



LINCS II 24 Volt DC System Circuit Description

Section 06-04-04

Komatsu has made every effort to make this manual as accurate as possible based on the information available at the time of publication and printing. Continuous improvement and advancement of product design may cause changes to machines which may not have been included in this publication. Komatsu reserves the right to make changes and improvements at any time. To ensure the most current information, please contact your service center.

Table of Contents

Control System I/O Types	3
Digital	3
Standard Input	3
Pull Up Input	3
Frequency Input	3
Hi Side Output	4
Low Side Output	4
Analog	5
Standard (Voltage) Input	5
4-20 MA Input	5
Electrical Circuit Descriptions	7
Key Switch	7
On Position	7
Off Position	7
Crank	7
HMI (Human Machine Interface).....	8
HMI Power	8
Park Brake	8
Speed Control Pedal.....	8
Wipers	9
Safety Systems	9
Emergency Stop	9
Fire Suppression System	9
Batteries	10
Cooling Pumps.....	10
Lights and Alarms	11
Power Distribution.....	12
Dealer Options	12
Speed Sensors	12
Drive System Interface	12
CAN (Controller Area Network).....	13
Cab (CAN 0)	13
Engine/Cooling Pump (CAN 1)	13
Drives System (CAN 2).....	13
Spare CAN (CAN 3).....	13
Engine	15
MTU DDEC IV Series 2000/4000	15
MTU ADEC Series 4000	15
Cummins QSK38/60	15

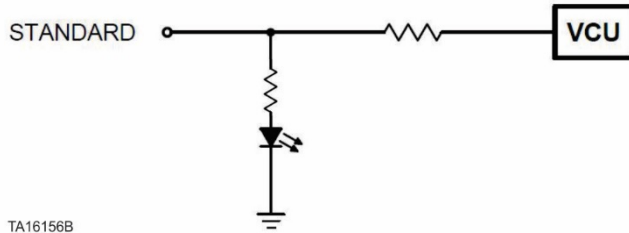
Cummins QST30	16
Options	17
Auxiliary Steering	17

Control System I/O Types

The LINCS II control system employs a variety of input/output (I/O) to perform the control and monitoring functions on the machine.

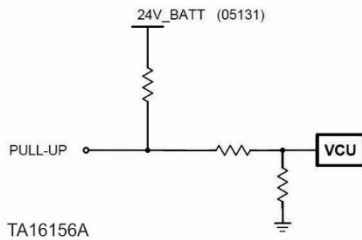
Digital

Standard Input



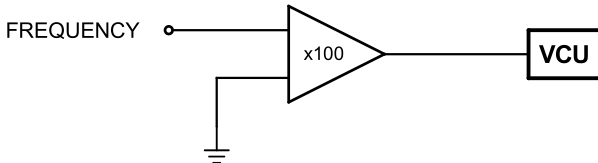
The standard input accepts a 0 – 40V DC input range where switched voltage detection is required. The switching threshold is approximately 3V DC. Each standard input to the digital interface card is associated with an LED on the card. When the LED is illuminated the voltage of the input is greater than 3V, conversely when the LED is extinguished the voltage of the input is less than 3V. The logic level “ON/OFF” of the digital input is presented to the VCU.

Pull Up Input



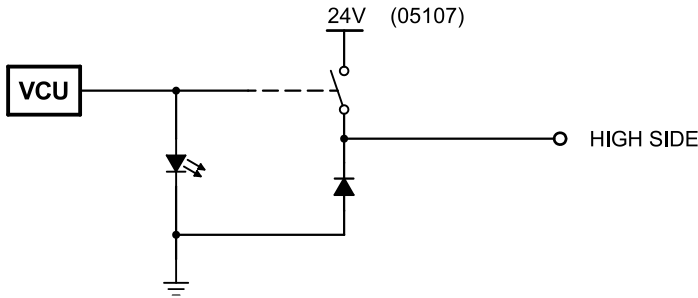
The standard input accepts a 0 – 40V DC input range where switched voltage detection is required. The switching threshold is approximately 3V DC. An internal pull up resistor is provided for circuits where a ground is switched onto the input. As with the standard digital input, each pull up input to the digital interface card is associated with an LED on the card. When the LED is illuminated the voltage of the input is greater than 3V, conversely when the LED is extinguished the voltage of the input is less than 3V. The logic level “ON/OFF” of the digital input is presented to the VCU.

Frequency Input



The frequency input is a high input impedance input that voltage multiplies (x 100) low level magnetic speed sensor input to a magnitude readable by the VCU. The input is presented to the VCU which uses internal counting capability to measure the frequency of the input signal.

Hi Side Output

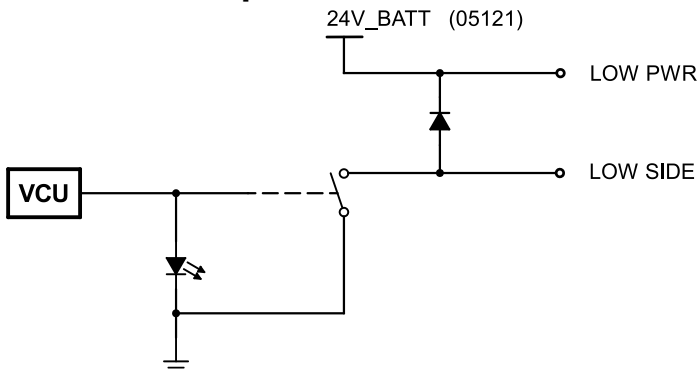


The high side output utilizes switching hardware to control 24V supply to the designated output. The high side output is current limited to 6 amps. In the event that a short circuit to ground is applied to the digital high side output the current supplied by the output will be limited to 6 amps.

The high side high speed output produces a pulse width modulated (PWM) output. The duty cycle of the digital output is controlled by the VCU. The frequency of the PWM output is fixed at 200 hertz. The duty cycle control is typically used to control current in the load device.

The percentage of duty cycle output can be observed at the LED for the respective output, located on the digital interface card. With a 0% duty cycle the LED will be off. As the duty cycle increases then the intensity of the LED will increase until it reaches a maximum at 100% duty cycle.

Low Side Output

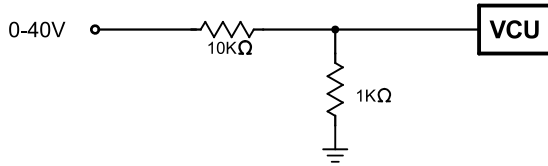


The low side output utilizes a switching device to switch ground to the designated output. The low side output is current limited to 6 amps. In the event that a short circuit to 24V is applied to the digital low side output the current supplied by the output will be limited to 6 amps. The state of the output is controlled by the VCU.

The state of a given output can be observed at the LED for the respective output, located on the digital interface card. When the output is of then LED will be off. As the duty cycle increases then the intensity of the LED will increase until it reaches a maximum at 100% duty cycle.

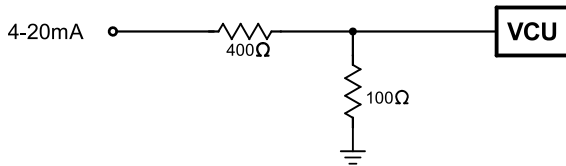
Analog

Standard (Voltage) Input



The standard analog input is a 0 to 40V capable input. The analog interface card performs a (x 0.1) gain reduction of the input signal to match the voltage sensitivity of the VCU analog input module.

4-20 MA Input



The 4 – 20 mA current loop input provides current to voltage conversion across the burden resistor network located on the analog interface card. The tight tolerance resistors in the circuit create a 0.4 – 2.0 V voltage span for the input current capability. This voltage output is presented to the analog input module.

This Page Intentionally Left Blank

Electrical Circuit Descriptions

The following text describes the operation of the 24V electrical circuits. The order of the descriptions loosely follows the order of the circuits as shown in the electrical schematic. The descriptions provided only provide electrical circuit operation and do not detail the operations of logic within the VCU. Only compound electrical circuits are described, simple repeated circuits such as solenoids and transducers are not described.

Key Switch

On Position

- VCU and HMI begin to boot.
- Once booted the VCU latches in 24V power to itself and HMI (DO2 & CRKA)
- 24V is supplied to the following:
 - Breakout Boxes (CRK2 & CRK3)
 - Junction Boxes (CRK3)
 - CAN devices such as keypad and joysticks
 - Climate Control (CRK5)
 - Generator Converter Panels (CRK4)
 - Local Options (CRK1)
- 24V is supplied to digital input DI7 (VCU ignition detect)
- Digital output power is enabled (CRDP via CRES) which provides power to the digital interface card, supplying:
 - High side switches
 - Foot pot supply

Off Position

- 24V is removed from digital input DI7 when the keyswitch is turned off.
- The VCU controls the machine 24V ignition function via DO3 until ready to shutdown.
- 24V is removed from the following:
 - Breakout Boxes
 - Junction Boxes
 - Climate Control
 - Generator Converter Panels
 - CAN devices such as keypad and joysticks
 - Local Options

Crank

- 24V is supplied to digital input DI6 when the key switch is placed in the crank position

HMI (Human Machine Interface)

HMI Power

- With the keyswitch in the ON position, 24V is supplied by relay CR HD to:
 - 24V to 12V converter that powers the display
 - HMI computer located under the seat
 - Ethernet switch located behind the display

Park Brake

- 24V is supplied to the park brake switch via FU25
- 24V is supplied to the park brake circuit via FU03
- The position of the park brake switch is monitored in LINCS II via digital input DI8
- The park brake interlock relay CRPI is controlled by LINCS II via digital output DO8
- When the park brake switch is pulled out to release the park brakes, the following events occur:
 - 24V is supplied to the park brake interlock relay CRPI contacts
 - If LINCS II has energized the relay coil CRPI the following events occur:
 - 24V will be supplied to the park brake relay coil CRPB
 - The park brake solenoids will be energized thereby releasing the brakes if sufficient air pressure is available.
 - If LINCS II has **not** supplied 24V to the park brake interlock relay coil CRPI via digital output DO8:
 - The park brake relay coil CRPB will not turn on
 - The park brake solenoid will not turn on
- When the park brake switch is pressed to set the park brake (assuming LINCS II has supplied 24V to the park brake interlock coil CRPI), the following events occur:
 - 24V is removed from the park brake interlock relay contacts
 - The park brake relay CRPB turns off
 - Park brake solenoids will turn off

Speed Control Pedal

- 5V and GND are supplied to the speed control pedal by the digital interface card. An LED on the interface card identifies the availability of the +5V supply.
- The foot pot signal is measured via the analog interface card on AI1. The 5V supply to the pedal is measured at the pedal connector approximately 12 inches from the actual speed control pedal via the analog interface card AI2.

Wipers

- 24V supplied via FU 22 to the wiper motors via a control relay network CRFH, CRFL and CRRL.
- Front Wiper
 - High speed is controlled via digital output DO17
 - Low speed is controlled via digital output DO18
 - Washer pump powered by digital output DO14
- Rear Wiper
 - Low speed is controlled via digital output DO19
 - Washer pump powered by digital output DO15

Safety Systems

Emergency Stop

The emergency stop circuit power is supplied through fuse FU01. 24V is supplied to the five emergency stop switches through the EST1 breakout box. The emergency stop switch box contains two sets of normally closed (NC) contacts which open with an emergency stop application. One set of contacts provides a 24V signal to the emergency stop interface card. The emergency stop interface card maintains a ground to one side of the coil of relay CRES. The other set of contacts provides a 24V signal to the VCU via the digital inputs DI23 through DI26.

When an emergency switch is pressed, the 24V signal from the switch is interrupted and the emergency stop interface card will remove GND from the coil of relay CRES turning it off, and supply GND to the hydraulic tank vent valve relay coil CRHT, turning it on. The normally open contacts of CRES will open and remove 24V power from the coil of relay CRDP and the 24V supply to the drive system generator panels (note, this does not remove 24V from the motor control panels, the motor drives will bring the machine to a stop and quickly discharge the high voltage bus). CRDP will remove power from all the high side digital outputs by removing 24V power to the digital interface card.

When the VCU observes a loss of 24V signal from the alternate set of contacts in the emergency stop switch it will disable DO23.

When CRHT turns on, it activates the hydraulic tank dump solenoid SOLTD which dumps the air in the hydraulic tank. Power is supplied to the contacts of CRHT and in turn SOLTD via FU10.

The interface card has 3 detection inputs that are unused and are supplied 24V via FU 01. If these inputs do not have 24V, the E-stop system will be activated. The interface card read outputs are connected directly to the detection inputs so they do not pass through any circuitry.

Fire Suppression System

The fire suppression system, whose interface to the machine is managed by the emergency stop card, has a pressure switch that will close to ground if the fire system is activated. When activated, the emergency stop interface card will only turn on CRHT causing the release of the air pressure in the hydraulic reservoir. The VCU monitors the fire system status via digital input DI3.

Batteries

- There are four 12V batteries fitted to the machine in a series/parallel network, located in the battery box on the right hand rear of the machine.
- A charging socket is provided in the battery isolator box, to facilitate charging the batteries.
- When the battery isolation switch is closed, a red indicator light in the isolation station will be lit indicating that battery voltage is present.
- When the starter isolation switch is closed, a yellow indicator light in the isolation station will be lit indicating that 24V power is available at the starter motors.
- The starter isolation switch is monitored by LINCS II via a digital input DI21.
- 24V supplied by the alternator is protected by FU202 150A.
- FU201 150A protects the 24V control system electrics.
- A double pole circuit breaker is provided in the isolation station so that the dealer/mine can install 24V hardware that is not isolated by the battery disconnect switch. To maintain battery isolation integrity the equipment powered by this circuit must not be grounded to machine frame. If using this connection, the circuit breaker must be turned off before welding on the machine or damage may occur.

Cooling Pumps

- The count of cooling pumps is dependent on the size of the machine; the L950 and L1150 machines each have two cooling pumps, the L1350, L1850 and L2350 have three.
- Power is supplied to the drive cooling pumps from the isolation box via the drive cooling pump junction box; each of the pump 24V supplies is individually fused by FU221, FU222, and FU223, located inside the drive cooling pump junction box.
- The pumps are CAN controlled where the address is defined by a resistance to ground on the address pin of the pump connector.
- The enable line is controlled via the CRDP relay contacts.
- A level sensor is mounted in the cooling pump reservoir and is monitored by digital input DI34.

Lights and Alarms

- Pole work lights
 - Digital output DO4 turns on 2 relays CRL1A and CRL1B
 - CRL1A relay supplies 24V power to the two left side pole lights via fuse FU16
 - CRL1B relay supplies 24V power to the two right side pole lights via fuse FU17
- Cab light bar lights
 - Digital output DO5 turns on two relays, CRL2 and CRL3.
 - CRL2 relay contacts provide 24V to the three left side cab light bar lights through fuse FU18.
 - CRL3 relay contacts provide 24V to the three right side cab light bar lights through fuse FU19.
- Rear cowl lights
 - Digital output DO7 provides 24V to the coil of relay CRL4.
 - CRL4 relay contacts provide 24V to the rear cowl lights through fuse FU20.
- Red alarm light
 - Digital output DO9 supplies 24V to the red light LTAL1 mounted in the display console.
- Yellow warning light
 - Digital output DO10 supplies 24V to the yellow light LTAL2 mounted in the display console.
- Cab audible alarm
 - Digital output DO11 supplies 24V to the ALMAU audible alarm
- Park brake switch light
 - Digital output DO16 supplies 24V to LTPB1 light.
- Left turn signal
 - Digital output DO37 supplies 24V to both the front and rear left turn signals.
- Right turn signal
 - Digital output DO38 supplies 24V to both the front and rear right turn signals.
- Tail lights
 - Digital output DO27 supplies 24V to both the tail lights via the rear cowl junction box.
- Backup light and alarm
 - Digital output DO58 supplies 24V to both backup lights and the audible backup alarm via the rear cowl junction box.
- Beacon
 - Digital output DO35 supplies 24V for dealer/mine installed beacon light on the mirror bar.
- Cab interior lights
 - Two door switches and a rocker switch in the overhead console enable the two LED interior lights. Each of the switches provides a ground to the LED lights which have a common 24V power supply.
- Ladder lights
 - 2 switches, one mounted on the left hand roll bar upright and the second mounted in the battery isolator box supply 24V to energize the coil of CRLL via FU13. The contacts of CRLL close to supply 24V for two ladder lights via fuse FU14.
- Maintenance light
 - Switch SWML energizes a relay CRML. The contacts of CRML supply 24V power to the following circuits via FU15;
 - Two lights in the front frame, LTMT1 and LTMT2 via FU109.

- Two lights in the front of the rear frame LTMT3 and LTMT4 via fuse FU110.
- Three lights in the back of the rear frame LTMT5, LTMT6 and LTMT7 via fuse FU111.

Power Distribution

- Supplies 24V to analog input AI4 to measure battery voltage.
- Supplies 24V to digital interface card
 - Supplies 24V to cooling pumps enable
 - Supplies GND to analog input interface card
 - 24V distribution to breakout boxes, control boxes and climate control are controlled by key switch

Dealer Options

- Supplies isolated 24V to seat suspension and 24V for dealer options in overhead console and dash
- Supplies 24V to the 24V to 12V converter
 - Converter supplies 12V to overhead console, dash and 2 power points below dash
- Supplies 24V to dash and overhead console (controlled by key switch)

Speed Sensors

- Blower speed sensor generates 48 pulses for every revolution of the fan
 - Read by a frequency input DI2 on the digital interface card
- Radiator speed sensor generates 60 pulses for every revolution of the fan
 - Read by a frequency input DI3 on the digital interface card

Drive System Interface

- Digital input DI12 reads HV interlock position
- Analog input AI3 reads impedance from HV bus isolation monitors
- FU11 supplies 24V from the battery to the motor converters
- FU26 supplies 24V to a relay CRK4 that powers the drive converters switched power
 - The relay is controlled by a low side digital output (see key switch description)
- 24V is supplied to the generator converters by FU02 and is controlled by the emergency stop relay
- Supplies GND to the HV cabinet.

CAN (Controller Area Network)

Cab (CAN 0)

- Supplies CAN data and device power to:
 - Keypad
 - Joystick left
 - Joystick right
- Has a terminating resistor on the end of the data lines

Engine/Cooling Pump (CAN 1)

- Supplies CAN data to:
 - Engine
 - Cooling pumps
- VCU CAN module requires +15V for this port to operate
- Has a terminating resistor on the end of the data lines

Drives System (CAN 2)

- Supplies CAN data to the drive system
- Has a terminating resistor on the end of the data lines

Spare CAN (CAN 3)

- Unused
- VCU CAN module requires +15V for this port to operate
- Has a terminating resistor on the end of the data lines

This Page Intentionally Left Blank

Engine

MTU DDEC IV Series 2000/4000

- Engine red lamp is read by a digital input DI36
- Engine yellow lamp is read by a digital input DI33
- A digital input DI21 monitors the state of the starter isolation switch
- A digital output DO56 supplies 24V to the coil of relay CR211. The contacts of CR211 supply the 24V ignition signal to the engine ECM via fuse FU211
- A digital output DO54 supplies 24V to the coil of relay CR212. The contacts of CR212 supply the 24V start signal to the starter solenoids SOL211 and SOL212 from wire 2S that is supplied from the batteries through the start isolator.

MTU ADEC Series 4000

- Engine red lamp is read by a digital input DI36
- Engine yellow lamp is read by a digital input DI33
- A digital input DI21 monitors the state of the starter isolation switch
- A digital output DO56 supplies 24V to the coil of relay CR211. The contacts of CR211 supply the 24V ignition signal to the engine ECM via fuse FU211
- A digital output DO54 supplies 24V to the coil of relay CR212 that provides the 24V start signal to the engine ECM. Following pre-lube the engine ECM initiates the start process by supplying 24V to the coil of relay CR214. The contacts of CR214 supply starter solenoids SOL211 and SOL212 with 24V from wire 2S that is supplied from the batteries through the start isolator.
- The coil of CR213 is energized by 24V supplied by the contacts of CRK3 through a fuse FU133. The contacts of relay CR213 supply 24V to the engine ECM via a fuse FU214 providing the ECM with the power supply enable signal.

Cummins QSK38/60

- Digital output turns on ignition signal to engines via a relay
- Engine red lamp is read by a digital input
- Engine yellow lamp is read by a digital input
- Engine blue lamp is read by a digital input
- A digital input monitors the state of the starter isolation switch
- A digital output turns on a relay that:
 - Turns on a solenoid that powers the pre-lube motor. When the pre-lube system is up to pressure, a pressure switch closes, turning off the pre-lube motor and turning on a series of solenoids that turn on the starter motors.
 - The alternator requires 24V to be supplied to an excitation coil so that it will function.

Cummins QST30

- Engine red lamp is read by a digital input DI36
- Engine yellow lamp is read by a digital input DI33
- A digital input DI21 monitors the state of the starter isolation switch
- A digital output DO56 supplies 24V to the coil of relay CR211. The contacts of CR211 supply the 24V ignition signal to the engine ECM via fuse FU211.
- A digital output DO54 supplies 24V to the coil of relay CR212.
 - The contacts of CR212 supply 24V from wire 2S to relay CR213 via an internal pressure switch on the engine. When the contacts of the pressure switch are open, the normally closed contacts of CR213 supply 24V to solenoid SOL211 whose contacts supply 24V power to the pre-lube pump via a fuse.
 - When sufficient engine oil pressure is achieved the engine pressure switch will close, energizing CR213 coil, opening the normally closed solenoid that powers the pre-lube motor. The normally open contacts of CR213 will close supplying 24V from wire 2SA to energize the coils of solenoids SOL211 and SOL212, which engage the starter motors.
- The alternator requires 24V to be supplied to an excitation coil so that it will generate 24V to charge the batteries.

Options

Auxiliary Steering

- A pressure switch is read by a digital input
- A digital output turns on a relay that:
 - Turns on 2 solenoids that turn on the motors.
 - On larger machines, it also turns on a solenoid for some hydraulic function.

This Page Intentionally Left Blank