



# Application Engineering Bulletin

Subject

**Installation Recommendations**

This AEB is for the following applications:

☐ **Automotive** ☒ **Industrial** ☐ **Power Generation**

Date April 2001 ([Rev Dec 2001](#))

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AEB Number 15.44

Engine Models included: QSB,QSC,QSL9,QSM11,QSX15,QSK19,QST30,QSK45,QSK60

Fuel Systems included:

[Changes in blue](#)

## Introduction

The Quantum Installation Recommendations Technical Package was written to assist OEMs in integrating Quantum engines into their equipment. This technical package includes the wiring diagram, pinouts, and other pertinent information needed to install a Quantum engine

**Refer to the following other Industrial AEB's:**

**AEB 15.40 – Electronic Features**

**AEB 15.42 – OEM Components and Interfaces**

**AEB 15.43 – Datalinks and Diagnostics**

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## Section I - Grid Heaters

### QSB, QSC, QSL9

The intake air heater system is used to aid in starting during cold temperatures and to reduce white smoke after such a start. The system consists of two heater elements that are controlled by the ECM via two high current relays. Grid heaters are required for QSB/C/L9 engines.

**Note: The installer is responsible for procuring and mounting the grid heater power relays in a location free of road splash and also for routing battery connections through the relay contacts to the (2) grid heaters which are shipped with the engines. The intake air heater relays must not be mounted on engine.**

Since power routed to the grid heaters is through one wire then the gauge of the wire should be 2 AWG minimally since each of the grid heating elements require 105 amps during the heating cycle. The gauge of the wire from the grid heater, relays to the grid heater elements, also need to be 6 AWG minimally to carry the required current. Fuses or fusible links set to 125 amps are advocated for the grid heating elements. The 24 V DC heater-relay is connected to the OEM interface connector. The ECM can source up to 3 amps to turn this relay on. The switch contact of this relay must carry the current from battery (+) to the grid heating elements. Only one relay is required to drive both grid heaters on 24 V DC systems since the grid heaters are wired in series.

### QSM11, QSX15

The intake air heater system is used to aid in starting during cold temperatures and to reduce white smoke after such a start. The system consists of one heater elements that are controlled by the ECM via one high current relay.

**Note: The installer is responsible for procuring and mounting the grid heater power relays in an acceptable location in respect to vibration and environmental influences such as road splash. The intake air heater relays must not be mounted on engine.**

The gauge of the wire from the grid heater, relays to the grid heater elements, also need to be sized for the heater's current requirement. Typically, a 6 AWG minimally to carry the required current. Fuses or fusible links set to 125 amps are advocated for the grid heating elements. The 24 V DC heater-relay is connected to the OEM interface connector. The ECM can source up to 3 amps to turn this relay on. The switch contact of this relay must carry the current from battery (+) to the grid heating elements. Only one relay is required to drive both grid heaters on 24 V DC systems since the grid heaters are wired in series.

The QSM11 grid heater requires that the installer provide the ground wire or strap. This ground wire should be routed directly to the starter ground connection or the battery ground. It is not acceptable to ground the grid heater to the engine block or cylinder head.

The QSX15 grid heater is grounded directly to the engine's ground lug. The QSX15 grounding wire is supplied with the engine.

### QST 30

The intake air heater system is used to aid in starting during cold temperatures, while helping to reduce white smoke. The system consists of twelve heater elements that are controlled by a primary and secondary ECM via two high current relays. The ECM can source up to 3 amps.

**Note: The installer is responsible for routing battery (+) connections to the contacts of the grid heater relays, which are shipped with each engine.**

Each grid heater element is rated for 86A@12V. As a result, each bank of grid heater elements will draw 258 amps in an ideal 24-volt system and have a total current draw of 512 amps for both banks. Therefore, the

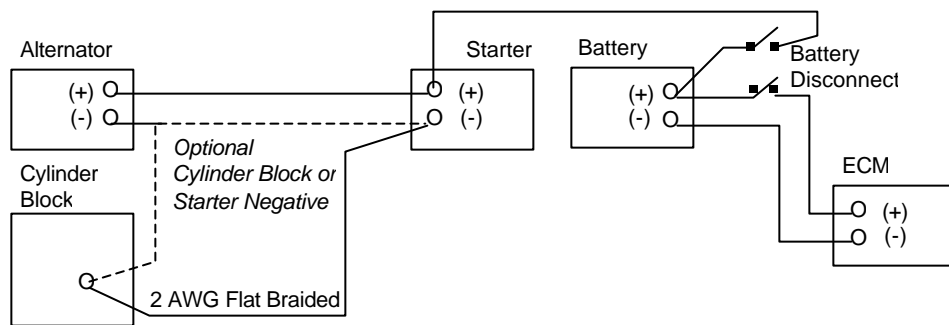
equipment manufacturer must be sure to size the supply wire appropriately to support the grid heater current draw requirements. A minimum #000 gauge cable routed to each bank is recommended.

Engine Family	Voltage	Heater Current	ECM Relay Source
QSB/QSC/QSL9	12	210	3 Amps
QSB/QSC/QSL9	24	105	3 Amps
QSM11	24	90	2 Amps
QSX15	24	105	2 Amps
QST30	24	258 amps/bank 512 amps total	3 Amps

## Section II - Power and Ground Requirements

### Power and Ground

**System Grounding Requirements** - Ground loops and electrical noise is a source of numerous problems with today's electronic engines. For example, a high current device such as an alternator can inject electromagnetic interference (EMI) through the cylinder block back through the ECM, which is case-grounded to the block to shunt radio frequency noise. Other examples are relays that switch at high speeds introducing high frequency noise into the cylinder block, which can introduce noise into the ECM. To minimize these problems, follow the practices described in interface specification IS-1377-9807 and the following paragraphs. Refer to the Power Connection Layout figure below.



Power Connection Layout

**High-Current Accessory Grounds** - Alternators and other engine accessories greater than 10 amps should be grounded to the starter negative terminal (always follow starter manufacturer's recommendations) rather than to the cylinder block. This minimizes the electrical noise and ground loops present in the overall system. Optional locations are to the battery negative terminal or a central location on the cylinder block. If the alternator is grounded to a central location on the cylinder block, e.g. ground stud or ground boss, it must be attached to the same location as the starter or battery negative.

**Cylinder Block as Ground** - The cylinder block represents a very large capacitance to system ground, which makes it a highly effective RF shunt. Therefore, many devices, including the engine ECM, prefer to shunt RF noise to the cylinder block. However, if the block contains current-induced voltage noise, it can become a point of noise entry for devices using it as a RF shunt. It is acceptable to use the cylinder block as a return for devices that are powered continuously. For devices that carry high currents (engine accessories greater than 10 amps) or that switch on and off rapidly, the return should route to starter or battery negative.

**Starter Ground** - Ground the starter negative with a 2 AWG wire or larger to the cylinder block to help shunt RD noise. A flat, braided wire is more effective than a round, stranded cable. An insulated welding cable is also acceptable. Since the braided wire is not insulated, the welding cable is acceptable and typically has a longer service life. This low impedance ground path design should take into account long-term degradation.

**Frame Returns** - Cab and chassis components should have common ground points to reduce ground loops. Frame ground returns are often a source of problems and should be avoided. The frame ground alternative adds more resistance to a return circuit.

**Minimum wire size** – The preferred method of connecting the ECM power supply to the batteries is by maintaining the required number of stranded 18 AWG wires over the entire length of the connection (see each engine family wiring diagram). When splices occur, a minimum of four stranded 10 AWG or larger wires must be used between the splices and the battery, two for (+) and two for (-). Circuit resistance must not exceed 40 milliohms, but 10 milliohms is desirable. This circuit resistance limit includes the OEM-supplied circuit protection system and any switches or interconnects.

## Switches and Sensors Grounding Requirements

All switches and sensors that are wired directly to the ECM must be referenced to an ECM switch return. These components use inputs that are susceptible to noise and voltage offsets that can be introduced through the return path. Follow these guidelines when designing the machine wiring.

**Inductive Load Sharing** - When used as a switch return, an ECM switch return must never be used to return unsuppressed inductive loads. Relay coils on the same circuit should be avoided. However, if a relay is used, it should contain a suppression diode. This will isolate noise from the return, which can impair the reliability of a switch or sensor input.

**Sensor Dedication** - When used as a return for certain analog sensors (i.e. pressure, temperature, or APS), an ECM switch return should be dedicated solely to that sensor. Radiometric and resistive ECM inputs are very sensitive, even a small change in voltage drop will affect the detected parameter.

**Isolation** - An ECM switch return must be kept isolated from machine chassis ground. This will prevent undesirable ground loops.

**Sourcing** - An ECM switch return should not be used to return any voltage that has not been sourced from the ECM. This will prevent overloading of the ECM supply returns.

**Star Ground** - For switch panels that contain critical switches such as the MUS on/off switch, it is good practice to establish a "star" ground fed by dual redundant ECM switch returns. A proper star ground will have a separate return to each switch. When designed in this manner, a single-point open-circuit return fault will result in the loss of no more than one switch.

## Solenoid Grounding Requirements

Solenoids and relay coils that are wired directly to the ECM may be referenced either to a good chassis ground or to an ECM solenoid return. The ECM solenoid return is a convenience and is not a requirement. If an ECM solenoid return is used, follow these guidelines when designing the machine wiring.

**Inductive Load Sharing** - When used as a solenoid return, an ECM solenoid return must not be used as a return for critical components such as switches or sensors. Guidelines for these components are more extensive as detailed in the previous paragraphs.

**Isolation** - An ECM solenoid return must be kept isolated from machine chassis ground. This will prevent undesirable ground loops.

**Sourcing** - An ECM switch return should not be used to return any voltage that has not been sourced from the ECM. This will prevent overloading of the ECM supply returns.

## Section III - Keyswitch Requirement

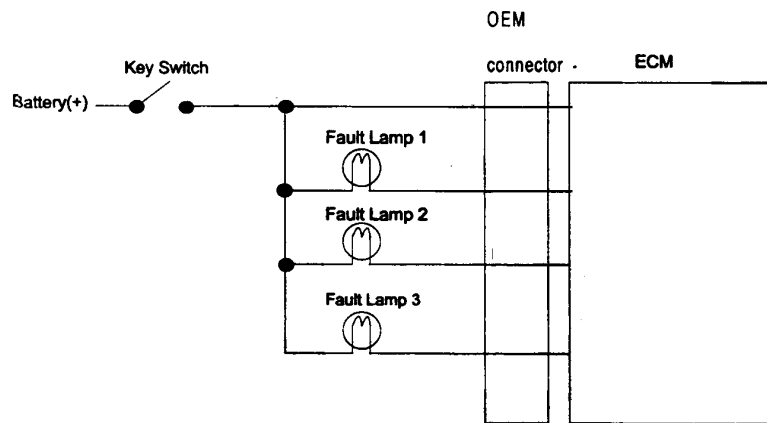
### Keyswitch Connection Requirements

Proper connections of the keyswitch to the ECM are critical for proper operation of the engine. The keyswitch signal must be continuously present in order for the engine to operate. A loss of this signal, even a momentary loss, can cause undesirable ECM resets, which can stall the engine and cause fault codes. Follow the installation guidelines in interface specification IS-1377-9807 and the following paragraphs.

**Sourcing** - The keyswitch must be connected directly to the ECM. There must be no switches or relay contacts between the keyswitch and the pinouts at ECM connector. Any engine shutdown systems designed to interrupt key switch power must have a Cummins application review completed and approved for that system.

**Fusing** - The keyswitch signal must be fused so that an electrical short due to some other component does not affect voltage at the ECM keyswitch input.

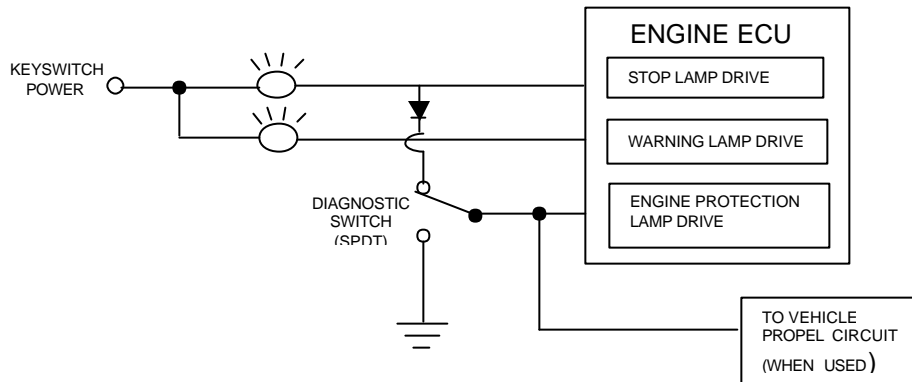
**Inductive Load Sharing** - The keyswitch signal must not share its circuit with unsuppressed inductive loads. Relay coils on the same circuit should be avoided. However, if a relay is used, it should contain a suppression diode. This will isolate noise, which can impair the reliability of the keyswitch input.



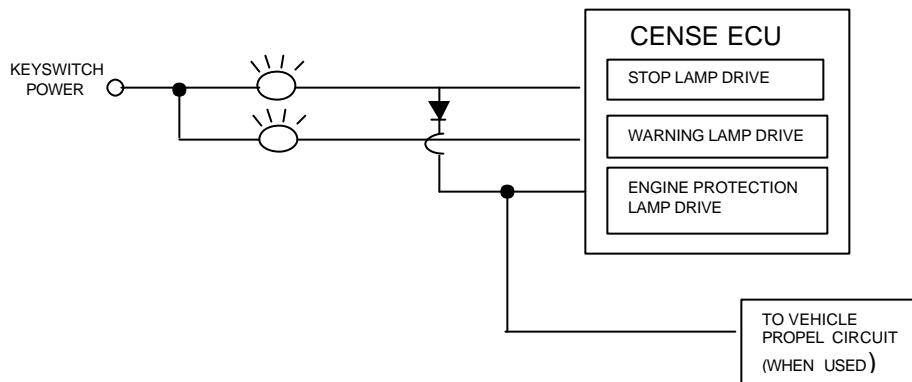
Lamp/Keyswitch Wiring Configuration

Fault

**Optional - 2 Lamp Strategy - QSK19/45/60** - The Optional 2-lamp strategy will eliminate the Engine Protection (white) Lamp. Therefore, the operator will only have a warning (yellow) and stop (red) lamp on the dashboard. All of the faults that were mapped to the Engine protection lamp will become annunciated through the stop (red) lamp. This change will only affect the wiring of the fault lamps and not the software or calibration. See wiring below.



### 2-Lamp Strategy with Cense



### 2-Lamp Strategy without Cense

## Section IV - Welding Requirements

### Welding

Welding on the engine or engine mounted components is not recommended. Cummins recommends disconnecting all OEM connectors. Attach the welder ground cable no more than two feet from the part being welded. Never connect the ground cable of the welder to the ECM.

## Section V - OEM Harness and Harness Routing

### Wire Selection

Wire selection is critical for proper operation of the engine. Follow these guidelines when designing the OEM wiring harness.

**Wire Size** - The size requirement for the harness wiring is 18 AWG stranded wire, covered with GXL or TXL insulation for all underhood wiring. Diameter range including insulation is 0.040-0.095 inches. This wire size and insulation type is the only one tested and approved by Cummins with the Deutsch 50-pin connector.

**Twisted Pairs** - There are three sets of twisted-pair wires. The wires are twisted at a rate of one twist per inch and are used with the Shaft Speed sensor, the tachometer and the J1587 datalink.

**Twisted Triplets** - There are three sets of twisted-triplet wires. The wires are twisted at the rate of one twist per inch and are used with the base throttle, remote throttle, and variable throttle option of the Intermediate Speed Control (ISC) feature.

**Datalinks** - A separate cable must be used on the J1939 datalink. Refer to SAE J1939/11 and J1939/13 for detailed specifications on the datalink wire requirements. Refer to AEB 15.43 Datalink and Diagnostics.

### Contacts and Connectors

The connection points of the OEM wiring harness must be adequately protected from vibration and moisture intrusion. The design practices and manufacturing methods for typical 12- and 24- volt systems are not adequate when the subsystem operates with low signal level electronics on some circuits. Follow the guidelines in the following paragraphs.

**Datalinks** - The quantum electronic subsystem requires gold plating for the OEM connector terminals and any J1939 and J1708 datalink connections.

**Switches** - The Quantum subsystem recommends that all switch contacts (except keyswitch) be gold flashed to ensure reliable switching at low voltages and currents. Ring terminals may be either solder dipped or tin plated. Follow the guidelines in interface specification IS-1377-9802.

**Connectors** - Chassis-mounted connectors should be environmentally sealed and, at a minimum, be tin-plated or nickel-plated. A lubricant should be applied to connector terminal surfaces as an added safeguard for use with tin-plated or nickel-plated contacts to reduce the risk of fretting corrosion. In the cab area, tin plating should be on wire-to-wire and wire-to-switch interconnections. This is a minimum requirement.

**Recommended Plating** - A detailed review of the termination and connector uses is to be conducted with the connector supplier. A sample of typical connector supplier recommendations for plating subsystems used in low current signal applications is shown in the Recommended Plating Systems table.



**Recommended Plating Systems Table**

<b>Surface Plating</b>	<b>Underplating</b>	<b>Terminal material</b>
<b>Gold, cobalt hardened</b>	<b>Nickel, matte</b>	<b>Brass</b>
120-200 Knoop	180-300 Knoop	
50-80 micro-inches	80-110 micro-inches	
<b>Tin, Matte</b>	<b>Nickel, matte</b>	<b>Brass</b>
30-120 micro-inches	50-120 micro-inches	
<250 micro-inches/pair		

**Plating Systems Not Recommended** - The following plating systems are not recommended: Tin with >250 micro-inches per terminal pair (male + female interface), gold with no underplating barrier, brass, silver, and copper.

**Dissimilar Metals** - The use of dissimilar metals for any terminal pair (male + female interface) is not recommended. Use of dissimilar metals will cause galvanic corrosion, resulting in terminal pitting and premature circuit failure.

**Throttle Circuit** - It is recommended that the connector terminal between the base throttle pedal and ECM be gold plated. This recommendation also applies to the remote throttle circuit and the variable ISC throttle circuit.

**OEM Sensor Circuit** - It is recommended that the connector terminals between the OEM temperature sensor and the ECM and between the OEM pressure sensor and the ECM, be gold plated.

## **Protective Covering**

The protective covering for the OEM wiring harness should have high abrasion and cut resistance, continuous temperature capability to 125° C (257° F) and intermittent temperature capability to 150° C (302° F). The material should also have high chemical resistance to fuel, engine oil and engine coolant. The harness covering should not strain the wire or the wire seal at the connector and typically should be terminated approximately 1/2 inch from the connector shell. Convuluted tubing, woven braid, or overfoamed is recommended as protective covering.

**Convuluted Tubing** - If convuluted conduit is selected, nylon material should be specified. The material should be slit lengthwise and have drainage provisions for fluids. Conduit ends should be secure to prevent unraveling.

**Woven Braid** - If woven braid is selected, the material should consist of a nylon core with a vinyl covering. The covering should be a minimum of 12 picks per inch and a tight, non-slip covering over the cables should be provided. The braid tail should be secured to prevent unraveling.

## **Harness Routing and Support**

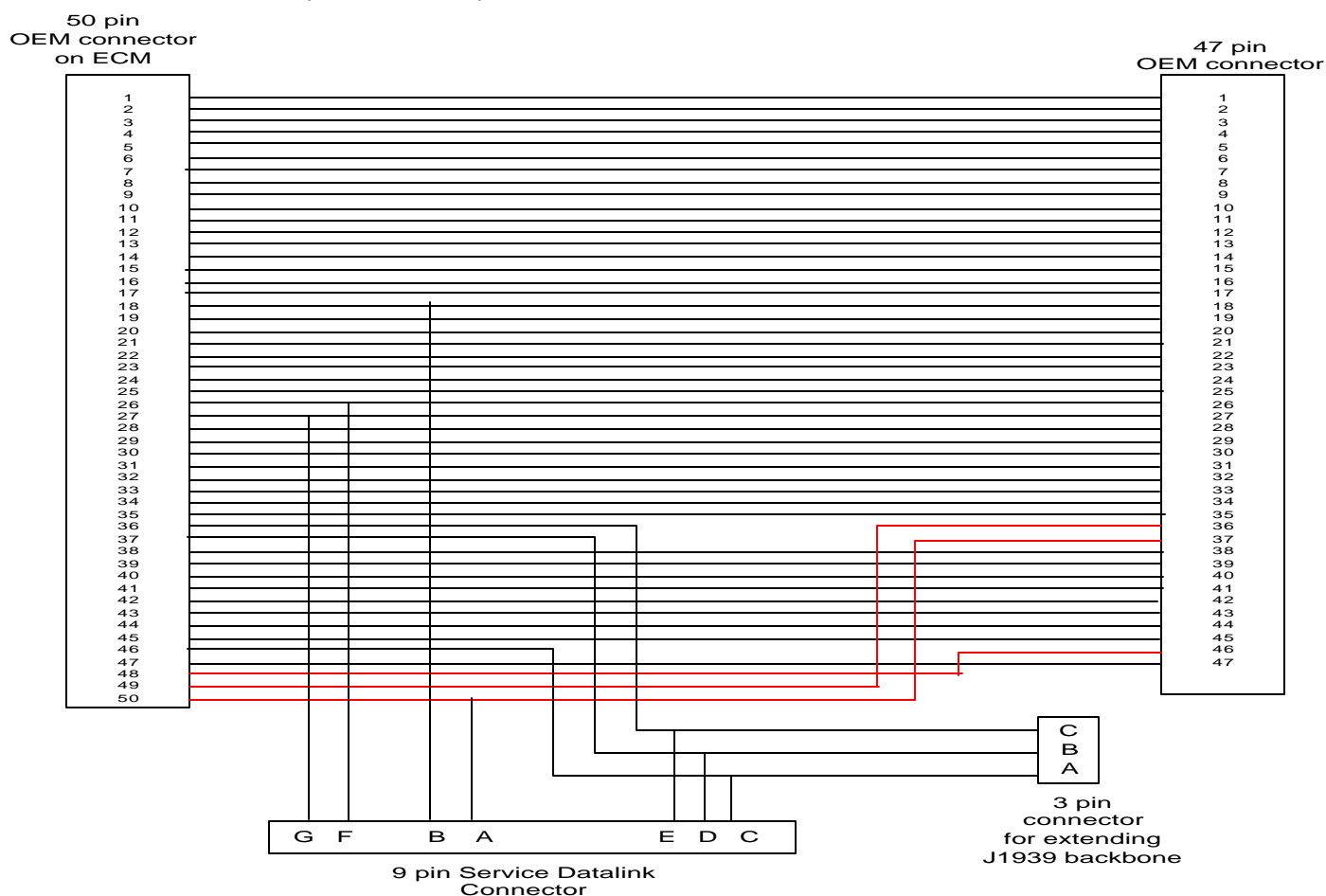
The physical routing and support of the OEM wiring harness should minimize strain in the wire seals and of all connectors and should protect the harness from damage due to abrasion, heat and sharp objects. The harness should be clamped at any location on the engine/machine where support is required to protect the harness from strain damage. Wherever possible, wires associated with the OEM harness should be routed physically close to metals connected to battery (-) (e.g. frame rails, engine block) to minimize electromagnetic interference with other electronic subsystems in the vehicle. All wiring should be kept free from sharp bends around components that can cause nicks, cuts or other damage. The harness should be routed away from sharp objects, exhaust system components and other high temperature components.

## Section VI - Datalink Requirements for QSM11 and QSM15

The 9-pin service datalink does not ship on the QSM11 and QSM15 engine unless you order the designated EA option. A 47-pin OEM Deutsch connector will also be available as the interface instead of connecting directly to the 50-pin OEM connection on the ECM. This option will include a 9-pin connector, 3-pin connector, a 50-pin connector and a 47-pin round connector. The new 47-pin OEM connector is in a mounting bracket generally above the ECM. The 9 and 3 pin connectors are in the same location, but are not mounted into the bracket. They come off the wiring harness extension. See wiring diagram below.

**J1939 Backbone** - A J1939 backbone is required on every machine that contains a QSM11 or QSM15 engine. Terminating resistors should be used on the J1939 backbone as specified in AEB 15.43 Datalinks and Diagnostics technical package. Recommended termination receptacles and stub connectors are defined in the OEM Components technical package.

**Stub Connector** - A 3-pin J1939 receptacle stub connector must be inserted between the ECM and the J1939

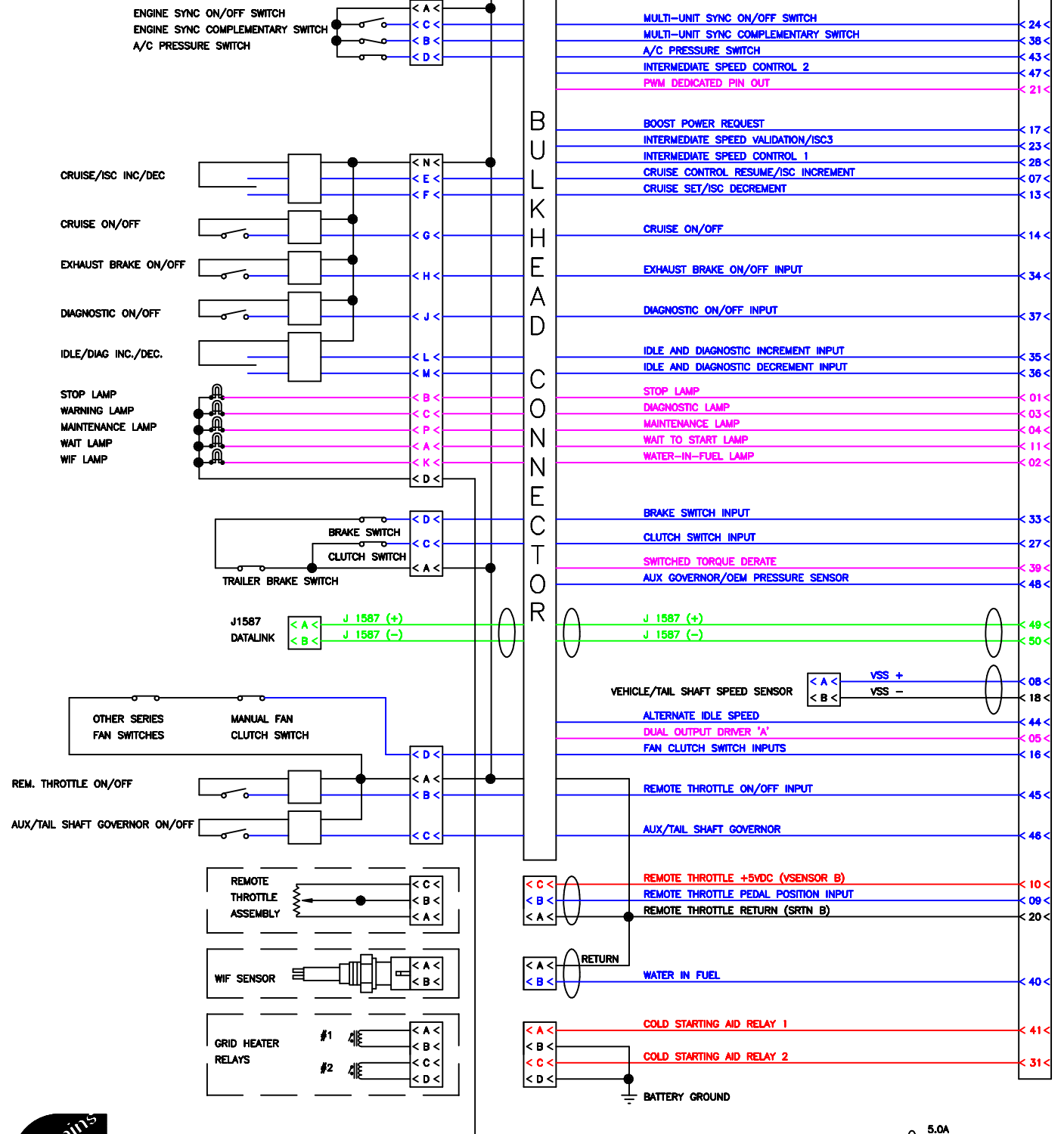


backbone. This is to prevent wiring faults between the ECM and the datalink connector from preventing communication with the ECM, thus rendering it unserviceable. This stub must be located within 12 inches of the 50-pin OEM connector.

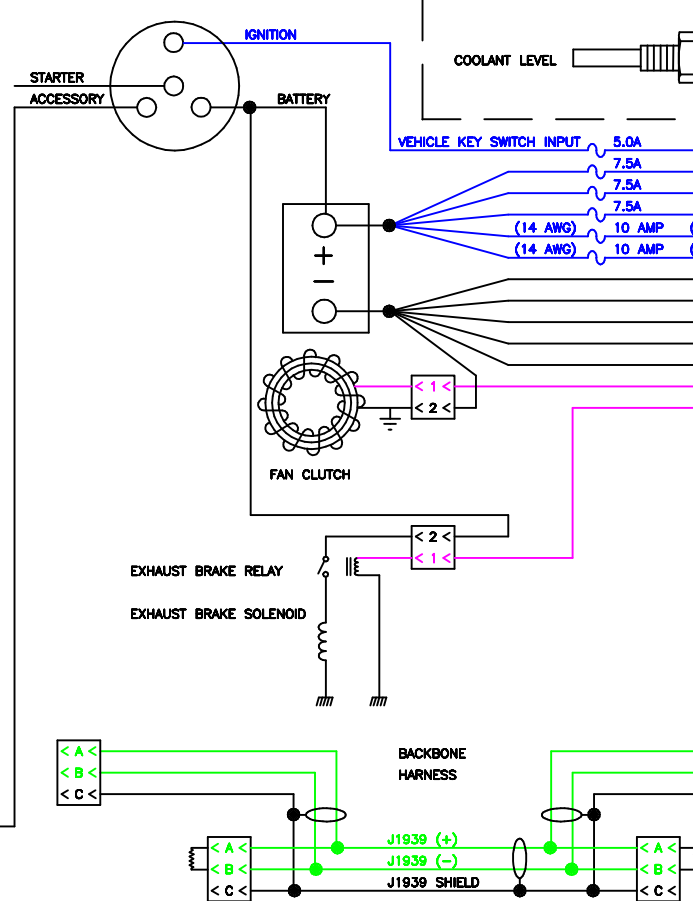
### OEM Datalink option wiring diagram



RED INDICATES POWER SUPPLIED BY THE ECM  
 BLUE INDICATES POWER AND SIGNALS INTO THE ECM  
 BLACK INDICATES ECM RETURNS, GROUNDS AND GENERIC OEM WIRING  
 GREEN INDICATES DATA LINKS  
 PURPLE INDICATES ECM OUTPUTS

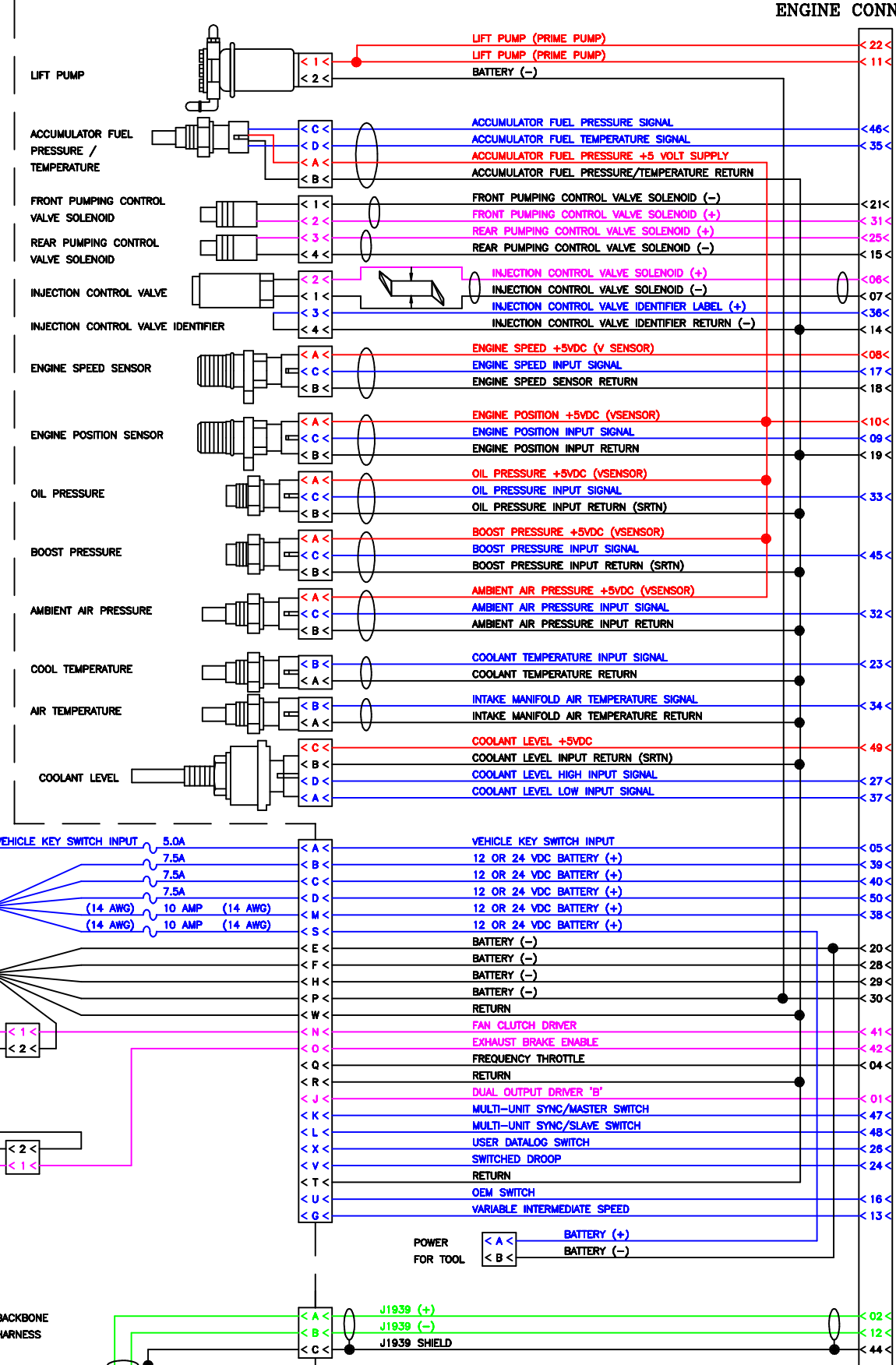


#### KEY SWITCH

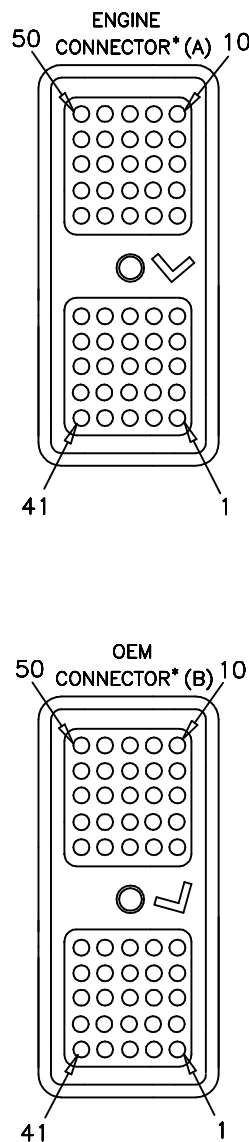


NOTE: SOME OF THE CIRCUITS SHOWN HERE WILL NOT BE ACTIVE IN ALL APPLICATIONS. CONSULT THE EQUIPMENT MANUFACTURER'S LITERATURE TO DETERMINE WHICH CIRCUITS ARE USED.

#### CUMMINS RESPONSIBILITY



#### ENGINE CONNECTOR (A)



# QSC Wiring Diagram

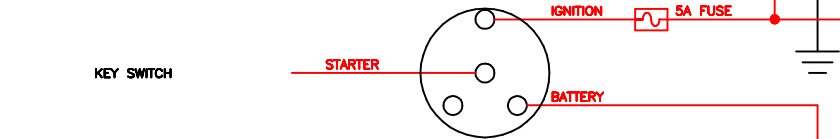
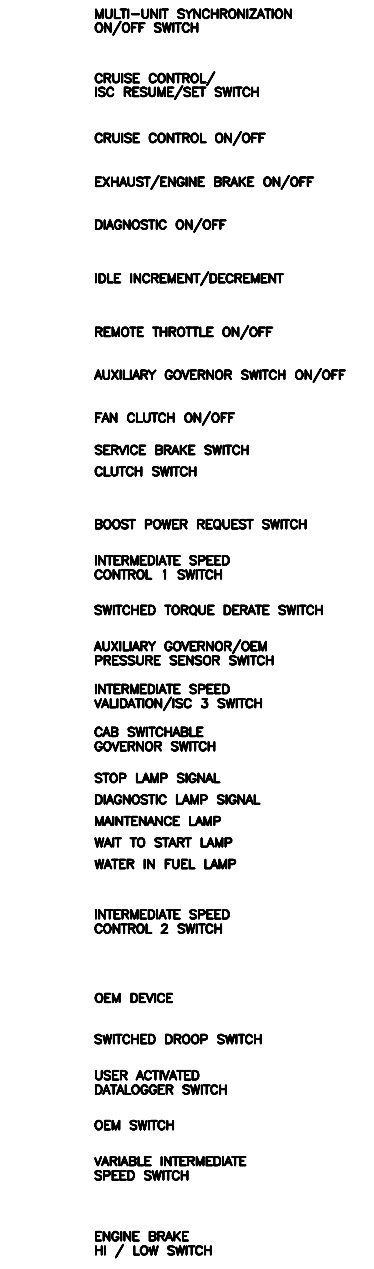
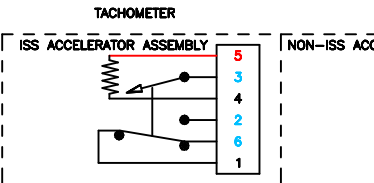
(for ECM Part No. 3944105)

Bulletin No. 3666395

OEM RESPONSIBILITY

CUMMINS RESPONSIBILITY

RED DC VOLTAGE  
BLUE INPUT SIGNALS  
BLACK GROUNDS, SHIELDS AND RETURNS  
PURPLE OUTPUT SIGNALS  
GREEN DATA LINKS



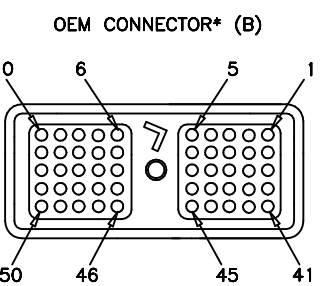
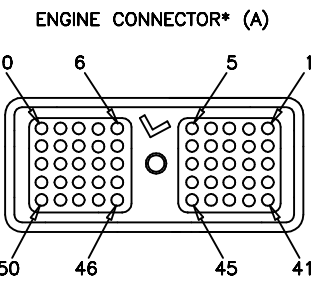
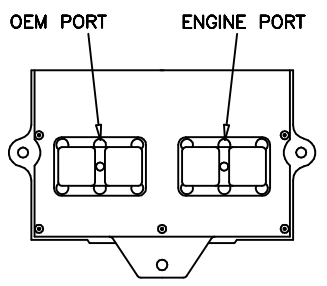
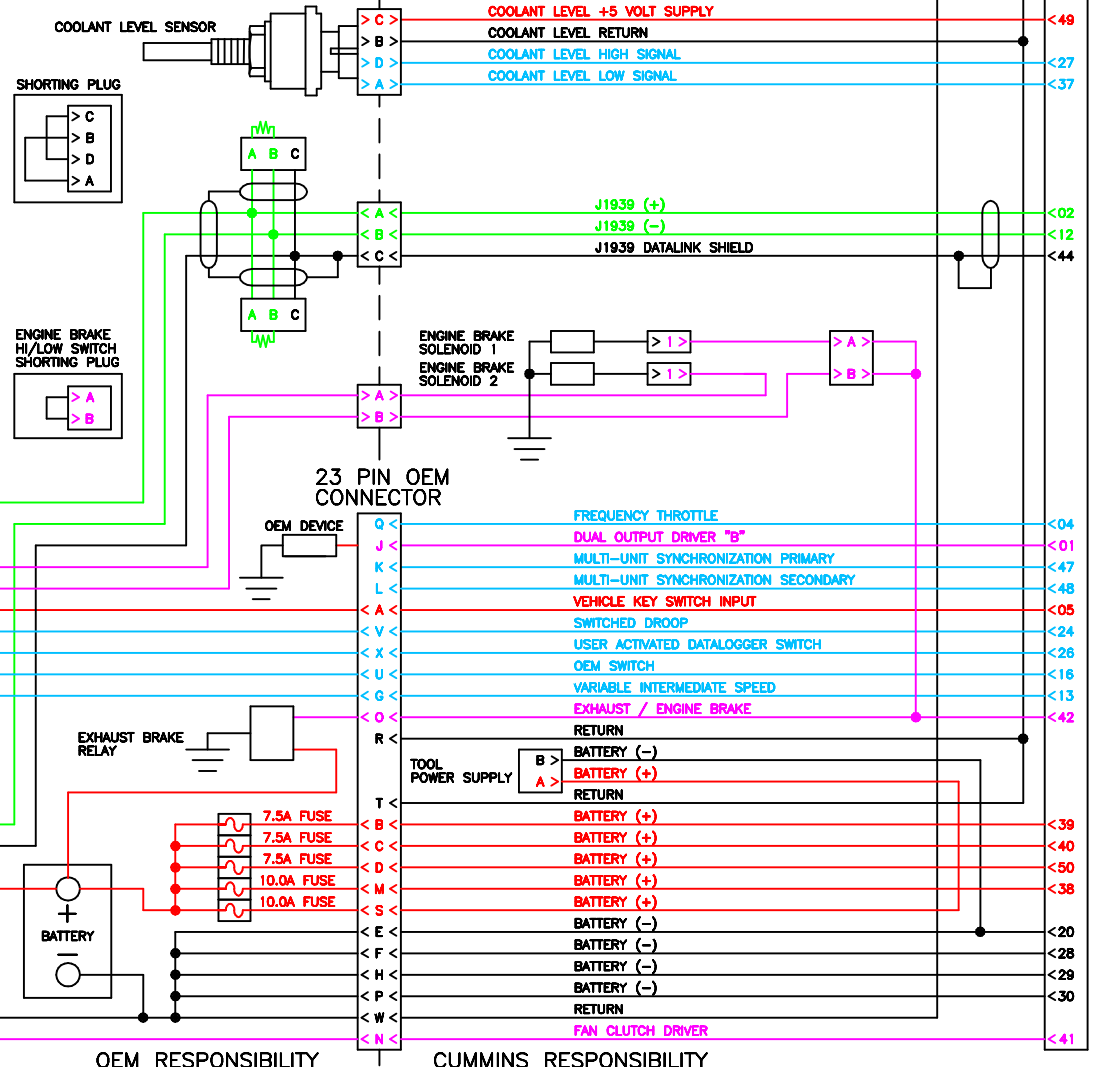
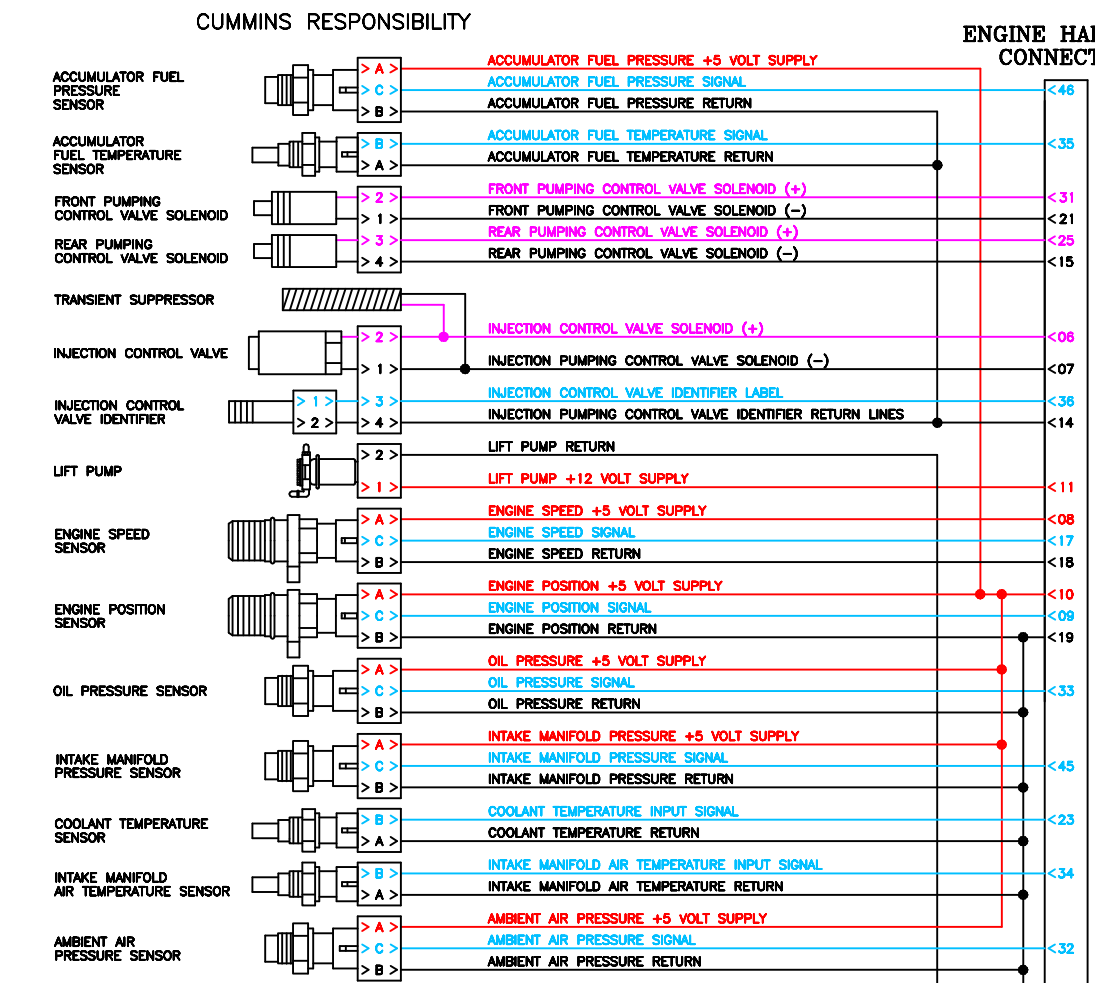
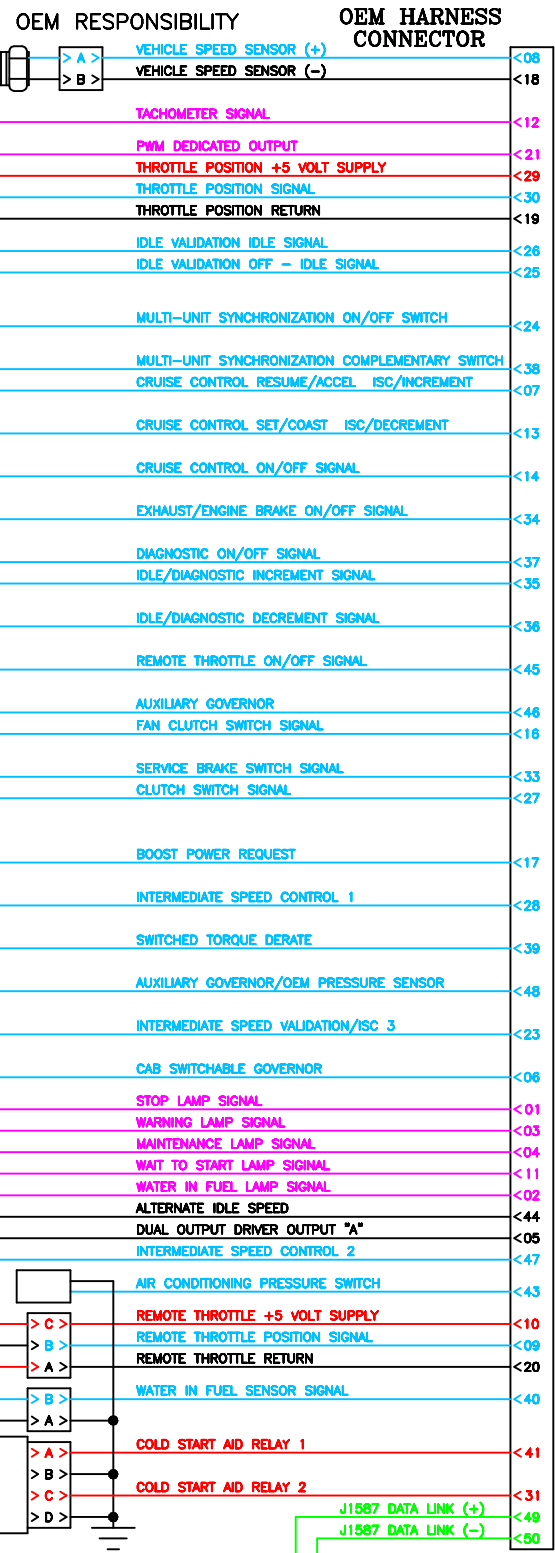
NOTE: SOME OF THE CIRCUITS SHOWN HERE WILL NOT BE ACTIVE IN ALL APPLICATIONS. CONSULT THE EQUIPMENT MANUFACTURER'S LITERATURE TO DETERMINE WHICH CIRCUITS ARE USED.

6 - PIN DEUTSCH

D <	NOT CONNECTED
F <	NOT CONNECTED
C <	BATTERY (+)
B <	BATTERY (-)
E <	DATA LINK (+)
A <	DATA LINK (-)

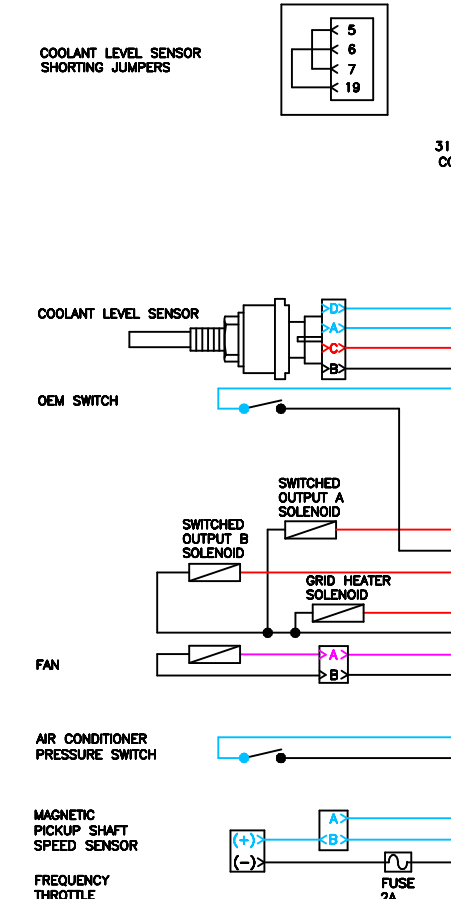
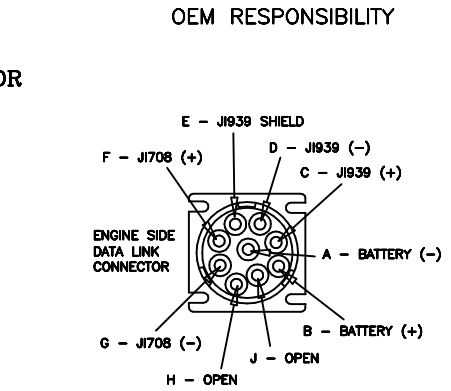
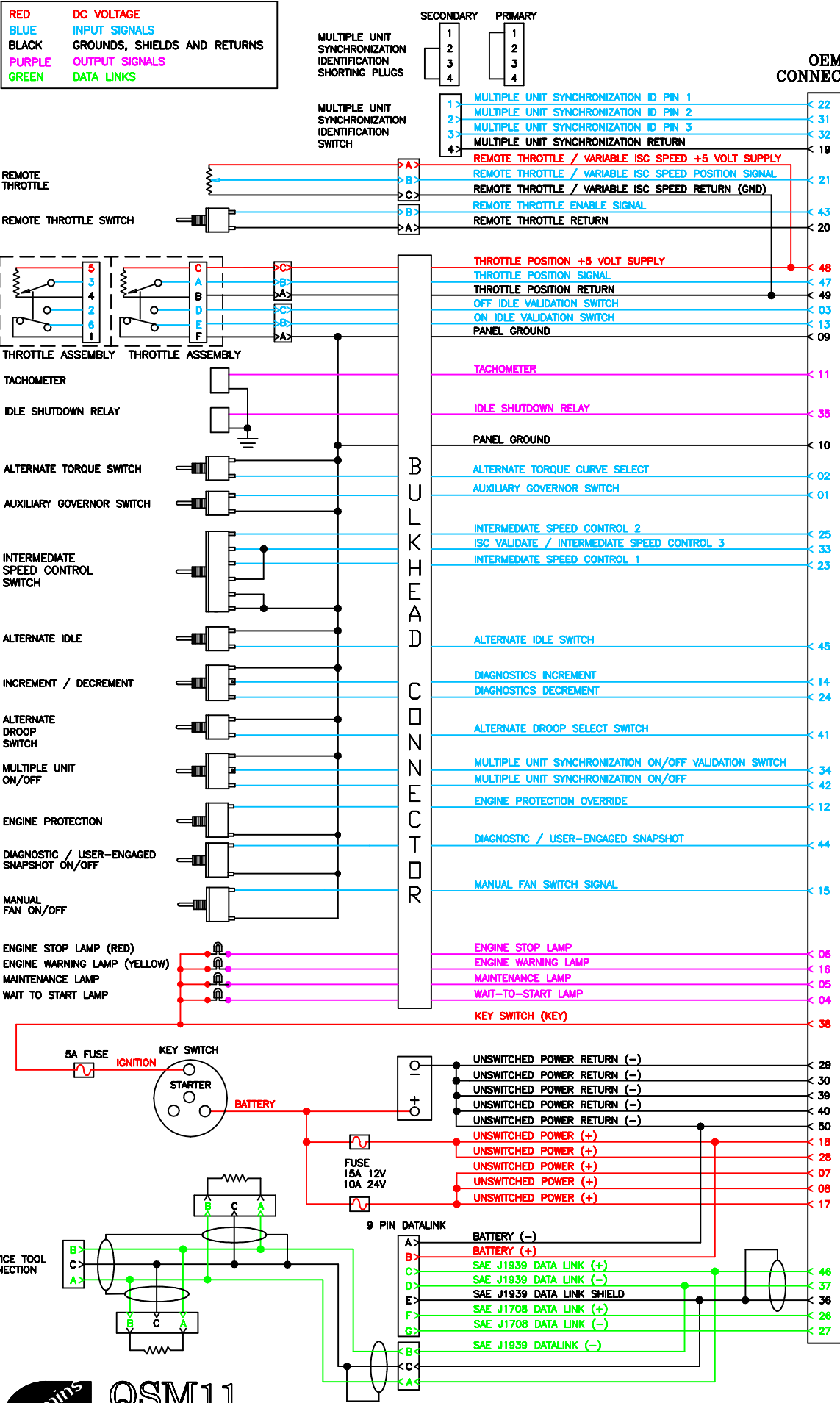
9 - PIN DEUTSCH

C <	J1939 (+)
D <	J1939 (-)
E <	J1939 DATA LINK SHIELD
H <	NOT CONNECTED
J <	NOT CONNECTED
B <	BATTERY (+)
A <	BATTERY (-)
F <	J1587 DATA LINK (+)
G <	J1587 DATA LINK (-)



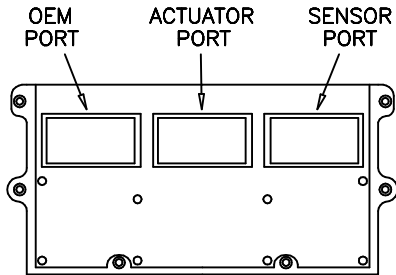
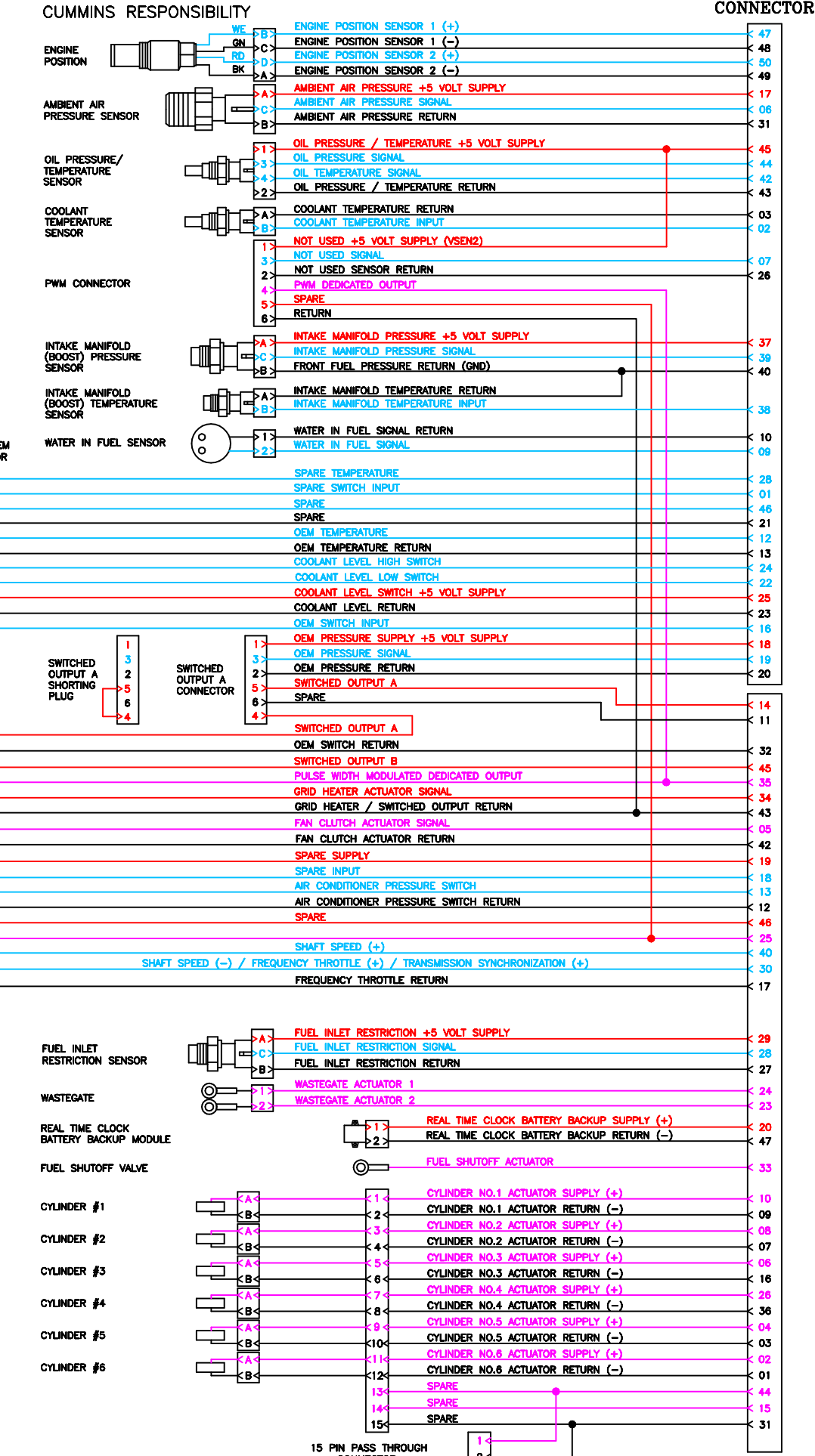


RED DC VOLTAGE  
 BLUE INPUT SIGNALS  
 BLACK GROUNDS, SHIELDS AND RETURNS  
 PURPLE OUTPUT SIGNALS  
 GREEN DATA LINKS

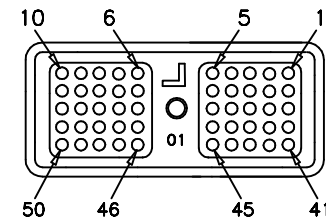


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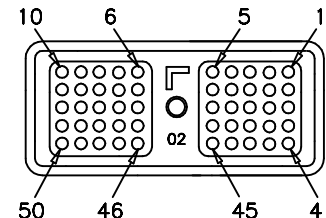
OEM RESPONSIBILITY



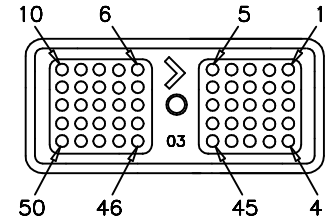
OEM CONNECTOR VIEW OF HARNESS CONNECTOR MATING FACE



ACTUATOR CONNECTOR VIEW OF HARNESS CONNECTOR MATING FACE

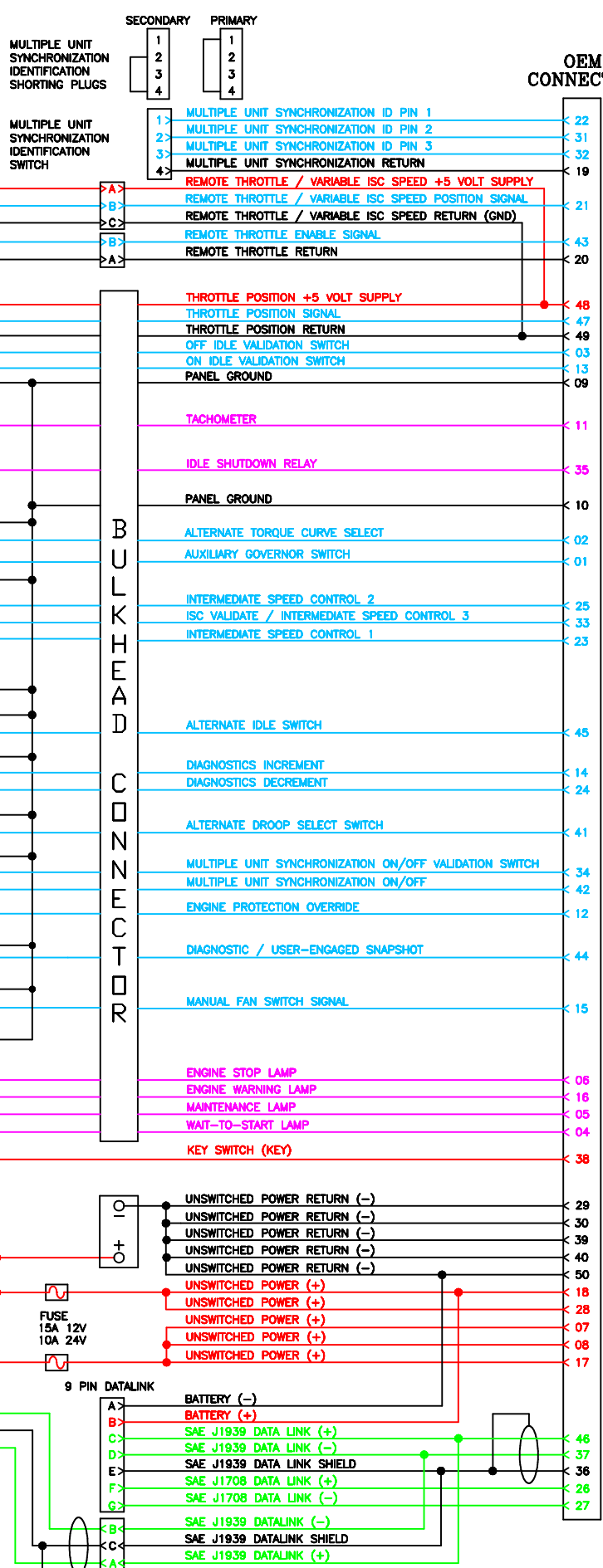


SENSOR CONNECTOR VIEW OF HARNESS CONNECTOR MATING FACE

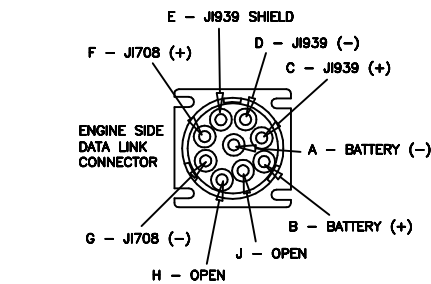


ACTUATOR CONNECTOR

RED DC VOLTAGE  
BLUE INPUT SIGNALS  
BLACK GROUNDS, SHIELDS AND RETURNS  
PURPLE OUTPUT SIGNALS  
GREEN DATA LINKS



## OEM RESPONSIBILITY



**COOLANT LEVEL SENSOR SHORTING JUMPERS**

**COOLANT LEVEL SENSOR**

**REAR SOLENOID**

**FAN**

**OEM SWITCH**

**AIR CONDITIONER PRESSURE SWITCH**

**MAGNETIC PICKUP SHAFT SPEED SENSOR**

**FREQUENCY THROTTLE**

NOTE: SOME OF THE CIRCUITS SHOWN HERE WILL NOT BE ACTIVE IN ALL APPLICATIONS. CONSULT THE EQUIPMENT MANUFACTURER'S LITERATURE TO DETERMINE WHICH CIRCUITS ARE USED.

## OEM RESPONSIBILITY

## CUMMINS RESPONSIBILITY

**CRANKSHAFT ENGINE SPEED SENSOR**

**CAMSHAFT ENGINE POSITION SENSOR**

**AMBIENT AIR PRESSURE SENSOR**

**FUEL PRESSURE SENSOR**

**OIL PRESSURE / TEMPERATURE SENSOR**

**COOLANT TEMPERATURE SENSOR**

**FRONT FUEL PRESSURE SENSOR**

**REAR FUEL PRESSURE SENSOR**

**INTAKE MANIFOLD PRESSURE / TEMPERATURE SENSOR**

**WATER IN FUEL**

**WASTEGATE**

**FUEL INLET RESTRICTION**

**FRONT FUELING ACTUATOR**

**FRONT TIMING ACTUATOR**

**REAR TIMING ACTUATOR**

**REAR FUELING ACTUATOR**

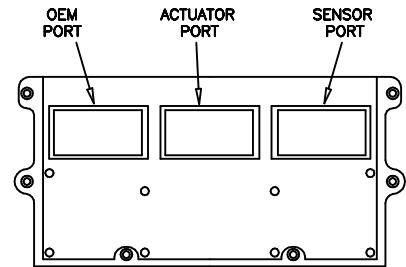
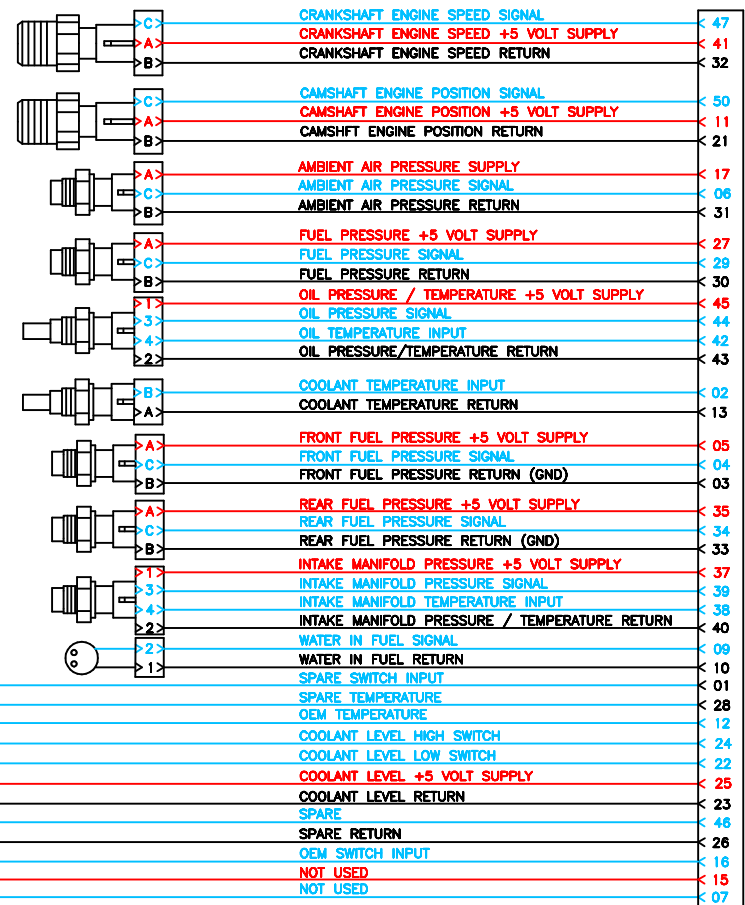
**FUEL SHUTOFF VALVE**

**REAL TIME CLOCK BATTERY BACKUP MODULE**

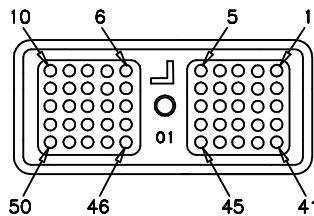
**ENGINE BRAKE CONNECTOR**

## CUMMINS RESPONSIBILITY

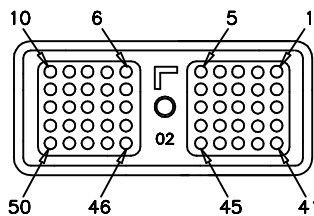
## SENSOR CONNECTOR



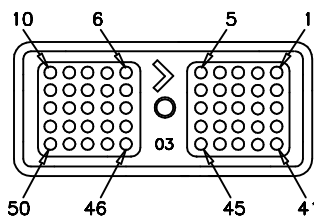
**OEM CONNECTOR VIEW OF HARNESS CONNECTOR MATING FACE**



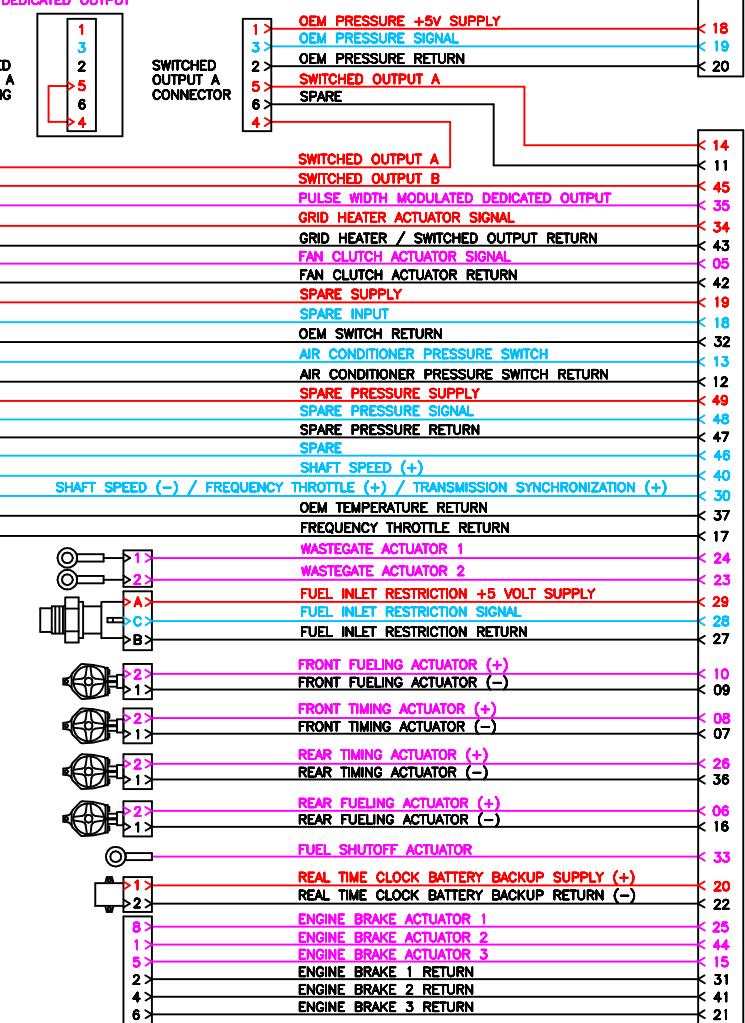
**ACTUATOR CONNECTOR VIEW OF HARNESS CONNECTOR MATING FACE**



**SENSOR CONNECTOR VIEW OF HARNESS CONNECTOR MATING FACE**



## ACTUATOR CONNECTOR



RED INDICATES POWER SUPPLIED BY ECM AND BATTERY

BLUE INDICATES SIGNALS INTO THE ECM

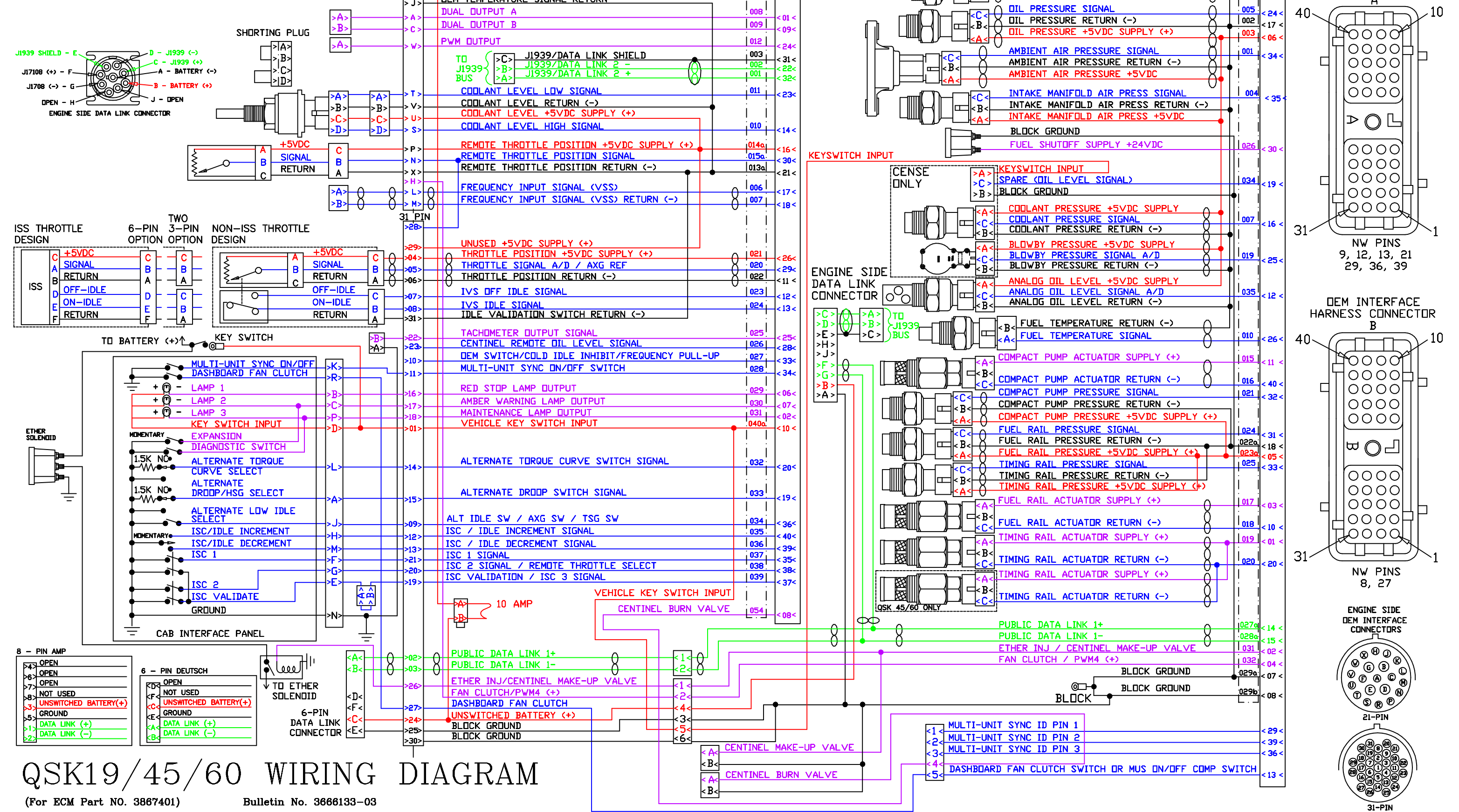
BLACK INDICATES ECM RETURNS, GROUNDS, NO CONNECTS AND GENERIC OEM WIRING

GREEN INDICATES DATA LINKS

PURPLE INDICATES ECM OUTPUTS

NW NO WIRE

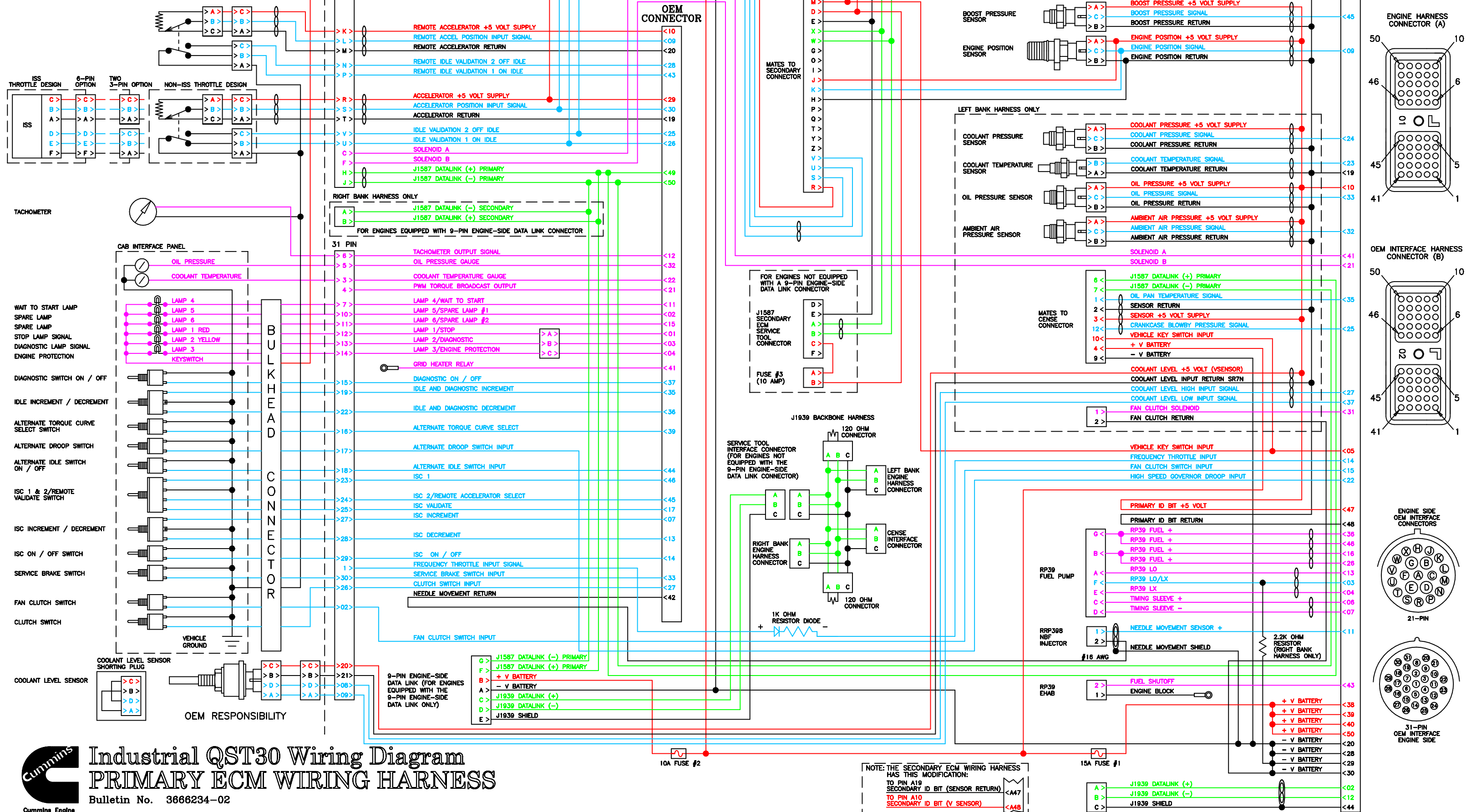
OEM RESPONSIBILITY CUMMINS RESPONSIBILITY





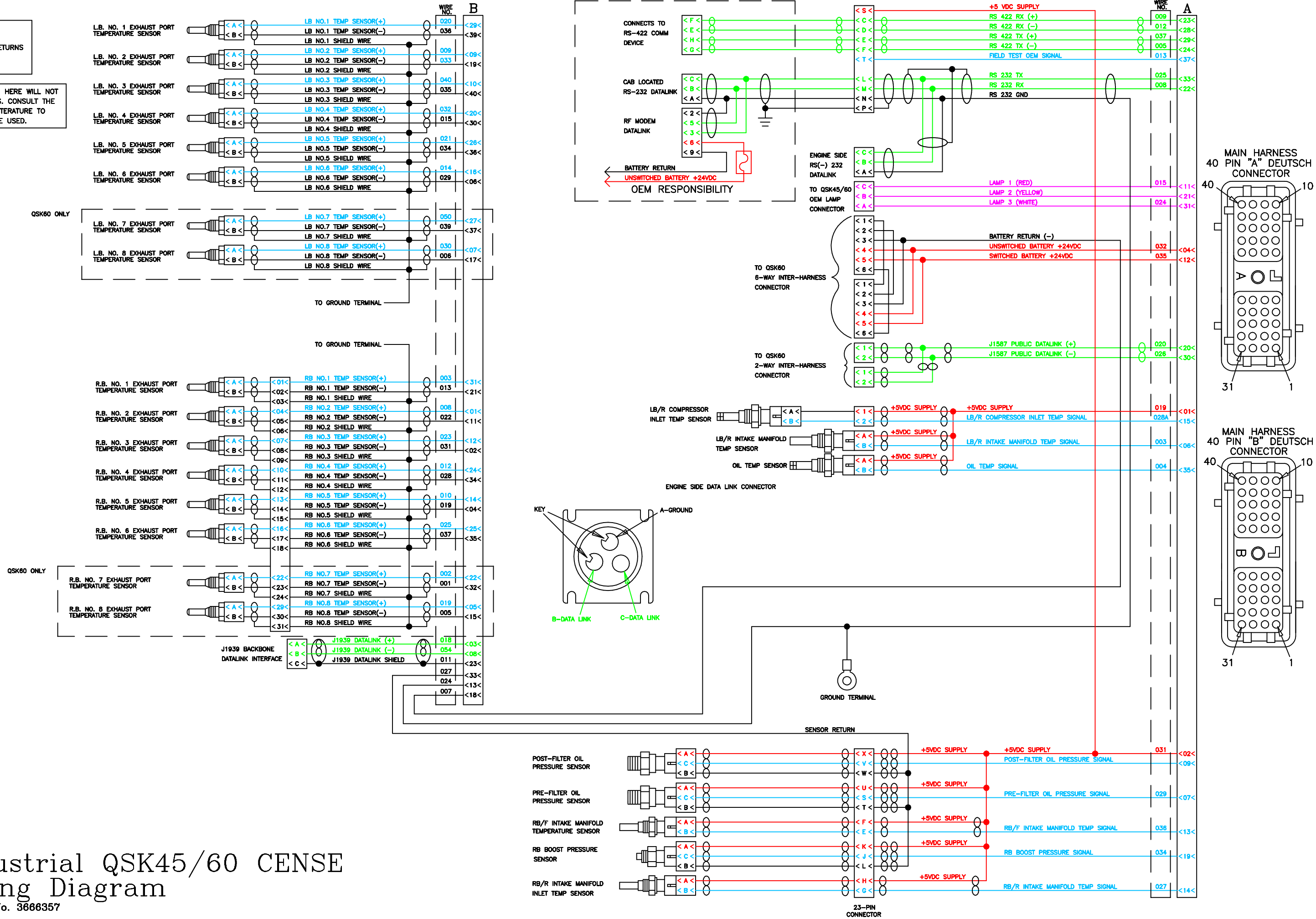
## CUMMINS RESPONSIBILITY

**NOTE:** SOME OF THE CIRCUITS SHOWN HERE WILL NOT BE ACTIVE IN ALL APPLICATIONS. CONSULT THE EQUIPMENT MANUFACTURER'S LITERATURE TO DETERMINE WHICH CIRCUITS ARE USED.



RED DC VOLTAGE  
 BLUE INPUT SIGNALS  
 BLACK GROUNDS, SHIELDS AND RETURNS  
 PURPLE OUTPUT SIGNALS  
 GREEN DATA LINKS

NOTE: SOME OF THE CIRCUITS SHOWN HERE WILL NOT BE ACTIVE IN ALL APPLICATIONS. CONSULT THE EQUIPMENT MANUFACTURER'S LITERATURE TO DETERMINE WHICH CIRCUITS ARE USED.



# Industrial QSK45/60 CENSE Wiring Diagram

Bulletin No. 3668357

Cummins Engine Company, Inc.

## Pin Mapping

### QSB - OEM 50 Pin connector

Pin	Pinout Type	Signal Name	Feature
1	600 mA current sink to ground	Stop Lamp	Engine Protection/Diagnostics
2	600 mA current sink to ground	Water In Fuel Lamp	Water-In-Fuel
3	600 mA current sink to ground	Diagnostic Lamp	Diagnostics
4	600 mA current sink to ground	Maintenance Lamp	Diagnostics
5	600 mA current sink to ground	Dual Output Driver A	Dual Outputs
7	<50 ohm Closed, 50Kohm Open	Cruise Control/ISC Increment/ ISC Resume	Cruise Control/ISC Increment
8	Vehicle/Tail Shaft Speed Sensor	Vehicle Speed Sensor Positive Input	Vehicle Speed
9	Remote Throttle Sensor	Remote Throttle Analog Input	Remote Throttle
10	Remote throttle (VsensorB)	Remote Throttle +5Vdc	Remote Throttle
11	600 mA current sink to ground	Wait to Start Lamp	Intake Air Heater/Grid Heater
12	Frequency Output	Tachometer Out (Logic Level)	Tachometer
13	<50 ohm Closed, 50Kohm Open	Cruise Set/ISC Decrement	Cruise Control/ISC Decrement
14	<50 ohm Closed, 50Kohm Open	Cruise On/Off	Cruise Control
15		Reserved	
16	<50 ohm Closed, 50Kohm Open	Fan Clutch Switch Inputs	Fan Clutch
17	<50 ohm Closed, 50Kohm Open	Boost Power Request Switch	Boost Power
18	Vehicle Speed Sensor	Vehicle Speed Sensor Negative Input	Vehicle Speed
19	Ground	Throttle Return	Throttle
20	Ground	Remote Throttle Return	Remote Throttle
21	3 amps	Dedicated PWM Output	Dedicated PWM
22		Reserved	
23	<50 ohm Closed, 50Kohm Open	ISC 3 / ISC Validation Switch	Intermediate Speed Control
24	50 ohm Closed, 50Kohm Open	Multi-Unit Sync On/Off Switch Input	Multi-Unit Sync
25	125 ohm Closed, 50 Mohm Open	Off Idle Switch	Idle Validation
26	<125 ohm Closed, 50 Mohm Open	On Idle Switch	Idle Validation
27	<50 ohm Closed, 50Kohm Open	Clutch Switch Input	Exhaust Brakes
28	<50 ohm Closed, 50Kohm Open	ISC 1 Switch	Intermediate Speed Control
29	+5 Vdc supply	Throttle\Potentiometer +5 Vdc	Throttle
30	Throttle Position Sensor	Throttle Position Input Signal	Throttle
31	1 amp, Hi side Drive	Cold Starting Aid Relay 2	Intake Air Heater/Grid Heater
32		Reserved	
33	<50 ohm Closed, 50Kohm Open	Brake Switch	Exhaust Brakes
34	<50 ohm Closed, 50Kohm Open	Exhaust Brake On/Off Switch	Exhaust Brakes
35	<50 ohm Closed, 50Kohm Open	Idle and Diagnostic Increment Switch	Diagnostics, Low Idle Gov.

36	<50 ohm Closed, 50Kohm Open	Idle and Diagnostic Decrement Switch	Diagnostics, Low Idle Gov., ISC
37	<50 ohm Closed, 50Kohm Open	Test (Diagnostic) On/Off Switch	Diagnostics
38	<50 ohm Closed, 50Kohm Open	Multi-Unit Sync Complementary Switch	Multi-Unit Sync
39	A/D Input	Alternate Torque Derate Switch Input	Alternate Torque
40	Water In Fuel Sensor	Water In Fuel Sensor	Water-In-Fuel
41	1 amp, Hi side drive	Cold Starting Aid Relay1	Intake Air Heater/Grid Heater
42		Reserved	
43	<125 ohm Closed, 50 Mohm Open	A/C Pressure Switch	Fan Clutch
44	<50 ohm Closed, 50Kohm Open	Alternate Idle Speed Switch Input	Alternate Idle
45	<50 ohm Closed, 50Kohm Open	Remote Throttle On/Off Switch	Remote Throttle
46	Switch (Pulled up)	Aux. Governor On/Off Switch	Auxiliary Speed Governor
47	<50 ohm Closed, 50Kohm Open	ISC 2 Switch	Intermediate Speed Control
48	A/D Input	OEM Pressure Sensor	OEM Pressure
49	Datalink	J1708/J1587 Datalink +	J1587 Datalink
50	Datalink	J1708/J1587 Datalink -	J1587 Datalink

**QSC/QSL9 - OEM 50 Pin connector**

Pin	Pinout Type	Signal Name	Feature
1	600 mA current sink to ground	Stop Lamp	Engine Protection/Diagnostics
2	600 mA current sink to ground	Water in Fuel Lamp	Water-In-Fuel
3	600 mA current sink to ground	Diagnostic Lamp	Diagnostics
4	600 mA current sink to ground	Maintenance Lamp	Diagnostics
5	600 mA current sink to ground	Dual Output Driver A	Dual Outputs
7	<50 ohm Closed, 50Kohm Open	CC/ISC Resume Switch Input	Cruise Control/ISC Increment
8	Vehicle/Tail Shaft Speed Sensor	Vehicle Speed Sensor + Input	Vehicle Speed
9	Remote Throttle Sensor	Remote Throttle Pedal Position Input	Remote Throttle
10	Remote throttle (VsensorB)	Remote Throttle +5VDC	Remote Throttle
11	600 mA current sink to ground	Wait to Start Lamp	Intake Air Heater/Grid Heater
12	Frequency Output	Tachometer Output (Logic Level)	Tachometer
13	Switch (Pulled up)	CC/ISC Set /Coast Switch Input	Cruise Control/ISC Decrement
14	<50 ohm Closed, 50Kohm Open	CC/On-OFF Switch Input	Cruise Control
15		Reserved	
16	<50 ohm Closed, 50Kohm Open	Fan Clutch Switch Input	Fan Clutch
17	<50 ohm Closed, 50Kohm Open	Boost Power Request Switch	Boost Power
18	Vehicle Speed Sensor	Vehicle Speed Sensor - Input	Vehicle Speed
19	Ground	Throttle Return	Throttle
20	Ground	Remote Throttle Return	Remote Throttle
21	3 amps	Dedicated PWM Output	Dedicated PWM
22		Reserved	
23	<50 ohm Closed, 50Kohm Open	ISC 3 / ISC Validation	Intermediate Speed Control
24	50 ohm Closed, 50Kohm Open	Multi-Unit Sync On/Off Switch	Multi-Unit Sync

25	125 ohm Closed, 50 Mohm Open	Off Idle Sw	Idle Validation
26	<125 ohm Closed, 50 Mohm Open	On Idle Sw	Idle Validation
27	<50 ohm Closed, 50Kohm Open	Clutch Switch Input	Exhaust Brakes
28	<50 ohm Closed, 50Kohm Open	ISC 1 Switch Input	Intermediate Speed Control
29	+5 Vdc supply	V Throttle +5VDC	Throttle
30	Throttle Position Sensor	Throttle Pos Input Signal	Throttle
31	1 amp, Hi side Drive	Cold Start Aid Relay 2	Intake Air Heater/Grid Heater
32		Reserved	
33	<50 ohm Closed, 50Kohm Open	Brake Switch Input	Exhaust Brakes
34	<50 ohm Closed, 50Kohm Open	Exhaust Brake On/Off Switch Input	Exhaust Brakes
35	<50 ohm Closed, 50Kohm Open	Idle/Diag Increment Switch Input	Diagnostics, Low Idle Gov.
36	<50 ohm Closed, 50Kohm Open	Idle/Diag Decrement Switch Input	Diagnostics, Low Idle Gov.
37	<50 ohm Closed, 50Kohm Open	Diagnostic On/Off Switch Input	Diagnostics
38	<50 ohm Closed, 50Kohm Open	Multi-Unit Sync Complementary Switch	Multi-Unit Sync
39	A/D Input	Alternate Torque Derate Switch Input	Alternate Torque
40	Water In Fuel Sensor	Water In Fuel	Water-In-Fuel
41	1 amp, Hi side drive	Cold Start Aid Relay 1	Intake Air Heater/Grid Heater
42		Reserved	
43	<125 ohm Closed, 50 Mohm Open	AC Pressure Switch	Fan Clutch
44	<50 ohm Closed, 50Kohm Open	Alternate Idle Switch	Alternate Idle
45	<50 ohm Closed, 50Kohm Open	Remote Throttle On/Off Input	Remote Throttle
46	Switch (Pulled up)	Aux. Governor On/Off Input	Auxiliary Speed Governor
47	<50 ohm Closed, 50Kohm Open	ISC 2 Switch Input	Intermediate Speed Control
48	A/D Input	OEM Pressure Sensor Input	OEM Pressure
49	Datalink	J1708/J1587 Datalink +	J1587 Datalink
50	Datalink	J1708/J1587 Datalink -	J1587 Datalink

**QSM11/QSX15 - OEM 50 Pin connector**

Pin	Pinout Type	Signal Name	Feature
1	10V Switched Pullup Input	AXG On/Off Switch	Auxiliary Speed Governor
2	10V Switched Pullup Input	Alternate Torque Switch	Switchable Torque
3	IVS 10V Switched Pullup Input	Off Idle Switch	Base Throttle
			Frequency Throttle
4	Switched Sink Driver Output	Wait-To-Start Lamp	Intake Air Heater
5	Switched Sink Driver Output	Maintenance Lamp	Real-Time Clock
			Water-In-Fuel
			Maintenance Monitor
6	Switched Sink Driver Output	Stop Lamp	Diagnostics
			Engine Protection
7	ECM Supply (+)	ECM Supply (+)	All
8	ECM Supply (+)	ECM Supply (+)	All

9	ECM Switch Return	Panel Return 1	All
10	ECM Switch Return	Panel Return 2	All
11	Tachometer Source Driver Output	Tachometer	All Tachometer
12	10V Switched Pullup Input	EP Shutdown Override Switch	Engine Protection
13	IVS 10V Switched Pullup Input	On Idle Switch	Base Throttle
			Frequency Throttle
14	10V Switched Pullup Input	Diagnostics Increment	Diagnostics
	F MULTIFUNCTION pinout	ISC Increment	Intermediate Speed Control
		Idle Increment	Low Idle Governor
15	10V Switched Pullup Input	Fan Accessory Switch	Electronic Fan Clutch
16	Switched Sink Driver Output	Warning Lamp	Diagnostics
			Low Idle Shutdown
17	ECM Supply (+)	ECM Supply (+)	All
18	ECM Supply (+)	ECM Supply (+)	All
19	ECM Switch Return	MUS ID Return	Multiple Unit Synchronization
20	ECM Switch Return	Remote Return	Remote Throttle
21	APS Ratiometric Analog Input	Remote Throttle Position	Remote Throttle
	F RECONFIGURABLE pinout	Variable ISC	Intermediate Speed Control
22	10V Switched Pullup Input	MUS ID1 Engine Brake Select 1	Multiple Unit Synchronization Engine Brakes
23	10V Switched Pullup Input	ISC Switched Speed 1	Intermediate Speed Control
24	10V Switched Pullup Input	Diagnostics Decrement	Diagnostics
	F MULTIFUNCTION pinout	ISC Decrement	Intermediate Speed Control
		Idle Decrement	Low Idle Governor
25	10V Switched Pullup Input	ISC Switched Speed 2	Intermediate Speed Control
26	J1587 Datalink (+)	J1587 Datalink (+)	J1708/J1587 Datalink
27	J1587 Datalink (-)	J1587 Datalink (-)	J1708/J1587 Datalink
28	ECM Supply (+)	ECM Supply (+)	All
29	ECM Supply Return	ECM Supply Return	All
30	ECM Supply Return	ECM Supply Return	All
31	10V Switched Pullup Input	MUS ID2 Engine Brake Select 2	Multiple Unit Synchronization Engine Brakes
32	10V Switched Pullup Input	MUS ID3 Engine Brake Select 3 (QSX15)	Multiple Unit Synchronization Engine Brakes (QSX15)
33	10V Switched Pullup Input	ISC Switched Speed 3	Intermediate Speed Control
	F RECONFIGURABLE pinout	ISC Validation	Intermediate Speed Control
34	10V Switched Pullup Input	MUS On/Off Validation	Multiple Unit Synchronization
35	Switched Source Driver Output	Idle Shutdown Relay	Low Idle Shutdown
36	J1939 Datalink Shield	J1939 Datalink Shield	J1939 Datalink
37	J1939 Datalink (-)	J1939 Datalink (-)	J1939 Datalink
38	Switched Pulldown Input	Keyswitch	All
39	ECM Supply Return	ECM Supply Return	All
40	ECM Supply Return	ECM Supply Return	All
41	10V Switched Pullup Input	Alternate Droop Switch	Alternate Droop
42	10V Switched Pullup Input	MUS On/Off Switch	Multiple Unit Synchronization
43	10V Switched Pullup Input	Remote Throttle Switch	Remote Throttle
44	10V Switched Pullup Input	Diagnostics Enable	Diagnostics
	F MULTIFUNCTION pinout	Manual Snapshot	User-Activated Datalogger
45	10V Switched Pullup Input	Alternate Low Idle Switch	Switchable Low Idle

46	J1939 Datalink (+)	J1939 Datalink (+)	All
47	APS Ratiometric Analog Input	Base Throttle Position	Base Throttle
48	APS 5V Sensor Voltage Source	Throttle Supply (+)	Base Throttle
			Remote Throttle
			Intermediate Speed Control
49	ECM Switch Return	Throttle Supply Return	Base Throttle
			Remote Throttle
			Intermediate Speed Control
50	ECM Supply Return	ECM Supply Return	All

**QSM11/QSX15 - OEM 31 Pin connector**

Pin	Pinout Type	Signal Name	Feature
1	5V Sensor Voltage Source	not used	none
2	Ratiometric Analog Input	not used	none
3	ECM Switch Return	OEM Temperature Return	Switched Outputs
			Electronic Fan Clutch
4	Resistive Analog Input	OEM Temperature	Switched Outputs
			Electronic Fan Clutch
5	5V Switched Pullup Input	Coolant Detected	Engine Protection
6	5V Switched Pullup Input	Coolant Not Detected	Engine Protection
7	5V Sensor Voltage Source	Coolant Level Supply (+)	Engine Protection
8	Switched Source Driver Output	Switched Output B	Switched Outputs
9	Switched Source Driver Output	Engine Speed	PWM Dedicated Output
	F RECONFIGURABLE pinout	Engine Torque	PWM Dedicated Output
		Commanded Throttle	PWM Dedicated Output
10	Switched Source Driver Output	Intake Air Heater	Intake Air Heater
11	ECM Solenoid Return	Solenoid Return	Switched Outputs
12	Switched Source Driver Output	Fan Clutch	Electronic Fan Clutch
13	ECM Solenoid Return	Fan Clutch Return	Electronic Fan Clutch
14	5V Sensor Voltage Source	not used	none
15	Hall Effect Input	not used	none
16	ECM Switch Return	SE Return	various features
17	10V Switched Pullup Input	AC Pressure Switch	PWM Dedicated Output
18	ECM Switch Return	AC Pressure Return	Electronic Fan Clutch
19	ECM Switch Return	Coolant Level Return	Electronic Fan Clutch
20	Switched Sink Driver Output	not used	none
21	Variable Reluctance Input (+)	Shaft Speed (+)	Auxiliary Governor
	F RECONFIGURABLE pinout		Switched Outputs
22	Variable Reluctance Input (-)	Shaft Speed (-)	Auxiliary Governor
	F RECONFIGURABLE pinout		Switched Outputs
		Frequency Throttle (+)	Frequency Throttle
		Transmission Synch (+)	Transmission Synchronization
23	Resistive Analog Input	not used	none
24	ECM Switch Return	spare	as required
25	10V Switched Pullup Input	not used	none
26	not connected	not used	none
27	Switched Source Driver Output	Switched Output A	Switched Outputs
28	ECM Switch Return	OEM Switch Return	Switched Outputs
29	Switched Source Driver Output	not used	none

30	5V Switched Pullup Input	Alternate Torque Select	Alternate Torque
31	5V Switched Pullup Input	OEM Switch	Switched Outputs

#### QSK19 – OEM 21 Pin Connector

Pin	Pinout Type	Signal Name	Feature
A	Source Driver Output	Dual Output A	Dual Outputs
C	Source Driver Output	Dual Output B	Dual Outputs
D	ECM Supply (+)	Unswitched Battery	All
F	Ratiometric A/D Input	OEM Pressure	Dual Outputs
			Electronic Fan Clutch
			Engine Protection
			Auxiliary Governor
G	ECM Supply (+)	Unswitched Battery	All
H	PWM Source Driver	Fan Clutch	Electronic Fan Clutch
J	Resistive A/D Input	OEM Temperature Return	Dual Outputs
			Electronic Fan Clutch
			Engine Protection
K	Ratiometric A/D Input	OEM Temperature	Dual Outputs
			Electronic Fan Clutch
			Engine Protection
L	Variable Reluctance Input (+)	Auxiliary Shaft Speed Frequency Throttle	Auxiliary Governor
			Frequency Throttle
M	Variable Reluctance Input (-)	Auxiliary Shaft Speed Frequency Throttle	Auxiliary Governor
			Frequency Throttle
N	APS Ratiometric Analog Input	Remote Throttle Position Variable ISC Position	Remote Throttle
			Variable ISC
P	APS Sensor 5V Source Voltage	Remote Throttle Supply Variable ISC Supply	Remote Throttle
			Variable ISC
U	5V Sensor Supply	Coolant Level Supply (+)	Engine Protection
			OEM Pressure Sensor Supply
S	5V Switched Pullup Input	Coolant Level High Input	Engine Protection
T	5V Switched Pullup Input	Coolant Level Low Input	Engine Protection
V	ECM Sensor Return	Coolant Level Return	Engine Protection
			OEM Pressure Sensor Supply
			Centinel (CORS)
W	PWM Output Output	Dedicated PWM Output	Dedicated PWM
X	ECM Throttle Return	Remote Throttle Return Variable ISC Return	Remote Throttle
			Variable ISC

#### QSK19 – OEM 31 Pin Connector

Pin	Pinout Type	Signal Name	Feature
1	Switched Pulldown Input	Vehicle Keyswitch Input	Keyswitch
2	J1587 Data Link +	J1587 Data Link +	J1708/J1587 Datalink
3	J1587 Data Link +	J1587 Data Link -	J1708/J1587 Datalink
4	APS Sensor 5V Source Voltage	Throttle Supply	Primary Throttle
5	APS Ratiometric Analog Input	Throttle Position	Primary Throttle
6	ECM Throttle Return	Throttle Return	Primary Throttle
7	Switched Pullup Input	Idle Validation Off Idle	Idle Validation
8	Switched Pullup Input	Idle Validation On Idle	Idle Validation
9	12V Switched Pullup Input	AXG Enable Switch Alternate Idle Switch	Auxiliary Governor
			Switched Alternate Idle
10	12V Switched Pullup Input	OEM Switch Cold Idle Inhibit	Dual Outputs
			Coolant Temp. Based Alt. Idle
11	12V Switched Pullup Input	Multi-Unit Sync On/Off	Multi-Unit Synchronization



12	12V Switched Pullup Input	ISC/Idle Increment	Diagnostics
			Intermediate Speed Control
			Low Idle Governor
13	12V Switched Pullup Input	ISC/Idle Decrement	Diagnostics
			Intermediate Speed Control
			Low Idle Governor
14	12V Switched Pullup Input	Alternate Torque Switch	Alternate Torque
15	12V Switched Pullup Input	Alternate Droop Switch	Alternate Droop
16	Switched Sink Driver Output	Red Stop Lamp	Diagnostics
			Engine Protection
17	Switched Sink Driver Output	Yellow Warning Lamp	Diagnostics
			Low Idle Shutdown
18	Switched Sink Driver Output	White Maintenance Lamp	Engine Protection
			Maintenance Monitor
19	12V Switched Pullup Input	ISC 3/ISC Validation	Intermediate Speed Control
20	12V Switched Pullup Input	ISC 2/Remote Throttle	Intermediate Speed Control
			Remote Throttle
21	12V Switched Pullup Input	ISC 1	Intermediate Speed Control
22	Tachometer Source Driver	Tachometer Output	Tachometer
23	12V Switched Pullup Input	Remote Oil Level	Centinel (CORS)
24	Battery Supply	Unswitched Battery	Datalink Connector Supply
25	ECM Return	Block Ground	All
26	Switched Source Driver Output	Ether Injection	Controlled Ether Injection
		Centinel Make-Up Valve	
27	12V Switched Pullup Input	Dashboard Fan Clutch	Electronic Fan Clutch
28	APS Ratiometric Analog Input	Remote Throttle Position	Remote Throttle
		Variable ISC Position	Variable ISC
29	5V DC Supply (+)	Unused 5V DC Supply (+)	N/A
30	ECM Return	Block Ground	All
31	ECM Switch Return	Idle Validation Switch Return	Idle Validation

**QST 30 - OEM 21 Pin Connector**

Pin	Pinout Type	Signal Name	Feature
A	Switched Pullup Input	Vehicle Key Switch Input	ALL
B	Battery Ground	-V Battery	ALL
C	Switched Driver Output	Solenoid A	Switched Outputs
D	Unswitched Battery Supply	+V Battery (secondary engine)	ALL
E	Battery Ground	-V Battery (Secondary engine)	ALL
F	Switched Driver Output	Solenoid B	Switched Outputs
G	Unswitched Battery Supply	-V Battery	ALL
H	Data Bus	J 1587 Data Link + (primary engine)	J1587 Datalink
J	Data Bus	J 1587 Data Link - (primary engine)	J1587 Datalink
K	Output	Remote Throttle Supply	Remote Throttle
L	Analog Input	Remote Throttle Position Input Signal	Remote Throttle
M	Input	Remote Throttle Return	Remote Throttle
N	Switched Pulldown Input	Remote Idle Validation 1 On	Idle Validation
P	Switched Pulldown Input	Remote Idle Validation 2 Off	Idle Validation
R	Output	Throttle Supply	Primary Throttle
S	Analog Input	Throttle Position Input Signal	Primary Throttle
T	Input	Throttle Return	Primary Throttle
U	Switched Pulldown Input	Idle Validation 1 On	Idle Validation
V	Switched Pulldown Input	Idle Validation 2 Off	Idle Validation

W	Data Bus	J1587 Data Link + (secondary engine)	J1587 Datalink
X	Data Bus	J 1587 Data Link - (secondary engine)	J1587 Datalink

#### QST30 - OEM 31 Pin Connector

Pins	Pinout Type	Signal Name	Feature
1	Analog Input	Frequency Throttle Input	Frequency Throttle
2	Switched Pulldown Input	Fan Clutch Switch	Fan Clutch
3	Analog Output	Coolant Temperature Gauge	Coolant Temp Gauge
4	PWM Source Driver Output	PWM Torque Broadcast Output	Dedicated PWM
5	Analog Output	Oil Pressure Gauge	Oil Pressure Gauge
6	Switched Source Driver Output	Tachometer Output Signal	Tachometer Output
7	Switched Sink Driver Output	Lamp 4 / Wait To Start	Grid Heater
8	Switched Pulldown Input	Coolant Level High Input Signal	Coolant Level
9	Switched Pulldown Input	Coolant Level Low Input Signal	Coolant Level
10	Switched Sink Driver Output	Lamp 5 / Spare Lamp #1	Diagnostics
11	Switched Sink Driver Output	Lamp 6 / Spare Lamp #2	Diagnostics
12	Switched Sink Driver Output	Lamp 1 / Stop	Diagnostics
13	Switched Sink Driver Output	Lamp 2 / Diagnostics	Diagnostics
14	Switched Sink Driver Output	Lamp 3 / Engine Protection	Diagnostics
15	Switched Pulldown Input	Diagnostic On/Off	Diagnostics
16	Switched Pulldown Input	Torque Curve Select	Alternate Torque
17	Switched Pulldown Input	Hi Speed Gov. Droop Select	Alternate Droop
18	Switched Pulldown Input	Alternate Idle Switch Input	Alternate Idle
19	Switched Pulldown Input	Idle and Diagnostic Increment	Diagnostics & Low Idle
20	Output	Coolant Level Supply	Coolant Level
21	Input	Coolant Level Return	Coolant Level
22	Switched Pulldown Input	Idle and Diagnostic Decrement	Diagnostics & Low Idle
23	Switched Pulldown Input	PTO 1	Intermediate Speed Control
24	Switched Pulldown Input	PTO 2 / Remote Throttle Select	Intermediate Speed Control/Remote Throttle
25	Switched Pulldown Input	PTO Validate	Intermediate Speed Control
26	Switched Pulldown Input	Clutch Switch	Clutch Input
27	Switched Pulldown Input	PTO Increment	Intermediate Speed Control
28	Switched Pulldown Input	PTO Decrement	Intermediate Speed Control
29	Switched Pulldown Input	PTO On/Off	Intermediate Speed Control
30	Switched Pulldown Input	Service Brake	Service Brakes
31	Switched Pulldown Input	Droop Switch Input	High Speed Governor Droop

## Section VIII – Pinout Specifications

**Disclaimer:** The pinout specification is applicable to the QSM11/QSX15 circuit requirements and descriptions may be different for each engine platform.

\* Note - the differences will be added in future revisions to this document

## 5V Sensor Voltage Source Pinout Specifications/APS 5V Sensor Voltage Source Pinout Specifications

**Application.** There are two 5V ECM regulated power supplies available to the OEM. The primary supply is available at any 5V Sensor Voltage Source pinout. This supply is used as excitation voltage for ratiometric sensors such as pressure sensors. There is also an electrically independent 5V supply available at the APS 5V Sensor Voltage Source pinout. It is designed to provide excitation voltage for Accelerator Position Sensors (APS's).

**Note:** Specifications for the APS 5V Sensor Voltage Source Pinout are defined in CES 14118 except as noted.

**5V Sensor Voltage Source Pinout Specifications**

Item	Requirement
Pin Voltage	5V $\pm$ 5%
Maximum Current Per Pin	50 mA, 10 mA APS
Maximum Total Current (Sum of All Pins)	200 mA, 10 mA APS
Maximum Ripple Voltage	100 mV p-p

## 5V Switched Pullup Input Pinout Specifications

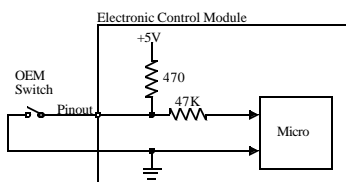
**Application.** The 5V Switched Pullup Input pinout type detects the state of a low-voltage, OEM-supplied binary switch or switching device. A typical application is the coolant level switch. The pinout is connected to one contact of the OEM switch. ECM ground is connected to the other contact of the OEM switch.

**Note.** For proper operation, the OEM switch must always be returned to ECM ground as defined in the Installation Recommendations section and IS-1377-9802.

**Operation.** The 5V Switched Pullup Input pinout can exist in one of two states: Grounded (@ 0 volts) or Not Grounded (@ 5 volts). These states are dictated by OEM switch position as follows.

**a. Grounded State.** When the OEM switch is closed, Nominal Pinout Current is present through the pinout by way of the 470 Ohm pullup resistor. Grounded Source Resistance can be measured between the pinout and ECM ground. Grounded Pin Voltage can be measured at the pinout with respect to ECM ground. The microprocessor detects a logic level low.

**b. Not Grounded State.** When the OEM switch is opened, Pinout Current is minimal. Not Grounded Source Resistance can be measured between the pinout and ECM ground. Not Grounded Pin Voltage can be measured at the pinout with respect to ECM ground. The microprocessor detects a logic level high.



**5V Switched Pullup Input Pinout Simplified Circuit**

#### 5V Switched Pullup Input Pinout Specifications

Item	Requirement
Number of States	Two: GROUNDED or NOT GROUNDED
Nominal Pinout Current	10 mA
Maximum Grounded Pin Voltage	1.5 V
Minimum Not Grounded Pin Voltage	4 V
Maximum Grounded Source Resistance	125 Ohm
Minimum Not Grounded Source Resistance	50k Ohm

#### 10V Switched Pullup Input Pinout Specifications/IVS 10V Switched Pullup Input Pinout Specifications

**Application.** The 10V Switched Pullup Input pinout type detects the state of an OEM-supplied binary mechanical or solid-state switch. Typical applications are panel-mounted toggle switches and Idle Validation Switches (IVS's). The pinout is connected to one contact of the OEM switch. ECM ground is connected to the other contact of the

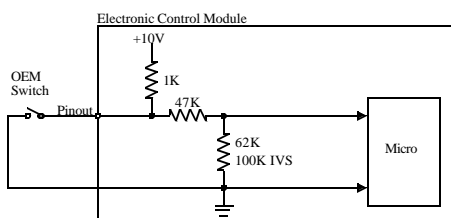
OEM switch. There are two 10V Switched Pullup Input pinouts designated IVS which are similar in operation to, but electrically independent from, non-IVS pinouts.

**Note.** For proper operation, the OEM switch must always be returned to ECM ground as defined in the Installation Recommendations section and IS-1377-9802. Specifications for the IVS 10V switched Pullup Input pinout are defined in CES 14118 except as noted.

**Operation.** The 10V Switched Pullup Input pinout can exist in one of two states: Grounded (@ 0 volts) or Not Grounded (@ 10 volts). These states are dictated by OEM switch position as follows.

**a. Grounded State.** When the OEM switch is closed, Nominal Pinout Current is present through the pinout by way of the 1K pullup resistor. Grounded Source Resistance can be measured between the pinout and ECM ground. Grounded Pin Voltage can be measured at the pinout with respect to ECM ground. The microprocessor detects a logic level low.

**b. Not Grounded State.** When the OEM switch is opened, Pinout Current is minimal. Not Grounded Source Resistance can be measured between the pinout and ECM ground. Not Grounded Pin Voltage can be measured at the pinout with respect to ECM ground. The microprocessor detects a logic level high.



10V Switched Pullup Input Pinout Simplified Circuit

#### 10V Switched Pullup Input Pinout Specifications

Item	Requirement
Number of States	Two: GROUNDED or NOT GROUNDED
Nominal Pinout Current	10 mA
Maximum Grounded Pin Voltage	2 V, 1.5 V IVS
Minimum Not Grounded Pin Voltage	8 V, 5.5 V IVS
Maximum Grounded Source Resistance	100 Ohm, 125 Ohm IVS
Minimum Not Grounded Source Resistance	50k Ohm

#### ECM Supply (+) Pinout Specifications/ECM Supply Return Pinout Specifications

**Application.** There are five ECM Supply (+) pinouts and five ECM Supply Return pinouts. These pinouts supply primary CM570 subsystem operating power to the ECM.

**Note.** This is a critical interface, special connection requirements must be followed as defined in the Installation Recommendations section and IS-1377-9807.

### ECM Supply Pinout Specifications

Item	Requirement
Supply Voltage	9-32 Vdc
Maximum Key-On Current	25A @ 12V, 15A @ 24V
Maximum Key-Off Current (Dormant Mode)	40 mA @ 12V, 80 mA @ 24V
Maximum Circuit Resistance, ECM to battery (+ and -)	40mOhms

### ECM Switch Return Pinout Specifications

**Application.** There are two types of ECM returns available to the OEM. These returns are available at several ECM pinouts. The ECM Switch Return pinouts provide a return for switches or sensors. The ECM Solenoid Return pinouts provide a return for relay coils or solenoids.

**Note.** For proper operation, special installation requirements must be followed as defined in the Installation Recommendations section and IS-1377-9807.

### ECM Return Pinout Specifications

Item	Requirement
Maximum Current Per Pin	7.5A*
Maximum Total Current (Sum of all Pins)	12.5A

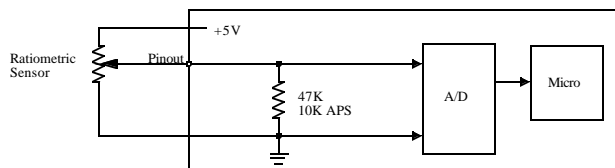
\* The following pinouts are limited to 5 A: Frequency Return and OEM Switch return

### Ratiometric Analog Input Pinout Specifications/APS Ratiometric Analog Input Pinout Specifications

**Application.** The Ratiometric Analog Input pinout detects the signal from an OEM-supplied ratiometric sensor. Ratiometric sensors are three-wire sensors that provide a continuously variable output voltage that represents a measured analog parameter. Typical applications are pressure sensors and Accelerator Position Sensors (APS's). The pinout is connected to the center tap of the ratiometric sensor. This sensor is typically connected to an excitation voltage and ECM ground. There are two Ratiometric Analog Input pinouts designated APS which are similar in operation to, but electrically independent from, non-APS pinouts.

**Note.** For proper operation, the ratiometric sensor must always be returned via a dedicated ECM ground as defined in the Installation Recommendations section. Specifications for the APS Ratiometric Analog Input pinout are defined in CES 14118 except as noted.

**Operation.** Current flow is present through the ratiometric sensor, whenever the ECM is powered up, by way of the +5V source. This results in a voltage drop at the center tap of the ratiometric sensor, which is applied to the ratiometric Analog Input pinout. Pinout Current is present through the pinout by way of the pulldown resistor. Pinout Voltage can be measured at pinout with respect to ECM ground. This voltage is sampled by the A/D converter and supplied to the microprocessor.



**Ratiometric Analog Input Pinout Simplified Circuit**

**Ratiometric Analog Input Pinout Specifications**

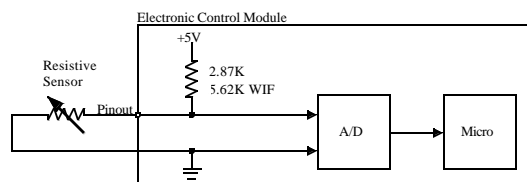
Item	Requirement
Resolution	5 mV
Maximum Pinout Current	100 $\mu$ A, 500 $\mu$ A APS
Maximum Pinout Voltage	5V

## **Resistive Analog Input Pinout Specifications/WIF Resistive Analog Input Pinout Specifications**

**Application.** The Resistive Analog Input pinout detects the signal from an OEM-supplied resistive sensor. Resistive sensors are two-wire sensors that provides a continuously variable resistance that represents a measured analog parameter. Typical applications are temperature sensors. The pinout is connected to one side of the OEM sensor. ECM ground is connected to the other side of the OEM sensor. There is a Resistive Analog Input pinout designated WIF which provides a lower current draw. Its applications are limited to Water-In-Fuel (WIF) sensors.

**Note.** For proper operation, the resistive sensor must always be returned via a dedicated ECM ground as defined in the Installation Recommendations section.

**Operation.** Pinout Current is present through the Resistive Analog Input pinout, whenever the ECM is powered up, by way of the pullup resistor. This results in a voltage drop between the pullup resistor and the sensor. Pinout Voltage can be measured at the pinout with respect to ECM ground. This voltage is sampled by the A/D converter and supplied to the microprocessor.



**Resistive Analog Input Pinout Simplified Circuit**

### Resistive Analog Input Pinout Specifications

Item	Requirement
Resolution	5 mV
Maximum Pinout Current	1.7 mA, 0.9 mA WIF
No-Load Pinout Voltage	5 V

### Switched Pulldown Input Pinout Specifications

**Application.** The Switched Pulldown Input pinout detects the critical Keyswitch signal. This signal must be present in order for the engine to operate. Proper connection of the Keyswitch signal is critical to proper operation of the CM570 electronic subsystem.

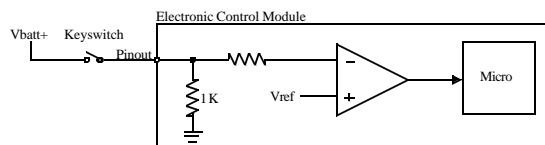
**Note.** This is a critical interface; special connection requirements must be followed as defined in the Installation Recommendations section and IS-1377-9807.

**Operation.** The Switched Pulldown Input pinout can exist in one of two states: Key-On (@ Vbatt+) or Key-Off (@ 0 volts). Pinout state is dictated by keyswitch position as follows.

**a. Key-On.** When the keyswitch is closed, Nominal Pinout Current is present through the pinout by way of the 1K pulldown resistor. Key-On Source Voltage can be measured at the pinout with respect to ECM ground. This voltage is greater than a reference voltage and turns an op amp OFF. After the op amp has been OFF for the Key-On Time, the micro assumes the Key-On state.



**b. Key-Off.** When the keyswitch is opened, Pinout Current is minimal. Key-Off Source Voltage can be measured at the pinout with respect to ECM ground. This voltage is less than a reference voltage and turns the op amp ON. After the op amp has been ON for the Key-Off Time, the micro assumes the Key-Off state.



Switched Pulldown Input Pinout Simplified Circuit

### Switched Pulldown Input Pinout Specifications

Item	Requirement
Number of States	Two: KEY ON or KEY OFF
Nominal Pinout Current	12 mA @ 12V, 24 mA @ 24V
Maximum Key-On Source Voltage	32 V
Minimum Key-On Source Voltage	6.0 V
Maximum Key-Off Source Voltage	4.0 V
Minimum Key-On Time	50 msec
Minimum Key-Off Time	150 msec
Maximum Allowable Key-On Drop-Out Time	80 msec

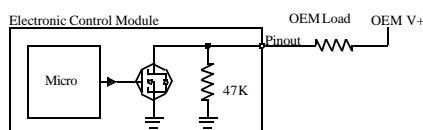
### Switched Sink Driver Output Pinout Specifications

**Application.** The Switched Sink Driver Output pinout type sinks an OEM-supplied load. The only applications are dashboard lamps. The pinout is connected to one side of the OEM load. A voltage source, typically Vbatt+, is connected to the other side of the OEM load.

**Operation.** The Switched Sink Driver Output pinout can exist in one of two states: Sink (low impedance) or Off (high impedance). These states are dictated by a microprocessor-controlled FET switch as follows.

**a. Sink State.** Pinout Voltage can be measured at the pinout with respect to ECM ground. When the FET switch is opened, Pinout Current is present through the pinout by way of the FET switch. Load Resistance can be measured between the pinout and the OEM voltage source. The OEM load is on or energized.

**b. Off State.** When the FET switch is closed, some leakage Pinout Current is still present by way of the 47K resistor. The OEM load is off or de-energized.



## Switched Sink Driver Output Pinout Simplified Circuit

### Switched Sink Driver Output Pinout Specifications

Item	Requirement
Number of States	Two: SINK or OFF
Maximum Pinout Voltage	32V
Maximum Pinout Current (Non-Inductive Load)	600 mA
Minimum Load Resistance	20 Ohm @ 12V, 40 Ohm @ 24V
Maximum Peak Current (Non-Inductive Load)	6.0 A for 20 msec
Maximum Pinout Current (Inductive Load)	2.5 A @ 12V, 1 A @ 24V
Maximum Load Induction	40 mH @ 12V, 130 mH @ 24V

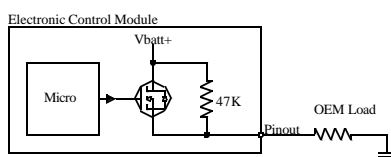
### Switched Source Driver Output Pinout Specifications

**Application.** The Switched Source Driver Output pinout type drives a bi-state or PWM OEM-supplied load. Typical applications are fan clutches or relays. The pinout is connected to one side of the OEM load. A good chassis ground is connected to the other side of the OEM load. An ECM Solenoid Return pinout may be used as ground if desired.

**Operation.** The Switched Source Driver Output pinout can exist in one of two states: Source (@ Vbatt+) or Off (@ 0 volts). These states are dictated by a microprocessor-controlled FET switch as follows.

**a. Source State.** When the FET switch is opened, Pinout Current is present through the pinout by way of the FET switch. Load Resistance can be measured between the pinout and ECM ground. Nominal Pinout Voltage can be measured at the pinout with respect to ECM ground. The OEM load is on or energized.

**b. Off State.** When the FET switch is closed, some leakage Pinout Current is still present through the pinout by way of the 47K resistor. Nominal Pinout Voltage can still be measured at the pinout with respect to ECM ground. The OEM load is off or de-energized.



### Switched Source Driver Output Pinout Simplified Circuit

### Switched Source Driver Output Pinout Specifications

Item	Requirement
Number of States	Two: SOURCE or OFF
Number of Modes	Two: 2-STATE or PWM
Nominal Pinout Voltage	(Vbatt+) - 0.5 volts
Maximum Pinout Current	2 A
Minimum Load Resistance	6 Ohm @ 12V, 12 Ohm @ 24V
Maximum Load Resistance (non-inductive load)	2.2 KOhm
Maximum Load Capacitance (non-inductive load)	.01 $\mu$ F
Frequency Range (PWM)	61-3907 Hz
Maximum Load Induction	130 mH

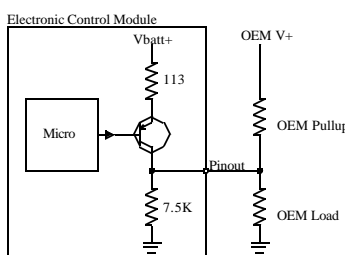
### Tachometer Source Driver Output Pinout Specifications

**Application.** The Tachometer Source Driver Output pinout type drives a low-current non-inductive OEM-supplied load. This pinout may be used to drive a tachometer with a single-ended pulse stream based on engine RPM. Tachometer requirements are defined ATA/TMC RP-123 except as noted below and in the Signal Descriptions section.

**Operation.** The Tachometer Source Driver Output pinout has two states, Source (@ Vbatt+) or Sink (@ 0 volts). These states are dictated by the microprocessor-controlled transistor switch as follows.

**a. Source State.** When the transistor switch is opened, forward current flow at the value of Source Current is present through the pinout by way of the transistor and the 113 Ohm pullup resistor. Load Resistance can be measured between the pinout and ECM ground. Nominal Source Voltage can be measured at the pinout with respect to ECM ground.

**b. Sink State.** For some applications, Sink Voltage can be measured at the pinout with respect to ECM ground. When the transistor switch is closed, reverse current flow at the value of Sink Current is present through the pinout by way of the 7.5K pulldown resistor



## Tachometer Source Driver Output Pinout Simplified Circuit

### Tachometer Source Driver Output Pinout Specifications

Item	Requirement
Number of States	Two: SOURCE or SINK
Number of Modes	One: PWM
Nominal Source Voltage	(Vbatt+) - 0.5 volts
Maximum Source Current	100 mA
Minimum Load Resistance	500 Ohm
Maximum Sink Voltage	500 mV
Maximum Sink Current	50 $\mu$ A
Frequency Range	2-2000 Hz

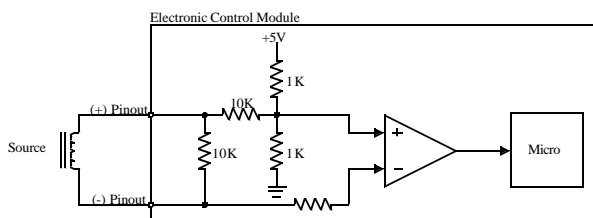
### Variable Reluctance Input Pinout Specifications - Differential Input

**Application.** The Variable Reluctance Input pinout detects the frequency of a periodic waveform. The pinout can operate in one of two configurations: differential or single-ended. A differential input is supplied by a Magnetic Pickup-type shaft speed sensor. This sensor's waveform will be an approximately sinusoidal AC voltage. This input is supplied by two wires, with one wire designated as signal (+) which is referenced to signal (-). These wires are usually connected directly to the (+) and (-) inputs of the Variable Reluctance Input pinouts.

**Note.** Specifications for the Variable Reluctance Input pinout are defined in the Installation Recommendations section and IS-1377-9803 except as noted.

**Operation.** The Variable Reluctance Input pinout can exist in one of two states: High or Low. The states are dictated by input voltage as follows.

- High.** Source Voltage can be measured at the (+) pinout with respect to the (-) pinout. Current flow is from the (+) pinout to the (-) pinout by way of the 10K load resistor. Source voltage is positive and turns an op amp ON.
- Low.** Current flow is from the (-) pinout to the (+) pinout by way of the 10K load resistor. Source voltage is negative and turns the op amp OFF. The microprocessor monitors op amp state and uses this information to calculate the signal's frequency.



### Variable Reluctance Input Pinout Simplified Circuit - Differential Input

**Variable Reluctance Input Pinout Specifications - Differential Input**

Item	Requirement
Maximum Source Voltage	26 V rms
Minimum Source Voltage	±0.4 Vrms @ 2 Hz ±0.6 Vrms @ 200 Hz ±4.0 Vrms @ 2 kHz ±8.0 Vrms @ 4 kHz
Maximum Noise Voltage	±0.1 Vrms
Frequency Range	2-8500 Hz

### Variable Reluctance Input Pinout Specifications - Single-Ended Input

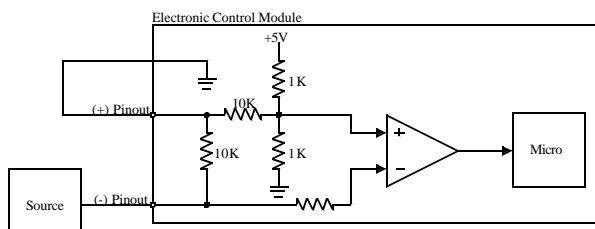
**Application.** The Variable Reluctance Input pinout detects the frequency of a periodic waveform. The pinout can operate in one of two configurations: differential or single-ended. A single-ended input is supplied by a pulse generator source such as a Frequency Throttle. This circuit's output waveform will be a positive-going pulse stream with a constant duty cycle and a variable frequency. This signal is usually connected directly to the (-) input of the Variable Reluctance Input pinouts. The (+) input may be connected to an ECM Switch Return or allowed to float (grounding is recommended).

**Note.** Specifications for the Variable Reluctance Input pinout are defined in the Installation Recommendations section and IS-1377-9803 except as noted. The pulse generator source must be properly grounded as defined in the Installation Recommendations section and the Wiring Diagram section.

**Operation.** The Variable Reluctance Input pinout can exist in one of two states: High or Low. Pinout state is dictated by pinout voltage as follows.

**a. High.** High State Pinout Voltage can be measured at the (-) pinout with respect to ECM ground. This voltage is greater than a reference voltage and turns the op amp OFF.

**b. Low.** Low State Pinout Voltage can be measured at the (-) pinout with respect to ECM ground. This voltage is less than a reference voltage and turns the op amp ON. The microprocessor monitors op-amp state and uses this information to calculate the signal's frequency.



**Variable Reluctance Input Pinout Simplified Circuit - Single-Ended Input**

**Variable Reluctance Input Pinout Specifications - Single-Ended Input**

<b>Item</b>	<b>Requirement</b>
Number of States	Two: HIGH or LOW
Maximum High State Pinout Voltage	32 V
Maximum Low State Pinout Voltage	0.9 V
Minimum High State Pinout Voltage	4.2 V