CATERPILLAR®

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March 2009

Systems Operation

Starting and Charging Systems

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. 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 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.

⚠ WARNING

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.

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. 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 the product will not be damaged or be made unsafe by the operation, lubrication, maintenance or repair procedures that you choose.

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. Caterpillar dealers have the most current information available.

⚠ WARNING

When replacement parts are required for this product Caterpillar recommends using Caterpillar replacement parts or parts with equivalent specifications including, but not limited to, physical dimensions, type, strength and material.

Failure to heed this warning can lead to premature failures, product damage, personal injury or death.

Table of Contents

Systems Operation Section

Index Section

Systems Operation Section

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General Information

SMCS Code: 0710; 1401; 1405; 1406; 1453

The analyzer performs tests that are identical to a multichannel voltmeter. The lamps for the analyzer illuminate in order to indicate a defect.

The analyzer is used in order to troubleshoot the starting charging system of all 24 volt Caterpillar machines. The analyzer can troubleshoot under the following conditions:

- Machines that were manufactured after July of 1981
- Machine that is equipped with an automotive keyswitch
- Machine that is equipped with a diagnostic connector

It is unnecessary to remove any sheet metal on the machine in order to find test points. The diagnostic connector is connected to the major test points for the starting and the charging system of the machine. The connector is located in an easily accessible location. A person without electrical experience can use the analyzer with the diagnostic connector. Electrical experience is necessary in order to replace a component. The analyzer can be used on all machines that use the diagnostic connector.

6V-2150 Starting/Charging Analyzer Group

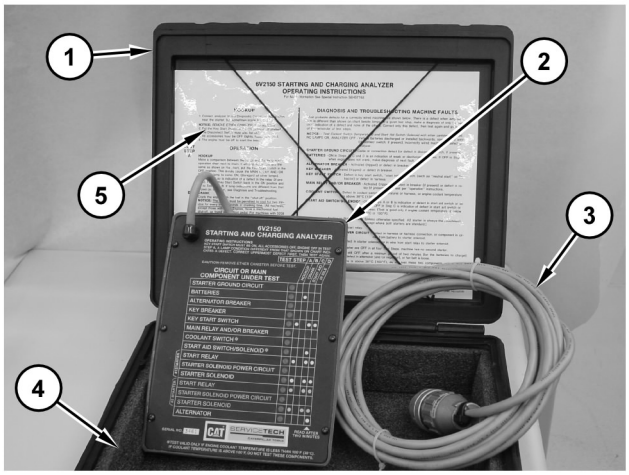

Illustration 1 g01289614

(1) Case
(2) Base
(3) Cable assembly
(4) Packing set
(5) Instruction

Features of the 6V-2150 Starting/Charging Analyzer Group

Cable Connector – A plug from the analyzer fits into a diagnostic connector. The diagnostic connector is normally in the engine area near the starter. The diagnostic connector can be located inside the cab.

Operation – Less than five minutes are needed in order to connect the analyzer for completing the test of the starting and charging system if a machine can start without assistance. More time is required for a machine that needs to be jumped.

Power supply – The power that is used in order to operate the analyzer comes through the diagnostic connector from the vehicle electrical system.

Rugged – The analyzer is designed in order to conform to various accuracies in field service conditions.

Convenient – The analyzer is easy to use.

The operation of the analyzer is convenient. The following tasks do not need to be performed:

- Remove sheet metal.
- Look for components or test points in a circuit

- Understand a voltmeter reading.
- Have more than one person in order to test a machine.

Less Downtime – The use of the analyzer results in less downtime of the machine. This is possible as the tests that are performed by the analyzer are performed easily. When the analyzer is used in an inspection, the analyzer can identify parts that have an unnoticed defect. Finding and correcting defects early can help in the prevention of future unscheduled downtime.

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Specifications

SMCS Code: 0710; 1401; 1405; 1406; 1453

Channels – The analyzer has fifteen channels (or readouts) that can check fifteen major components or circuits.

Accuracy – In field service conditions, this analyzer will keep and/or have the accuracy needed for diagnosis of failed or worn parts when used within the operating temperature range specification.

Temperature Range of Ambient Air During Analyzer Operation – Will maintain the needed accuracy from −18 to 60 °C (0 to 140 °F). The analyzer will operate outside this temperature range, but may not have the specified accuracy.

Temperature Range of Ambient Air During Analyzer Storage – −40 to 80 °C (−40 to 176 °F)

Power Required – 10 VDC to 30 VDC at approximately 250 mA using the 24 volt vehicle electrical system as a source.

Cable Length – 5500 mm (217 in).

Operating Position – Any position.

Size – Carrying Case: 394 × 311 × 102 mm (15.5 × 12.25 × 4 in) Analyzer: 254 × 191 × 30 mm (10.0 × 7.5 × 1.19 in)

Weight – Complete Group: 3.2 kg (7 lbs) Analyzer only: 1.8 kg (4 lbs)

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Basic Operation

SMCS Code: 0710; 1401; 1405; 1406; 1453

The analyzer can indicate that the components have a defect and the machine will continue to start without a problem. Also, the machine will continue to operate without problems.

This normally indicates that the components that include the wiring harness and/or the harness connectors are at the point of being worn. Replacement of these parts may be necessary.

Before making the component replacement, check for loose corroded connectors in the circuit that shows a defect.

If a replacement is necessary, install the new components in order to prevent any unexpected downtime for the machine.

NOTICE
Field service replacement of an original equipment wiring harness with wire of a different gauge can cause incorrect readings from the analyzer.

The complete test that is performed by the analyzer is made in the following four test steps:

- “Test Step A, Hookup”
- “Test Step B, Crank”
- “Test Step C, Start Aid”
- “Test Step D, High Idle”

See Systems Operation, “Analyzer Test Description” for more information.

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Test Setup A, Hookup

SMCS Code: 0710; 1401; 1405; 1406; 1453

This is a test of the machine with the engine and all accessories in the SHUT OFF position. The key start switch is in the ON position.

In this Test Step, the 6V-2150 Starting/Charging Analyzer performs the following checks:

1. At the battery, the analyzer checks the open circuit voltage as an indication of the battery charge level.
2. At the alternator circuit breaker, the analyzer checks for an activated breaker.

3. At the key circuit breaker, the analyzer checks for an activated breaker.

4. At the key start switch, the analyzer checks if the START position of the switch is open.

5. If equipped, at the main relay, the analyzer checks for closed contacts. The analyzer also checks that the breaker is not activated.

6. The analyzer checks the position of the coolant switch. The switch should be CLOSED. While the engine is cooling down, switch closes at 27 °C (80 °F). While the engine is warming up, the switch opens at 38 °C (100 °F).

Note: It is possible that the machine does NOT have components for starting aid.

7. The analyzer checks the starting aid switch. The switch should be OPEN. The coil for the starting aid solenoid should not be open.

Note: For machines that have dual starting motors, Test steps 8 and 9 apply to both starting motors.

The number 2 starting motor is always the attachment unless a dual starting system is standard equipment.

8. The analyzer checks the contacts of the start relay. The start relay should be OPEN.

9. The analyzer checks the starting solenoid. The contacts of the starting solenoid should be OPEN.

Note: If all three of the lamps for the second starting motor are OFF, this may indicate that there is no second starting motor on the machine.

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Test Step B, Crank

SMCS Code: 0710; 1401; 1405; 1406; 1453

Shut off the fuel supply in order to prevent the engine from starting during this test.

This test will activate all of the cranking circuits, so that the 6V-2150 Starting/Charging Analyzer can measure the voltage, in relation to the components on the following circuits. The analyzer performs the following checks:

1. The analyzer checks for an excessive voltage drop on the starter ground circuit.

2. The analyzer checks that the battery voltage is within the expected range for cranking.

3. The analyzer checks the alternator circuit breaker for an excessive voltage drop. The analyzer also checks if the breaker is activated.

4. The analyzer checks the key circuit breaker for an excessive voltage drop. The analyzer also checks if the breaker is activated.

5. A check for an excessive voltage drop is performed on the key start switch. The switch or the harness could be open.

6. If equipped, the main relay is checked for closed contacts. The breaker is checked for activation.

7. The analyzer checks if the coolant switch is CLOSED.

Note: It is possible that the machine does NOT have components for starting aid. Also, the machine may have an automatic starting aid system.

8. The analyzer checks that the starting aid switch is open. Also, the starting aid solenoid should have a closed circuit.

9. The analyzer checks if the start relay is CLOSED. The analyzer also checks if there is an excessive voltage drop across the contacts.

10. The analyzer checks the power circuit of the starter solenoid. A check for an excessive voltage drop is performed.

11. The analyzer checks if the starter solenoid contacts are CLOSED. The analyzer also checks if there is an excessive voltage drop across the contacts.

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Test Step C, Start Aid

SMCS Code: 0710; 1401; 1405; 1406; 1453

Note: It is not necessary to perform this test if the machine is not equipped with a starting aid switch on the dash panel of the machine. It is not necessary if the machine has a Caterpillar 3500 Engine with an automatic ether injection system. Proceed to Systems Operation, “Test Step D, High Idle”.

If the machine is equipped with a starting aid switch on the dash panel, see the procedure that follows. The indications of the lamps and the test procedures are identical to test step 1 until the starting aid switch is pushed. After the starting aid switch is pushed the analyzer performs the following checks by measuring voltage drops:

1. The analyzer checks if the coolant switch is closed. The analyzer also checks if there is an excessive voltage drop across the contacts.

2. The analyzer checks if the starting aid switch has CLOSED. The analyzer also checks if there is an excessive voltage drop across the contacts for the starting aid solenoid.

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Test Step D, High Idle

SMCS Code: 0710; 1401; 1405; 1406; 1453

The indications of the lamps and the test procedures are identical to “Test Setup A, Hookup”. There are two exceptions. The exceptions are listed below.

1. The analyzer measures the battery voltage of the alternator. The voltage should be within the charging limits.

Note: There are times when a battery needs over two minutes to charge up to an acceptable range. This is true if the machine is jump started.

2. The alternator that was tested is good. Turn ON all of the electrical loads. This will permit the analyzer to test for an excessive voltage drop across the contacts for the main relay and across the contacts for the breaker.

The breaker for the alternator is tested. The test is for an excessive voltage drop across the breaker. An excessive voltage drop is caused by the current of the alternator that is going through a faulty breaker.

Note: Excessive alternator output voltage will completely shut off the analyzer. The indicator lamp for the alternator will turn to ON. Then, the lamp will turn OFF. Then, the analyzer will turn OFF. The output of the alternator is more than 30 volts. The high output of the alternator put the analyzer in a safety SHUTOFF mode.

Panel for the Analyzer

The analyzer has a panel.

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Test Considerations

SMCS Code: 0710; 1401; 1405; 1406; 1453

Test Steps for a Machine That Cannot Start

To diagnose the problem(s) on a machine that has dead batteries, use the following procedure.

1. Connect the batteries of the machine that does not start to the batteries of the booster.

Note: See the section on jumping the engine with starter cables in the OMM for the correct machine.

2. Connect the 6V-2150 Starting/Charging Analyzer to the diagnostic connector.

3. Complete the first three test steps for the analyzer in order to obtain the necessary diagnosis.

   The following test steps should be performed:

   - “Test Setup A, Hookup”
   - “Test Step B, Crank”
   - “Test Step C, Start Aid”

4. Start the engine of the machine that did not start. Disconnect the booster from the machine. See the section on jumping the engine with starter cables in the OMM for the correct machine.

5. Perform “Test Step D” in order to obtain the necessary diagnosis.

The voltage of the former dead batteries should start to increase and the indicator lamp for the alternator should illuminate. The lamp indicates proper operation of the alternator. Stop the engine. Perform test step A through D in order to obtain the diagnosis of the defect according to the test results.

Note: The lamps for the analyzer may not give a correct indication while the booster is connected to the dead batteries.

Test Steps for Machines That are Equipped with a 3208 Engine

The fuel system on a 3208 Engine does not have a mechanical shutoff. The 3208 engines have an electrically operated shutoff solenoid that is located on the fuel pump housing.

The electrically operated shutoff solenoid is automatically activated for approximately thirty seconds when the key start switch is turned OFF. Older models activate the shutoff solenoid for approximately seventy seconds.

Use the following procedure in order to keep the engine from starting during “Test Step B, Crank”.

1. Use a piece of 14 GA, 16 GA, or 18 GA wire that is approximately 2000 mm (79 in) in length to make a jumper wire.

   Install a #63 clip or an equivalent clip to one end of the wire. Install a 46-A clip for a battery or an equivalent clip to the other end of the wire.

2. Connect the jumper wire to the “MOTOR” terminal of the starter solenoid and to “BATTERY” terminal of the shutoff solenoid.

Note: The jumper wire will activate the shutoff solenoid when the engine is cranking. The jumper wire will prevent the engine from starting during “Test Step B, Crank”.

NOTICE
Check starter cycle: Thirty seconds of cranking requries two mintues of cool down.

Do NOT connect the shutdown solenoid directly to 24 volts. This could damage the coil.

3. Connect the 6V-2150 Starting/Charging Analyzer to the diagnostic connector. Complete the first three test steps for the analyzer in order to obtain the necessary diagnosis for any machine.

   The following test steps should be performed:

   - “Test Setup A, Hookup”
   - “Test Step B, Crank”
   - “Test Step C, Start Aid”

4. Disconnect the jumper wire. Complete “Test Step D, High Idle.”.

Test Steps for Machines That are Equipped with Energize-to-Run Fuel Shutoff Solenoids

Note: This test does not apply to 3208 Engines.

The fuel system on some later engines does not have a mechanical fuel shutoff. Older engines have an electrically operated energize-to-run solenoid.

Disconnect the blue wire at the fuel solenoid on the fuel pump. This will prevent the engine from starting during “Test Step B, Crank”. Insulate the wire.

Make sure that the wire does not touch the chassis while the tests are performed. Disconnect the connector if the solenoid has a two-pin connector.

NOTICE
Check starter cycle: Thirty seconds of cranking requires two minutes of cool down.

Connect the 6V-2150 Starting/Charging Analyzer to the diagnostic connector. Complete the first three test steps for the analyzer.

The following test steps should be performed:

- “Test Setup A, Hookup”
- “Test Step B, Crank”
- “Test Step C, Start Aid”

Reconnect the blue wire at the solenoid on the fuel pump. Complete “Test Step D, High Idle.”.

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Analyzer Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

Explanation of the Tests for the Analyzer

Note: The voltages that are listed in this manual are direct current volts with two exceptions. The basic schematic that follows is typical of all Caterpillar machines that have a diagnostic connector. The following is an explanation of the two exceptions:

1. All of the machines will not be equipped with all of the components that are shown on the schematic. The starting aid, the main relay, and the two starters are examples of such components.

   The wire connections of the components in the schematic are identical for all machines that contain the same components.

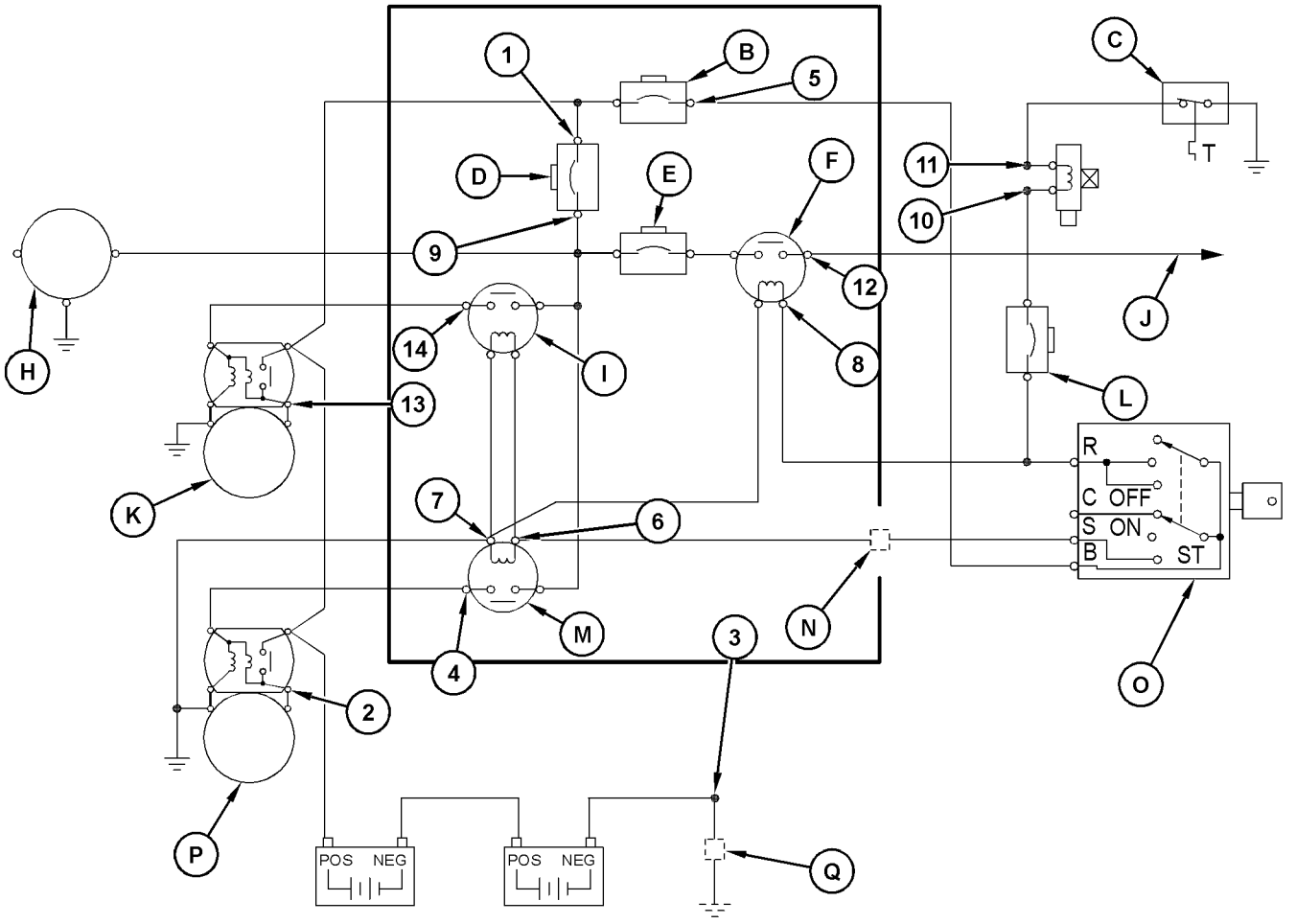
2. The harness connectors that are used to connect the components are not shown on the schematic.

All of the harness connectors are not shown on the schematic. The harness connectors are considered when a machine is tested for defects. The tests by the analyzer include the connectors in the circuit.

Compare the basic schematic with the wiring diagram of the machine that is tested. Determine the connectors and the wiring harnesses that are within the test points of the analyzer.

A basic machine illustrates each circuit test that is made by the analyzer in the topics that follow. The schematic with each topic shows only the circuit for that part of the test.

Reference the wiring diagram for the machine in order to see the actual machine wiring.



g01275680

Illustration 2

(A) Enclosure for Breaker
(B) Key Circuit Breaker
(C) Coolant Switch
(D) Alternator Circuit Breaker
(E) Main Breaker
(F) Main Relay
(G) Starting Aid Solenoid
(H) Alternator
(I) Start Relay 2
(J) The loads for the vehicle
(K) Starter 2
(L) Starting Aid Switch
(M) Start Relay 1
(N) Starter Switch
(O) Key Start Switch
(P) Starter 1
(Q) Disconnect Switch (if equipped)
(1) Test Point
(2) Test Point
(3) Test Point
(4) Test Point
(5) Test Point
(6) Test Point
(7) Test Point
(8) Test Point
(9) Test Point
(10) Test Point
(11) Test Point
(12) Test Point
(13) Test Point
(14) Test Point

Note: The location numbers for the test points on the schematic are identical to the pin numbers on the diagnostic connector. For example, Test point 1 on the schematic is Pin 1 on the connector.

i02549169

Starter Ground Circuit Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

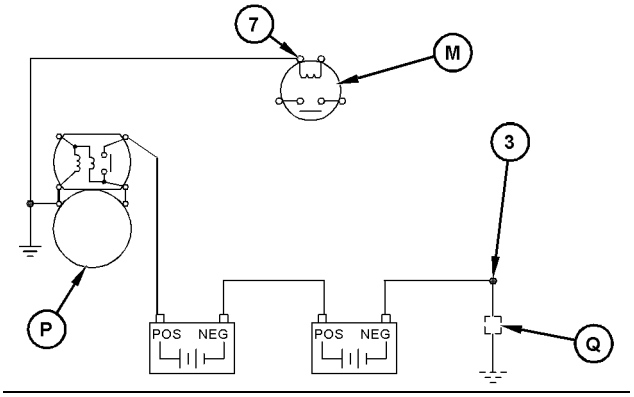


Illustration 3 g01275957

Specification

This test measures the voltage drop in the ground lead of the starter (R). The voltage drop is measured across test point (7) and test point (3).

A voltage drop will cause the indicator lamp for the starter ground circuit to turn ON. The voltage drop must be larger than 1.30 ± 0.15 volts. The lamp turned ON in order to signal a defect.

A defect can only be indicated during “Test Step B, Crank”.

The possible causes of this condition are listed:

- Disconnect switch with an excessive voltage drop
- Cable connections to the frame with excessive voltage drops

Note: Disconnected switches will be tested as part of the starter ground circuit.

Information for Other Circuits

There are three ways to wire a circuit for the starter ground.

1. Connect a single cable from the negative battery terminal directly to the negative post of the starter. Test point 1 is tied to test point 2. The analyzer does not check the voltage drop.
2. A disconnect switch is located in the ground cable. The switch is between the negative battery terminal and the negative starter terminal. The analyzer checks the disconnect switch. Also, the analyzer checks the cable for the switch to the starter.
3. The negative starter terminal is tied to the frame. The negative battery terminal is tied to the frame in a different location. This type of connection includes a disconnect switch. The analyzer checks the connections and the switch. Cleaning the connections for the cable at the frame will usually correct the defect.

i02549615

Batteries Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

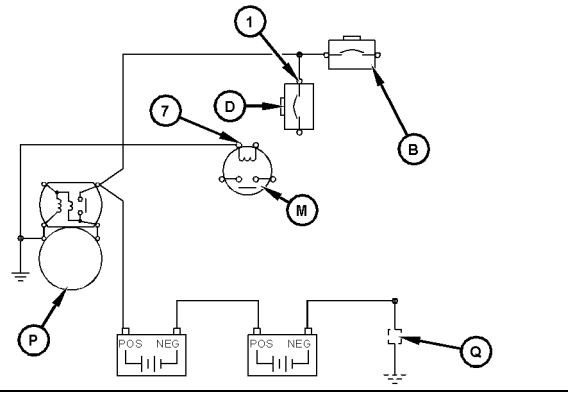


Illustration 4 g01276069

Specification

This test measures the terminal voltage of the batteries. The voltage is measured across test point (1) and test point (7).

A voltage drop during the “Test Setup A, Hookup” will cause the indicator lamp for the batteries to turn ON. The voltage drop must be below 23.10 ± 0.15 volts. The lamp turned ON in order to indicate a low state of charge.

The batteries do not have enough power in order to crank the engine in this condition. A defect can be indicated during any Test Step.

The possible causes of this condition are listed:

- No alternator output
- Worn out batteries that will not hold a charge
- Light was left ON while the machine was shut down.

Specification

It is normal for the battery voltage to go below 23.1 volts when the engine is cranking. The lamp will turn ON when this happens. The batteries will crank the engine momentarily if the battery voltage goes below 12.50 ± 0.15 volts. The lamp will turn OFF in order to indicate a very low voltage.

The possible causes of this condition are listed:

- Batteries with low voltage
- Faulty starter
- Excessive drag of the engine or friction

Information for Other Circuits

To find the defect that is the cause of problem, check the alternator.

No Alternator Output

Jump start the machine in order to check the output of the alternator. For more information, see the explanation of the test in the Systems Operation, “Test Step D, High Idle” section.

Check the batteries if the alternator is operating correctly. Charge the batteries if it is necessary. For more information, see the explanation in Special Instruction, SEHS7633, “Battery Test Procedure”.

Note: See the section on jumping the engine with a booster and starter cables in the OMM for the correct machine.

i02549733

Alternator Breaker Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

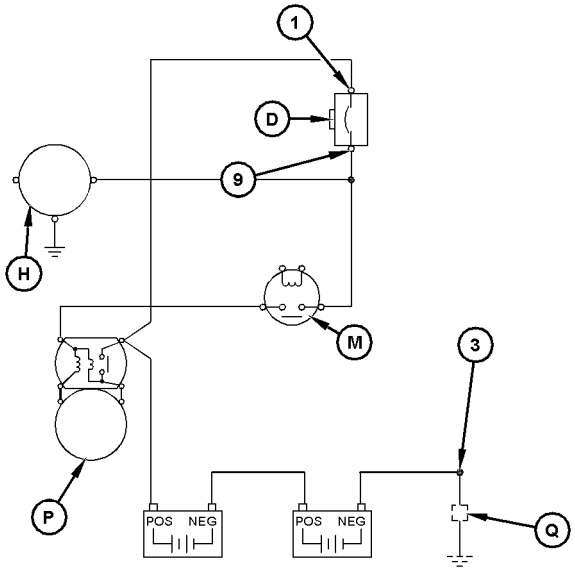


Illustration 5 g01276092

Specification

This test measures a voltage drop of either polarity across the alternator circuit breaker. The voltage drop is measured across test point 1 and test point 9.

A voltage drop will cause the indicator lamp for the lamp for the alternator circuit breaker to turn ON. The voltage drop must be larger than 0.45 ± 0.15 volts. The lamp turned ON in order to indicate a defect in the circuit. A defect can be indicated during any Test Step.

The possible causes of this condition are listed:

- Activated breaker
- Closed breaker with excessive voltage drop

Information for Other Circuits

In the steps “Test Setup A, Hookup”, “Test Step B, Crank”, and “Test Step C, Start Aid” test point (1) will be positive and test point (9) will be negative. Test point (1) and test point (9) are this way because the battery is sourcing current through the alternator circuit breaker (D) to the circuits for cranking.

The voltage will reverse polarity at test point (1) and test point (9) during “Test Step D, High Idle”. Test point (1) will be negative and test point (9) will be positive. The polarity reverses because the battery is receiving current through alternator circuit breaker (D) from alternator circuit breaker (H).

The batteries cannot get a full charge if the charging circuit has an excessive voltage drop.

The indicator for the alternator circuit breaker blinks for a few seconds. The indicator may turn ON for a few seconds. The indicator will turn OFF and the indicator for the alternator will turn ON. This is acceptable during engine start-up.

i02549754

Key Breaker Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

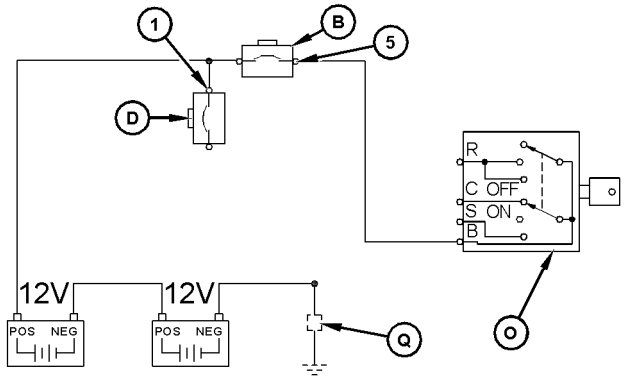


Illustration 6 g01276108

Specification

This test measures the voltage drop of the key circuit breaker. The voltage is measured across test point (1) and test point (5). Test point (1) is the positive contact and test point (5) is the negative contact.

A voltage drop will cause the indicator lamp for the key circuit breaker to turn ON. The voltage drop must be larger than 0.75 ± 0.15 volts. The lamp turned ON in order to indicate a low state of charge. A defect can be indicated during any Test Step.

The possible causes of this condition are listed:

- Activated circuit breaker
- Closed circuit breaker with an excessive voltage drop

i02549832

Key Start Switch Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

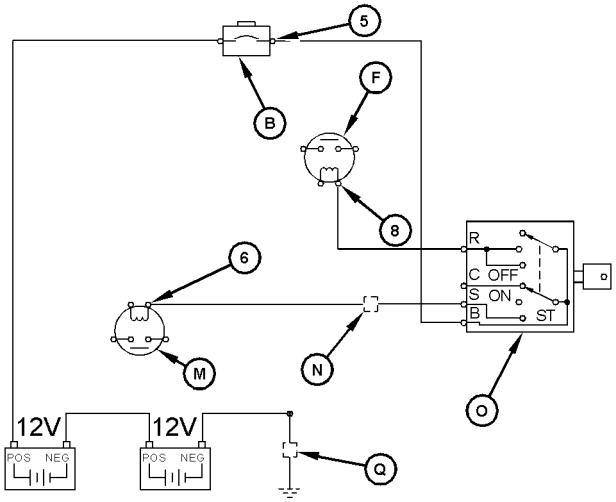


Illustration 7 g01276592

Specification

This test measures the voltage drop across two of the poles for the key start switch. The voltage drop between test point (5) and test point (6) represents the “STAR” pole. The voltage drop between test point (5) and test point (8) represents the “RELAY” pole.

A voltage drop will cause the indicator lamp for the key start switch to turn ON. The voltage drop can be across one or both of the poles. The voltage drop must be larger than 2.50 ± 0.15 volts. The lamp turned ON in order to indicate a defect. A defect can be indicated during any Test Step.

The possible causes of this condition are listed:

- Open pole on the switch
- Closed switches with excessive voltage drops
- Poles on the switch with welded contacts

Note: The keyswitch START position is open for three of the tests. The three tests are “Test Setup A, Hookup”, “Test Step C, Start Aid”, and “Test Step D, High Idle”. The indicator for the keyswitch is turned ON during the steps. This is correct.

Information for Other Circuits

An inhibitor for the key start switch instead of the key start switch can cause a failure during the “Test Step B, Crank”. Direct drive machines use a neutral start switch to inhibit the starting of the engine.

Switches that inhibit the starting of the engine (N) are always installed between test point 5 and test point 6.

The wiring harness and the connections for the wiring harness are also checked in this test. Refer to the wiring schematic for the machine that is being serviced for the location of the components. An open in the harness will indicate a defect.

i02550586

Main Relay and/or Breaker Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

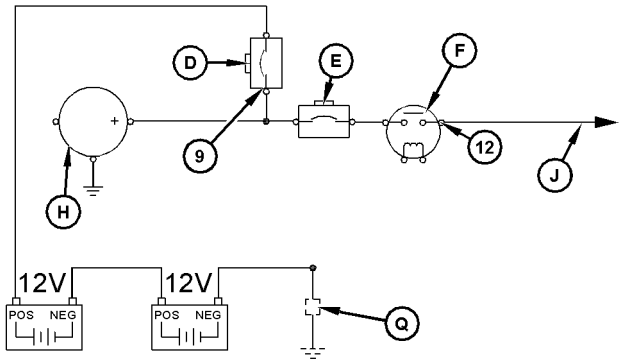


Illustration 8 g01276599

Specification

This test measures the voltage drop across the main relay and/or the circuit breaker. The voltage drop is measured across test point (9) and test point (12). Test point (9) is the positive contact and test point (12) is the negative contact.

A voltage drop will cause the indicator lamp for the main relay and/or the circuit breaker to turn ON. The voltage drop must be larger than 1.30 ± 0.15 volts. The lamp turned ON in order to indicate a low state of charge. A defect can be indicated during any Test Step.

The possible causes of this condition are listed:

- Activated circuit breaker
- Closed circuit breaker with an excessive voltage drop
- Open relay contact
- Closed relay with excessive voltage drop
- Relay with welded contacts

Note: It is necessary to find the two components that have a defect if a machine fails this test.

Use a digital multimeter in order to find the faulty components. Check for an excessive voltage drop across the man relay (F) and the main circuit breaker (E). Use the multimeter to troubleshoot the conditions for the test step that caused the analyzer to show a defect.

Information for Other Circuits

It is possible that a machine will have both of the components. It is also possible that a machine will not have either component.

Test point 12 is connected directly to test point 9 on machines that do not have either component. This type of connection will never indicate a defect on the analyzer.

Replace the component(s) that is faulty if a machine has a main circuit breaker and/or a main relay.

Refer to the wiring schematic for the machine that is being serviced. Use the schematic in order to determine the components that are used in the electrical circuit that is under the test.

i02550613

Coolant Switch Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

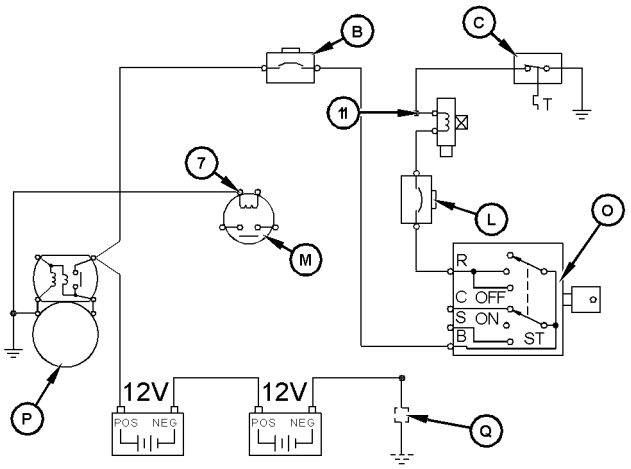


Illustration 9 g01276763

Specification

This test measures the voltage drop across the coolant switch. The voltage drop is measured across test point (11) and test point (7). Test point (11) is the positive contact and test point (7) is the negative contact.

A voltage drop will cause the indicator lamp for the coolant to turn ON. The voltage drop must be larger than 1.30 ± 0.15 volts. The lamp turned ON in order to indicate a defect.

The possible causes of this condition are listed:

- Open switch
- Closed switch with excessive voltage drop
- Switch with welded contacts

Information for Other Circuits

The coolant switch opens when the engine coolant temperature reaches 38°C (100°F).

This switch prevents the use of a starting aid in a warm engine. The use of a starting aid in a warm engine may cause possible damage.

The engine coolant must be below a temperature of 38°C (100°F) in order for this test to be valid. A warm engine must first cool down to a temperature of 27°C (80°F) in order to close the coolant switch.

i02550852

Start Aid Switch/Solenoid Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

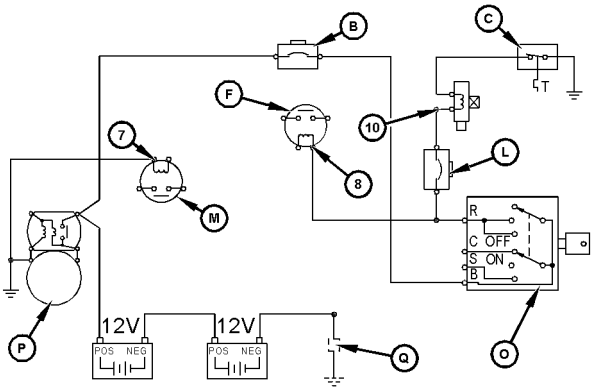


Illustration 10 g01276888

Specification

This test measures the voltage drop across the starting aid switch or the solenoid. The voltage drop is measured across test point (8) and test point (10). Test point (8) is the positive contact and test point (10) is the negative contact.

A voltage drop will cause the indicator lamp for the starting aid switch or the solenoid to turn OFF. The voltage drop must be larger than 2.50 ± 0.15 volts. The lamp turned OFF in order to indicate a defect. A defect may be indicated during any Test Step.

This test also measures the resistance across the starting aid switch or the solenoid circuit. The resistance is measured across test point (7) and test point (10).

A voltage drop will cause the indicator lamp for the starting aid switch/solenoid to turn OFF or ON. The resistance must be less than 300 Ohms in order for the lamp to stay OFF. The resistance must be greater than 3600 Ohms in order for the lamp to turn ON. The lamp turned ON in order to indicate a defect. A defect may be indicated during the following Test Steps:

- “Test Setup A, Hookup”
- “Test Step B, Crank”
- “Test Step D, High Idle”

The starting aid switch can cause this defect from the following:

- Open switch
- Closed switch with an excessive voltage drop
- Switch with welded contacts

The starting aid solenoid can cause this defect from the following:

- Open solenoid circuit

Information for Other Circuits

The lamp for the starting aid circuit is turned ON and the switch is not activated. The switch has a defect. The contacts for the switch could be welded. The solenoid and/or the harness could be open.

Disconnect the analyzer and use a digital multimeter in order to check the continuity of the test points. Check the continuity from test point 10 to test point 7 or the machine ground. The resistance from test point 10 to test point 7 should be greater than 8 Ohms. The switch has probably failed if the resistance is less than 8 Ohms.

Welded contacts on the switch can cause the solenoid coil to open. An open in the solenoid coil is a failure.

The wiring harness and the connections for the wiring harness are also checked in this test. Refer to the wiring schematic for the machine that is being serviced for the location of the components. An open in the harness will indicate a defect.

Note: The engine coolant must be below 38°C (100°F) in order to perform this test. A warm engine must first cool down to a temperature of 27°C (80°F) in order to perform this test.

i02550914

Start Relay (Starter One) Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

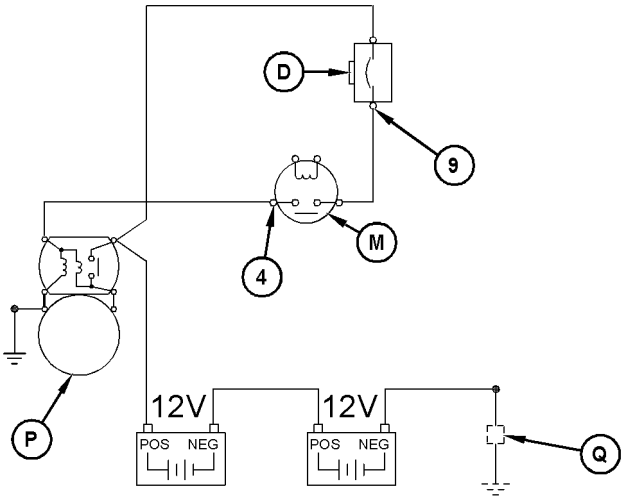


Illustration 11 g01276975

Specification

This test measures the voltage drop across the starter relay 1. The voltage drop is measured across test point (9) and test point (4). Test point (9) is the positive contact and test point (4) is the negative contact.

A voltage drop will cause the indicator lamp for the starting aid switch or the solenoid to turn ON. The voltage drop must be larger than 0.45 ± 0.15 volts. The lamp turned ON in order to indicate a defect. A defect may be indicated during any Test Step. “Test Step B, Crank” is the most common test in order to identify a defect.

The open relay can cause this defect from the following:

- Burned contacts
- Open relay coils

The closed relay can cause this defect from the following:

- Relay with excessive voltage drop

i02550947

Starter Solenoid Power Circuit (Starter One) Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

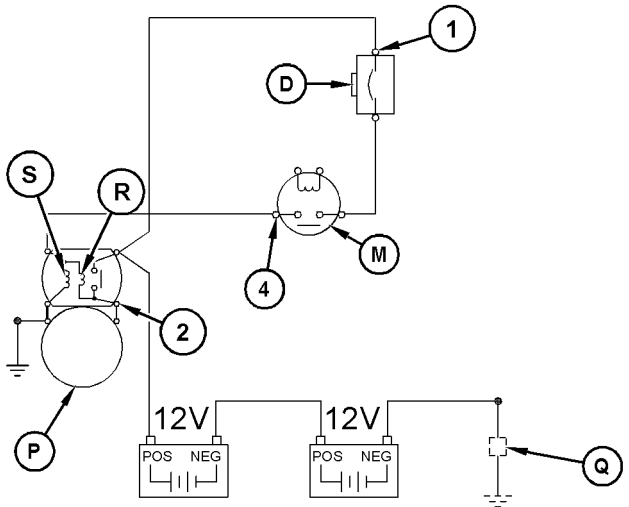


Illustration 12 g01285461

Specification

This test measures the voltage drop of the coil (R) for the starter solenoid “PULL-IN”. The voltage drop is measured between test point (2) and test point (4). Test point (2) is the positive contact and test point (4) is the negative contact.

A voltage drop will cause the indicator lamp for the starter solenoid power circuit to turn ON. The voltage drop must be larger than 1.00 ± 0.15 volts. The lamp turned ON in order to indicate a defect. A defect may be indicated only during “Test Step B, Crank”.

The possible causes of this condition are listed:

- Alternator circuit breaker with excessive voltage drop
- Start relay with excessive voltage drop

Note: The alternator circuit breaker or the start relay may have an excessive voltage drop that is within specified range.

Information for Other Circuits

The starter solenoid has two coils. The “PULL-IN” coil is coil (R). The “HOLD-IN” coil is coil (S). Both of the coils will receive power when the start relay closes. Battery voltage is applied to the high end of both coils at test point (4). The “LOW” end of the coil (S) is permanently grounded to the ground post of the starter.

The grounding for the low end of coil (R) is momentary. The grounding takes place through the direct current resistance of the starter. The contacts of the solenoid close after the magnetic force is built in both coils. The temporary ground is removed from the coil (R) and battery voltage is applied to both ends.

The solenoid closes. The solenoid is closed by the coil (R) and coil (S).

Coil (W) is out of the circuit since a battery voltage is present on both ends of the coil. The voltage across the “PULL-IN” coil is nearly zero. It is possible that test point (4) is more negative than test point (2). If test point (4) is more negative than test point (2) by one or more volts, the current flows backward. The current flows backward through the “PULL-IN” coil and the solenoid releases.

Test point (2) grounds the “PULL-IN” coil when the solenoid releases. The solenoid releases several times in a second. The contacts are burned to an open condition. The contacts become burned unless the problem is found. Replacing the solenoid returns the machine to work. Replacing the solenoid does not fix the problem.

Resolving the Problem

During the cranking of the engine, the voltage drop is incorrect. The voltage drop that is across test point (1) and test point (4) is greater than the voltage drop that is across test point (1) and test point (2). The analyzer shows that the alternator circuit breaker and the start relay are within the specifications. Replacing one or both of the components can reduce the voltage drop to an acceptable range between test point (1) and test point (2). The harness connectors can have an effect on the test of the circuit. For more information on the circuit, see the complete System Schematic for the machine that is being serviced. The lamp for the power circuit of the starter solenoid is OFF in order to indicate the acceptable limits.

i02566459

Starter Solenoid (Starter One) Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

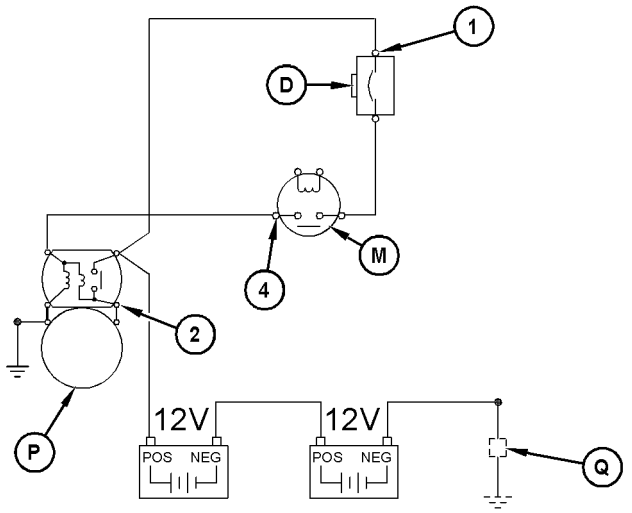


Illustration 13 g01285385

Specification

This test measures the voltage drop across the starter solenoid. The voltage drop is measured across test point (1) and test point (2). Test point (1) is the positive contact and test point (2) is the negative contact.

A voltage drop will cause the indicator lamp for the starting solenoid to turn ON. The voltage drop must be larger than 0.45 ± 0.15 volts. The lamp turned ON in order to indicate a defect. A defect may be indicated during any Test Step. “Test Step B, Crank” is the most common test in order to identify a defect.

The possible causes of this condition are listed:

- Open solenoid contacts
- Closed solenoid contacts with excessive voltage drop

Information for Other Circuits

A wire that is open from test point 4 to the starter solenoid will give an indication of a faulty solenoid. For more information on the circuit, see the complete System Schematic for the machine that is being serviced.

i02566514

Start Relay (Starter Two) Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

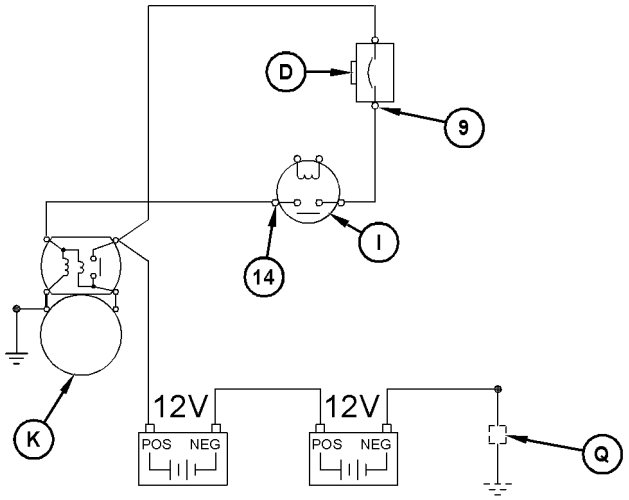


Illustration 14 g01285410

Specification

This test measures the voltage drop across the starter relay. The voltage drop is measured across test point (9) and test point (14). Test point (9) is the positive contact and test point (14) is the negative contact.

A voltage drop will cause the indicator lamp for the starting solenoid to turn ON. The voltage drop must be larger than 0.45 ± 0.15 volts. The lamp turned ON in order to indicate a defect. A defect may be indicated during any Test Step. “Test Step B, Crank” is the most common test in order to identify a defect.

The possible causes of this condition are listed:

- Open solenoid contacts
- Closed solenoid contacts with excessive voltage drop

i02566524

Starter Solenoid Power Circuit (Starter Two) Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

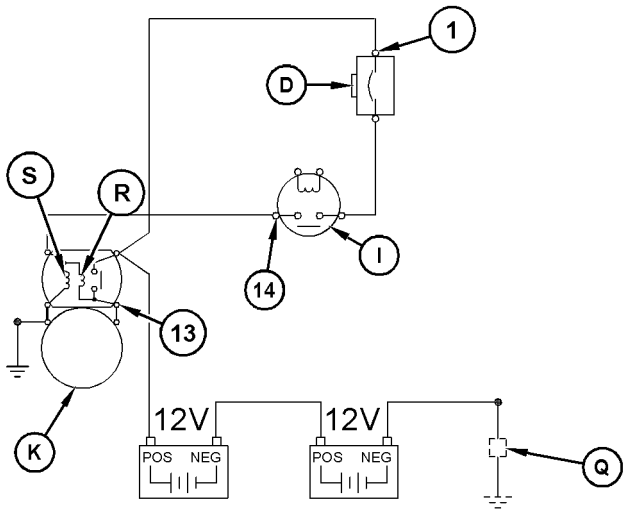


Illustration 15 g01285462

Specification

This test measures the voltage drop of the coil (R) for the starter solenoid “PULL-IN”. The voltage drop is measured between test point 13 and test point 14. Test point 13 is the positive contact and test point 14 is the negative contact.

A voltage drop will cause the indicator lamp for the starter solenoid power circuit to turn ON. The voltage drop must be larger than 1.00 ± 0.15 volts. The lamp turned ON in order to indicate a defect. A defect may be indicated only during “Test Step B, Crank”.

The possible causes of this condition are listed:

- Alternator circuit breaker with excessive voltage drop
- Start relay with excessive voltage drop

Note: The alternator circuit breaker or the start relay may have an excessive voltage drop that is within specified range.

Information for Other Circuits

The starter solenoid has two coils. The “PULL-IN” coil is coil (R). The “HOLD-IN” coil is coil (S). Both of the coils will receive power when the start relay closes. Battery voltage is applied to the high end of both coils at test point 14. The “LOW” end of the coil (S) is permanently grounded to the ground post of the starter.

The grounding for the low end of coil (R) at test point 13 is momentary. The grounding takes place through the direct current resistance of the starter. The contacts of the solenoid close after the magnetic force is built in both coils. The temporary ground is removed from the coil (R) and battery voltage is applied to both ends.

The solenoid closes. The solenoid is closed by the coil (R) and coil (S).

Coil (W) is out of the circuit since a battery voltage is present on both ends of the coil. The voltage across the “PULL-IN” coil is nearly zero. It is possible that test point 14 is more negative than test point 13. If test point 14 is more negative than test point 13 by one or more volts, the current flows backward. The current flows backward through the “PULL-IN” coil and the solenoid releases.

Test point 13 grounds the “PULL-IN” coil when the solenoid releases. The solenoid releases several times in a second. The contacts are burned to an open condition. The contacts become burned unless the problem is found. Replacing the solenoid returns the machine to work. Replacing the solenoid does not fix the problem.

Resolving the Problem

During the cranking of the engine, the voltage drop is incorrect. The voltage drop that is across test point 1 and test point 14 is greater than the voltage drop that is across test point 1 and test point 13. The analyzer shows that the alternator circuit breaker and the start relay are within the specifications. Replacing one or both of the components can reduce the voltage drop to an acceptable range between test point 1 and test point 13. The harness connectors can have an effect on the test of the circuit. For more information on the circuit, see the complete System Schematic for the machine that is being serviced. The lamp for the power circuit of the starter solenoid is OFF in order to indicate the acceptable limits.

i02567459

Starter Solenoid (Starter Two) Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

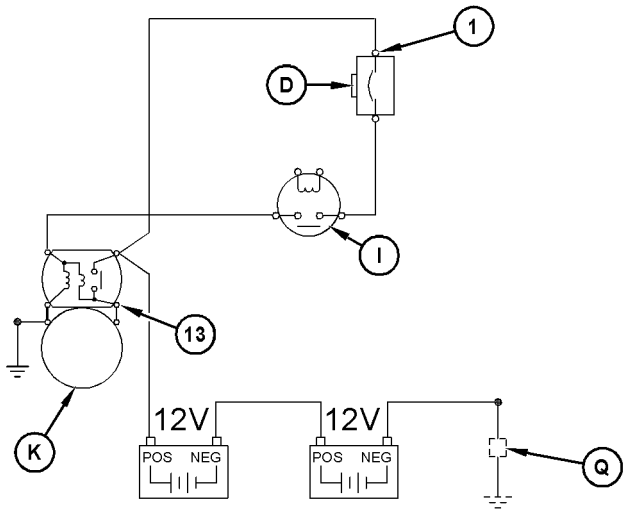


Illustration 16 g01286027

Specification

This test measures the voltage drop across the starter solenoid. The voltage drop is measured across test point (1) and test point (13). Test point (1) is the positive contact and test point (13) is the negative contact.

A voltage drop will cause the indicator lamp for the starting solenoid to turn ON. The voltage drop must be larger than 0.75 ± 0.15 volts. The lamp turned ON in order to indicate a defect. A defect may be indicated during any Test Step. “Test Step B, Crank” is the most common test in order to identify a defect.

The possible causes of this condition are listed:

- Open solenoid contacts
- Closed solenoid contacts with excessive voltage drop

Information for Other Circuits

A wire that is open from test point (4) to the starter solenoid will give an indication of a faulty solenoid. For more information on the circuit, see the complete System Schematic for the machine that is being serviced.

i02569979

Alternator Test Description

SMCS Code: 0710; 1401; 1405; 1406; 1453

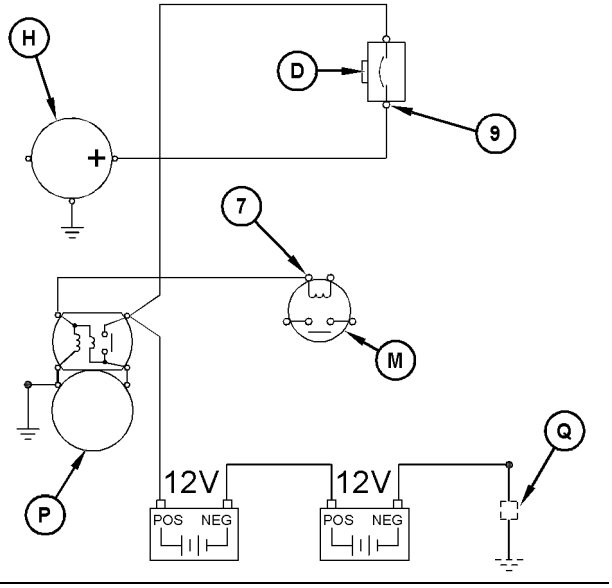


Illustration 17 g01287589

Specification

This test measures the voltage drop of the alternator output. The voltage drop is measured across test point (9) and test point (7). Test point (9) is the positive contact and test point (7) is the negative contact.

Voltage measurement that is less than 26.2 ± 0.15 volts

A voltage measurement that is between the two test points causes the lamp for the alternator to stay OFF if the voltage is less than 26.2 ± 0.15 volts. The lamp is OFF after a minimum of two minutes in order to indicate a defect. The defect indicates that the alternator is charging inadequately.

The defect can be caused by the following:

- Loose belts on fan
- Loose belts on alternator
- Ground cable from the starter to the engine block is damaged, loose, or missing.
- Faulty alternator
- Faulty batteries

Voltage measurement that is more than 28.9 ± 0.15 volts

A voltage measurement that is between the two test points causes the lamp for the alternator to turn OFF if the voltage measurement is more than 28.9 ± 0.15 volts. The lamp is ON for one minute and turns OFF in order to indicate a defect. The defect indicates that the alternator is charging at an excessive rate.

The defect can be caused by the following:

- Alternator

Information for Other Circuits

Inadequate Charge

A faulty alternator causes the lamp to turn ON. Then, the lamp turns OFF when all of the electrical loads are turned ON. The lamp does not turn ON again.

In the event of such a condition, use a ammeter in order to verify the correct output amperage of the alternator. For the correct alternator output, refer to the service manual for the machine that is under the test.

Excessive Charge

The analyzer shuts down to a safe mode when the alternator is excessively charging at a severe output. The safe mode is indicated when all of the lamps for the analyzer turn OFF.

An overcharge can be confirmed. Slowly reduce the engine speed to idle. The analyzer turns ON. The lamp for the alternator is OFF. Then, the lamp turns ON. The overcharge is confirmed. An overcharge can also be confirmed if low amounts of water are found in every cell of the batteries.

i02548849

Troubleshooting

SMCS Code: 0710; 1401; 1405; 1406; 1453

Panel of the Analyzer

Illustration 18 g01289644

Troubleshooting the 6V-2150 Starting/Charging Analyzer During Operation with an Indication of a Defect in the Analyzer

There is an indication of a defect in the analyzer. This procedure will aid in the location of the problem.

1. Repair work that was completed on the machine such as removal of the engine or replacement of the wiring harness could have caused the problem. The following is a list of possible problems:

   - Errors in connections of the machine wiring harness
   - Error in wiring of the diagnostic connector

Note: When an error in the wiring is the problem, use a digital multimeter to perform a test on the correct wiring harness. For more information, see the explanation of the tests on the analyzer in the Systems Operation, “Test Considerations” section.

2. The machine wiring is correct and the analyzer does not show the expected results. Use an analyzer that is known to be good and then repeat the tests.

If the analyzer has a defect, see Systems Operation, “Reference Information”.

i02570382

Reference Information

SMCS Code: 0710; 1401; 1405; 1406; 1453

Repair Information

The repair of the analyzer will be performed by Advanced Technology Services.

Warranty Policy

Analyzers that are less than one year old are repaired under Caterpillar Warranty except in the event of abuse. If the repair is being returned under Caterpillar warranty, follow the standard Caterpillar Warranty Claim Procedure in order to regain expenses. Obtain an authorization number from the Caterpillar Service Technology Group Hotline if the claim is over $200.

Telephone

Caterpillar Service Technology Group Hotline

In Illinois call 1-800-542-8665

Outside Illinois call 1-800-541-8665

Canada call 1-800-523-8665

Advanced Technology Services

For 24 hour customer care call 1-800-328-7287

Outside North America call 1-309-693-4170

Write

E-mail: CSR@AdvancedTech.com

Address: 8201 N. University Peoria, IL 61615 Attn: Caterpillar Diagnostic Tool Repair

Index

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