The resistance measurement is not indicating an open in the circuit. Proceed to Test Step 4.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the signal circuit.

Repair: If both of the ECM modules have active diagnostic codes, there is most likely an open connection or a bad connection on the sensor side of the machine harness splice connection for the signal wire.

If only the Transmission/Chassis ECM has an active diagnostic code, there is most likely an open or a bad connection on the ECM side of the machine harness splice connection for the signal wire.

In either case, refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the suspected section of the sensor signal circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE SIGNAL CIRCUIT FOR A SHORT

The key start switch and the disconnect switch remain in the OFF position. The sensor connector and the harness connectors of the Transmission/Chassis ECM remain disconnected from the machine harness.

- A. Remove the jumper wire that was installed in the last step.
- B. Disconnect the machine harness connectors J1 and J2 from the Implement ECM.
- C. At the J1 and J2 machine harness connectors for the Transmission/Chassis ECM, measure the resistance from the sensor contact J2-17 (wire U768-BU(Blue)) to all of the other J1 and J2 contacts that are used for the Transmission/Chassis ECM.
- D. At the J1 and J2 machine harness connectors for the Implement ECM, measure the resistance from the sensor signal contact J2-17 (wire U768-BU(Blue)) to all of the other J1 and J2 contacts that are used for the Implement ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The signal circuit is not shorted. Proceed to Test Step 5.
- NOT OK – A resistance measurement is less than 5000 ohms.

Repair: There is a short in the machine harness. The short is between the signal circuit and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE SIGNAL OF THE SENSOR

The key start switch and the disconnect switch remain in the OFF position.

- A. Reconnect the harness connectors for the sensor and the J1 and J2 connectors to the Transmission/Chassis ECM and to the Implement ECM.
- B. At the back of the harness connector for the sensor, insert the multimeter probe along contact B (wire X800-OR(Orange)) and insert the probe along the signal contact C (wire U768-BU(Blue)).
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Monitor the signal of the sensor with a digital multimeter.
- E. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 6.
- NOT OK – The sensor's signal does not respond correctly. The sensor is not operating correctly.

Repair: Replace the "articulation angle 2" sensor. After the replacement of the sensor, the sensor must be calibrated. Refer to the Testing and Adjusting, "Calibration" section of this manual for the correct calibration procedure.

STOP.

Test Step 6. CHECK THE OPERATION OF THE ECM

Note: This check should be performed on the ECM that has the active diagnostic code. If both of the ECM modules have activated the diagnostic code, perform this check on both of the ECM modules.

- A. Turn the disconnect switch and the key start switch to the OFF position.
- B. At the machine harness connector J2 for the ECM, use a 151 - 6320 Removal Tool to remove the sensor signal U768-BU(Blue) and the socket at contact J2-17 from the harness connector. The J2 connector remains connected to the ECM.
- C. Turn the key start switch and the disconnect switch to the ON position.
- D. Use a 7X - 1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the ECM pin at J2-17 through the empty space in the J2 connector.
- E. Observe the status of the active CID 2252 FMI 03 diagnostic code and ground the other end of the 7X - 1710 Multimeter Probe to frame ground.

Expected Result:

The CID 2252 FMI 03 diagnostic code is no longer active. A CID 2252 FMI 04 diagnostic code becomes active when the ECM pin at J2-17 is grounded.

Results:

- YES – The CID 2252 FMI 03 diagnostic code is no longer active. A CID 2252 FMI 04 diagnostic code has been activated after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition in the solenoid circuit. It is unlikely that the cause of the problem is the ECM. Reinstall the disconnected sensor signal wire back into the correct spot in the ECM connector before proceeding to the next test step. Proceed to Test Step 7.
- NO – The CID 2252 FMI 03 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin for the sensor signal is grounded.

Repair: The ECM has not responded correctly to the grounded condition in the sensor circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 7. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2252 FMI 03 diagnostic code is active.

Expected Result:

The CID 2252 FMI 03 diagnostic code is not active.

Results:

- OK – The CID 2252 FMI 03 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2252 FMI 03 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a “wiggle test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the active diagnostic code is not found, replace the sensor. After the replacement of the sensor, the sensor must be calibrated. Refer to the Testing and Adjusting, “Calibration” section of this manual for the correct calibration procedure.

If the problem is still present after the replacement of the sensor, the ECM may have failed. This is unlikely as the ECM responded correctly to the condition change in the previous test step.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, and the ECM must be replaced, refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i05758249

MID 027 - CID 2252 - FMI 04

SMCS Code: 4806-038

Conditions Which Generate This Code:

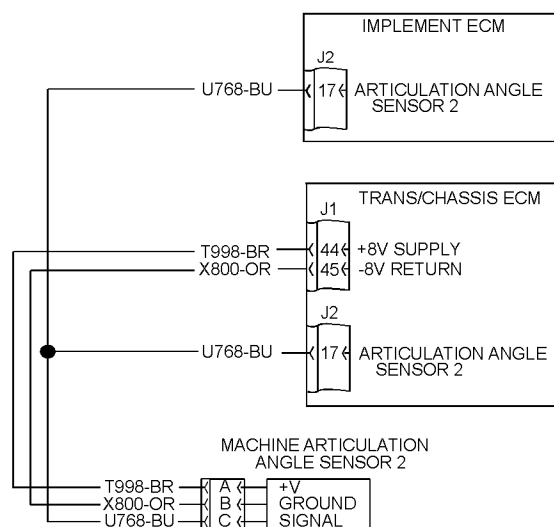


Illustration 342

g03664637

Connections of the Machine Articulation Angle Sensor 2

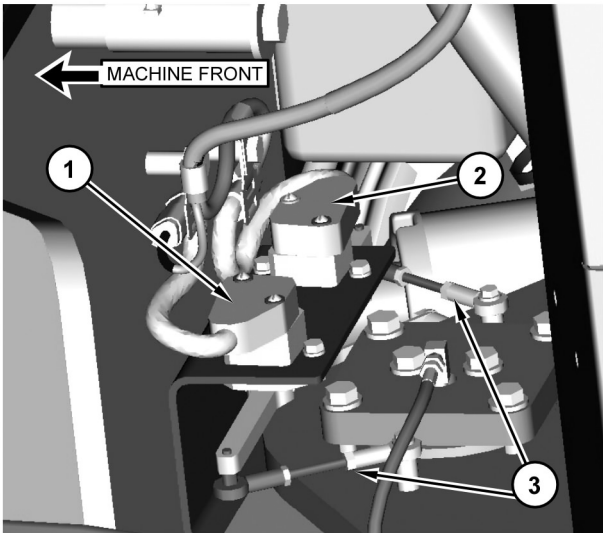


Illustration 343 g03663349

Locations of Articulation Angle Sensors

- (1) Articulation angle sensor 1
- (2) Articulation angle sensor 2
- (3) Mechanical linkage

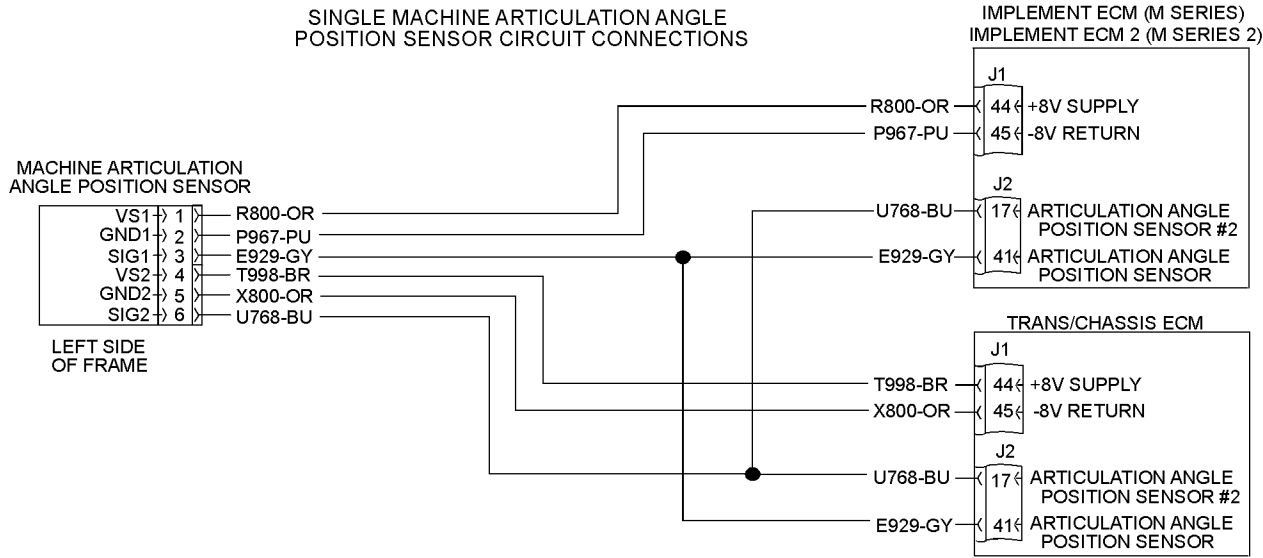


Illustration 344 g03655165

Single Sensor with two outputs

This single sensor sends a signal 1 to J2-41 and signal 2 to J2-17

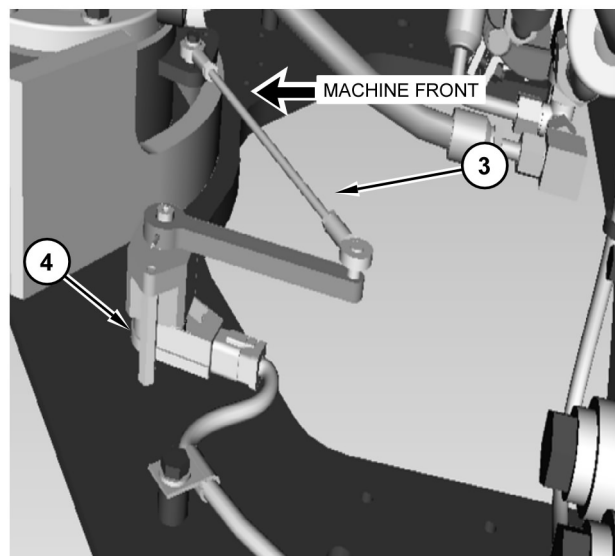


Illustration 345

g03655166

“Machine Articulation Angle Position Sensor” location
(View from the left side of the machine at the articulation hitch)

- (3) Mechanical linkage
(4) “Articulation angle sensor”

Two articulation angle sensor signals are required for correct operation of the articulation on the machine. Either the two separate sensors or the dual output sensor provides a PWM input to the Implement ECM and to the Transmission/Chassis ECM.

This diagnostic code is associated with the number two sensor signal for the angle of machine articulation connected to each ECM at J2-17. This diagnostic code is recorded when the ECM reads the input signal from the machine “articulation angle sensor signal 2” and the voltage of the signal is below normal. The Implement ECM, the Transmission/Chassis ECM or both ECM modules can activate this diagnostic code.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. When the machine is in the neutral position, the input of the duty cycle of the sensor input to the ECM is approximately 55%. When the machine is articulated to the “full left position”, the duty cycle will be approximately 33%. When the machine is articulated to the “full right position”, the duty cycle will be approximately 74%.

The possible causes of this diagnostic code are listed below:

- The signal circuit is shorted to ground.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the “articulation sensor signal 2”. Both ECM modules can activate a CID 2252 FMI 04 diagnostic code when a below normal voltage signal is detected. If one ECM has an active CID 2252 FMI 04 diagnostic code and the other ECM does not have an active diagnostic code, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, either the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either ECM is causing the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL LINKAGE

- Turn the key start switch and the disconnect switch to the OFF position.
- Remove any guards or shielding for the articulation sensors.
- Check the mounting bolts for the articulation sensors. Ensure that the sensors are securely mounted.
- Visually inspect the mechanical linkage for the articulation sensors. Verify that all mechanical components are tight and that all mechanical components are in good condition. Verify that the adjustment of the linkage is correct.

Expected Result:

All mechanical linkage and adjustable components for the articulation sensor(s) are in good condition and no mechanical connections are loose.

Results:

Diagnostic Code Procedures

- OK – All mechanical linkage and adjustment for the articulation sensor is correct. Proceed to Test Step 2.
- NOT OK – All mechanical linkage and adjustment for the articulation sensors is not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the articulation sensor(s). After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SENSOR

- A. Turn the disconnect switch and the key start switch to the ON position.
- B. Ensure that the diagnostic code is active.
- C. Observe the status of the diagnostic code and disconnect the sensor from the machine harness.

Expected Result:

The CID 2252 FMI 04 diagnostic code is no longer active. A CID 2252 FMI 03 diagnostic code is now active.

Results:

- YES – The CID 2252 FMI 04 diagnostic code is no longer active. A CID 2252 FMI 03 diagnostic code is now active. The ECM and the circuit are correct. The position sensor is causing the problem.

Repair: The sensor has failed. Replace the “articulation angle 2” sensor. After the replacement of the sensor, the sensor must be calibrated. Refer to Testing and Adjusting, RENR9013, “Implement Electronic Control System” “Calibrations” for information on the method to access the articulation sensor calibration procedure.

STOP.

- NO – The CID 2252 FMI 04 diagnostic code remains active. Disconnecting the sensor did not affect the status of the active diagnostic code. The position sensor is not causing the problem. Proceed to Test Step 3.

Test Step 3. CHECK THE SIGNAL CIRCUIT FOR A SHORT TO GROUND

- A. The sensor remains disconnected from the machine harness.

- B. Turn the key start switch and the disconnect switch to the OFF position.
- C. Disconnect the J1 and J2 machine harness connectors from the Implement ECM and the Transmission/Chassis ECM.
- D. At machine harness connector J2 for the Transmission/Chassis ECM, measure the resistance from contact J2-17 (wire U768-BU(Blue)) to frame ground. Measure the resistance to all of the contacts that are used on the connectors for the Transmission/Chassis ECM.
- E. At machine harness connector J2 for the Implement ECM, measure the resistance from contact J2-17 (wire U768-BU(Blue)) to frame ground. Measure the resistance to all of the contacts that are used on the connectors for the Implement ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 4.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness.

Repair: There is a short in the machine harness between the signal circuit and the circuit with the low resistance measurement.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the sensor circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, “Wiring Harness (Short Circuit) - Test”. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE OPERATION OF THE ECM

The key start switch and the disconnect switch remain in the OFF position. The machine harness connectors for the sensor and both the Implement ECM and the Transmission/Chassis ECM remain disconnected.

Note: This check should be performed on the ECM that has activated the diagnostic code. If both of the ECM modules have an active diagnostic code, perform this check on both of the ECM modules.

- A. At the machine harness connector J2 for the ECM, use a 151 - 6320 Removal Tool to remove the sensor signal wire U768-BU(Blue) and the socket at contact J2-17 from the harness connector.
- B. Reconnect the machine harness J1 and J2 connectors to the ECM.
- C. Turn the key start switch and the disconnect switch to the ON position.
- D. Observe the status of the active CID 2252 FMI 04 diagnostic code.

Expected Result:

The CID 2252 FMI 04 diagnostic code is no longer active. A CID 2252 FMI 03 diagnostic code is now active.

Results:

- YES – The CID 2252 FMI 04 diagnostic code is no longer active. A CID 2252 FMI 03 diagnostic code is active after the sensor signal wire is disconnected. The ECM has responded correctly to the open circuit condition in the sensor circuit. Reconnect the sensor signal wire back into the correct spot in the ECM connector. Proceed to the next test step. Proceed to Test Step 5.
- NO – The CID 2252 FMI 04 diagnostic code remains active. The status of the active diagnostic code does not change when the sensor signal wire is disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the sensor circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2252 FMI 04 diagnostic code is active.

Expected Result:

The CID 2252 FMI 04 diagnostic code is not active.

Results:

- OK – The CID 2252 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2252 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a "wiggle test" on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The "wiggle test" can detect intermittent shorts or open connections in the machine wiring harness.

If the problem is still present, the ECM may have failed. The failure of the ECM is unlikely. The ECM response was correct for the condition of the previous test step.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, and the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i05758250

MID 027 - CID 2252 - FMI 08

SMCS Code: 4806-038

Conditions Which Generate This Code:

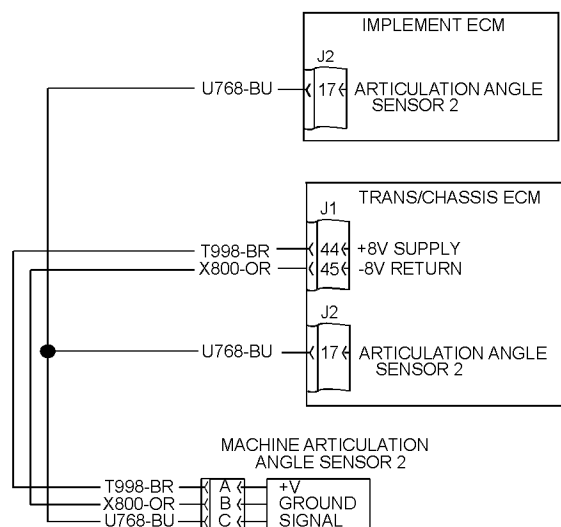


Illustration 346

g03664637

Connections of the Machine Articulation Angle Sensor 2

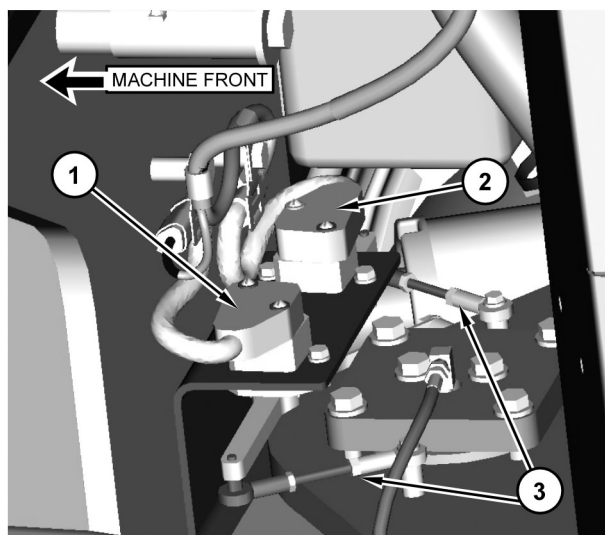


Illustration 347

g03663349

Locations of Articulation Angle Sensors

- (1) Articulation angle sensor 1
- (2) Articulation angle sensor 2
- (3) Mechanical linkage

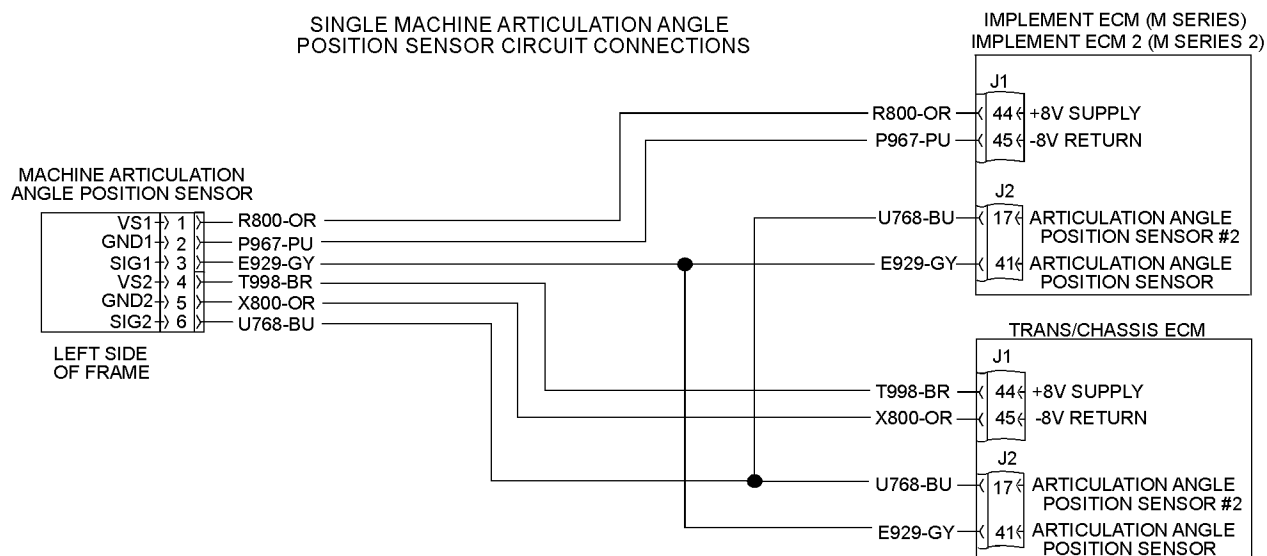


Illustration 348

g03655165

Single Sensor with two outputs

This single sensor sends a signal 1 to J2-41 and signal 2 to J2-17

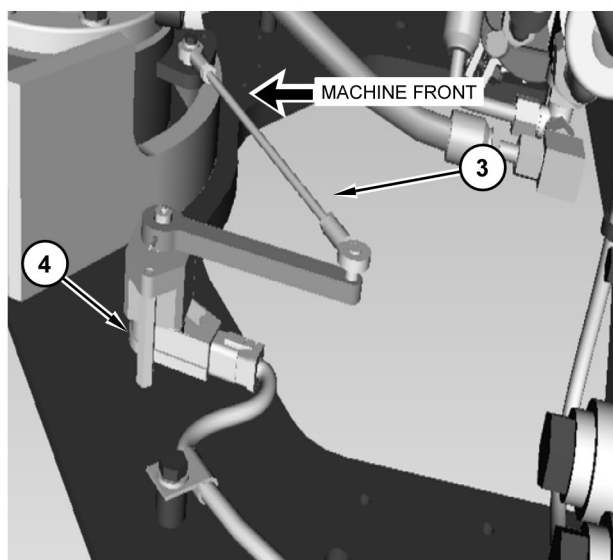


Illustration 349

g03655166

“Machine Articulation Angle Position Sensor” location
(View from the left side of the machine at the articulation hitch)

- (3) Mechanical linkage
(4) “Articulation angle sensor”

Two articulation angle sensor signals sensors are required for correct operation of the articulation on the machine. Either the two separate sensors or the dual output sensor will provide a PWM signal to the Implement ECM and the Transmission/Chassis ECM.

This diagnostic code is associated with the number two sensor signal for the angle of machine articulation connected to each ECM at J2-17. The FMI 08 means that the ECM has determined that the signal frequency or the signal pulse width is not within the expected range. The Implement ECM, the Transmission/Chassis ECM or both ECM modules can activate this diagnostic code.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. When the machine is in the neutral position, the input for the duty cycle for the sensor to the ECM is approximately 55%. When the machine is articulated to the full left position, the duty cycle will be approximately 33%. When the machine is articulated to the full right position, the duty cycle will be approximately 74%.

The possible causes of this diagnostic code are listed below:

- The sensor has failed.
- Intermittent connections or poor connections
- Mechanical devices are loose.
- The ECM has failed. This is unlikely.

Before performing this procedure, check for an active CID 0041 diagnostic code for the 8 volt sensor power supply of the ECM. Correct any problem with the 8 volt power supply before performing this procedure.

Note: The Transmission/Chassis ECM (MID 027) and the Implement ECM (MID 082) receive an input signal from the “articulation sensor 2”. Both ECM modules can activate a CID 2252 FMI 08 diagnostic code when the signal frequency or the signal pulse width is not within the expected range. If one ECM has an active CID 2252 FMI 08 diagnostic code and the other ECM does not have an active diagnostic code, it is likely that the sensor is operating correctly. When this occurs, a poor connection in the machine harness would be suspected. When both ECM modules have activated the diagnostic code, the sensor or a harness problem could be the cause. If both ECM modules have activated the diagnostic code, it is very unlikely that either of the ECM modules is the cause of the problem. For either condition, proceed with this procedure in order to verify the cause of the problem.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE MECHANICAL LINKAGE

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Remove any guards or shielding for the articulation sensors.
- C. Check the mounting bolts for the articulation sensors. Ensure that the sensors are securely mounted.
- D. Visually inspect the mechanical linkage for the articulation sensors. Verify that all mechanical components are tight and that all mechanical components are in good condition. Verify that the adjustment of the linkage is correct.

Expected Result:

All mechanical linkage and adjustable components for the articulation sensor(s) are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical linkage and adjustment for the articulation sensor is correct. Proceed to Test Step 2.
- NOT OK – All mechanical linkage and adjustment for the articulation sensors is not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the articulation sensor(s). After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CHECK THE SIGNAL OF THE SENSOR

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. At the back of the harness connector for the sensor, insert 7X-1710 Multimeter Probes along return contact B (wire X800-OR(Orange)) and insert a probe along the signal contact C (wire U768-BU(Blue)).
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Monitor the signal of the sensor with a digital multimeter.
- E. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, take the sensor through the full operating range of the sensor.

Expected Result:

The signal of the sensor responds in the manner that is described at the beginning of this procedure.

Results:

- OK – The signal of the sensor responds correctly. The sensor is operating correctly. Proceed to Test Step 3.
- NOT OK – The signal of the sensor does not respond correctly. The sensor is not operating correctly.

Repair: Replace the “articulation angle 2” sensor. After the replacement of the sensor, the sensor must be calibrated. Refer to Testing and Adjusting, RENR9013, “Implement Electronic Control System” “Calibrations” for information on the method to access the articulation sensor calibration procedure.

STOP.

Test Step 3. CHECK FOR AN OPEN IN THE SIGNAL CIRCUIT

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector from the sensor.
- C. At the machine harness connector for the sensor, connect a jumper wire between return contact B (wire X800-OR(Orange)) and signal contact C (wire U768-BU(Blue)).
- D. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- E. At the machine harness connectors for the Transmission/Chassis ECM, measure the resistance from return contact J1-45 (wire X800-OR(Orange)) to contact J2-17 (wire U768-BU(Blue)).
- F. Observe the resistance measurement and wiggle the ECM connector and the sensor connector. Gently pull on the wires and wiggle the wires for both connectors.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the wiring harness.

Results:

- OK – The resistance measurement is less than 5 ohms. The resistance measurement is not indicating an open in the circuit. Proceed to Test Step 5.
- NOT OK – One or both of the resistance measurements is greater than 5 ohms. There is an open or a bad connection in the signal circuit.

Repair: If both of the ECM modules have an active diagnostic code, then there is probably an open connection or a bad connection on the sensor side on the signal wire at the splice of the machine harness.

If only the Transmission/Chassis ECM has an active diagnostic code, then there is probably an open connection or a bad connection on the ECM side of the machine harness at the splice for the signal wire.

In either case, refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the suspected section of the sensor signal circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE OPERATION OF THE ECM

The key start switch and the disconnect switch remain in the OFF position. The machine harness connectors for the sensor and the Transmission/Chassis ECM remain disconnected.

Note: This check should be performed on the ECM that has activated the diagnostic code. If both of the ECM modules have activated the diagnostic code, perform this check on both of the ECM modules.

- A. Remove the jumper wire that was connected in the previous test step.
- B. At the machine harness connector J2 for the ECM, use a 151 - 6320 Removal Tool to remove the sensor signal wire U768-BU(Blue) and the socket at contact J2-17 from the harness connector.
- C. Reconnect any disconnected machine harness connectors to the ECM.
- D. Turn the key start switch and the disconnect switch to the ON position.
- E. Observe the status of the active CID 2252 FMI 08 diagnostic code.

Expected Result:

The CID 2252 FMI 08 diagnostic code is no longer active. A CID 2252 FMI 03 diagnostic code is now active.

Results:

- YES – The CID 2252 FMI 08 diagnostic code is no longer active. A CID 2252 FMI 03 diagnostic code is active after the sensor signal wire is disconnected. The ECM has responded correctly to the open circuit condition in the sensor circuit. Reinstall the disconnected sensor signal wire back into the correct spot in the ECM connector before proceeding to the next test step. Proceed to Test Step 5.
- NO – The CID 2252 FMI 08 diagnostic code remains active. The status of the active diagnostic code does not change when the sensor signal wire is disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the sensor circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Test Step 5. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Check the status of the CID 2252 FMI 08.

Expected Result:

The CID 2252 FMI 08 is not active.

Results:

- OK – The CID 2252 FMI 08 is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2252 FMI 08 is active. The active diagnostic code has not been corrected.

Repair: Check the circuit again. Perform a "wiggle test" on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The "wiggle test" can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the active diagnostic code is not found, replace the sensor. After the replacement of the sensor, verify that the new sensor corrected the problem. If the problem is still present after the replacement of the sensor, the ECM may have failed. The failure of the ECM is not likely. The ECM response was correct for the condition in the previous test step.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, and the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i05758251

MID 027 - CID 2252 - FMI 13

SMCS Code: 4806-038

Conditions Which Generate This Code:

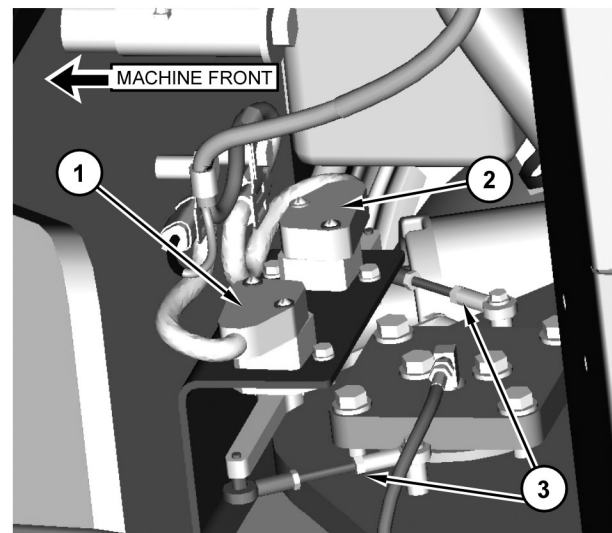


Illustration 350

g03663349

Locations of Articulation Angle Sensors

- (1) Articulation angle sensor 1
- (2) Articulation angle sensor 2
- (3) Mechanical linkage

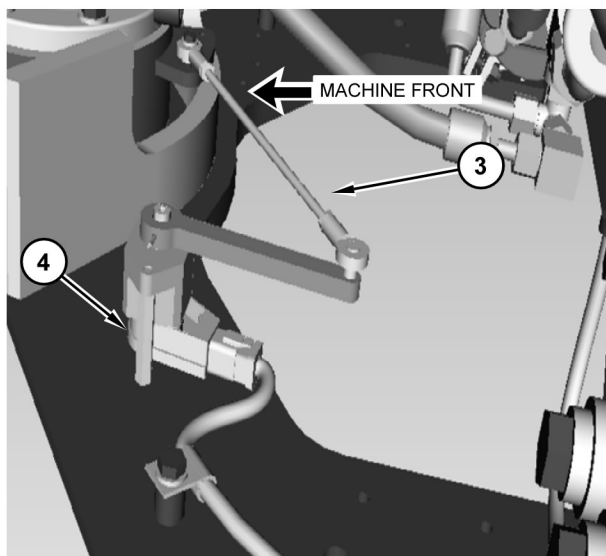


Illustration 351

g03655166

“Machine Articulation Angle Position Sensor” location (View from the left side of the machine at the articulation hitch)

(3) Mechanical linkage

(4) “Articulation angle sensor”

Two articulation angle sensors are required for the correct operation of the function of the articulation on the machine. Each sensor will provide a PWM signal to the Implement ECM and the Transmission/Chassis ECM.

This diagnostic code is associated with the number two sensor signal for the angle of machine articulation connected to each ECM at J2-17. The CID 2252 FMI 13 diagnostic code is recorded by the ECM. In the event that the ECM detects the signal from the machine “articulation angle sensor signal 2” is out of calibration, a record of the event is logged. The Implement ECM and the Transmission/Chassis ECM can activate this diagnostic code.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. When the machine is in the neutral position, the input of the duty cycle of the sensor to the ECM is approximately 55%. When the machine is articulated to the full left position, the duty cycle will be approximately 33%. When the machine is articulated to the full right position, the duty cycle will be approximately 74%.

Note: Verify that no other CID 2252 diagnostic codes are active. Any other active CID 2252 diagnostic codes must be investigated and must be cleared before performing this procedure.

CALIBRATION

- A.** Perform the calibration procedure for the sensor. Refer to Testing and Adjusting, RENR9013, “Implement Electronic Control System” “Calibrations” for information on the method to access the articulation sensor calibration procedure

Expected Result:

The calibration procedure was performed successfully.

Results:

- YES – The calibration procedure was performed successfully. Resume normal machine operation.
- STOP.
- NO – The calibration was not successful.

Repair: Repeat the calibration procedure for the sensor.

If the second calibration procedure is not successful, replace the position sensor. Refer to Testing and Adjusting, RENR9013, “Implement Electronic Control System” “Calibrations” for information on the method to access the articulation sensor calibration procedure. If the problem is still present after replacement and calibration of the new sensor, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM that activated the diagnostic code. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i05758252

MID 027 - CID 2252 - FMI 14

SMCS Code: 4806-038

Conditions Which Generate This Code:

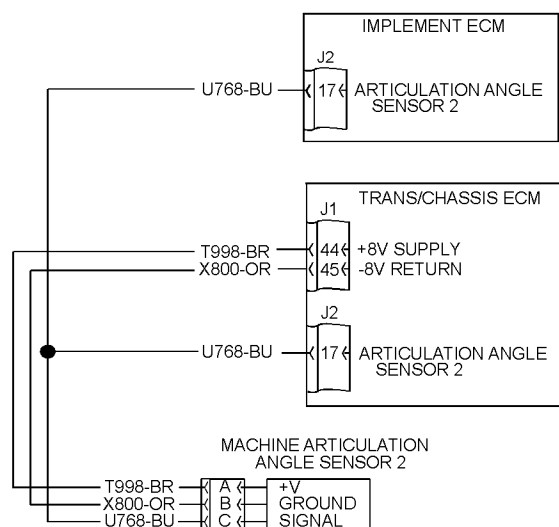


Illustration 352

g03664637

Connections of the Machine Articulation Angle Sensor 2

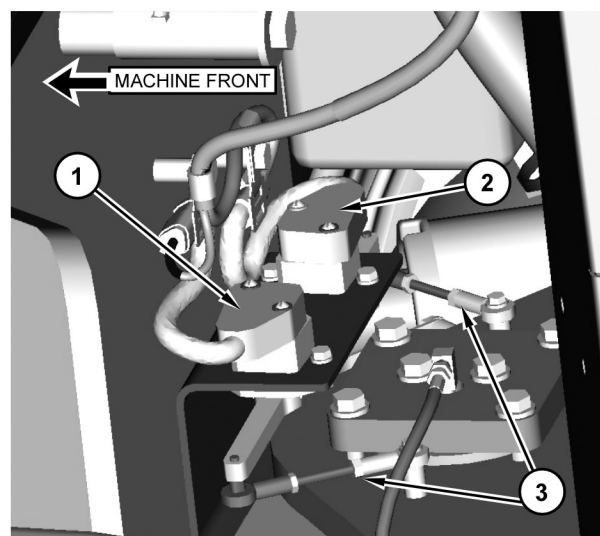


Illustration 353

g03663349

Locations of Articulation Angle Sensors

- (1) Articulation angle sensor 1
- (2) Articulation angle sensor 2
- (3) Mechanical linkage

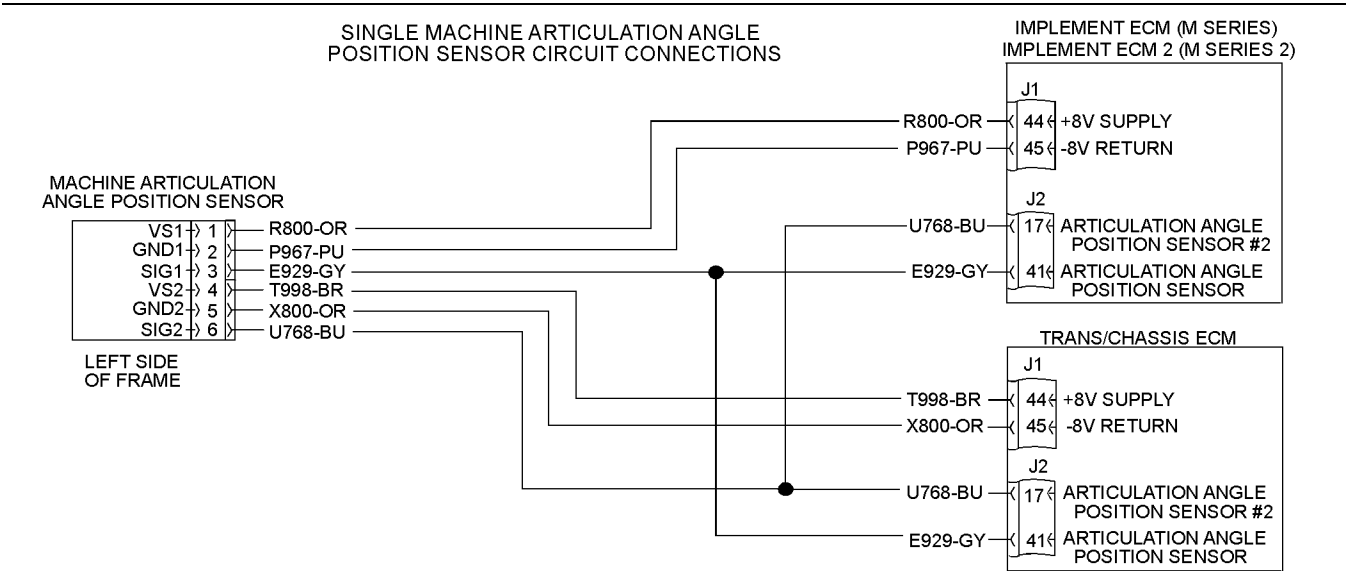


Illustration 354 g03655165

Single Sensor with two outputs
This single sensor sends a signal 1 to J2-41 and signal 2 to J2-17

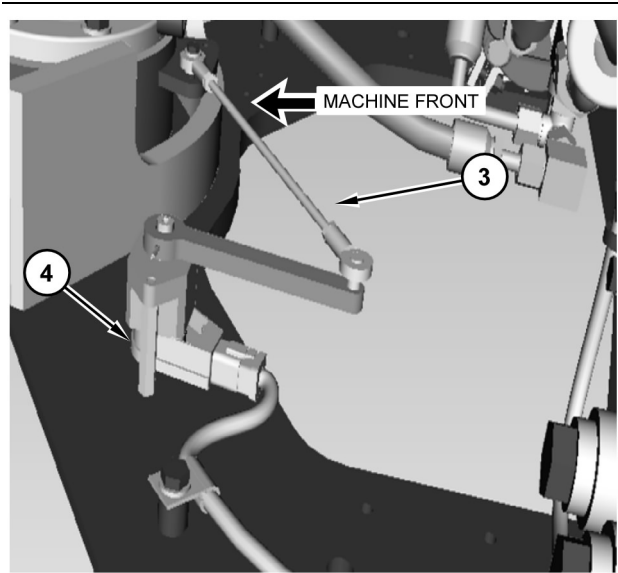


Illustration 355 g03655166
"Machine Articulation Angle Position Sensor" location
(View from the left side of the machine at the articulation hitch)
(3) Mechanical linkage
(4) "Articulation angle sensor"

Two articulation angle sensor signals are required for correct operation of the function for the articulation on the machine. Either the two separate sensors or the dual output sensor will provide a PWM signal to the Implement ECM and to the Transmission/Chassis ECM.

This diagnostic code is associated with the number two sensor signal for the angle of machine articulation connected to each ECM at J2-17. A record is made of the FMI 14 diagnostic code. The record is made after the ECM detects that the signal from the sensor is incorrect.

The sensor is a PWM sensor that operates at a frequency of approximately 500 hertz. When the machine is in the neutral position, the input of the duty cycle of the sensor to the ECM is approximately 55%. When the machine is articulated to the full left position, the duty cycle will be approximately 33%. When the machine is articulated to the full right position, the duty cycle will be approximately 74%.

The possible causes of this diagnostic code are listed below:

- The mechanical linkage for the position sensor is not functioning correctly.
- The sensor needs to be calibrated.
- The sensor has failed.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, ensure that there are no active CID 0041 diagnostic codes for the power supply of the sensor (8 VDC). Ensure that the power supply for the "angle sensor" is correct.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic codes have been corrected.

Test Step 1. CHECK THE MECHANICAL LINKAGE

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Remove any guards or shielding for the articulation sensors.
- C. Check the mounting bolts for the articulation sensors. Ensure that the sensors are securely mounted.
- D. Visually inspect the mechanical linkage for the articulation sensors. Verify that all mechanical components are tight and that all mechanical components are in good condition. Verify that the adjustment of the linkage is correct.

Expected Result:

All mechanical linkage and adjustable components for the articulation sensor(s) are in good condition and no mechanical connections are loose.

Results:

- OK – All mechanical linkage and adjustment for the articulation sensor is correct. Proceed to Test Step 2.
- NOT OK – All mechanical linkage and adjustment for the articulation sensors is not correct.

Repair: Perform the maintenance that is required in order to correct the problem with the mechanical connections for the articulation sensor(s). After the problem has been corrected, verify that this diagnostic code is still active before proceeding with this procedure.

STOP.

Test Step 2. CALIBRATE THE POSITION SENSOR

- A. After the linkage for the sensor is verified to be correct, use the Caterpillar Electronic Technician (ET) service tool to perform the calibration procedure for the “articulation angle sensor 2”. Refer to Testing and Adjusting, REN9013, “Implement Electronic Control System” “Calibrations” for information on the method to access the articulation sensor calibration procedure.

Expected Result:

The calibration procedure has been performed for the machine “articulation sensor 2” and the FMI 14 diagnostic code is no longer active.

Results:

- OK – The calibration procedure has been performed for the machine “articulation sensor 2” and the FMI 14 diagnostic code is no longer active. NOTE: If the position sensor has been calibrated recently and the FMI 14 diagnostic code becomes active again after a short time, the linkage for the “articulation position” sensor is probably the cause of the problem. Repair the linkage for the sensor or replace the linkage for the sensor.

STOP.

- NOT OK – The calibration procedure has been performed for the machine “articulation sensor 2”, however, the FMI 14 diagnostic code is still active. The problem has not been corrected. Proceed to Test Step 3.

Test Step 3. CHECK THE SIGNAL CIRCUIT OF THE SENSOR

- A. The key start switch and the disconnect switch remain in the OFF position.
- B. Do not disconnect the harness connector from the sensor.
- C. At the back of the harness connector for the sensor, insert 7X - 1710 Multimeter Probes along return contact B (wire X800-OR(Orange)) and insert a multimeter probe along the signal wire C (wire U768-BU(Blue)).
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Monitor the signal of the sensor with a digital multimeter.
- F. Without disconnecting the sensor or the hardware that is associated with the sensor from the machine, articulate the machine through the full range of operation.

Expected Result:

The sensor's signal responds in the manner that is described at the beginning of this procedure.

Results:

- OK – The sensor's signal responds correctly. The sensor is operating correctly. Proceed to Test Step 4.
- NOT OK – The sensor's signal does not respond correctly. The sensor is not operating correctly.

Repair: Replace the “articulation angle 2” sensor. After the replacement of the sensor, the sensor must be calibrated. Refer to Testing and Adjusting, RENR9013, “Implement Electronic Control System” “Calibrations” for information on the method to access the articulation sensor calibration procedure.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the 2252 FMI 14 diagnostic code.

Expected Result:

The CID 2252 FMI 14 diagnostic code is not active.

Results:

- OK – The CID 2252 FMI 14 diagnostic code is not active. The diagnostic code does not exist at this time. The initial diagnostic code was probably caused by a poor connection or a short at one of the connectors that was disconnected and reconnected. Resume normal operation.

STOP.

- NOT OK – The CID 2252 FMI 14 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, replace the ECM that activated the diagnostic code. See Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

i02926840

MID 027 - CID 2304 - FMI 03

SMCS Code: 4493-038

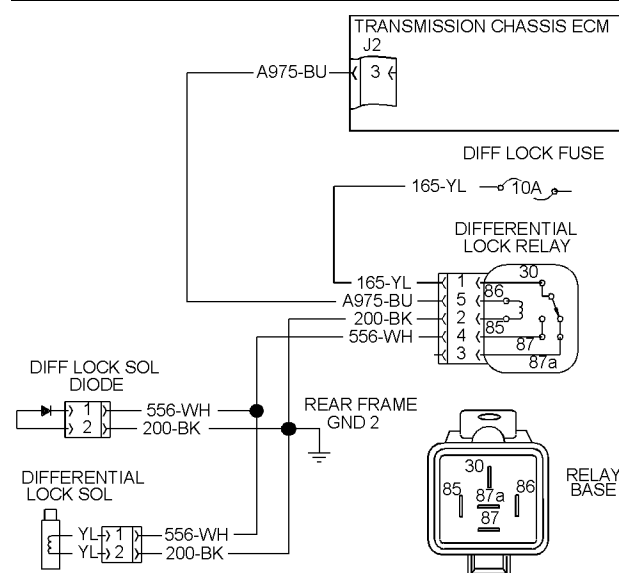
Conditions Which Generate This Code:

Illustration 356

g01322415

Connections of “Differential Lock” relay

This diagnostic code is associated with the “differential lock” relay. The “differential lock relay” is controlled by the ECM through an “ON/OFF” output driver. The FMI 03 means that the ECM has determined that the voltage is present in the relay circuit when the output driver is OFF.

The conditions that could cause this diagnostic code to activate are listed below:

- The relay has failed.
- The energize circuit of the relay is shorted to another voltage source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE RELAY

- A. Turn the key start switch and the disconnect switch to the ON position.
- B. Observe the status of the active CID 2304 FMI 03 diagnostic code and disconnect the “differential lock relay” from the machine harness.
- C. At the relay, measure the resistance of the coil between contact 85 and contact 86. Measure the resistance between power contact 30 and all of the other relay contacts.

Expected Result:

When the relay is disconnected from the harness, the status of the active CID 2304 FMI 03 diagnostic code does not change.

The resistance of the relay coil is in the range of 288 to 396 ohms at 25 °C (77 °F).

The resistance measurement between power contact 30 and contact 87a is less than 5 ohms. The measurement of the resistance between the power contact 30 and all the other contacts of the relay is greater than 5000 ohms.

Results:

- YES – All of the checks for the relay are correct. The relay is not the cause of the problem. The CID 2304 FMI 03 diagnostic code is still active. Proceed to Test Step 2.
- NO – The active CID 2304 FMI 03 diagnostic code became inactive when the relay was disconnected. The resistance checks are not correct, according to the expected results that are listed above. The relay has failed.

Repair: Verify that the relay has failed by substituting a known good relay that is the same part number for the faulty relay. The relay for the backlight can be substituted. Replace the faulty relay.

STOP.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE RELAY FOR A SHORT

The relay remains disconnected from the machine harness.

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.

- C. At the machine harness connector J2 for the ECM, measure the resistance from contact J2-3 (wire A975-BU(Blue)) to all of the other contacts that are used in the machine harness connectors J1 and J2 for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The energize circuit is not shorted to another circuit in the machine harness. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J2-3 (wire A975-BU(Blue)) and the circuit that has a low resistance measurement.

Repair: Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the relay circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, “Wiring Harness (Short Circuit) - Test”. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2304 FMI 03 diagnostic code is active.

Expected Result:

The CID 2304 FMI 03 diagnostic code is active.

Results:

- YES – The CID 2304 FMI 03 diagnostic code is active. The problem has not been corrected.

Repair: Check the relay circuit again. Perform a “wiggle test” on the wiring harness of the machine. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Troubleshooting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 2304 FMI 03 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection, a short at one of the harness connectors or a loose connection at the base of the relay that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02926863

MID 027 - CID 2304 - FMI 05

SMCS Code: 4493-038

S/N: B921-Up

S/N: B551-Up

S/N: B561-Up

S/N: B571-Up

S/N: B591-Up

S/N: R9A1-Up

S/N: R9B1-Up

S/N: B9C1-Up

S/N: R9C1-Up

S/N: B9D1-Up

S/N: B9E1-Up

S/N: B9F1-Up

S/N: B9G1-Up

S/N: D9G1-Up

S/N: B9H1-Up

S/N: B9J1-Up

S/N: B9L1-Up

S/N: B9M1-Up

S/N: B9R1-Up

S/N: B9T1-Up

S/N: D9T1-Up

S/N: B9W1-Up

S/N: D9W1-Up

Conditions Which Generate This Code:

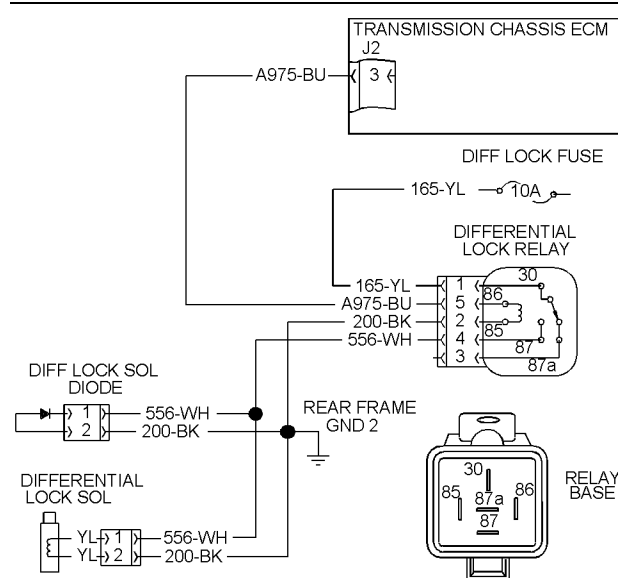


Illustration 357

q01322415

Connections of “Differential Lock Relay”

This diagnostic code is associated with the “differential lock relay” . The “differential lock relay” is controlled by the ECM through an “ON/OFF” output driver. The FMI 05 means that the ECM has energized the output for the relay and the current for the relay circuit is below normal.

The conditions that could cause this diagnostic code to activate are listed below:

- The relay has failed.
- The energize circuit of the relay has an open connection or a bad connection in the machine harness.

- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE RELAY

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector from the relay.
- At the harness connector for the relay, connect a jumper wire between contact 5 (wire A975-BU(Blue)) and contact 2 (wire 200-BK(Black)).
- Turn the disconnect switch and the key start switch to the ON position.
- Observe the status of the active CID 2304 FMI 05 diagnostic code.

Expected Result:

The active CID 2304 FMI 05 diagnostic code is no longer active when the key start switch is turned ON. A CID 2304 FMI 06 diagnostic code is now active.

Results:

- YES – The CID 2304 FMI 05 diagnostic code is no longer active. The CID 2304 FMI 06 diagnostic code becomes active after the key start switch is turned ON.

Repair: The relay is the cause of the problem. Verify that the relay has failed by substituting a known good relay that is the same part number as the faulty relay. The backlight relay can be substituted. Replace the faulty relay.

STOP.

- NO – The jumper wire does not affect the status of the active CID 2304 FMI 05 diagnostic code when the key start switch is turned ON. The relay is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE RELAY CIRCUIT FOR AN OPEN

The relay remains disconnected from the machine harness. The jumper wire remains connected between contact 5 and contact 2.

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector J2 from the Transmission/Chassis ECM.
- At the machine harness connector J2 for the ECM, measure the resistance between contact J2-3 (wire A975-BU(Blue)) and a good ground contact on the frame.

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The energize circuit and the ground circuit are not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open or a bad connection in the ground circuit at the frame or the energize circuit of the relay.

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is not connected or that a wire is open. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points or a splice in the circuit is not an open connection but not a good connection.

Determine if the energize circuit or the return circuit is the cause of the problem. Disconnect the jumper wire. Use a spare length of wire in order to check the resistance of the energize circuit and the ground circuit individually.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

Start at either the ECM connector or the component connector for the faulty circuit. Check the wire for an open connection or a bad connection point by working through the circuit in order to isolate the location of the problem. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all harness connectors in order to make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2304 FMI 05 diagnostic code is active.

Expected Result:

The CID 2304 FMI 05 diagnostic code is active.

Results:

- YES – The CID 2304 FMI 05 diagnostic code is active. The problem has not been corrected.

Repair: Check the relay circuit again. Perform a “wiggle test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Troubleshooting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NO – The CID 2304 FMI 05 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors or at the base of the relay that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02926884

MID 027 - CID 2304 - FMI 06

SMCS Code: 4493-038

Conditions Which Generate This Code:

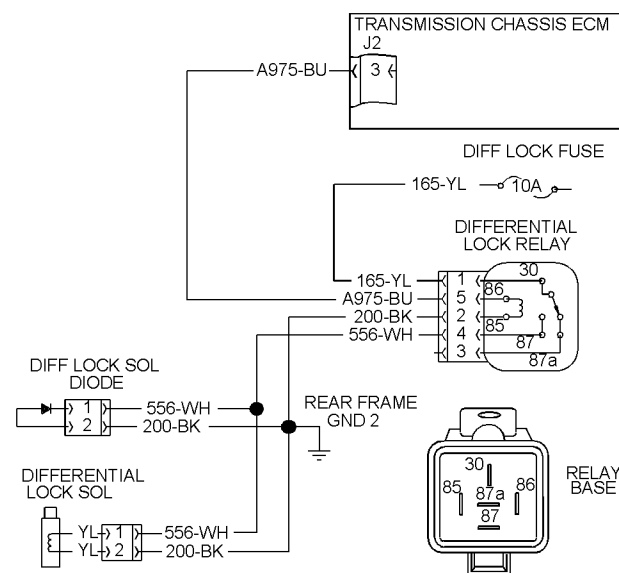


Illustration 358

g01322415

Connections of “Differential Lock Relay”

This diagnostic code is associated with the “differential lock relay”. The “differential lock relay” is controlled by the ECM through an “ON/OFF” output driver. The FMI 06 means that the ECM has energized the output for the relay and the current for the relay circuit is above normal.

The conditions that could cause this diagnostic code to activate are listed below:

- The relay has failed.
- The energize circuit of the relay is shorted to a ground source.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE RELAY

- A. Turn the key start switch and the disconnect switch to the ON position.
- B. Observe the status of the active CID 2304 FMI 06 diagnostic code and disconnect the machine harness connector from the relay.

Expected Result:

When the relay is disconnected from the harness, the CID 2304 FMI 06 diagnostic code is no longer active. A CID 2304 FMI 05 is now active.

Results:

- YES – When the relay is disconnected from the harness, the CID 2304 FMI 06 diagnostic code is no longer active. A CID 2304 FMI 05 diagnostic code becomes active. The relay is the cause of the problem.

Repair: Verify that the relay has failed by substituting a known good relay that is the same part number as the faulty relay. The backlight relay can be substituted. Replace the faulty relay.

STOP.

- NO – The status of the active CID 2304 FMI 06 diagnostic code did not change when the relay was disconnected from the machine harness. The relay is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE RELAY FOR A SHORT

The relay remains disconnected from the machine harness.

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connectors J1 and J2 from the Transmission/Chassis ECM.
- C. At the machine harness connector J2 for the ECM, measure the resistance from contact J2-3 (wire A975-BU(Blue)) to frame ground. Measure the resistance from contact J2-3 (wire A975-BU(Blue)) to all of the other contacts that are used in the machine harness connectors J1 and J2 for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The energize circuit is not shorted to frame ground or to another circuit in the machine harness. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between wire A975-BU(Blue) and the ground connection at the frame or the short might be between the voltage connection and the wire with the low resistance reading.

Repair: Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the relay circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- B. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the circuit.
- C. Reconnect all harness connectors in order to make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Operate the machine.
- F. Determine if the CID 2304 FMI 06 diagnostic code is active.

Expected Result:

The CID 2304 FMI 06 diagnostic code is active.

Results:

- YES – The CID 2304 FMI 06 diagnostic code is active. The problem has not been corrected.

Repair: Check the relay circuit again. Perform a “wiggle test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Troubleshooting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NO – The CID 2304 FMI 06 diagnostic code is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors or at the base of the relay that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02926903

MID 027 - CID 2734 - FMI 03

SMCS Code: 7332-038-BRK

Conditions Which Generate This Code:

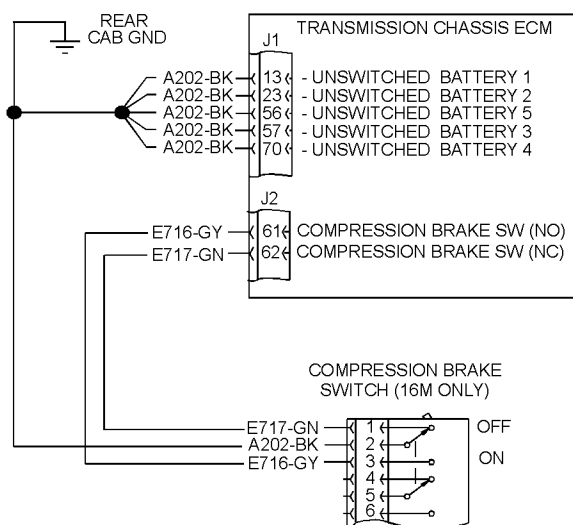


Illustration 359

g01378651

Connections of “Compression Brake” switch

The “compression brake” switch is equipped exclusively on the 16M Motor Grader.

The “compression brake” switch is a two pole, double-throw switch. One pole is used to provide two switch to ground inputs to the ECM in order to indicate the status of the switch. The other pole of the switch is not used for operation with the ECM.

During normal operation, one of the inputs is not connected to ground and the other input is connected to ground through the switch contacts. An internal pull-up voltage is present at the ECM switch inputs. When the input is grounded through the switch, the ECM detects the ground signal.

The FMI 03 diagnostic code is activated by the ECM when neither of the inputs is showing a ground signal.

The conditions that could cause the ECM to activate this diagnostic code are listed below:

- The switch has failed.
- The common ground circuit is an open connection or a bad connection.
- There is an open or a bad connection in one or both of the switch input circuits.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SWITCH

Table 32

States of Contact for “Compression Brake” Switch		
Switch Position	OFF Input J2-62 (wire E717-GN(Green))	ON Input J2-61 (wire E716-GY(Grey))
Compression Brake ON	Open ⁽¹⁾	Closed ⁽²⁾
Compression Brake OFF	Closed	Open

⁽¹⁾ Open to common ground A202-BK(Black).

⁽²⁾ CLOSED to common ground A202-BK(Black).

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector from the switch.
- C. With the switch in the ON position, measure the resistance from common contact of the switch 2 to input contact of the switch 1. Compare the measurement of the switch to the "contact status table" above.
- D. With the switch in the ON position, measure the resistance from common contact of the switch 2 to input contact of the switch 3. Compare the measurement of the switch to the "contact status table" above.
- E. Move the switch to the OFF position and repeat Steps "C" and "D".

Expected Result:

The resistance measurements in each switch position are correct according to the "contact status table" for the switch at the beginning of this test step.

Results:

- YES – All of the resistance checks for the switch are correct in each position of the switch according to the "contact status" table. The switch is working correctly. Proceed to Test Step 2.
- NO – The states of the switch are not correct according to the "contact status table" for the switch. The switch has failed.

Repair: Replace the "compression brake" switch. After the switch is replaced, verify that the operation of the switch is correct before operating the machine.

STOP.

Test Step 2. CHECK THE COMMON GROUND CIRCUIT OF THE SWITCH FOR AN OPEN

The key start switch and the disconnect switch remain in the OFF position. The machine harness remains disconnected from the switch.

- A. At the machine harness connector for the switch, measure the resistance between the common ground contact of the switch 2 (wire A202-BK(Black)) and frame ground.
- B. Observe the resistance measurement of the multimeter and wiggle the machine harness connector for the switch. Gently pull on the wires and wiggle the wires.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the harness.

Results:

- OK – The resistance measurement is less than 5 ohms. The common ground circuit of the switch is correct. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5 ohms. There is an open connection or a bad connection in the common ground circuit of the switch (wire A202-BK(Black)).

Repair: A resistance measurement that is greater than 5000 ohms could indicate that a wire is not connected or that a wire is open. A resistance measurement that is greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points or that a splice in the ground circuit is not an open connection but not a good connection.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the ground circuit. Start checking the circuit from the switch and work your way back to the ground terminal connections located at the rear of the cab. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE INPUT CIRCUITS OF THE SWITCH FOR AN OPEN

The key start switch and the disconnect switch remain in the OFF position. The machine harness remains disconnected from the switch.

- A. At the machine harness connector for the switch, place a jumper wire between input contact 1 (wire E717-GN(Green)) and input contact 3 (wire E716-GY(Grey)).
- B. Disconnect the machine harness connectors J1 and J2 from the ECM.
- C. At the machine harness connector of the ECM J2, measure the resistance from input contact of the switch J2-62 (wire E717-GN(Green)) to the input contact of the switch J2-61 (wire E716-GY(Grey)).
- D. Observe the resistance measurement of the multimeter and wiggle the machine harness connectors for the ECM. Gently pull on the wires and wiggle the wires.

- E.** Observe the resistance measurement of the multimeter and wiggle the machine harness connector for the switch. Gently pull on the wires and wiggle the wires. Do not disconnect the jumper wire.

Expected Result:

The resistance measurement is less than 5 ohms at all times during the manipulation of the harness.

Results:

- OK – The resistance measurement is less than 5 ohms. The input circuits of the switch are not open in the machine harness. Proceed to Test Step 4.
- NOT OK – The resistance measurement is greater than 5 ohms. There is a problem with one or both of the input circuits of the switch in the machine harness.

Repair: Refer to the illustration of the connection diagram at the beginning of this procedure.

Connect one end of the jumper wire to the harness connector of the switch, contact 2 (wire A202-BK(Black)).

One at a time, connect the other end of the jumper wire to each of the inputs of the switch. Check the resistance at the harness connector of the ECM J1 from the appropriate input contact to one of the ground contacts (wire A202-BK(Black)) that are used on the J1 connector. This will identify the input circuit that is an open connection or a bad connection.

A resistance measurement that is greater than 5000 ohms could indicate that a wire is not connected or that a wire is open. A resistance measurement that is greater 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the faulty input circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A.** Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.

- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- D.** Turn the disconnect switch and the key start switch to the ON position.
- E.** Operate the machine.
- F.** Check the status of the CID 2734 FMI 03 diagnostic code.

Expected Result:

The CID 2734 FMI 03 diagnostic code is active.

Results:

- YES – The CID 2734 FMI 03 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the input circuits of the switch again. Perform a “wiggle test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause can not be found, the ECM may have failed. Verify that all possible causes of the diagnostic code have been investigated before replacement of the ECM.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NO – The CID 2734 FMI 03 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i02926947

MID 027 - CID 2734 - FMI 04

SMCS Code: 7332-038-BRK

Conditions Which Generate This Code:

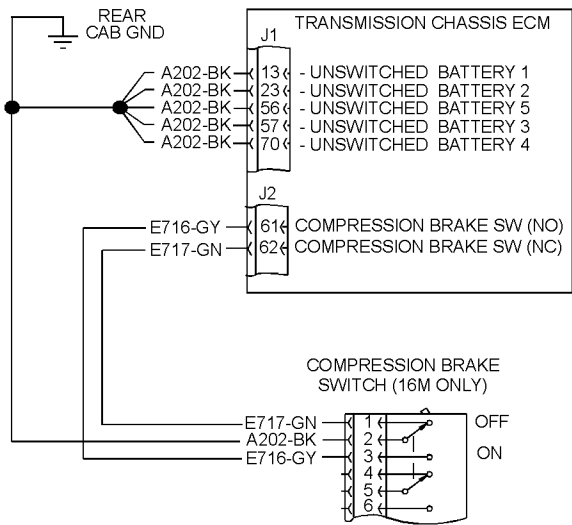


Illustration 360

g01378651

Connections of "Compression Brake" switch

The "compression brake" switch is exclusively equipped on the 16M Motor Grader.

The "compression brake" switch is a two pole, double-throw switch. One pole is used to provide two switch to ground inputs to the ECM in order to indicate the status of the switch. The other pole of the switch is not used for operation with the ECM.

During normal operation, one of the inputs is not connected to ground and the other input is connected to ground through the contacts of the switch. An internal pull-up voltage is present at the inputs of the switch. When the input is grounded through the switch, the ECM detects the ground signal.

The FMI 04 diagnostic code is activated by the ECM when both of the inputs are showing a ground signal at the same time.

The conditions that could cause the ECM to activate this diagnostic code are listed below:

- The switch has failed.
- There is a short to a ground source in one or both of the switch input circuits.
- The ECM has failed. This is unlikely.

Note: Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may cause other diagnostic codes to be activated. Ignore these created diagnostic codes and clear the diagnostic codes when the problem has been corrected.

Test Step 1. CHECK THE SWITCH

Table 33

States of Contact for the "Compression Brake" Switch		
Position of Switch	OFF Input J2-62 (wire E717-GN(Green))	ON Input J2-61 (wire E716-GY(Grey))
"Compression Brake" ON	OPEN ⁽¹⁾	CLOSED ⁽²⁾
"Compression Brake" OFF	CLOSED	OPEN

(1) Open to common ground A202-BK(Black).

(2) Closed to common ground circuit A202-BK(Black).

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the harness connector of the machine from the switch.
- With the switch in the ON position, measure the resistance from the common contact of the switch 2 to the input contact of the switch 1. Compare the measurement to the contact status table for the switch (above).
- With the switch in the ON position, measure the resistance from the common contact of the switch 2 to the input contact of the switch 3. Compare the measurement to the contact status table of the switch (above).
- Move the switch to the OFF position and repeat Steps "C" and "D" .

Expected Result:

The resistance measurements in each position of the switch agree with the contact status table for the switch at the beginning of this test step.

Results:

- YES – All of the resistance checks for the switch are correct in each of the positions of the switch, according to the contact status table. The switch is working correctly. Proceed to Test Step 2.
- NO – The states of the switch are not correct according to the contact status table for the switch. The switch has failed.

Repair: Replace the “compression brake” switch. After the switch is replaced, verify that the operation of the switch is correct before operating the machine.

STOP.

Test Step 2. CHECK THE SWITCH INPUT CIRCUITS FOR A SHORT

The key start switch and the disconnect switch remain in the OFF position. The machine harness remains disconnected from the switch.

- Disconnect the machine harness connectors J1 and J2 from the ECM.
- At the machine harness connector J2 for the ECM, measure the resistance between input contact of the switch J2-61 (wire E716-GY(Grey)) and frame ground. Measure the resistance between the input contact of the switch J2-61 (wire E716-GY(Grey)) and all of the other contacts that are used in the J1 and J2 harness connectors for the ECM.
- At the machine harness connector J2 for the ECM, measure the resistance between the input contact of the switch J2-62 (wire E717-GN(Green)) and frame ground. Measure the resistance between the input contact of the switch J2-62 (wire E717-GN(Green)) and all of the other contacts that are used in the J1 and J2 harness connectors for the ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The input circuits of the switch are not shorted to ground or to another circuit in the machine harness. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short to ground or to another circuit in the machine harness.

Repair: The input circuit that checks the low resistance to frame ground or to another circuit is the cause of the problem.

Refer to the complete Electrical System Schematic of the machine. Check all of the connectors that are in the faulty input circuit. Ensure that all connections are clean, that all connections are secure and that all connections are in good condition.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, “Wiring Harness (Short Circuit) - Test”. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the harness connectors. Clean the contacts of the harness connectors. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 2734 FMI 04 diagnostic code.

Expected Result:

The CID 2734 FMI 04 diagnostic code is active.

Results:

- YES – The CID 2734 FMI 04 diagnostic code is active. The diagnostic code has not been corrected.

Repair: Check the input circuits of the switch again. Perform a “wiggle test” on the machine wiring harness. Use the Caterpillar Electronic Technician (ET) in order to perform the test. The “wiggle test” can detect intermittent shorts or open connections in the machine wiring harness.

If the cause can not be found, the ECM may have failed. Verify that all possible causes of the diagnostic code have been investigated before replacement of the ECM.

Diagnostic Code Procedures

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 2734 FMI 04 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i06193469

MID 027 - CID 2976 - FMI 03

SMCS Code: 1439-038-PX; 4278-038-PXS; 429F-038-PXS

Conditions Which Generate This Code:

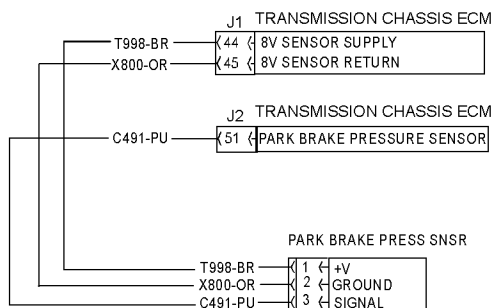


Illustration 361

g03844959

Schematic of the "park brake oil pressure" sensor

This diagnostic code is associated with the "park brake oil pressure" sensor. The FMI 03 means that the ECM has determined that the voltage of the circuit for the sensor is above normal. Refer to Systems Operation, "Sensors" for information regarding the operation of the sensor and the location.

The temperature sensor is a PWM sensor that uses a frequency of the approximately 500 Hz. The duty cycle operates from a range of 10% to 90%.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is open.

- The signal circuit for the sensor is shorted to the +battery circuit.
- The sensor has failed.
- The power circuit or the ground circuit has failed.
- The Transmission ECM has failed. The ECM failing is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 2976 FMI 03 is active before performing this procedure.**

Note: Use the 146 - 4080 Digital Multimeter for the measurements in this procedure.

WARNING

When it is necessary to work under the machine with the body (bed) raised, attach the body (bed) retaining cables to the rear tow points. Install the rear tow point pins through the ends of the retaining cables.

Failure to properly secure the body (bed) may result in personal injury or death.

Test Step 1. CHECK FOR POWER AT THE SENSOR.

- Do not disconnect the harness connector from the sensor.
- Turn the key start switch and the disconnect switch to the ON position.
- At the back of the harness connector for the sensor, insert a 7X - 1710 Multimeter Probe along the voltage supply wire at contact 1 (T998-BR(Brown)).
- Measure the voltage from contact 1 to frame ground.

Expected Result:

The voltage is 8 DCV.

Results:

- OK – The voltage is 8 DCV. Proceed to Test Step 2.
- NOT OK – The voltage is not 8 DCV. The + battery circuit in the machine harness has failed.

Repair: Replace the machine harness or repair the machine harness.

STOP.

Test Step 2. CHECK FOR PROPER GROUND AT THE SENSOR.

- A. The machine harness remains connected to the sensor.
- B. Turn the key start switch and the disconnect switch to the OFF position.
- C. Remove the 7X-1710 Multimeter Probe from the voltage supply wire (T998-BR(Brown)).
- D. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the ground wire at contact 2 (X800-OR(Orange)).
- E. Measure the resistance from contact 2 to frame ground.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The ground circuit is correct. Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5 ohms. The ground circuit in the machine harness has failed.

Repair: Replace the machine harness or repair the machine harness.

STOP.

Test Step 3. CHECK THE WIRING HARNESS OF THE SENSOR FOR AN OPEN CIRCUIT.

- A. The key start switch and the disconnect switch remain in the OFF position.
- B. Disconnect the machine harness from the sensor.
- C. At the harness connector for the sensor, connect a jumper wire between contact 2 (X800-OR(Orange)) and contact 3 (C491-PU(Purple)).
- D. Disconnect the machine harness connector from the Transmission ECM.

- E. At the harness connector for the ECM, measure the resistance between contact J1-45 (wire X800-OR(Orange)) and contact J2-51 (wire C491-PU(Purple)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The circuit is correct. Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The circuit is not correct. There is an open circuit in the wiring harness.

Repair: There is an open circuit in the wiring harness. Repair the wiring harness or replace the wiring harness.

STOP.

Test Step 4. CHECK THE WIRING HARNESS OF THE SENSOR FOR A SHORT TO THE +BATTERY CIRCUIT.

- A. The key start switch and the disconnect switch remain in the OFF position.
- B. The machine harness remains disconnected from the sensor. Remove the jumper wire that was installed in the previous step.
- C. The machine harness connector remains disconnected from the ECM.
- D. At the machine harness connector for the ECM, measure the resistance from the signal contact J2-24 (wire 491-YL(Yellow)) of the machine harness to all contacts that are used in the machine harness connectors for the Transmission ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 5.
- NOT OK – One or more resistance measurements are not correct. There is a short in the machine harness.

Repair: The short is between signal contact J2-51 (wire C491-PU(Purple)) and the circuit with

the low resistance measurement. Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE OUTPUT OF THE SENSOR.

- A. Reconnect the machine harness connectors to the Transmission Chassis ECM. Reconnect the machine harness connector to the sensor.
- B. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the signal wire (contact C).
- C. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the ground wire (contact B).
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Measure the signal of the sensor. The proper signal is described at the beginning of this procedure.

Expected Result:

The signal from the sensor is valid.

Results:

- OK – The signal from the sensor is valid. Proceed to Test Step 6.
- NOT OK – The signal from the sensor is not valid.

Repair: The sensor has failed. Replace the sensor.

STOP.

Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

- A. Inspect the contacts of the harness connectors and clean the connectors.
- B. Reconnect all harness connectors.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Operate the machine.
- E. Check the status of the CID 2976 FMI 03 diagnostic code.

Expected Result:

The CID 2976 FMI 03 diagnostic code is active.

Results:

- YES – The CID 2976 FMI 03 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: An ECM failure is unlikely. Exit this procedure and perform this procedure again. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 2976 FMI 03 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i06193485

MID 027 - CID 2976 - FMI 04

SMCS Code: 1439-038-PX; 4278-038-PXS; 429F-038-PXS

Conditions Which Generate This Code:

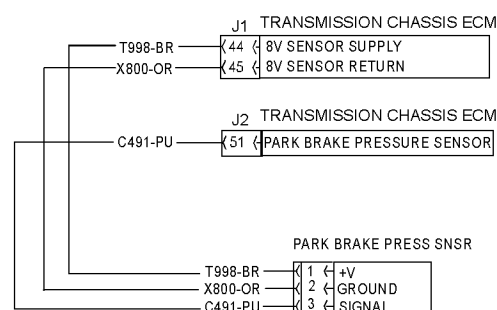


Illustration 362

g03844974

Schematic of the "park brake oil pressure" sensor

This diagnostic code is associated with the "park brake oil pressure" sensor. The FMI 04 means that the ECM has determined that the voltage of the circuit for the position sensor is below normal.

The pressure sensor is a PWM sensor that uses a frequency of the approximately 500 Hz. The duty cycle operates from a range of 10% to 90%.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is shorted to ground.
- The sensor has failed.
- The Transmission ECM has failed. The ECM failing is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 2976 FMI 04 is active before performing this procedure.**

Note: Use the 146-4080 Digital Multimeter for the measurements in this procedure.

WARNING

When it is necessary to work under the machine with the body (bed) raised, attach the body (bed) retaining cables to the rear tow points. Install the rear tow point pins through the ends of the retaining cables.

Failure to properly secure the body (bed) may result in personal injury or death.

Test Step 1. CHECK THE SENSOR

- Turn the disconnect switch and the key start switch to the ON position.
- Ensure that the diagnostic code is active.
- Observe the status of the diagnostic code.
Disconnect the sensor from the machine harness.

Expected Result:

The CID 2976 FMI 04 diagnostic code remains active.

Results:

- OK – The diagnostic code remains active. The sensor is correct. Proceed to Test Step 2.
- NOT OK – The diagnostic code is no longer active. The sensor has failed.

Repair: Replace the sensor.

STOP.

Test Step 2. CHECK THE WIRING HARNESS OF THE SENSOR FOR A SHORT TO GROUND.

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness from the sensor.
- Disconnect the machine harness connector from the ECM.
- At the machine harness connector for the ECM, measure the resistance from the signal contact J2-51 (wire C491-PU(Purple)) of the machine harness to all possible sources of ground. Measure the resistance to all contacts of the machine harness connectors for the Transmission ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more resistance measurements are not correct. There is a short in the machine harness.

Repair: The short is between signal contact J2-51 (wire C491-PU(Purple)) and the circuit with the low resistance measurement. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK IF THE DIAGNOSTIC CODE REMAINS.

- Inspect the contacts of the harness connectors and clean the contacts.
- Reconnect all harness connectors.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 2976 FMI 04 diagnostic code.

Expected Result:

The CID 2976 FMI 04 diagnostic code is active.

Diagnostic Code Procedures

Results:

- YES – The CID 2976 FMI 04 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: An ECM failure is unlikely. Exit this procedure and perform this procedure again. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, refer to Testing and Adjusting, “Electronic Control Module (ECM) - Replace”.

STOP.

- NO – The CID 2976 FMI 04 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i06193502

MID 027 - CID 2976 - FMI 08

SMCS Code: 1439-038-PX; 4278-038-PXS; 429F-038-PXS

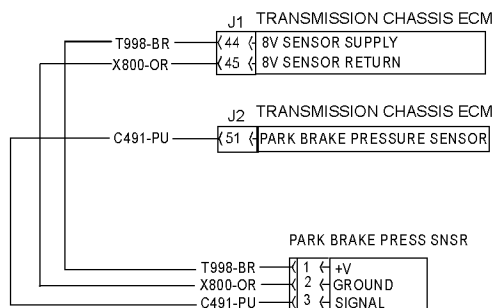
Conditions Which Generate This Code:

Illustration 363

g03844983

Schematic of the “park brake oil pressure” sensor

This diagnostic code is associated with the “park brake oil pressure” sensor. The FMI 08 means that the Transmission ECM has determined that the signal of the circuit for the sensor is abnormal. Refer to Systems Operation, “Sensors” for information regarding the operation of the sensor and the location.

The temperature sensor is a PWM sensor that uses a frequency of the approximately 500 Hz. The duty cycle operates from a range of 10% to 90%.

The possible causes of this diagnostic code are listed below:

- The signal circuit for the sensor is open.
- The signal circuit for the sensor is shorted to the +battery circuit.
- The sensor has failed.
- The power circuit or the ground circuit has failed.
- The Transmission ECM has failed. An ECM failure is unlikely.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear the diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 2976 FMI 08 is active before performing this procedure.**

Note: Use the 146 - 4080 Digital Multimeter for the measurements in this procedure.

⚠ WARNING

When it is necessary to work under the machine with the body (bed) raised, attach the body (bed) retaining cables to the rear tow points. Install the rear tow point pins through the ends of the retaining cables.

Failure to properly secure the body (bed) may result in personal injury or death.

Test Step 1. CHECK FOR POWER AT THE SENSOR.

- Do not disconnect the harness connector from the sensor.
- Turn the key start switch and the disconnect switch to the ON position.
- At the back of the harness connector for the sensor, insert a 7X - 1710 Multimeter Probe along the voltage supply wire at contact 1 (T998-BR(Brown)).
- Measure the voltage from contact 1 to frame ground.

Expected Result:

The voltage is 8 DCV.

Results:

- OK – The voltage is 8 DCV. Proceed to Test Step 2.
- NOT OK – The voltage is not 8 DCV. The + battery circuit in the machine harness has failed.

Repair: Replace the machine harness or repair the machine harness.

STOP.

Test Step 2. CHECK FOR PROPER GROUND AT THE SENSOR.

- A. The machine harness remains connected to the sensor.
- B. Turn the key start switch and the disconnect switch to the OFF position.
- C. Remove the 7X-1710 Multimeter Probe from the voltage supply wire (T998-BR(Brown)).
- D. At the back of the harness connector for the sensor, insert a 7X-1710 Multimeter Probe along the ground wire at contact 2 (X800-OR(Orange)).
- E. Measure the resistance from contact 2 to frame ground.

Expected Result:

The resistance is less than 5 ohms.

Results:

- OK – The resistance is less than 5 ohms. The ground circuit is correct. Proceed to Test Step 3.
- NOT OK – The resistance is greater than 5 ohms. The ground circuit in the machine harness has failed.

Repair: Replace the machine harness or repair the machine harness.

STOP.

Test Step 3. CHECK THE WIRING HARNESS OF THE SENSOR FOR AN OPEN CIRCUIT.

- A. The key start switch and the disconnect switch remain in the OFF position.
- B. Disconnect the machine harness from the sensor.
- C. At the harness connector for the sensor, connect a jumper wire between contact 2 (X800-OR(Orange)) and contact 3 (C491-PU(Purple)).

- D. Disconnect the machine harness connector from the Transmission ECM.

- E. At the harness connector for the ECM, measure the resistance between contact J1-45 (wire X800-OR(Orange)) and contact J2-51 (wire C491-PU(Purple)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The resistance measurement is less than 5 ohms. The circuit is correct. Proceed to Test Step 4.
- NOT OK – The resistance is greater than 5 ohms. The circuit is not correct. There is an open circuit in the wiring harness.

Repair: There is an open circuit in the wiring harness. Repair the wiring harness or replace the wiring harness.

STOP.

Test Step 4. CHECK THE WIRING HARNESS OF THE SENSOR FOR A SHORT TO THE +BATTERY CIRCUIT.

- A. The key start switch and the disconnect switch remain in the OFF position.
- B. The machine harness remains disconnected from the sensor. Remove the jumper wire that was installed in the previous step.
- C. The machine harness connector remains disconnected from the ECM.
- D. At the machine harness connector for the ECM, measure the resistance from the signal contact J2-51 (wire C491-PU(Purple)) of the machine harness to all contacts that are used in the machine harness connectors for the Transmission ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 5.

Diagnostic Code Procedures

- NOT OK – One or more resistance measurements are not correct. There is a short in the machine harness.

Repair: The short is between signal contact J2-51 (wire C491-PU(Purple)) and the circuit with the low resistance measurement. Repair the machine harness or replace the machine harness.

STOP.

Test Step 5. CHECK THE OUTPUT OF THE SENSOR.

- Reconnect the machine harness connectors to the Transmission ECM. Reconnect the machine harness connector to the sensor.
- At the back of the harness connector for the sensor, insert a 7X - 1710 Multimeter Probe along the signal wire (contact C).
- At the back of the harness connector for the sensor, insert a 7X - 1710 Multimeter Probe along the ground wire (contact B).
- Turn the disconnect switch and the key start switch to the ON position.
- Measure the signal of the sensor. The proper signal is described at the beginning of this procedure.

Expected Result:

The signal from the sensor is valid.

Results:

- OK – The signal from the sensor is valid. Proceed to Test Step 6.
- NOT OK – The signal from the sensor is not valid.

Repair: The sensor has failed. Replace the sensor.

STOP.

Test Step 6. CHECK IF THE DIAGNOSTIC CODE REMAINS.

- Inspect the contacts of the harness connectors and clean the connectors.
- Reconnect all harness connectors.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.

- Check the status of the CID 2976 FMI 08 diagnostic code.

Expected Result:

The CID 2976 FMI 08 diagnostic code is active.

Results:

- YES – The CID 2976 FMI 08 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: An ECM failure is unlikely. Exit this procedure and perform this procedure again. Prior to replacing an ECM, always contact your dealership for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM requires replacement, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

- NO – The CID 2976 FMI 08 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i03618023

MID 027 - CID 3210 - FMI 03

SMCS Code: 5479-038-T3

Conditions Which Generate This Code:

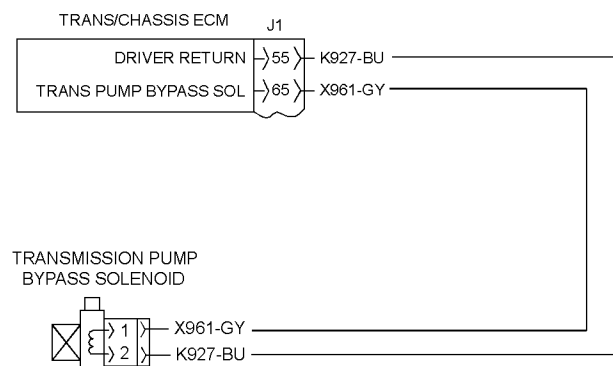


Illustration 364

g01941814

Circuit of the transmission pump bypass solenoid

This diagnostic code is associated with the transmission pump bypass solenoid. The FMI 03 means that the transmission/chassis electronic control module (ECM) has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.
- The energize circuit of the solenoid is shorted to the +battery circuit.
- The transmission/chassis ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 3210 FMI 03 is active before performing this procedure.**

Use a calibrated digital multimeter for the following procedures.

System Response:

The diagnostic code of CID 3210 FMI 03 will be logged in the internal memory of the transmission/chassis ECM.

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connectors from the solenoid and the transmission/chassis ECM.
- C. At the machine harness connector for the transmission/chassis ECM, measure the resistance from contact J1-65 (wire X961-GY(Grey)) to all contacts that are used in the machine harness connectors for the transmission/chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between J1-65 (wire X961-GY(Grey)) and the circuit that has a low resistance measurement.

Repair: Repair the machine harness or replace the machine harness. For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE RETURN CIRCUIT OF THE SOLENOID FOR A SHORT TO +BATTERY.

- A. The key start switch remains in the OFF position.
- B. The solenoid remains disconnected from the machine harness.
- C. The machine harness connectors J1 and J2 remain disconnected from the transmission/chassis ECM.
- D. At the machine harness for the solenoid, measure the voltage between the contact for (wire K927-BU(Blue)) and frame ground.

Expected Result:

The voltage is approximately 0.0 ± 0.5 DCV.

Results:

- OK – The voltage is approximately 0.0 ± 0.5 DCV. The voltage is correct. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between wire K927-BU(Blue) and the circuit that has a low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoid and the transmission/chassis ECM remain disconnected.

- A.** At the machine harness connector J1 of the ECM, remove the X961-GY (Grey) energize wire of the solenoid and remove the J1-65 socket from the harness connector. Perform these removals with a 151 - 6320 Removal Tool.
- B.** Reconnect the machine harness J1 and J2 connectors to the ECM.
- C.** Turn the disconnect switch and the key start switch to the ON position.
- D.** Observe the status of the active CID 3210 FMI 03 diagnostic code.

Expected Result:

The CID 3210 FMI 03 diagnostic code is no longer active. A CID 3210 FMI 05 diagnostic code is now active.

Results:

- YES – The CID 3210 FMI 03 diagnostic code is no longer active. A CID 3210 FMI 05 diagnostic code has been activated after the solenoid energize circuit was disconnected. The ECM has responded correctly to the open circuit condition in the solenoid circuit. Reinstall the energize wire of the solenoid into the correct space of the connector on the ECM. Proceed to Test Step 4.
- NO – The CID 3210 FMI 03 diagnostic code remains active. The status of the active diagnostic code did not change when the energize wire of the solenoid was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to the Testing and Adjusting, "Electronic Control Module (ECM) - Replace" Section of this manual.

STOP.

Test Step 4. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

- A.** Inspect the contacts and clean the contacts of the harness connectors.
- B.** Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- C.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- D.** Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- E.** Turn the disconnect switch and the key start switch to the ON position.
- F.** Operate the machine.
- G.** Determine if the CID 3210 FMI 03 is active.

Expected Result:

The CID 3210 FMI 03 is active.

Results:

- YES – The CID 3210 FMI 03 is active. The problem has not been corrected. The ECM may have failed.

Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to the Testing and Adjusting, "Electronic Control Module (ECM) - Replace" Section of this manual.

STOP.

- NO – The CID 3210 FMI 03 is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i03619040

MID 027 - CID 3210 - FMI 05

SMCS Code: 5479-038-T3

Conditions Which Generate This Code:

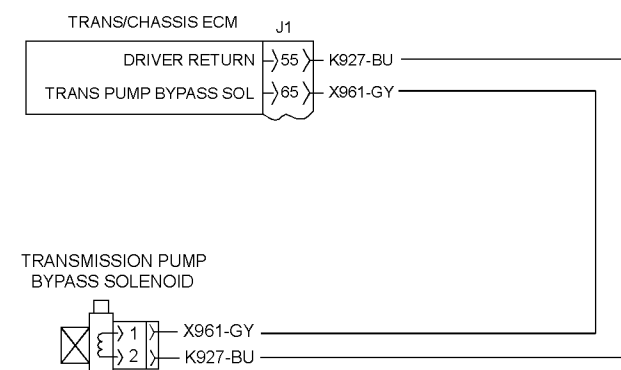


Illustration 365

g01941814

Circuit of the transmission pump bypass solenoid

This diagnostic code is associated with the transmission pump bypass solenoid. The FMI 05 means that the transmission/chassis electronic control module (ECM) has determined that the current for the solenoid circuit is below normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Use a calibrated digital multimeter for the following procedures.

Test Step 1. CHECK THE SOLENOID

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

- Disconnect the solenoid from the machine harness.
- At the machine harness connector for the solenoid, place a jumper wire from the contact for (wire K927-BU(Blue)) to the contact for (wire X961-GY(Grey)).
- Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- Observe the status of the CID 3210 FMI 05 diagnostic code.

Expected Result:

The active diagnostic code changes from an FMI 05 to an FMI 06 diagnostic code when the jumper wire is installed.

Results:

- YES – The active diagnostic code changes from an FMI 05 to an FMI 06 diagnostic code when the jumper wire is installed. The solenoid has failed.

Repair: The solenoid has failed. Repeat this Test Step “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

STOP.

- NO – The CID 3210 FMI 05 diagnostic code remains active. The jumper wire does not affect the status of the diagnostic code. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR AN OPEN

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connector J1 from the transmission/chassis ECM.
- The jumper wire that was installed in the previous test step remains in place.
- At the machine harness connector J1 for the transmission/chassis ECM, measure the resistance from the return contact J1-55 (wire K927-BU(Blue)) to the energize contact J1-65 (wire X961-GY(Grey)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

Diagnostic Code Procedures

- OK – The measurement of the resistance is less than 5 ohms. The circuit is not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5000 ohms. The resistance measurement is not correct. There is an open or a bad connection in the machine harness. A resistance measurement that is much greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

Repair: The open or the possible poor connection is in supply wire X961-GY(Grey) or in return wire K927-BU(Blue) of the machine harness. Refer to the complete Electrical Schematic of the machine. Check all of the connectors that are in the solenoid circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connector for the solenoid and the ECM J1 connector remain disconnected.

- Remove the jumper wire that was installed in the last test step.
- At the machine harness connector J1 of the ECM, remove the X961-GY(Grey) energize wire of the solenoid and remove the J1-65 socket from the harness connector. Perform these removals with a 151 - 6320 Removal Tool.
- Reconnect the machine harness J1 connector to the ECM.
- Turn the disconnect switch and the key start switch to the ON position.
- Use a 7X - 1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the ECM pin at J1-65 through the empty space in the J1 connector.
- Observe the status of the active CID 3210 FMI 05 diagnostic code and ground the other end of the 7X - 1710 Multimeter Probe to frame ground.

Expected Result:

The CID 3210 FMI 05 diagnostic code is no longer active. A CID 3210 FMI 06 diagnostic code becomes active when the ECM pin at J1-65 is grounded.

Results:

- YES – The CID 3210 FMI 05 diagnostic code is no longer active. A CID 3210 FMI 06 diagnostic code has been activated after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition in the solenoid circuit. The problem is probably not being caused by the ECM. Reinstall the energize wire of the solenoid into the correct spot of the connector on the ECM. Proceed to Test Step 4.
- NO – The CID 3210 FMI 05 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin for the solenoid is grounded.

Repair: The ECM has not responded correctly to the grounded condition in the solenoid circuit. The ECM may have failed.

If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the transmission/chassis ECM. If the ECM must be replaced, refer to the Testing and Adjusting, "Electronic Control Module (ECM) - Replace" Section of this manual.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the contacts and clean the contacts of the harness connectors.
- Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 3210 FMI 05 diagnostic code.

Expected Result:

The CID 3210 FMI 05 diagnostic code is active.

Results:

- YES – The CID 3210 FMI 05 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the circuit again. Perform a wiggle test on the machine wiring harness with the Caterpillar Electronic Technician (Cat ET) service tool. The wiggle test can detect intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed. This is unlikely as the ECM responded correctly to the grounded condition in the previous test step.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the transmission/chassis ECM. If the ECM must be replaced, refer to the Testing and Adjusting, "Electronic Control Module (ECM) - Replace" Section of this manual.

STOP.

- NO – The CID 3210 FMI 05 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i03619280

MID 027 - CID 3210 - FMI 06

SMCS Code: 5479-038-T3

Conditions Which Generate This Code:

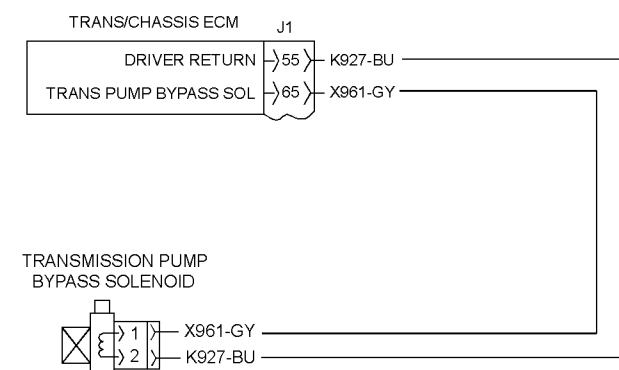


Illustration 366

g01941814

Circuit of the transmission pump bypass solenoid

This diagnostic code is associated with the transmission pump bypass solenoid. The FMI 06 means that the transmission/chassis electronic control module (ECM) has determined that the current of the solenoid circuit is above normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all the connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Use a calibrated digital multimeter for the following procedures.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SOLENOID

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

Diagnostic Code Procedures

- A. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- B. Observe the status of the diagnostic code.
- C. Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

The active CID 3210 FMI 06 diagnostic code changes to a CID 3210 FMI 05 diagnostic code when the solenoid is disconnected.

Results:

- YES – The active CID 3210 FMI 06 diagnostic code changes to a CID 3210 FMI 05 diagnostic code when the solenoid is disconnected. The circuit is correct.

Repair: The solenoid has failed. Repeat this test "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid.

STOP.

- NO – The CID 3210 FMI 06 remains active when the solenoid is disconnected. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. The solenoid remains disconnected from the machine harness.
- C. Disconnect the machine harness connectors J1 and J2 from the transmission/chassis ECM.
- D. At the machine harness connectors of the ECM, measure the resistance from the contact J1-55 (wire K927-BU(Blue)) to frame ground. Measure the resistance from the contact J1-55 (wire K927-BU(Blue)) to all of the other J1 and J2 contacts that are used in the connectors of the transmission/chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.

- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness. The short is between wire K927-BU(Blue) and the circuit with the low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors.
- B. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- D. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- E. Turn the disconnect switch and the key start switch to the ON position.
- F. Operate the machine.
- G. Check the status of the CID 3210 FMI 06 diagnostic code.

Expected Result:

The CID 3210 FMI 06 diagnostic code is still active.

Results:

- YES – The CID 3210 FMI 06 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (Cat ET) service tool, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the transmission/chassis ECM. If the ECM must be replaced, refer to the Testing and Adjusting, "Electronic Control Module (ECM) - Replace" Section of this manual.

STOP.

- NO – The CID 3210 FMI 06 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i03619482

MID 027 - CID 3382 - FMI 03

SMCS Code: 1387-038-JV; 5479-038-NP

Conditions Which Generate This Code:

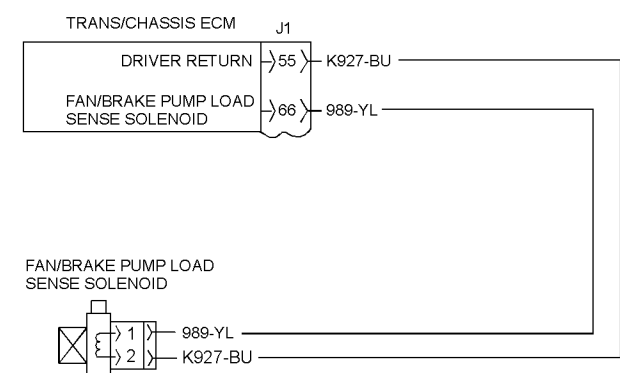


Illustration 367

g01942393

Circuit of the fan/brake pump load sense bypass solenoid

This diagnostic code is associated with the fan/brake pump load sense bypass solenoid. The FMI 03 means that the transmission/chassis electronic control module (ECM) has determined that the voltage of the solenoid circuit is above normal.

The possible causes of the diagnostic code are listed:

- The solenoid has failed.

- The energize circuit of the solenoid is shorted to the +battery circuit.
- The transmission/chassis ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected. **Ensure that the diagnostic code of CID 3382 FMI 03 is active before performing this procedure.**

Use a calibrated digital multimeter for the following procedures.

System Response:

The diagnostic code of CID 3382 FMI 03 will be logged in the internal memory of the transmission/chassis ECM.

Test Step 1. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO THE +BATTERY CIRCUIT.

- Turn the key start switch and the disconnect switch to the OFF position.
- Disconnect the machine harness connectors from the solenoid and the transmission/chassis ECM.
- At the machine harness connector for the transmission/chassis ECM, measure the resistance from contact J1-66 (wire 989-YL (Yellow)) to all contacts that are used in the machine harness connectors for the transmission/chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 2.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the

Diagnostic Code Procedures

machine harness. The short is between J1-66 (wire 989-YL(Yellow)) and the circuit that has a low resistance measurement.

Repair: Repair the machine harness or replace the machine harness. For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 2. CHECK THE RETURN CIRCUIT OF THE SOLENOID FOR A SHORT TO +BATTERY.

- A. The key start switch remains in the OFF position.
- B. The solenoid remains disconnected from the machine harness.
- C. The machine harness connectors J1 and J2 remain disconnected from the transmission/chassis ECM.
- D. At the machine harness for the solenoid, measure the voltage between the contact for (wire K927-BU(Blue)) and frame ground.

Expected Result:

The voltage is approximately 0.0 ± 0.5 DCV.

Results:

- OK – The voltage is approximately 0.0 ± 0.5 DCV. The voltage is correct. Proceed to Test Step 3.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between wire K927-BU(Blue) and the circuit that has a low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connectors for the solenoid and the transmission/chassis ECM remain disconnected.

- A. At the machine harness connector J1 of the ECM, remove the 989-YL(Yellow) energize wire of the solenoid and remove the J1-66 socket from the harness connector. Perform these removals with a 151 - 6320 Removal Tool.
- B. Reconnect the machine harness J1 and J2 connectors to the ECM.
- C. Turn the disconnect switch and the key start switch to the ON position.
- D. Observe the status of the active CID 3382 FMI 03 diagnostic code.

Expected Result:

The CID 3382 FMI 03 diagnostic code is no longer active. A CID 3382 FMI 05 diagnostic code is now active.

Results:

- YES – The CID 3382 FMI 03 diagnostic code is no longer active. A CID 3382 FMI 05 diagnostic code has been activated after the solenoid energize circuit was disconnected. The ECM has responded correctly to the open circuit condition in the solenoid circuit. Reinstall the energize wire of the solenoid into the correct space of the connector on the ECM. Proceed to Test Step 4.
- NO – The CID 3382 FMI 03 diagnostic code remains active. The status of the active diagnostic code did not change when the energize wire of the solenoid was disconnected from the ECM.

Repair: The ECM has not responded correctly to the open condition in the solenoid circuit. The operation of the ECM is not correct.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to the Testing and Adjusting, "Electronic Control Module (ECM) - Replace" Section of this manual.

STOP.

Test Step 4. CHECK IF THE DIAGNOSTIC CODE IS STILL ACTIVE.

- A. Inspect the contacts and clean the contacts of the harness connectors.
- B. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.

- D. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- E. Turn the disconnect switch and the key start switch to the ON position.
- F. Operate the machine.
- G. Determine if the CID 3382 FMI 03 is active.

Expected Result:

The CID 3382 FMI 03 is active.

Results:

- YES – The CID 3382 FMI 03 is active. The problem has not been corrected. The ECM may have failed.

Repair: It is unlikely that the ECM has failed. Exit this procedure and perform this procedure again. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to the Testing and Adjusting, "Electronic Control Module (ECM) - Replace" Section of this manual.

STOP.

- NO – The CID 3382 FMI 03 is not active. The problem does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i03619542

MID 027 - CID 3382 - FMI 05

SMCS Code: 1387-038-JV; 5479-038-NP

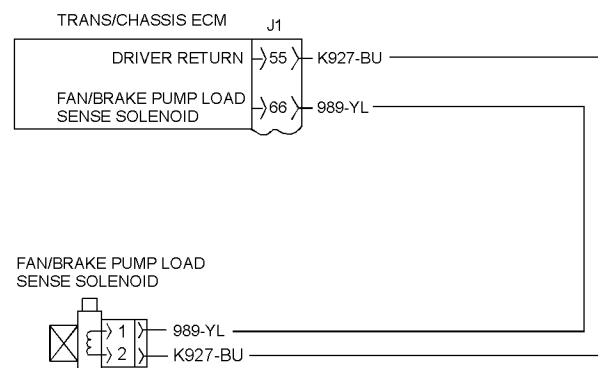
Conditions Which Generate This Code:

Illustration 368

g01942393

Circuit of the fan/brake pump load sense bypass solenoid

This diagnostic code is associated with the fan/brake pump load sense bypass solenoid. The FMI 05 means that the transmission/chassis electronic control module (ECM) has determined that the current for the solenoid circuit is below normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is open.
- The return circuit of the solenoid is open.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Use a calibrated digital multimeter for the following procedures.

Test Step 1. CHECK THE SOLENOID

Diagnostic Code Procedures

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

- A. Disconnect the solenoid from the machine harness.
- B. At the machine harness connector for the solenoid, place a jumper wire from the contact for (wire K927-BU(Blue)) to the contact for (wire 989-YL(Yellow)).
- C. Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- D. Observe the status of the CID 3382 FMI 05 diagnostic code.

Expected Result:

The active diagnostic code changes from an FMI 05 to an FMI 06 diagnostic code when the jumper wire is installed.

Results:

- YES – The active diagnostic code changes from an FMI 05 to an FMI 06 diagnostic code when the jumper wire is installed. The solenoid has failed.

Repair: The solenoid has failed. Repeat this Test Step “CHECK THE SOLENOID” in order to verify the solenoid failure. Replace the solenoid. Verify that the new solenoid corrects the problem.

STOP.

- NO – The CID 3382 FMI 05 diagnostic code remains active. The jumper wire does not affect the status of the diagnostic code. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE CIRCUIT FOR AN OPEN

- A. Turn the key start switch and the disconnect switch to the OFF position.
- B. Disconnect the machine harness connector J1 from the transmission/chassis ECM.
- C. The jumper wire that was installed in the previous test step remains in place.
- D. At the machine harness connector J1 for the transmission/chassis ECM, measure the resistance from the return contact J1-55 (wire K927-BU(Blue)) to the energize contact J1-66 (wire 989-YL(Yellow)).

Expected Result:

The resistance measurement is less than 5 ohms.

Results:

- OK – The measurement of the resistance is less than 5 ohms. The circuit is not open in the machine harness. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5000 ohms. The resistance measurement is not correct. There is an open or a bad connection in the machine harness. A resistance measurement that is much greater than 5 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not an open connection but not a good connection.

Repair: The open or the possible poor connection is in supply wire 989-YL(Yellow) or in return wire K927-BU(Blue) of the machine harness. Refer to the complete Electrical Schematic of the machine. Check all of the connectors that are in the solenoid circuit. Ensure that all connections are clean, that all connectors are secure and that all connectors are in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE OPERATION OF THE ECM

The disconnect switch and the key start switch remain in the OFF position. The machine harness connector for the solenoid and the ECM J1 connector remain disconnected.

- A. Remove the jumper wire that was installed in the last test step.
- B. At the machine harness connector J1 of the ECM, remove the 989-YL(Yellow) energize wire of the solenoid and remove the J1-66 socket from the harness connector. Perform these removals with a 151-6320 Removal Tool.
- C. Reconnect the machine harness J1 connector to the ECM.
- D. Turn the disconnect switch and the key start switch to the ON position.
- E. Use a 7X-1710 Multimeter Probe that is not connected to a multimeter or a similar device to make contact with the ECM pin at J1-66 through the empty space in the J1 connector.
- F. Observe the status of the active CID 3382 FMI 05 diagnostic code and ground the other end of the 7X-1710 Multimeter Probe to frame ground.

Expected Result:

The CID 3382 FMI 05 diagnostic code is no longer active. A CID 3382 FMI 06 diagnostic code becomes active when the ECM pin at J1-66 is grounded.

Results:

- YES – The CID 3382 FMI 05 diagnostic code is no longer active. A CID 3382 FMI 06 diagnostic code has been activated after the ECM pin is grounded. The ECM has responded correctly to the grounded circuit condition in the solenoid circuit. The problem is likely not being caused by the ECM. Reinstall the energize wire of the solenoid into the correct spot of the connector on the ECM. Proceed to Test Step 4.
- NO – The CID 3382 FMI 05 diagnostic code remains active. The status of the active diagnostic code does not change when the ECM pin for the solenoid is grounded.

Repair: The ECM has not responded correctly to the grounded condition in the solenoid circuit. The ECM may have failed.

If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the transmission/chassis ECM. If the ECM must be replaced, refer to the Testing and Adjusting, "Electronic Control Module (ECM) - Replace" Section of this manual.

STOP.

Test Step 4. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- Inspect the contacts and clean the contacts of the harness connectors.
- Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- Turn the disconnect switch and the key start switch to the ON position.
- Operate the machine.
- Check the status of the CID 3382 FMI 05 diagnostic code.

Expected Result:

The CID 3382 FMI 05 diagnostic code is active.

Results:

- YES – The CID 3382 FMI 05 diagnostic code is active. The diagnostic code has not been corrected. The ECM may have failed.

Repair: Check the circuit again. Perform a wiggle test on the machine wiring harness with the Caterpillar Electronic Technician (Cat ET) service tool. The wiggle test can detect intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found in the machine harness, the ECM may have failed. This is unlikely as the ECM responded correctly to the grounded condition in the previous test step.

Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the transmission/chassis ECM. If the ECM must be replaced, refer to the Testing and Adjusting, "Electronic Control Module (ECM) - Replace" Section of this manual.

STOP.

- NO – The CID 3382 FMI 05 diagnostic code is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

i03619559

MID 027 - CID 3382 - FMI 06

SMCS Code: 1387-038-JV; 5479-038-NP

Conditions Which Generate This Code:

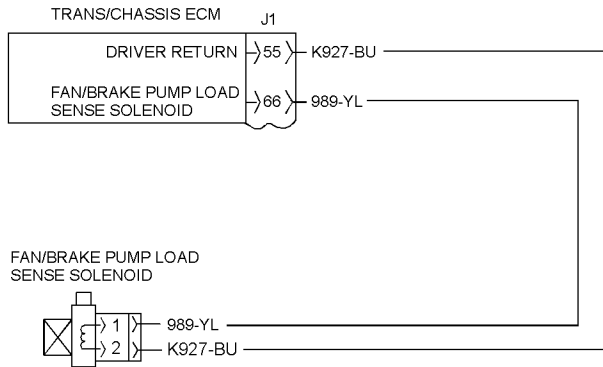


Illustration 369

g01942393

Circuit of the fan/brake pump load sense bypass solenoid

This diagnostic code is associated with the fan/brake pump load sense bypass solenoid. The FMI 06 means that the transmission/chassis electronic control module (ECM) has determined that the current of the solenoid circuit is above normal.

Some possible causes of this diagnostic code are listed below:

- The energize circuit of the solenoid is shorted to ground.
- The solenoid has failed.
- The ECM has failed. This is unlikely.

Before performing this procedure, inspect the harness connectors that are involved in the circuit. Poor connections can often be the cause of a problem in an electrical circuit. Verify that all connections in the circuit are clean, that all connections are secure and that all the connections are in good condition. If a problem with a connection is found, correct the problem and verify that this diagnostic code is active before performing this procedure.

Use a calibrated digital multimeter for the following procedures.

Note: The following test procedure may create other diagnostic codes. Ignore these created diagnostic codes and clear these diagnostic codes when the original diagnostic code has been corrected.

Test Step 1. CHECK THE SOLENOID

Note: The resistance of the solenoid coil should be $8.7 \pm .4$ ohms at 25 °C (77.0 °F).

- Turn the disconnect switch and the key start switch to the ON position. Do not start the engine.
- Observe the status of the diagnostic code.
- Disconnect the solenoid with the active diagnostic code from the machine harness.

Expected Result:

The active CID 3382 FMI 06 diagnostic code changes to a CID 3382 FMI 05 diagnostic code when the solenoid is disconnected.

Results:

- YES – The active CID 3382 FMI 06 diagnostic code changes to a CID 3382 FMI 05 diagnostic code when the solenoid is disconnected. The circuit is correct.

Repair: The solenoid has failed. Repeat this test "CHECK THE SOLENOID" in order to verify the solenoid failure. Replace the solenoid.

STOP.

- NO – The CID 3382 FMI 06 remains active when the solenoid is disconnected. The solenoid is not causing the problem. Proceed to Test Step 2.

Test Step 2. CHECK THE ENERGIZE CIRCUIT OF THE SOLENOID FOR A SHORT TO GROUND

- Turn the key start switch and the disconnect switch to the OFF position.
- The solenoid remains disconnected from the machine harness.
- Disconnect the machine harness connectors J1 and J2 from the transmission/chassis ECM.
- At the machine harness connectors of the ECM, measure the resistance from the contact J1-55 (wire K927-BU(Blue)) to frame ground. Measure the resistance from the contact J1-55 (wire K927-BU(Blue)) to all of the other J1 and J2 contacts that are used in the connectors of the transmission/chassis ECM.

Expected Result:

Each resistance measurement is greater than 5000 ohms.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is correct. Proceed to Test Step 3.
- NOT OK – One or more of the resistance measurements is less than 5000 ohms. There is a short in the machine harness. The short is between wire K927-BU(Blue) and the circuit with the low resistance measurement.

Repair: For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, “Wiring Harness (Short Circuit) - Test”. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE DIAGNOSTIC CODE

- A. Inspect the harness connectors. Clean the contacts of the harness connectors.
- B. Check the wires for damage to the insulation that is caused by excessive heat, battery acid, or chafing.
- C. Perform a 45 N (10 lb) pull test on each of the wires that are associated with the sensor circuit.
- D. Reconnect all harness connectors. Make sure that the connectors are fully seated. Observe that the clips for each connector are completely fastened.
- E. Turn the disconnect switch and the key start switch to the ON position.
- F. Operate the machine.
- G. Check the status of the CID 3382 FMI 06 diagnostic code.

Expected Result:

The CID 3382 FMI 06 diagnostic code is still active.

Results:

- YES – The CID 3382 FMI 06 diagnostic code is still active. The diagnostic code has not been corrected.

Repair: Check the circuit again. Use the Caterpillar Electronic Technician (Cat ET) service tool, in order to perform a wiggle test on the machine wiring harness. The wiggle test can detect intermittent shorts or opens in the machine wiring harness.

If the cause of the problem is not found, the ECM may have failed.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the transmission/chassis ECM. If the ECM must be replaced, refer to the Testing and Adjusting, “Electronic Control Module (ECM) - Replace” Section of this manual.

STOP.

- NO – The CID 3382 FMI 06 is not active. The diagnostic code does not exist at this time.

Repair: The initial diagnostic code was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

Diagnostic System Procedures

i02650508

Power Supply Circuit of Electronic Control Module

SMCS Code: 1417-038-EK2; 1420-038-EK2

System Operation Description:

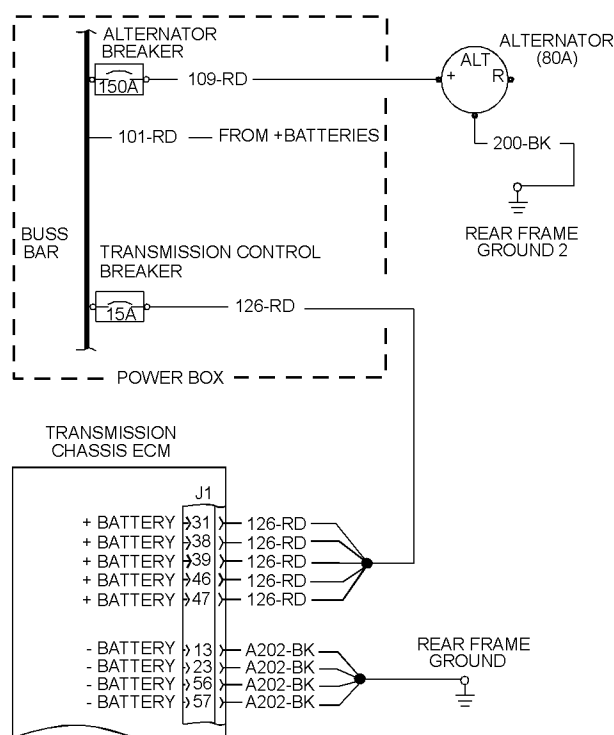


Illustration 370

g01331068

Transmission Chassis ECM Power and Ground connections

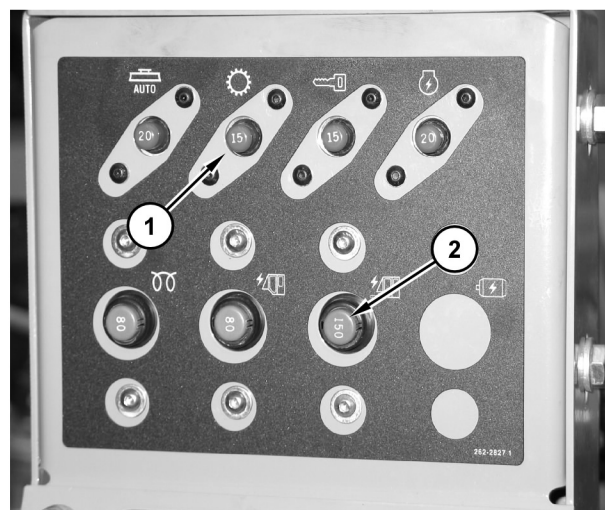


Illustration 371

g01331075

Circuit Breaker Panel located behind the door on left side of machine behind the cab

- (1) Transmission Control Breaker
- (2) Alternator breaker

The Transmission Chassis ECM receives system power through the transmission control circuit breaker. The Transmission Chassis ECM is connected to the machine system power at five contacts on the J1 connector. The Transmission Chassis ECM is connected to the machine frame ground at four contacts on the J1 connector. Other ground connections are used for the location code contacts, however, these are not used for operating grounds.

An ECM would have to lose power at each of the five connections in order to completely lose all power for the ECM. There are conditions that can cause the ECM to completely lose power. An open transmission control circuit breaker will cause a loss of power. An open or a faulty connection in certain sections of the machine harness could cause a complete loss of power. Open or poor ground connections can also cause a loss of power to the ECM.

If power is completely lost to the Transmission Chassis ECM or to another ECM on the machine, the ECM that has lost power will not activate any diagnostic codes. When this occurs, a large amount of machine functions will not operate and the other ECMs on the machine will activate multiple diagnostic codes.

If multiple diagnostic codes have been activated within a short amount of time, always check the power circuits for the ECM controls before investigating individual components. If the power circuits for the ECM controls are OK, look for a common factor for the components that have the active diagnostic codes such as shared grounds or power circuits. An individual component is usually not causing the problem when more than one or two diagnostic codes are activated at the same time.

The following lists give examples of multiple diagnostic codes and events that will most likely be activated when a particular ECM has lost power:

Loss of power to the Implement ECM

CID 0569 FMI 09 - Implement ECM – Activated by: Transmission Chassis ECM, Engine ECM and the Messenger.

CID 0615 FMI 03 - Articulation Angle Sensor 1 – Activated by: Transmission Chassis ECM.

CID 1471 FMI 03 - Steer Position Sensor 1 – Activated by: Transmission Chassis ECM.

CID 1472 FMI 03 - Steer Position Sensor 2 – Activated by: Transmission Chassis ECM.

CID 2199 FMI 03 - Secondary Steer Request Signal – Activated by: Transmission Chassis ECM.

CID 2201 FMI 03 - Right Steering Cylinder Position Sensor – Activated by: Transmission Chassis ECM.

EID 0192 Level 3 - Steering System Malfunction – Activated by: Transmission Chassis ECM.

Loss of power to the Transmission Chassis ECM

CID 0569 FMI 09 - Transmission Chassis ECM – Activated by: Implement ECM, Engine ECM and the Messenger.

CID 1473 FMI 03 - Steer Position Sensor 3 – Activated by: Implement ECM

CID 2200 FMI 03 - Left Steering Cylinder Position Sensor – Activated by: Implement ECM.

CID 2252 FMI 03 - Articulation Angle Sensor 2 – Activated by: Implement ECM.

EID 0192 Level 3 - Steering System Malfunction – Activated by: Implement ECM.

EID 0263 Level 3 - Low Main Pump Pressure – Activated by: Implement ECM.

Loss of power to the Engine ECM

CID 0590 FMI 09 - Engine ECM – Activated by: Implement ECM, Transmission Chassis ECM and the Messenger.

EID 0192 Level 3 - Steering System Malfunction – Activated by: Implement ECM and Transmission Chassis ECM.

The Transmission Chassis ECM is receiving +battery power at all times. When the key start switch is in the OFF position, the ECM is in a “sleep mode”. When the key start switch is in the ON position, the ECM immediately becomes active and will activate a diagnostic code for another control module if expected information from that module is not received on the data link circuits.

If the power circuit for the Transmission Chassis ECM is suspected to have failed, perform the following procedure.

Note: The main disconnect switch is in the ON position.

Test Step 1. CHECK THE CIRCUIT BREAKER

An open “Transmission Control” circuit breaker will disrupt power to the Transmission Chassis ECM.

The key start switch is in the OFF position.

A. Check for an open at the 15 amp “Transmission Control” circuit breaker.

Expected Result:

The 15 amp “Transmission Control” circuit breaker is open.

Results:

- YES – The circuit breaker is open.

Repair: Reset the open circuit breaker.
Resume machine operation.

STOP.

- NO – The 15 amp “Transmission Control” circuit breaker is not open. Proceed to Test Step 2.

Test Step 2. CHECK THE SYSTEM POWER AT THE ECM

This step requires the use of a 7X-1710 Probe group or similar tool in order to enable voltage measurement at the ECM connector without disconnecting it.

The key start switch is in the OFF position.

- A.** At machine harness connector J1 for the Implement ECM, insert multimeter probes along supply contact J1-31 (wire 126-RD(Red)) and along ground contact J1-13 (wire A202-BK(Black)). Measure the DC voltage.
- B.** Repeat the last step for each of the ECM supply contacts and each of the ECM ground contacts that are shown in the illustration at the beginning of this procedure.

Expected Result:

Each voltage measurement measures between 18.0 and 32 VDC.

Results:

- OK – Each voltage measurement measures between 18.0 and 32 VDC. The voltage supply is correct. Proceed to Test Step 3.
- NOT OK – One or more of the voltage measurements is less than 18.0 VDC. There is an open or a bad connection in the machine harness.

Repair: The machine harness is faulty. There is an open or a bad connection in the machine harness for either the power supply circuit wire 126-RD(Red) or a ground wire A202-BK(Black).

Refer to the complete machine Electrical System Schematic. Check all of the connectors that are in the suspect power or ground circuit. Ensure that all connections are clean, secure and in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK THE STATUS OF THE ECM

- A.** Inspect the harness connectors and clean the contacts of the harness connectors in the power supply circuit. Check the wires for damage to the insulation. Verify that each connector contact is clean, secure and in good condition.
- B.** Perform a 45 N (10 lb) pull test on each of the wires that are associated with the power supply circuit.
- C.** Reconnect all harness connectors. Make sure that the connectors are fully seated and the clips for each connector are completely fastened.
- D.** Turn key start switch to the ON position.
- E.** Check the status of the ECM.

Expected Result:

The Transmission Chassis ECM is performing normally.

Results:

- OK – The Transmission Chassis ECM is performing normally. The diagnostic codes that were active are no longer active

Repair: The problem was probably caused by a poor electrical connection at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NOT OK – The Transmission Chassis ECM is not performing normally. The ECM is still not powered.

Repair: Check the power supply circuit again.

If the cause of the problem is not found, the ECM may have failed.

It is unlikely that the ECM has failed. Verify that all possible causes of the diagnostic code have been investigated. If the cause of the failure is not found, contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the ECM must be replaced, refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

i02650613

Pulse Width Modulated Sensor

SMCS Code: 1439-038

System Operation Description:

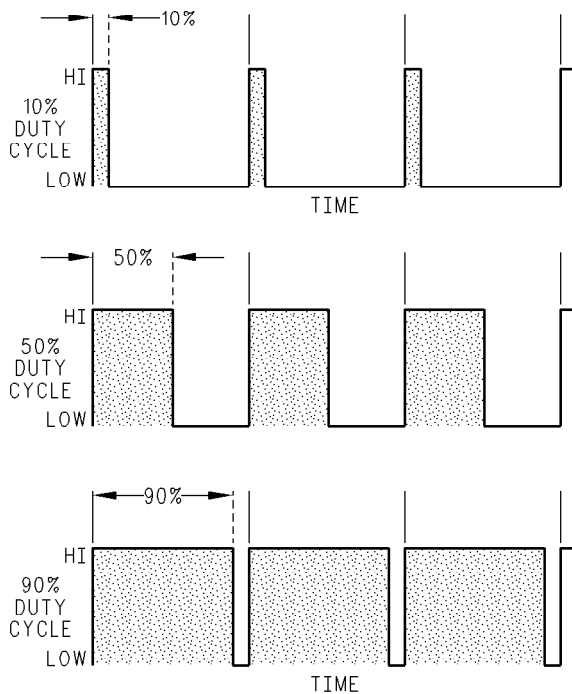


Illustration 372

g00288430

Typical Square Wave Pulse Width Modulated Duty Cycle Signal

When powered up, a position sensor will continuously send a Pulse Width Modulated (PWM) square wave signal to the ECM. The frequency of the signal is most often 500 hertz. Some sensors operate at 5000 hertz. The operating frequency stays at approximately the same rate during operation.

During operation, the duty cycle of the PWM sensor signal changes depending on the direction and amount of movement on the axis that is being monitored. The duty cycle is the percentage of time that the signal is high as compared to the total time for one cycle. The percentage of duty cycle signal from a typical position sensor that the ECM will recognize as valid is 10 ± 5 percent to 90 ± 5 percent at the extreme ends of the axis movement. An axis that is in the center or neutral position would result in a duty cycle signal of approximately 50 ± 6 percent.

The sensor signal can also be measured as voltage. Most PWM sensor signals will measure an RMS (average) voltage of between 0.0 VDC to 5.0 VDC depending on the duty cycle value. A low duty cycle results in a low voltage measurement. A high duty cycle results in a higher voltage value. A valid duty cycle range that the ECM will accept of 10 ± 5 percent to 90 ± 5 percent equates to a voltage range of 0.5 VDC to 4.5 VDC.

In order to aid in ECM circuit diagnostics, all of the PWM sensor signal input circuits have an internal "pull up voltage". An above normal voltage is internally connected to the ECM sensor PWM signal input circuit through a resistor.

During normal operation, the sensor signal will hold the circuit at a certain signal amplitude, however, circuit conditions such as a loss of power to the component, a disconnection or an open circuit will allow the circuit to be pulled high by the ECM pull up voltage. This will result in an above normal voltage condition at the ECM contact. As a result, the ECM will activate a diagnostic code for the affected circuit.

When the ECM detects an abnormal condition in the circuit, the ECM will activate a diagnostic code for the PWM sensor signal circuit. The ECM will most often monitor the circuit for the following FMI conditions:

FMI 02 – Data erratic, intermittent or incorrect

FMI 03 – Voltage above normal

FMI 04 – Voltage below normal

FMI 08 – Abnormal frequency, pulse width or period

FMI 13 – Out of calibration

Note: The ECM may activate diagnostic codes for other FMI conditions, however, the FMI conditions that are listed are the most common.

When the ECM activates an FMI 13 diagnostic code for a particular sensor, a calibration procedure must be performed in order to maximize performance in the involved system.

A calibration procedure for a PWM sensor enables the ECM to "map" a specific position for a cylinder or pedal to a specific sensor signal. This allows the ECM to control the component more precisely.

For troubleshooting, the PWM duty cycle of the sensor can be measured using most digital multimeters. The duty cycle would be expected to be in the acceptable range according to the position of the assigned axis of a particular component. The voltage of the signal circuit can be measured also, however, most signals from the PWM sensors are usually measured as a duty cycle percentage.

For operation information on a specific machine PWM position sensor, refer to the System Operation, "Electrical Input Components" section of this manual.

All PWM sensors on the machine are assigned a Component Identifier (CID) for diagnostics.

FINDING A TROUBLESHOOTING PROCEDURE FOR A SENSOR

A. When the ECM activates a diagnostic code for a PWM sensor, refer to the Troubleshooting, "Diagnostic Code Procedures" section of this manual. Go to the procedure for the CID FMI diagnostic code that has been activated and perform the procedure in order to isolate the probable cause of the problem.

Expected Result:

The troubleshooting procedure has been performed.

Results:

- OK – The troubleshooting procedure has been performed.

STOP.

i02443774

Starting System

SMCS Code: 1450-038

System Operation Description:

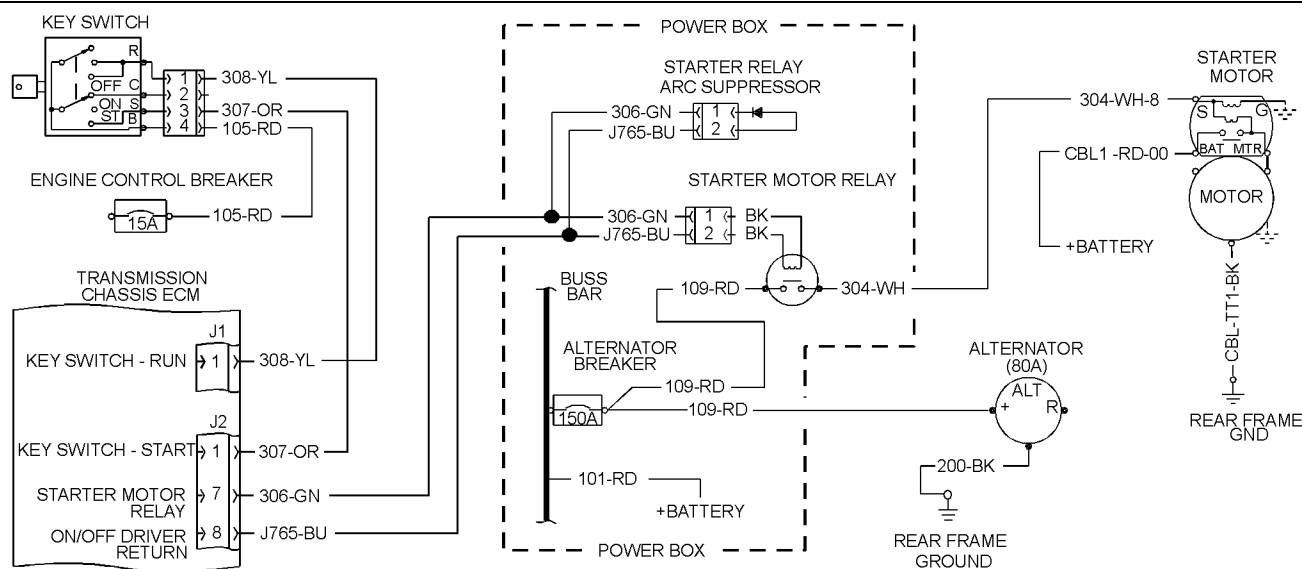


Illustration 373

g01331158

Engine Starting System connections

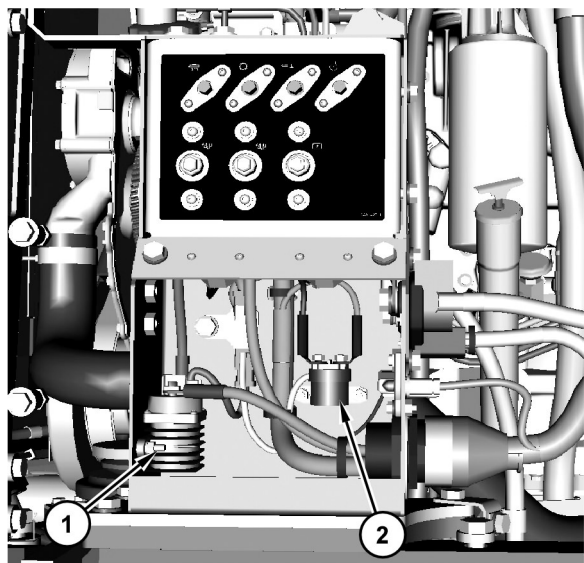


Illustration 374

g01331129

Power Breaker Box located on left side of machine behind the Cab

- (1) Main Power Relay
(2) Starter Motor Relay

The Transmission Chassis ECM controls the engine starting system for the machine. The ECM monitors the status of the key start switch. When the key start switch is in the ON position or in the START position, a system voltage input is supplied to the ECM through the key switch contacts.

When the Transmission Chassis ECM detects the system voltage at the START input, the ECM will activate the starter motor relay in order to initiate the engine start process provided the following machine conditions are present:

- The parking brake is engaged.
- The transmission is in NEUTRAL.
- The operator present switch is indicating that an operator is in the seat.

System battery voltage that has passed through the buss bar and the 150 amp alternator breaker is present at one side of the starter motor relay contacts. When the starter motor relay is energized by the ECM, system battery voltage is directed through the closed relay contacts and on to the starter motor solenoid. The starter motor solenoid contacts will close and +battery voltage will be applied to the starter motor in order to crank the engine for starting.

In the event that the engine will not crank when the key start switch is in the START position, perform the following procedure.

Note: If the engine is cranking when the key start switch is in the START position and the engine is not starting, refer to the engine service manual for your model machine.

Verify that there are no active CID 0444 diagnostic codes for the starter motor relay. If a diagnostic code for the relay is active, troubleshoot and repair the relay circuit problem before attempting to start the engine.

Test Step 1. Verify That The Machine Conditions Are Correct

A. Verify that the following conditions are correct:

- The disconnect switch is in the ON position.
- The Alternator Breaker is not open.
- The parking brake is engaged.
- The transmission is in NEUTRAL.
- The operator present switch is indicating that an operator is in the seat.

Expected Result:

One or more of the listed machine conditions was not correct.

Results:

- YES – One or more of the listed machine conditions was not correct.

Repair: Ensure that all the listed machine conditions are correct. Then attempt to start the engine again.

STOP.

- NO – All of the listed machine conditions are correct. The engine still will not crank and no diagnostic codes for the starter motor relay are active. Proceed to Test Step 3

Test Step 2. Check The Relay

The key switch is in the OFF position.

- A. Enlist the aid of another technician. Remove the lower cover from the power box in order to access the starter motor relay. Have the other technician turn the key start switch to the START position while observing the starter motor relay. The relay should create an audible “click” when the key is first moved to the START position in order to energize the relay.

Expected Result:

The relay is being energized by the ECM.

Results:

- OK – The relay is being energized by the ECM. Proceed to Test Step 3.
- NOT OK – The relay is not being energized by the ECM.

Repair: There is a problem in the starter motor relay circuit. Refer to the Troubleshooting section of this manual. Perform the diagnostic code procedure for the CID 0444 FMI 05 (Starter Motor Relay - current below normal) in order to find the problem. Find the problem in the relay circuit and repair the circuit.

STOP.

Test Step 3. Check The Condition Of The Batteries

The key switch is in the OFF position.

- At starter motor relay inside of the power box, measure the battery voltage between the contact that is connected to the red cable (109-RD(Red)) and a good frame ground contact. Verify that the correct voltage is present at the relay contact. If no voltage is present, check the circuit back to the Alternator Breaker and then to the batteries in order to determine why no system voltage is present at one side of the relay contacts.
- Verify that the battery connections are clean and tight. Load test the batteries. Use a 4C-4911 Battery Load Tester. Refer to , Special Instruction, SEHS9249, "Use of 4C-4911 Battery Load Tester for 6, 8 and 12 Volt Lead Acid Batteries" and Special Instruction, SEHS7633, "Battery Test Procedure".

Expected Result:

The batteries pass the load test and the connections are in good condition.

Results:

- OK – The batteries and the connections are OK. Proceed to Test Step 4.
- NOT OK – The batteries do not pass the load test or the connections are not in good condition.

Repair: Charge or replace the batteries if needed or clean and repair the battery connections.

STOP.

Test Step 4. Check The Voltage At the Starter Motor

- Turn the key start switch to the OFF position.
- At the starter motor, measure the system voltage between the +battery contact (cable 1-RD-00(Red)) and a good frame ground contact.
- At the starter motor, fasten ONE clamp-on multimeter probe to the starter solenoid power contact (304-WH-8(White)) and fasten the other clamp-on probe to a good frame ground.
- While observing the multimeter for a voltage measurement, turn the key start switch to the START position for a few seconds.

Expected Result:

System voltage is present at the +battery contact (cable 1-RD-00(Red)) on the starter motor and system voltage is present at the starter solenoid power contact (304-WH-8(White)) when the key switch is in the START position.

Results:

- OK – The system voltage is present at the starter solenoid contact at the right time and system voltage is present at the starter motor contact.

Repair: The starter motor should be cranking the engine when the key start switch is in the START position. The starter motor has failed. Replace the starter motor.

STOP.

- NOT OK – There is a problem with the system voltage at the starter motor or at the starter solenoid connection.

Repair: Investigate the circuit that is not providing the correct voltage at the starter motor or the starter motor solenoid. Repair the system voltage circuit.

If the voltage is not present at the starter solenoid when the key start switch is turned to the START position, verify that the voltage is passing through the starter motor relay contacts. Check the relay operation and the wire from the relay to the starter motor solenoid contact.

STOP.

i02443779

Switch Circuits

SMCS Code: 1435-038; 7332-038

System Operation Description:

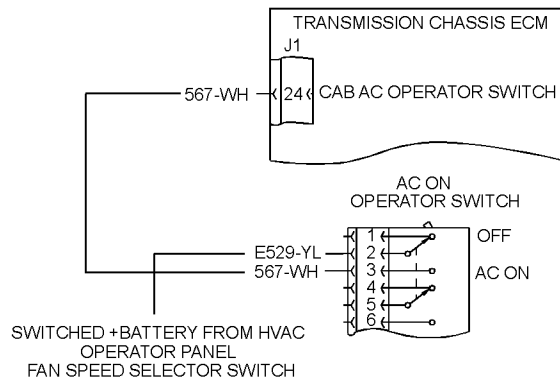


Illustration 375

g01331641

Air Conditioning Operator Switch connections

The air conditioning operator switch supplies one switch to +battery input to the Transmission Chassis ECM. The ECM does not monitor the switch circuits that have one input for diagnostics.

During normal operation, the ECM internal pull down voltage will hold the switch input circuit low until the +battery signal from the HVAC fan selector switch is passed through the switch contacts. The ECM detects the high +battery signal in the circuit and determines that the switch contacts are closed.

Note: For a more detailed explanation of the Air Conditioning system operation, refer to Systems Operation, "Features" section of this manual.

If the switch circuit is open or the switch contacts have failed in the OFF state, the ECM will not detect that the switch contacts are closed and will not activate the air conditioning system.

If the switch input circuit is shorted to frame ground or to another ground source, the HVAC fuse will open when the switch is moved to the AC ON position.

If the switch contacts fail in the AC ON state, the ECM will not detect the low in the circuit to indicate that the contacts are open. When this occurs, the air condition system will be active at all times.

Some conditions that can cause the AC operator switch input circuit to fail are listed.

- The HVAC fuse is open due to a short to ground in the switch input circuit or other factors.
- The switch has failed.
- The switch input circuit is open or has a poor connection in the machine harness.

- The switch input circuit is shorted to another +battery source in the machine harness.
- The ECM has failed. This is not likely

When a switch circuit is suspected of not operating correctly, perform the following troubleshooting procedure for the switch circuit.

Test Step 1. CHECK THE SWITCH

- Turn the disconnect switch and the key start switch to the OFF position.
- Disconnect the machine harness connector from the switch.
- At the AC operator switch, use a multimeter to measure the resistance between the switch contact 2 and switch contact 3. Measure the resistance in the AC OFF contact state and in the switch AC ON contact state several times each.

Expected Result:

When the switch is in the AC OFF contact state, the resistance measurement is greater than 5000 ohms. When the switch is in the AC ON contact state, the resistance measurement is less than 5 ohms.

Results:

- OK – The switch operation checks correct in both of the switch states. The switch is working correctly. Proceed to Test Step 2.
- NOT OK – The switch operation is not correct. The resistance measurement of the switch is not changing when the state of the switch is changed. The switch has failed.

Repair: Replace the switch. After replacing the switch, verify that the operation of the new switch is correct before operating the machine.

STOP.

Test Step 2. CHECK THE SWITCH INPUT CIRCUIT FOR AN OPEN

The key switch and the disconnect switch remain in the OFF position.

- At the machine harness connector for the switch, connect one end of a jumper wire to contact 3 (wire 567-WH(White)). Connect the other end of the jumper wire to a good frame ground contact.
- Disconnect the machine harness connector J1 from the ECM.

- C.** At the machine harness connector for the ECM, measure the resistance between the switch input contact J1-24 (wire 567-WH(White)) and a good frame ground contact.

Expected Result:

The resistance measurement is less than 5.0 ohms.

Results:

- OK – The resistance measurement is less than 5.0 ohms. The switch input circuit in the machine harness is not open. Proceed to Test Step 3.
- NOT OK – The resistance measurement is greater than 5.0 ohms. There is an open or a bad connection in the switch input circuit in the machine harness.

Repair: A resistance measurement that is much greater than 5.0 ohms but less than 5000 ohms could indicate that one of the connection points in the circuit is not open but is not a good connection.

Refer to the complete machine Electrical System Schematic. Check all of the connectors that are in the switch input circuit. Ensure that all connections are clean, secure and in good condition. Repair the machine harness or replace the machine harness.

STOP.

Test Step 3. CHECK FOR A SHORT TO ANOTHER VOLTAGE SOURCE

The key switch and the disconnect switch remain in the OFF position. The machine harness connectors J1 remains disconnected from the ECM.

- A.** Disconnect the machine harness connector J2 from the ECM.
- B.** At the machine harness ECM connector J1, measure the resistance from switch input contact J1-24 (wire 567-WH(White)) to all of the other J1 and J2 contacts that are used for the ECM.
- C.** While observing the resistance measurement, wiggle the wires and move the machine harness around at the ECM connectors and at the switch.

Expected Result:

Each resistance measurement is greater than 5000 ohms at all times during the manipulation of the machine harness wires and connectors.

Results:

- OK – Each resistance measurement is greater than 5000 ohms. The machine harness is not indicating a short to another voltage source. Proceed to Test Step 4.
- NOT OK – Each resistance measurement is not greater than 5000 ohms. There is a short in the machine harness. The short is between the switch input circuit wire 567-WH(White) and the circuit with the low resistance measurement.

Repair: Refer to the complete machine Electrical System Schematic. Examine all of the connectors in the defective circuit for points in the machine harness where a short could occur.

For information on testing for short circuits and finding short circuits, refer to Testing and Adjusting, "Wiring Harness (Short Circuit) - Test". Repair the machine harness or replace the machine harness.

STOP.

Test Step 4. CHECK THE OPERATION OF THE SWITCH

- A.** Inspect the harness connectors and clean the contacts of all of the harness connectors that are in the switch input circuit.
- B.** Reconnect all harness connectors. Make sure that the connectors are fully seated and the clips for each connector are completely fastened.
- C.** Turn the disconnect switch and the key start switch to the ON position.
- D.** Check the operation of the switch.

Expected Result:

The switch is operating properly.

Results:

- OK – The switch is operating properly. The operation of the switch is correct at this time.

Repair: The initial problem was probably caused by a poor electrical connection or a short at one of the harness connectors that was disconnected and reconnected. Resume normal machine operation.

STOP.

- NOT OK – The switch circuit is still not operating correctly. The problem has not been corrected.

Repair: Check the switch input circuit again. Use the Caterpillar Electronic Technician (ET) service tool, if available, in order to perform a

"Wiggle Test" on the machine wiring harness. The wiggle test can detect momentary or intermittent shorts or opens in the machine wiring harness.

If the cause of the problem can not be found, the ECM may have failed. Verify that all possible causes of the problem have been investigated before replacement of the ECM.

Prior to replacing an ECM, always contact your dealership's Technical Communicator for possible consultation with Caterpillar. This consultation may greatly reduce repair time. If the cause of the diagnostic code is not found, replace the ECM. Refer to Testing and Adjusting, "Electronic Control Module (ECM) - Replace".

STOP.

Testing And Adjusting Section

Testing and Adjusting

Establish communication by turning on the computer, turning the machine switch key to the "On" position and opening the Cat[®] ET application. When Cat[®] ET establishes a connection, select the Trans/Chassis ECM.

i05737344

Calibration

SMCS Code: 4800

Transmission Fill Calibration

If the parameters for the clutch fill are not correct, the quality of the transmission shift can be greatly affected. Incorrect calibration of the Electronic Clutch Pressure Control (ECPC) modulation valves will cause transmission shifting problems. The transmission clutch fill calibration will fine-tune each clutch solenoid valve within an ECPC valve. Perform the "Transmission Fill Calibration" if any of the following diagnostic codes are triggered by the Transmission/Chassis ECM (MID 027):

- CID 1401 - FMI 13 (Transmission Solenoid 1 - Out of Calibration)
- CID 1402 - FMI 13 (Transmission Solenoid 2 - Out of Calibration)
- CID 1403 - FMI 13 (Transmission Solenoid 3 - Out of Calibration)
- CID 1404 - FMI 13 (Transmission Solenoid 4 - Out of Calibration)
- CID 1405 - FMI 13 (Transmission Solenoid 5 - Out of Calibration)
- CID 1406 - FMI 13 (Transmission Solenoid 6 - Out of Calibration)
- CID 1407 - FMI 13 (Transmission Solenoid 7 - Out of Calibration)
- CID 1408 - FMI 13 (Transmission Solenoid 8 - Out of Calibration)

Reference: For information on the ECPC modulation valves, refer to Testing and Adjusting, KENR8886, "Fill Time for the Transmission Clutch - Calibrate"

To perform the automatic "Transmission Fill Calibration", connect the Comm Adapter III to the machine service tool connector in the cab and a computer. A current version on the Caterpillar Electronic Technician (Cat[®] ET) software tool is required on the The computer (laptop).

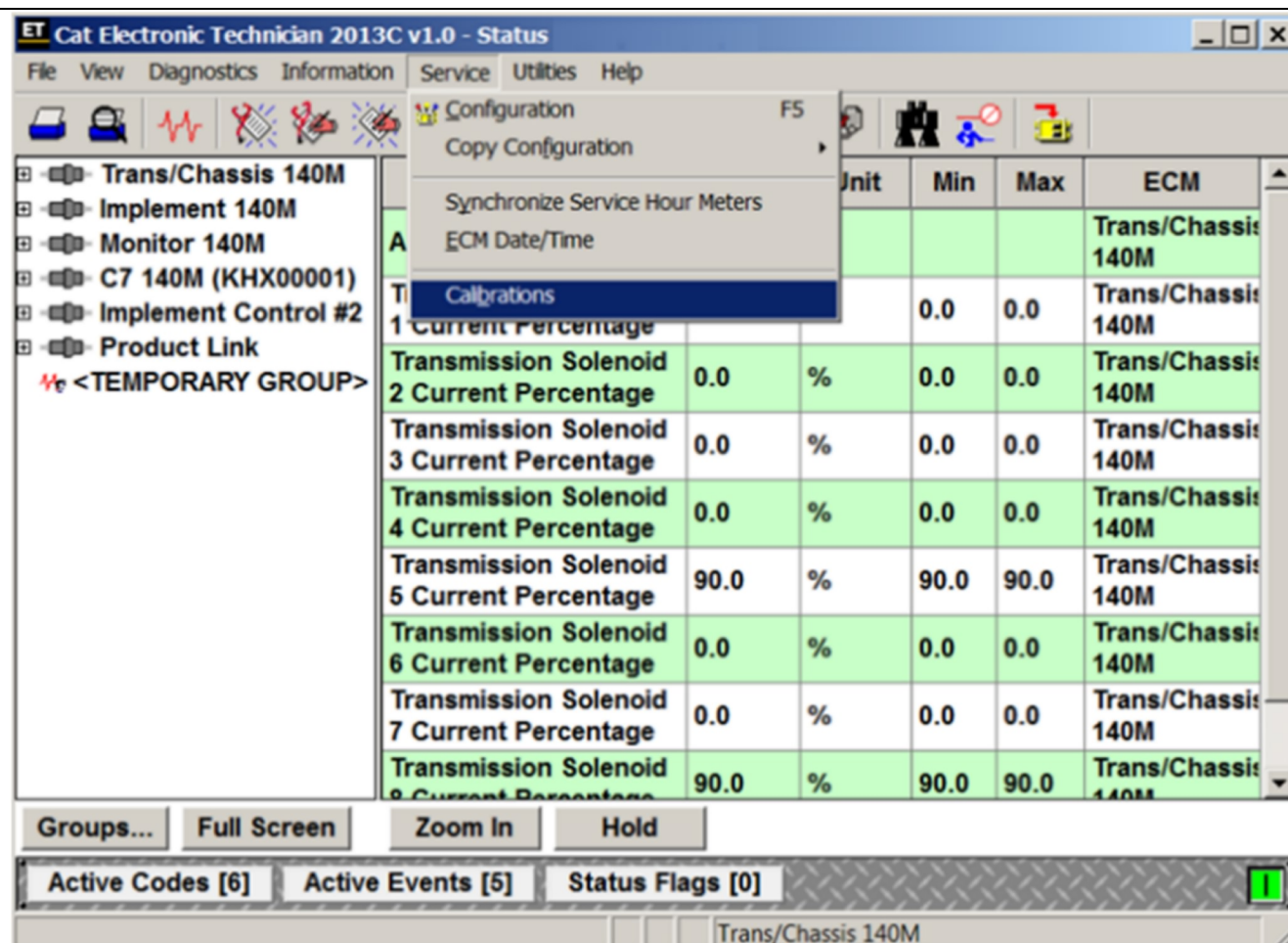


Illustration 376

g03645783

Select "Calibrations"

Navigate to the calibration screens by clicking "Service", then "Calibrations". Select the "Trans/Chassis" ECM and "Transmission Fill Calibration" and click the "Start" button. See illustrations 376 and 377.

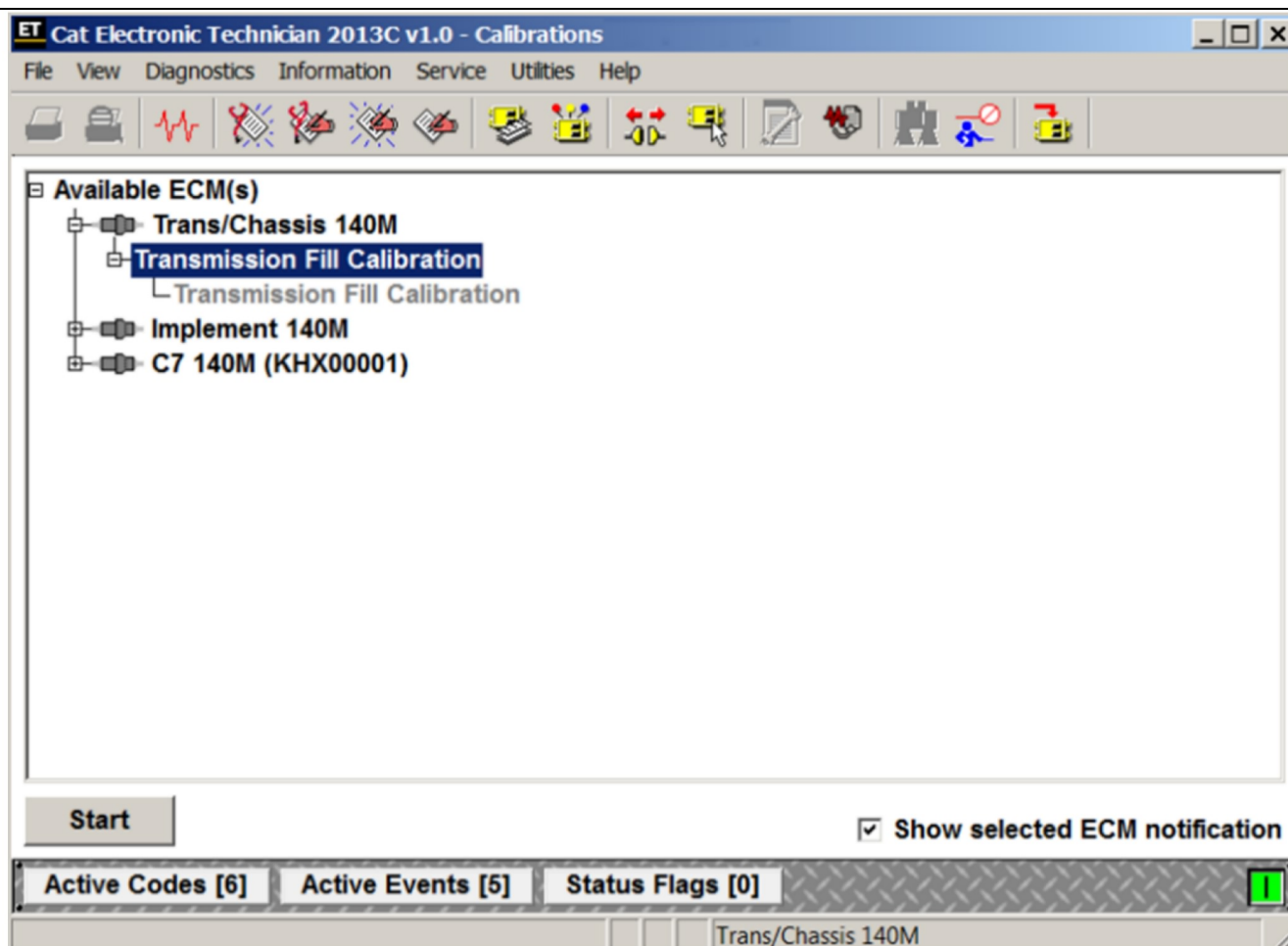


Illustration 377

g03645801

Select "Transmission Fill Calibration"

Once the calibration is selected, Cat[®] ET will guide you through the calibration procedure.

Description	Value	Unit
Engine Speed	801	rpm
Transmission Oil Temperature	100	Deg F
Direction Switch Position	Neutral	
Parking Brake	Engaged	
Implement Lockout Switch Position	Locked	

When the setup conditions are met, click the Next> button to continue

☐ Set up calibration conditions:

- > Warm Transmission Oil to 100 Deg F or higher.
- > Move the direction lever to the neutral position.
- > Set the parking brake.
- > Implement Lockout Switch must be in the Locked position.

☐ To abort the calibration, press the Inching Pedal or click the Cancel button.

Next > Cancel

Active Codes [6] Active Events [5] Status Flags [0] Trans/Chassis 140M

Illustration 378

g03645873

Ensure that "Transmission Fill Calibration" conditions are met

The listed "Set up calibration conditions:" must be met, before the ECM will allow the calibration to continue. See illustration 378 . When all conditions are met, click the "Next >" button to complete the calibration.

During the automated fill calibration, text will scroll across the screen informing which clutch solenoid (1 through 8) is being calibrated.

Note: The user can abort the calibration by pressing the "Cancel" button or by bumping the inching pedal.

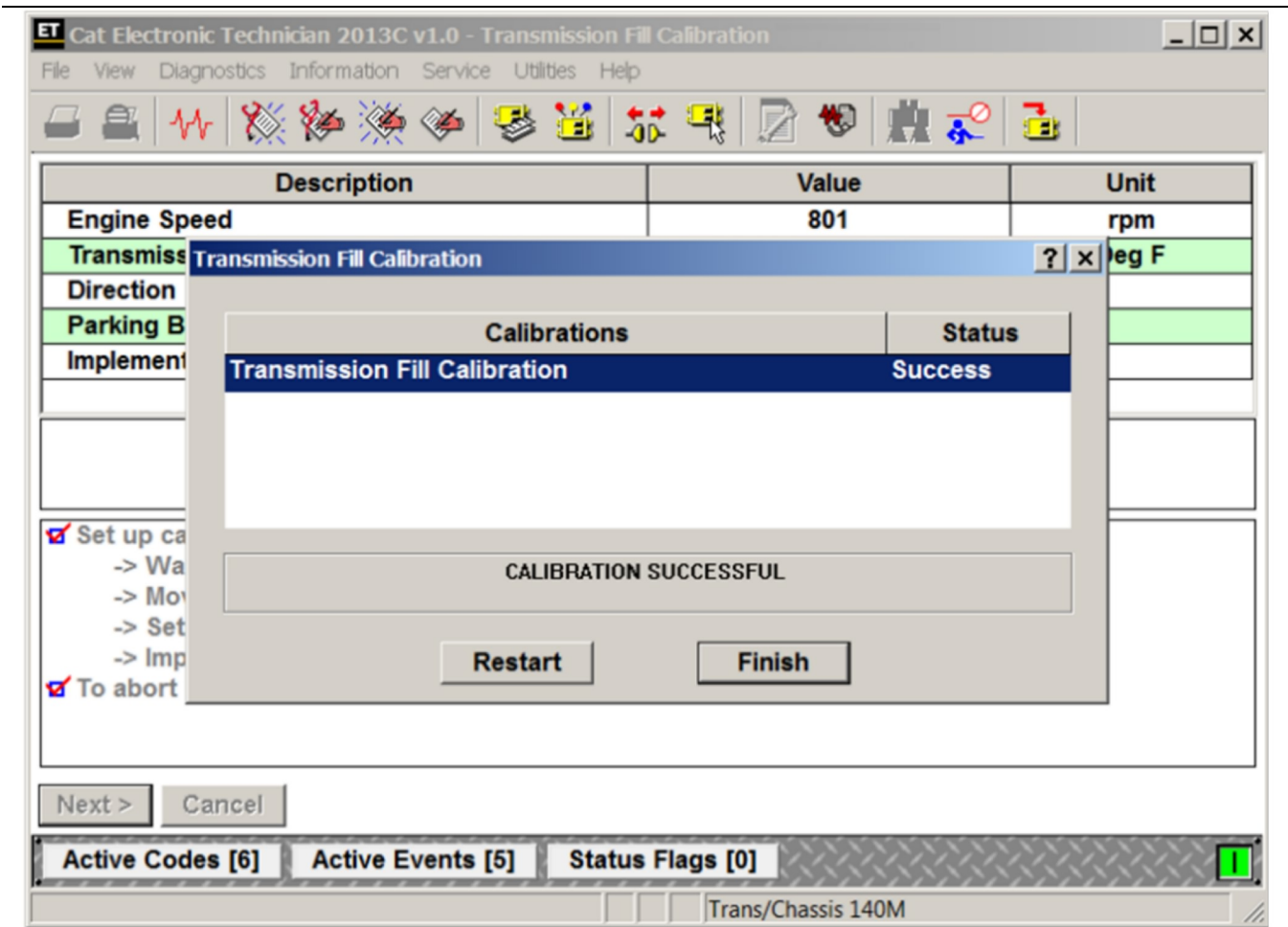


Illustration 379 g03645885

“Calibration Successful”

A “Calibration Successfully” pop-up will be visible when the calibration is completed. See illustration 379 . When a successful calibration is finished, the calibration data for each ECPC valve is placed into the memory of the Transmission/Chassis ECM.

Cycle the key switch and operate the machine to check the quality of transmission shifts.

Note: For more information, refer to Testing and Adjusting, RENR8454, “Fill Time for the Transmission Clutch - Calibrate”.

Calibration Error Codes

The following table lists error codes can be activated when performing the “Transmission Fill Calibration” .

Table 34

Cat ® ET Error Codes for Transmission Fill Calibration		
Error Code	Probable Cause of Activation	Recommended Actions

(continued)

(Table 34, contd)

0002 - Active Diagnostic Present	An active diagnostic has stopped the calibration.	Resolve the active diagnostic code and continue the calibration.
0006 - Aborted by Tool	Calibration aborted by clicking the "Cancel" button in Cat® ET.	Restart the calibration.
0009 - Aborted by ECM	Calibration canceled by the ECM.	· Cancelling the calibration may cause an 0006 or 0009 error code to activate. If so wait at least 15 seconds before performing another calibration. · Check for another active error code that indicates the cause of the problem and resolve the problem.
000B - Calibration Not Supported	Early version of Cat ET is used that does not support the calibration. Incorrect ECM software (flash file) is installed.	· Ensure that the latest version of Cat ET is installed on your PC. · Ensure that the correct flash file is loaded into the ECM. Note: After the ECM has been flashed, cycle the key start switch from ON to OFF. Wait 10 seconds, then turn the key start switch to ON and rerun the calibration procedure.
1012 - Engine RPM Incorrect	Engine speed is incorrect.	Calibration engine speed (1,700 rpm) was not achieved within 5 seconds after commanded by the ECM. · Investigate the engine performance issue
1017 - Service Brake Pedal Depressed	The service brake pedal is detected as engaged.	Do not press the service brake pedal, during the calibration, unless you wish to abort.
1018 - Park Brake Disengaged	Calibration requires an engaged park brake.	Apply the park brake and proceed with the calibration.
101B - TOS High	Detected Transmission Output Speed (TOS) is not zero.	· Ensure that the machine has not moved. · Check TOS status in Cat ET and troubleshoot TOS circuit if not zero. · Check that the electrical wiring from the ground speed sensor to the ECM is correct. · Replace the ground speed sensor if all else fails.
101F - Direction Lever Not Neutral	The Direction Lever is not in the "Neutral" position.	Place the direction lever in the "Neutral" position.
1021 - Trans Oil Temp Low	Transmission oil temperature is too low for successful calibration.	Operate the transmission to warm the oil to normal operating temperature. Transmission oil temperature must be at or above 100° C (212° F).
1022 - Trans Oil Temp High	Transmission oil temperature is too high for successful calibration.	Allow the transmission oil to cool.
1023 - Trans Clutch 1 Limit	Solenoid current needed to fill the indicated clutch is outside the specified parameters.	Rerun calibration three times before troubleshooting or replacing any suspect electronic clutch pressure control (ECPC) valve. · Check for debris and any indicated damage. · If a new valve is installed, shift the transmission several times into a gear that uses the new valve before calibration is performed. · Ensure the ECPC valves are correctly torqued when the machine is cool. · If the error persists, document the fault and contact the Technical Communicator (TC) at your dealership for possible consultation with Caterpillar.
1024 - Trans Clutch 2 Limit		
1025 - Trans Clutch 3 Limit		
1026 - Trans Clutch 4 Limit		
1027 - Trans Clutch 5 Limit		
1028 - Trans Clutch 6 Limit		
1029 - Trans Clutch 7 Limit		
1065 - Trans Clutch 8 Limit		

(continued)

(Table 34, contd)

1043 - Implement Lockout Switch Off	Implement lockout switch is not detected as "Locked".	The implement lockout switch must be in the locked position. If needed, troubleshoot the switch circuit.
1071 - Inching Pedal Depressed	Calibration aborted due to the inching pedal being pressed.	Do not bump the inching pedal during the calibration unless you wish to abort.
1074 - Engine RPM Too Low	Engine RPM is too low to start calibration.	Increase engine RPM and continue the calibration.
10A2 - Trans Oil Filter Bypass Active	Transmission oil filter bypass switch is closed.	Replace the transmission oil filter.

i02203138

Electrical Connector - Inspect

SMCS Code: 7553-040-WW

Reference: Special Instruction, SEHS9615, "Servicing DT Connectors".

Reference: Special Instruction, REHS0148, "Listing Of Deutsch Connector Components"

Reference: Special Instruction, SEHS9065, "Use Of CE Connector Tools".

Reference: Service Magazine, SEPD0342,27 January 97, "Field Repair Of Single Wire Breaks In Harnesses (Sealed Splice)".

Reference: Service Magazine, SEPD0371,28 July 97, "Protection Of Unsealed Electrical Terminations For Machines In Corrosive Applications".

Reference: Service Magazine, SEPD0473,24 May 99, "New DT Connector Plugs With Improved Seal Retention".

Reference: Service Magazine, SEPD0545,09 October 00, "Dielectric Grease Should Not Be Used In Electrical Connectors".

Reference: Pocket Guide, SEBD0402, "Guidelines For Routing And Installing Wire Harness Assemblies".

Use this procedure under the following situation:

Use the following steps to help determine if the connector is the cause of the problem. If a problem is found in the electrical connector, repair the connector and verify that the problem has been corrected.

The following background information is related to this procedure:

Many of the operational procedures and the diagnostic code procedures in this troubleshooting guide will instruct you to check a specific electrical connector.

Intermittent electrical problems are often caused by poor connections. Always check for an active diagnostic code before breaking any connections. Also, always check for an active diagnostic code after the connector is reconnected in order to verify that the problem disappears.

Simply disconnecting the connectors and then reconnecting the connectors can temporarily solve a problem at times. If this occurs, likely causes are loose terminals, bent terminals, improperly crimped terminals, corrosion, or harness routing that is improper.

The original source of the problem must then be identified in order to ensure that the problem does not reoccur.

Follow this procedure to thoroughly inspect the connectors in order to determine if the connectors are the cause of the problem.

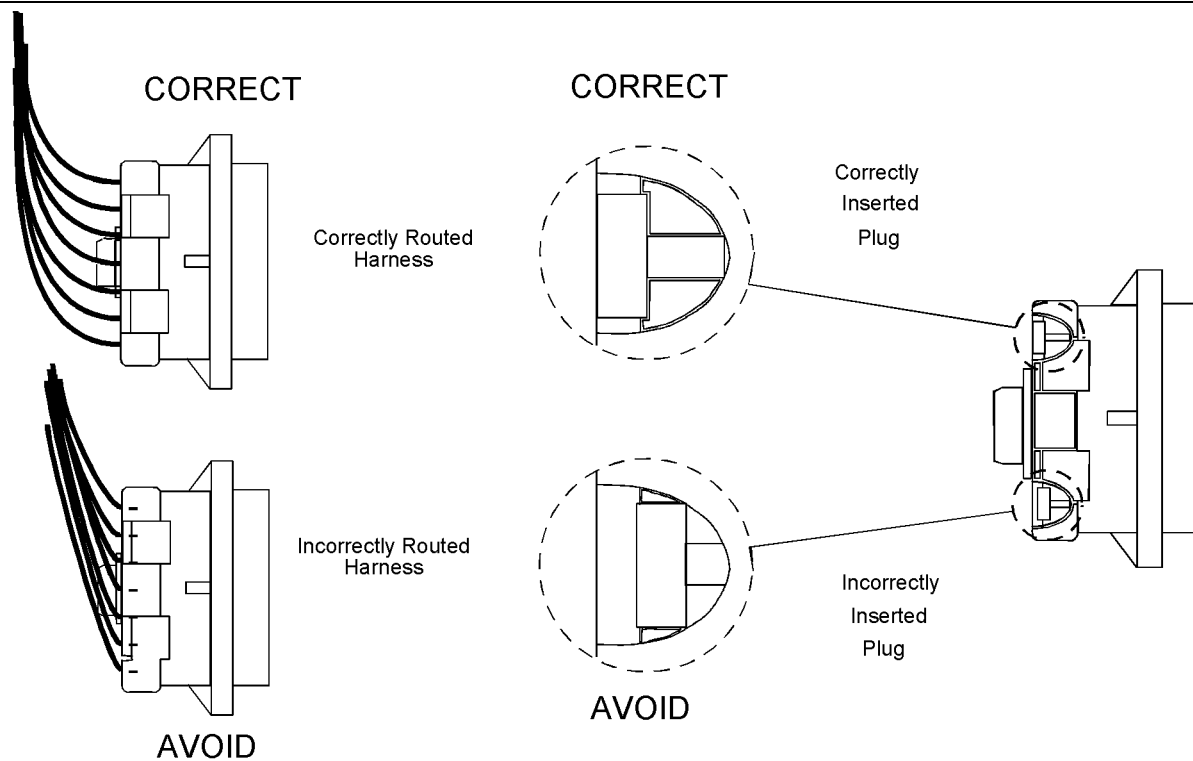
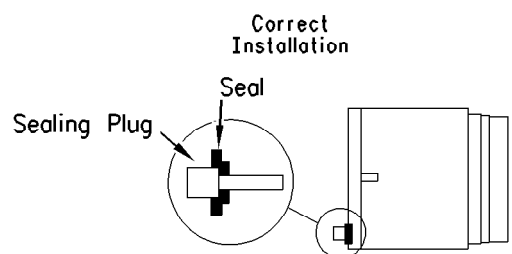


Illustration 380

g01135980

Correct way to route a harness and insert a plug



Deutsch Sealing Plug Insertion

Illustration 381

g00690571

Proper Installation of Plug

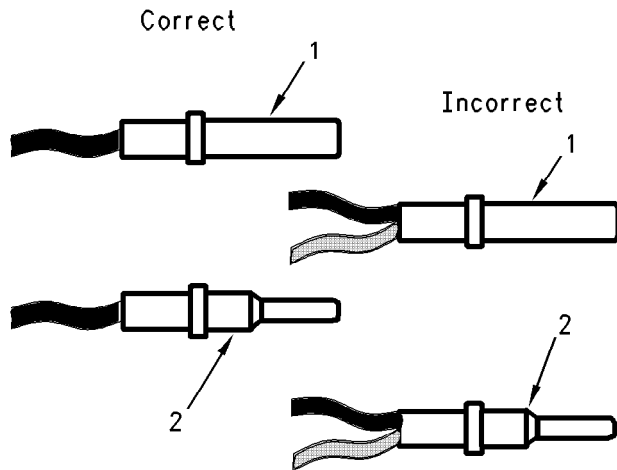


Illustration 382

g00828600

DT Type sealing plug

The 8T-8729 Connector Pin (2) and the 8T-8730 Connector Socket (1) is designed to accept only one 16/18 AWG wire. Do not insert multiple wires of a smaller wire size. An incorrect method would be using two 24 AWG wires. The 9W-0852 Connector Pin and the 9W-0844 Connector Socket is designed to accept only one 14 AWG wire. Do not insert multiple wires of a smaller wire size. An example of an incorrect method is the use of two 20 AWG wires.

1. CHECK THE CONNECTORS.

- Ensure that the connector is properly locked. Also, ensure that the two halves of the connector can not be pulled apart.
- Verify that the latch tab of the connector is properly latched. Verify that the latch tab of the connector is fully latched.

Expected Result: The connector will securely lock. The connector and the locking mechanism are without cracks or breaks.

Results:

OK – The connector will securely lock. The connector and the locking mechanism are without cracks or breaks. Proceed to test step 2.

NOT OK – A problem exists with the connector.

Repair: Repair the connector or replace the connector, as required.

STOP.**2. CHECK THE ALLEN HEAD SCREW ON THE HARNESS CONNECTOR OF THE ECM.**

- Ensure that the connector bolt is properly tightened. Be careful not to tighten the bolt too much. The bolt may break.
- Do not exceed 6.0 N·m (53.0 lb in) of torque on the connector bolt of the harness when the connector is being installed on the ECM.

Expected Result: The harness connector is secure and the connector bolt of the ECM is properly torqued.

Results:

OK – The harness connector is secure and the connector is properly torqued. Proceed to test step 3.

NOT OK – A problem exists with the connector.

Repair: Secure the harness connector of the ECM. Ensure that the connector bolt is properly torqued.

STOP.**3. PERFORM A PULL TEST ON EACH CONNECTOR CONTACT.**

- Each connector contact should withstand 45 N (10 lb) of pull. Each wire should remain in the connector body. This test checks whether the wire was properly crimped in the contact and whether the contact was properly inserted into the connector.
- The DT connectors use an orange wedge to lock the terminals in place.
- Check in order to ensure that the orange wedge is not missing and that the orange wedge is installed properly on the DT connectors.

Note: A Crimp Tool should ALWAYS be used in order to crimp wires on connector contacts. Do not solder the terminals. Use the proper Crimp Tool.

Expected Result: Each connector contact should withstand 45 N (10 lb) of pull. Each wire remains in the connector body.

Results:

OK – Each connector contact withstands 45 N (10 lb) of pull. Each wire remains in the connector body. Proceed to test step 4.

NOT OK – A problem exists with the connector.

Repair: Repair the wiring or replace the connector contact.

STOP.

4. CHECK THE WIRES FOR NICKS OR ABRASIONS IN THE INSULATION.

- a. Carefully inspect each wire for signs of abrasion, nicks, or cuts.

The following areas are locations that should be checked:

- Exposed insulation
- Points of rubbing wire

- b. Check all of the hold down clamps for the harness in order to verify that the harness is properly clamped. Also check all of the hold down clamps for the harness in order to verify that the harness is not compressed by the clamp. Pull back the harness sleeves in order to check for a flattened portion of wire. The flattened portion of wire is caused by the clamp that holds the harness.

Expected Result: The wires are free of abrasion, nicks, or cuts and the harness is properly clamped.

Results:

OK – The wires are free of abrasion, nicks, or cuts and the harness is properly clamped. Proceed to test step 5.

NOT OK – A problem exists with the wiring.

Repair: Repair the wires or replace the wires, as required.

STOP.

5. CHECK THE CONNECTORS FOR MOISTURE OR CORROSION.

- a. Ensure that the connector seals and the white sealing plugs are in place. If any of the seals or plugs are missing, replace the seal or plug. If necessary, replace the connector.
- b. Check all of the wiring harnesses in order to verify that the harness does not make a sharp bend out of a connector. This will deform the connector seal and this will create a path for the entrance of moisture. See Illustration 380 .

Note: It is normal to see some minor seal abrasion on the ECM connector seals. Minor seal abrasion will not allow the entry of moisture.

- c. Thoroughly inspect ECM connectors for evidence of moisture entry. If moisture or corrosion is evident in the connector, the source of the moisture entry must be found and the source of the moisture entry must be repaired. If

the source of the moisture entry is not repaired, the problem will reoccur. Simply drying the connector will not fix the problem. Likely paths for the entrance of moisture are from missing seals, improperly installed seals, nicks in exposed insulation, and improperly mated connectors.

Note: Moisture can also travel from one connector through the inside of a wire to the ECM Connector. If moisture is found in the ECM connector, thoroughly check all connectors and wires on the harness that connect to the ECM. The ECM is not the source of the moisture. Do not replace an ECM if moisture is found in either ECM connector.

Note: If corrosion is evident on the contacts or the connector, use only denatured alcohol to remove the corrosion. Use a cotton swab or a soft brush to remove the corrosion. Do not use cleaners that contain trichloro-ethylene because trichloro-ethylene may damage the connector.

Expected Result: All of the connectors should be completely coupled and all of the seals should be completely inserted. The harness and the wiring should be free of corrosion, moisture, abrasion or pinch points.

Results:

OK – All of the connectors are completely coupled and all of the seals are completely inserted. The harness and the wiring are free of corrosion, moisture, abrasions or pinch points. Proceed to test step 6.

NOT OK – A problem exists with the connector, the wiring or the wiring harness. Moisture is present.

Repair: Repair the connectors or wiring and/or replace the connectors or wiring. Ensure that all of the seals are properly in place and ensure that the connectors are completely coupled. Verify that the repair eliminates the problem by operating the machine for several minutes and by checking again for moisture.

STOP.

6. INSPECT THE CONNECTOR CONTACTS.

- a. Verify that the contacts are not damaged. Verify that the contacts are properly aligned in the connector and verify that the contacts are properly located in the connector.

Expected Result: The contacts are properly aligned and the contacts appear undamaged.

Results:

OK – The contacts are properly aligned and the contacts appear undamaged. Proceed to test step 7.

NOT OK – A problem exists with the connector contacts.

Repair: Repair the contacts and wiring and/or replace the contacts and wiring.

STOP.

7. CHECK THE FIT OF THE CONTACTS.

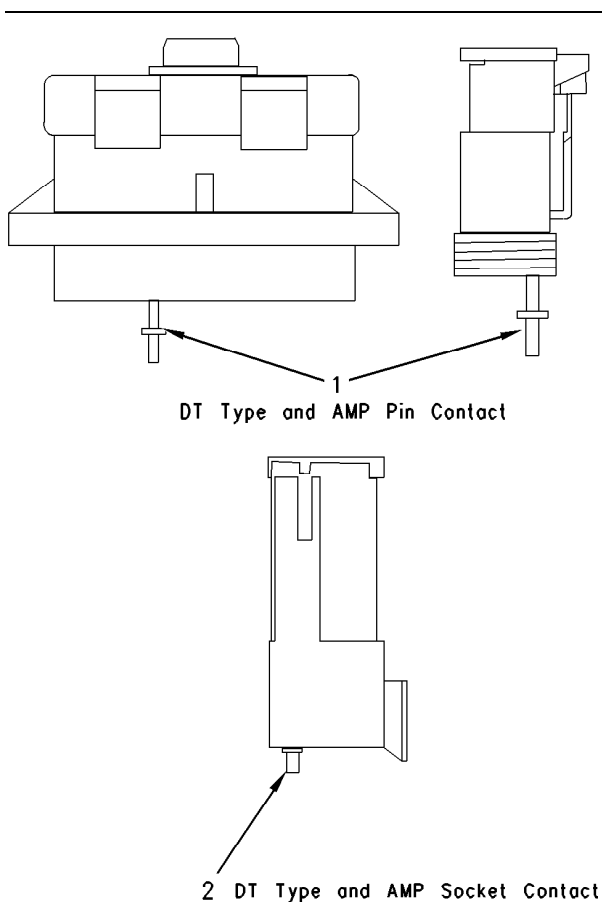


Illustration 383

g00838765

Retention of the Connector

- (1) Pin Contact
- (2) Socket Contact

Note: This is especially important for intermittent problems.

- a. Use a new pin contact. Insert the pin contact into each socket contact one at a time in order to check for a good grip on the pin contact by the socket contact.
- b. Use a new socket contact. Insert the pin contact into each socket contact one at a time

in order to check for a good grip on the pin contact by the socket contact. The pin contact are located on the mating side of the connector.

- c. The connector contact should stay connected when the connector is held in the position shown in Illustration 383 . The connector contact is the pin contact or the socket contact.

Expected Result: The pin contacts and the socket contacts appear to be OK.

Results:

OK – The pin contacts and the socket contacts appear to be OK. **STOP.**

NOT OK – A problem exists with the connector terminal.

Repair: Replace the connector contact.

STOP.

i02634314

Wiring Harness (Open Circuit) - Test

SMCS Code: 1408-081

An open circuit is a failure of an electrical circuit that results in no flow of electrical current. An open circuit is can be caused by a break in a circuit wire. Most often, an open circuit is caused by a poor connection or a failed connection in one of the electrical connectors that is used in a circuit.

The following procedure is a way to check for an open or a poor connection in a circuit.

TEST FOR AN OPEN CIRCUIT.

1. Identify the connectors and the wire numbers of the suspect circuits. Use the Electrical System Schematic of the machine to identify the circuits.
2. Turn the key start switch and the disconnect switch to the OFF position.
3. Disconnect the component and the ECM from the wiring harness.
4. At one of the disconnected harness connections, place a jumper wire from the contact of the suspect wire to frame ground.
5. At the other connector of the machine harness, use the multimeter probes to measure the resistance from the contact of the suspect wire to frame ground.

Expected Result: The resistance is less than 5 ohms.

OK – The resistance is less than 5 ohms. The harness circuit is correct.

Stop.

NOT OK – The resistance is greater than 5000 ohms. There is an open in the machine harness.

Repair: Repair the machine harness or replace the machine harness.

Stop.

When the resistance of a good circuit is measured, less than 5.0 ohms of resistance is expected. In a circuit that has an electrical wire or a connection that is completely open (broken or no connection), the flow of electrical current through the circuit is interrupted. A circuit that is completely open due to a broken wire or no connection in a connector will measure greater than 5000 ohms of resistance.

Many times a circuit is not completely open and will allow some current to pass through, however, not enough current will pass to allow the circuit to function properly. This can be caused by a wire that is partially broken but still is intact enough to allow a small amount of current to pass. Partial breaks in a wire are difficult to diagnose because the resistance measurement may check OK through the section of wire that is still intact. Partial breaks in a wire are not common. When a partial break is suspected in a wire, the current through the circuit should be checked under load in order to verify that the correct amount of current is present.

Most often, a resistance measurement of greater than 5.0 ohms and less than 5000 ohms is due to a poor connection in a circuit connector. The connector contacts may be corroded due to moisture that has entered the connector body. A connector pin or socket may not have been seated securely in the connector body and is not making good contact or a wire may be broken at the point where the pin or socket is connected. When checking for problems in a circuit, the connectors in the circuit should be examined closely.

When an open is suspected in a circuit, try to isolate the section of the machine harness where the open is occurring. The complete Electrical System Schematic for your machine must be used in order to identify and find the harness connectors that are in the suspect circuit.

Once the harness connectors for the circuit are identified, isolate the section of the circuit that is open. Start at either the component or the ECM end of the circuit. With the disconnect switch and the key start switch in the OFF position, disconnect the component or the ECM connector and use a jumper wire to connect two of the circuit wires. Go to the next harness connector in the circuit and disconnect the connector. Check the connector contacts for corrosion. Make sure the contacts are not damaged, are clean and are securely installed in the connector body. Use the electrical schematic to determine the contacts for the jumpered circuit wires. Check the resistance between the two wires. A good circuit will measure less than 5.0 ohms. Repeat the steps as you go to the next connector in the circuit until the faulty section of the circuit is identified.

Once the wire or connector that is causing the problem is found, replace the broken wire or repair the harness connector. Do not use a splice to repair a broken wire. A splice will not keep moisture out of the connection and will create another potential problem area in the circuit.

i02563153

Wiring Harness (Short Circuit) - Test

SMCS Code: 1408-081

A short circuit is a failure of an electrical circuit that results in the flow of electrical current through an unintended path. A circuit can be shorted to a ground source, either frame ground or a ground circuit, or a circuit can be shorted to another circuit in the machine wiring harness such as a system voltage (+battery) circuit, a sensor power supply circuit or a sensor signal circuit.

A short circuit to a ground source will cause excessive current to flow through the circuit and will cause the voltage in the circuit to decrease. In a machine circuit that is not controlled by an ECM such as a lighting circuit, this will cause the fuse or the circuit breaker for the circuit to open. In a ECM controlled circuit, the ECM will detect these conditions and can activate a diagnostic code for the circuit with an FMI 04 (voltage below normal) or an FMI 06 (current above normal) condition code.

A short circuit to another voltage source circuit can result in voltage being present in the circuit when no voltage should be present. When this occurs in ECM controlled output circuits (solenoids), uncontrolled machine movement can occur. When this occurs in ECM input circuits (sensors), machine functions may not operate when requested due to signal interference. The ECM will detect these conditions and can activate a diagnostic code for the circuit with an FMI 03 (voltage above normal) or possibly an FMI 08 (abnormal frequency, pulse width or period) condition code.

Short circuits can be caused by damage to the insulation of a wire as a result of repeated contact with the machine frame or with another wire. A short circuit can also be caused by a damaged or contaminated machine harness connector. A short circuit can also be caused by a failed circuit component.

When troubleshooting a circuit for a short, the connection schematics that are provided in the back of this manual are a good quick reference source, however, the complete Machine Electrical System Schematic should be used in order to identify all of the machine wiring harness connectors that are in a specific circuit.

Reference: For a complete electrical schematic, refer to Electrical System Schematic for the machine that is being serviced.

TEST FOR A SHORT CIRCUIT.

1. Identify the connectors and the wire numbers of the suspect circuits. Use the Electrical System Schematic of the machine to identify the circuits.
2. Turn the key start switch and the disconnect switch to the OFF position.
3. Disconnect the component and the ECM from the wiring harness.
4. At the machine harness connector for the ECM, place one of the multimeter probes on the contact of the suspect circuit wire.
5. Use the other multimeter probe to check the resistance between the suspect circuit wire and frame ground and all of the other contacts that are used in the ECM connectors.
6. As each measurement is made, observe the multimeter resistance measurement and wiggle the machine harness connectors for the ECM. Gently pull on the wires and move the wires around.
7. While observing the multimeter resistance measurement, wiggle the machine harness and the harness connectors that are involved in the circuit. Gently pull on the wires and move the wires around.

Expected Result: The resistance measurement is greater than 5000 ohms for each of the measurements.

OK – The resistance is greater than 5000 ohms for all the measurements. An obvious short is not evident. An intermittent short circuit could still be causing a problem.

NOT OK – One or more of the resistance measurements is less than 5 ohms. There is a short in the machine harness. The short is between the

suspected circuit wire and the circuit wire with the lowest resistance measurement or the short is between the suspected circuit wire and the machine frame ground.

ISOLATING THE LOCATION OF THE SHORT CIRCUIT

Once it has been determined that a short circuit is present, the location of the short in the circuit must be found and repaired.

Use the troubleshooting procedure for the specific diagnostic code that is activated in order to isolate whether the problem is caused by a system component or is present in the machine wiring harness.

When the machine wiring harness is suspected, examine the circuit on the full Machine Electrical System Schematic. Starting at the ECM, identify and locate each machine harness connector that is involved in the circuit. Starting at the ECM, one at a time, disconnect each connector. Inspect the pins and the sockets on the male connector and on the female connector. Verify that all of the contacts are securely installed in the connector body. Ensure that the contacts are clean and the contacts are in good condition.

While each of the connectors is disconnected, use a digital multimeter to again measure the resistance between either frame ground or measure the resistance between the suspect circuit wire and the circuit wire with the low resistance measurement. While observing the measurement, wiggle the connector and the machine harness in order to check for intermittent short circuits. Do this as you move outward from the ECM in order to isolate the section of the harness where the short circuit is occurring.

Reconnect the connector. Ensure that the locking clips on the connectors are engaged. Check all of the connectors that are in the suspect circuit in this manner. After the connectors have been examined, check to see if a short is still present in the circuit.

A "Short Finder" device is available from most tool distributors that will aid in locating the short. In order to locate the short, these devices detect the changes that a short creates in the magnetic field that is created by a current in the wire. Detailed instructions on the operation of the device is included with these devices.

When damaged insulation is present on a wire, use a good quality electrical tape or electrical heat shrink tubing to repair the section of insulation. Ensure that the section of wire or harness is not making contact with any part of the machine frame. Do not use an "RTV" or silicone sealer to repair the insulation as these types of sealants are not compatible with the copper wire.

i03122440

Electronic Control Module (ECM) - Flash Program

SMCS Code: 7610-591-DTN

Perform the following procedure in order to flash program the ECM. The ECM is flashed in order to upgrade the software. Flash programming of the ECM must also be done if the ECM has been replaced. The Caterpillar Electronic Technician (ET) contains the program WinFlash. WinFlash is used in order to load software into the ECM. The following procedure is used in order to FLASH software into the ECM.

Note: The 171 - 4400 Communication Adapter II should be used to flash ALL components on the machine.

1. Procedure

- Connect the Data Link Cable between the Communication Adapter and the Electronic Technician.
- Connect the Data Link Cable between the Communication Adapter and the diagnostic connector of the machine.
- Use WinFlash in order to load the software.

i02738327

Electronic Control Module (ECM) - Configure

SMCS Code: 7610-025-DTN

When an ECM is replaced, the ECM is configured when the software is flashed either at the factory or at the time of installation on the machine. The saved configuration data from the ECM that was replaced will restore the parameters that were configured.

An explanation of the configured parameters for the Transmission Chassis ECM that will load factory defaults when the software is flashed are listed below:

Transmission Serial Number – The serial number will be listed for the transmission that is installed on the machine.

Autoshift Installation Status – Autoshift is a software enabled function. A factory password is required to install this function. Factory default is "Not Installed".

Transmission Shift Control Parameters – Transmission Shifting patterns can be configured for the Manual Mode and the Autoshift Modes. The parameters that can be configured are: Initial gear in the forward and reverse direction Maximum gear in the forward and reverse direction Maximum Autoshift gear in the forward and reverse direction Minimum Autoshift gear in the forward and reverse direction Refer to Systems Operation, "Features" for more information on the transmission parameters that can be configured.

Machine Speed Limit – This function limits machine maximum travel speed. The factory default is "Disabled". When enabled, this parameter will limit engine driven speed for specific gears. The parameter will not limit speed caused by other factors such as rolling downhill. The configurable range is 16.1 km/h (10 mph) to 80.5 km/h (50 mph). Factory default is 80.5 km/h (50 mph).

Machine Speed Correction Factor – The machine travel speed is calculated using the transmission output speed and the tire size. This parameter allows for adjustment for higher accuracy when measured against external speed measuring devices. The configurable adjustment range is minus (-) 8 percent to plus (+) 8 percent of the ECM calculated value. The factory default is 0 percent.

Engine Pre-Lube System Installation Status – Engine pre-lube is a software enabled function. A factory password is required to install this function. The factory default is "Not Installed". When installed, this function will lubricate the engine before the engine is started.

Auto Lube System Installation Status – Attachment only on the 16M. The factory default is "Not Installed". For all other machines, the default is "Unavailable". When installed, this parameter allows the Auto Lube Interval, Auto Lube Duration and the Auto Lube Target Pressure parameters to be configured.

Auto Lube Interval – Sets the amount of time between lube cycles. The configurable range is between 2 minutes to 120 minutes in 1 minute increments. The factory default is 60 minutes.

Auto Lube Duration – Sets the maximum amount of time that the Auto Lube Relay will be energized in order to reach the Auto Lube Target Pressure. The configurable range is between 120 seconds to 240 seconds in 1 second increments. The factory default is 240 seconds.

Auto Lube Target Pressure – This parameters detects when the system has completed a lube cycle. The configurable range is between 17236.9 kPa (2500 psi) to 22063.2 kPa (3200 psi) in 6.9 kPa (1.0 psi) increments. The factory default is 18615.9 kPa (2700 psi).

Air Conditioning System Installation Status –

Indicates whether the air conditioning system is enabled. The factory default for the 16M is “Installed” . For all other models, the factory default is “Not Installed” .

Bypass Schedule Start/Stop Times – This is an optional function. The bypass schedule can be set up to allow any key to operate the machine during a specified time on any day of the week. The following limits will apply to setup times: Do not set the start time to 00:00 and the stop time to 23:59. Doing so will disable the Machine Security System. When no bypass is desired, start time and stop time will both be set to 0. Electronic keys that are stored in the ECM will enable machine start ups at any time. The bypass start time and the bypass stop time parameters can be set for all seven days of the week, however, bypass times can not be set up to start on one day and to stop on the next day. The start time must be earlier than the stop time on the same day.

Transmission Oil Type Configuration – When the transmission oil is changed, the correct viscosity of the new transmission oil must be entered using either the Messenger or in the Cat ET Configuration Screen. After the oil is changed, select the correct viscosity of the new oil. Once the new oil viscosity has been entered, the Transmission Clutch Oil Fill Calibration must be performed.

The following list of oil viscosities are available for selection:

- TDTO SAE 0W-20
- TDTO SAE 0W-30
- TDTO SAE 5W-30
- TDTO SAE 10W
- TDTO Artic
- TDTO TMS
- TDTO SAE 30W (Factory Default)

- TDTO SAE 50W

i03121762

Electronic Control Module (ECM) - Replace

SMCS Code: 7610-510-DTN

Prior to replacement of the ECM, ensure that replacement of the ECM is absolutely necessary. The ECM is seldom the cause of an active diagnostic code. Verify that all possible causes of the problem have been investigated. Always check that the proper ground and power is available to the ECM. Before replacing the ECM, contact your Caterpillar dealership's Technical Communicator for possible consultation with Caterpillar.

Note: Corrupted configuration software or the wrong software may cause an ECM to incorrectly report diagnostic codes. Prior to replacing the ECM, flash the ECM with the correct configuration software in order to verify that the failure is not related to the corrupted software. See Testing and Adjusting, “Electronic Control Module (ECM) - Flash Program”.

Note: New electronic control modules are available either pre-programmed for a particular machine or the ECM is not programmed. An ECM that has not been programmed must be programmed by using the Caterpillar Electronic Technician (Cat ET). See Testing and Adjusting, “Electronic Control Module (ECM) - Flash Program”. See step 8 in order to determine whether the ECM has been programmed.

The following “**Replacement Procedure For An ECM That Is Communicating**” procedure is for replacement of an ECM that is capable of communicating with Cat ET. This procedure can be performed for replacement of most ECM controls on most Caterpillar machine models.

For replacement of a Transmission Chassis ECM on the M Series Motor Graders that will not communicate with Cat ET or will not save the configuration data to file, proceed to the “**Replacement Procedure For A Transmission Chassis ECM That Is Not Communicating**” procedure below.

Replacement Procedure For An ECM That Is Communicating

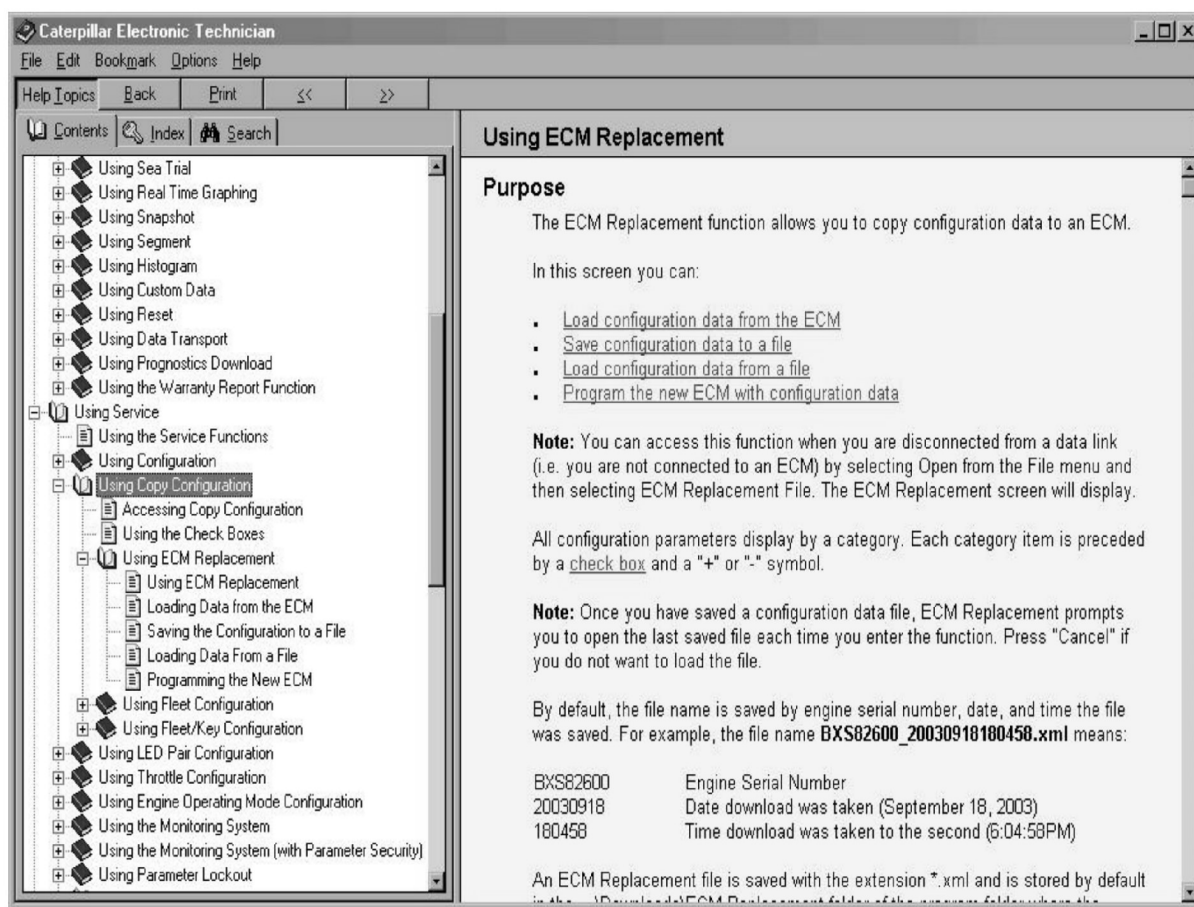


Illustration 384

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1. Save the ECM configuration data. Go to the help screen that is shown in illustration 384 , and follow the instruction in order to save the configuration data to a file. This file will be used in order to load the configuration data to the new ECM.
2. Turn the key start switch and the disconnect switch to the OFF position.
3. Disconnect the machine harness from the ECM.
4. Remove the ECM.
5. Ensure that the replacement ECM has the correct part number.
6. Connect the machine harness to the ECM.

Note: Two key start ON/OFF cycles are required for correct initialization of the new ECM.

7. Turn the disconnect switch and the key start switch to the ON position. Wait for a minute to let the ECM initialize. Turn the key start switch to the OFF position. Wait 10 seconds. Turn the key start switch to the ON position a second time for correct initialization of the ECM.
8. Determine whether the ECM has been programmed. Connect the (Cat ET) to the service tool connector. Cat ET communicates with the ECM.

Cat ET will indicate whether the ECM has been programmed. An ECM that has not been programmed must be programmed by using the WinFlash software which is contained in Cat ET. See Troubleshooting, "Electronic Control Module (ECM) - Flash Program".

Cat ET will provide access to the ECM if the ECM has already been programmed.

9. Using the Cat ET service tool, select the “Service” function from the drop-down menu. Then, select the “Configuration” function. A list of items will appear. Each item in this list should be checked in order to verify that the setting matches the machine configuration. The following information is an example of what might be viewed in order to verify the proper machine configuration. Select “Ripper Installation Status” from the choices. Select the “change” button. Select “Installed” or “Not Installed” .
10. Select the “Service” function from the Cat ET. Select “Configuration” from the choices. A list of items will appear. From the list, select “Ripper Auto Stow Configurations” . Select the “change” button. Select “Ripper Raise” or “Ripper Raise And Shank In” .
11. Perform all applicable system calibrations. See the Testing and Adjusting, “Calibration” procedure in the service manual for your machine.

Note: Some variations in Cat ET menu may be experienced. View the proper subject for information about a specific Cat ET menu.

Note: Performance will be affected by ANY calibration procedures that are omitted. Make sure that all calibration procedures are performed. Perform all calibration procedures, even if the replacement ECM was acquired from a similar machine.

Replacement Procedure For A Transmission Chassis ECM That Is Not Communicating

This procedure should be performed for an M Series Motor Grader Transmission Chassis ECM that will not communicate with Cat ET or will not save the configuration data to a file.

Prior to replacement of the ECM, ensure that replacement of the ECM is absolutely necessary. The ECM is seldom the cause of an active diagnostic code. Verify that all possible causes of the problem have been investigated. Always check that the proper ground and power is available to the ECM. Before replacing the ECM, contact your Caterpillar dealership's Technical Communicator for possible consultation with Caterpillar.

Note: The first steps will verify that the Cat Data Link circuit between the service connector and the ECM that being replaced is not causing the communication problem.

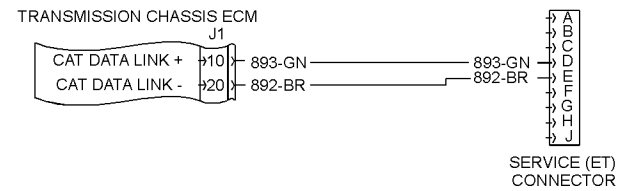


Illustration 385

g01330559

Cat Data Link connections

1. Turn the key start switch and the disconnect switch to the OFF position.
2. Disconnect the machine harness J1 connector from the Transmission Chassis ECM that is being replaced.
3. Using the diagram for the Cat Data Link connections, connect a jumper wire between the data link (+) contact (wire 893-GN(Green)) and the data link (-) contact (wire 892-BR(Brown)).
4. At the service connector, measure the resistance between data link (+) contact D (wire 893-GN(Green)) and data link (-) contact E (wire 892-BR(Brown)).

Result: The resistance measurement should be less than 5.0 ohms.

If the resistance measurement is greater than 5.0 ohms, there is an open or a poor connection in the Cat Data Link circuit. Refer to the complete machine Electrical System Schematic for your machine. Check the data link circuit for opens or bad connections. Repair the data link circuit and then try to establish communication with the ECM. If the ECM still will not communicate, proceed to the next step.

If the resistance measurement is less than 5.0 ohms, proceed to the next step.

5. Disconnect the machine harness connector J2 from the ECM.
6. Remove the Transmission Chassis ECM.
7. Ensure that the replacement ECM has the correct part number.
8. Connect the machine harness to the ECM.

Note: Two key start ON/OFF cycles are required for correct initialization of the new Implement ECM.

9. Turn the disconnect switch and the key start switch to the ON position. Wait for a minute to let the ECM initialize. Turn the key start switch to the OFF position. Wait 10 seconds. Turn the key start switch to the ON position a second time for correct initialization of the ECM.

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