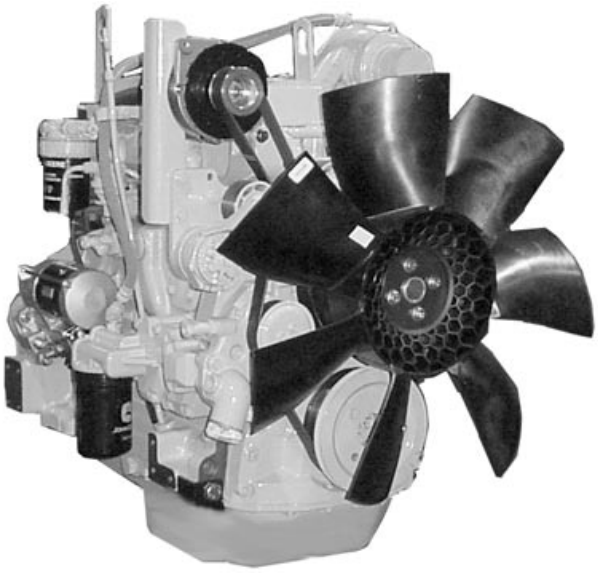
POWERTECH® 4.5 L Engine with Level 12 Electronic Fuel System and Stanadyne DE10 Pump



RG11931 –UN–06NOV01

Right Side of Engine



RG11932 –UN–06NOV01

Left Side of Engine

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DPSG,OUO1004,129 –19–15MAY98–1/1

7. Select correct size of seal. Slide the seal over the wire insulation with the smaller diameter side facing the end of the wire. Small diameter side of seal should line up with the outer edge of the insulation.

IMPORTANT: The seal must fit snug over the cable insulation without a gap between the cable seal and the insulation.

NOTE: Cable seals are color coded for three sizes of wire:

- *Green - 18—20 Gauge Wire*
- *Gray - 14—16 Gauge Wire*
- *Blue - 10—12 Gauge Wire*



TS0136 –UN–23AUG88

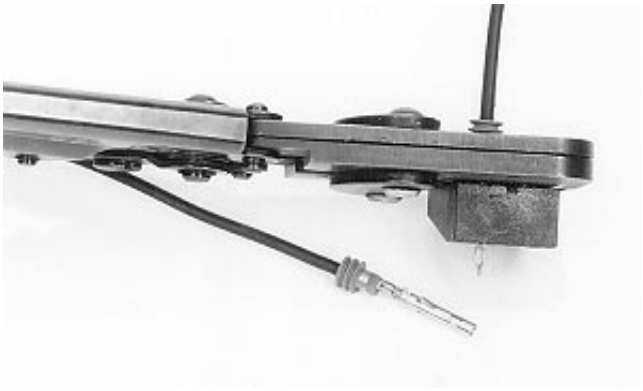
AG,OUOD008,296 –19–06MAR02–2/4

8. Select correct size terminal on wire and crimp in position with a W-type crimp using a JDG783 WEATHER PACK™ Crimping Tool.

NOTE: Terminals have numbered identification for two sizes of wire:

- *#15 - 14—16 Gauge Wire*
- *#19 - 18—20 Gauge Wire*

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TS1623 –UN–02NOV94

Continued on next page

AG,OUOD008,296 –19–06MAR02–3/4

Level 12 ECU - E4 - Engine Emits Excessive White Exhaust Smoke

RG40854,00000D6 –19–02JAN02–1/1

Level 12 ECU - E4 - Engine Emits Excessive White Exhaust Smoke Diagnostic Procedure

NOTE: This procedure should be used if the engine emits excessive white exhaust smoke. This type of smoke causes a burning sensation to the eyes. If engine emits a less heavy, bluish exhaust smoke see 4.5L/6.8L - L1 - EXCESSIVE OIL CONSUMPTION in Section 04, Group 150 of 4.5 L & 6.8 L Diesel Engines Base Engine Manual (CTM 104).

– – –1/1

❶ **E4 - Preliminary Check**	Before using this diagnostic procedure: • Ensure fuel quantity and quality are OK. See CHECK FUEL SUPPLY QUALITY later in this Group. • Ensure engine coolant temperature is not extremely low.	**No problems found:** GO TO ❷ **Problem found:** Repair and retest
❷ **Head Gasket Failure Test**	Check for a failed head gasket. See CHECK FOR HEAD GASKET FAILURES in Group 150 of 4.5 L & 6.8 L Diesel Engines Base Engine Manual (CTM 104).	**No signs of head gasket failure:** GO TO ❸ **Signs of head gasket failure are found:** See CHECK FOR HEAD GASKET FAILURES in Group 020 of 4.5 L & 6.8 L Diesel Engines Base Engine Manual (CTM 104).
❸ **Compression Pressure Check**	Check compression pressure. See TEST ENGINE COMPRESSION PRESSURE Section 04, Group 150 of 4.5 L & 6.8 L Diesel Engines Base Engine Manual (CTM104).	**Compression pressure is within specification:** GO TO ❹ **Compression pressure is not within specification:** GO TO ❻

– – –1/1

Diagnostic Trouble Codes (DTCs)

There are several different methods of displaying both stored and active DTCs from the ECU.

SPN/FMI CODES

SPN/FMI codes are written from the SAE J1939 standard as a two part code. The first part is called the Suspect Parameter Number (SPN). Typically, it contains between 2 and 4 digits. The SPN identifies the system or the component that has the failure; for example SPN 110 indicates a failure in the engine coolant temperature circuit. The second part of the code is called the Failure Mode Identifier (FMI) code. The FMI contains 2 digits. The FMI identifies the type of failure that has occurred; for example FMI 3 indicates value above normal. In order to determine the exact failure, both the SPN and FMI are required. Combining SPN 110 with FMI 3 yields engine coolant temperature input voltage high. To find out the equ

On all applications with the Level 12 Engine Control Unit (ECU), the ECU transmits SPN/FMI codes over the Controller Area Network (CAN). This allows for service tools such as the DST, SERVICE ADVISOR™, and the Diagnostic Gauge to display active and stored DTCs. In CTM 331, the diagnostic procedures are titled by SPN/FMI codes.

2-DIGIT CODES

Some applications do not display engine codes as an SPN/FMI. In most of these cases, the code is displayed as a 2-digit code. An example of a 2-digit code is 18 for engine coolant temperature input voltage high. If used on an application with multiple controllers, ECU may be displayed in front of the numbers, such as ECU 018. A 2-digit code may be seen on SERVICE ADVISOR™, the on-board display, or when the code is blinked for various reasons. In this manual, it will be necessary to convert these codes to the SPN/FMI code in order to follow the correct diagnostic procedure. See LISTING OF DIAGNOSTIC TROUBLE CODES (DTCS) ON ECU in Group 160 of this manual.

OTHER CODES

If codes are not displayed as SPN/FMI or as 2-digit codes, there may be another format that the application is using. For example on some applications, the code F455 is displayed for engine coolant temperature input voltage high. This may be seen on some applications within SERVICE ADVISOR™. In this manual, it is necessary to convert this format of code into an SPN/FMI code to ensure that the correct diagnostic procedure is followed. See LISTING OF DIAGNOSTIC TROUBLE CODES (DTCS) ON ECU

WARNING LAMP

On some applications, there is a warning lamp that is used when a code becomes active. When a code is active, this lamp will either blink or stay on solid. Typically, a solid light indicates that the ECU is taking extreme measures to protect the engine, and a blinking light indicates that the ECU has detected a fault and engine performance may be affected. Refer to Operator's Manual for a given application for more detailed information.

CLEARING STORED DTCS

Stored DTCs can be cleared through the OEM instrument panel, through the Diagnostic Scan Tool (DST) or SERVICE ADVISOR™. For more information on clearing DTCs using the diagnostic code reader on the instrument panel, see CLEARING STORED DTCS ON DIAGNOSTIC GAUGE earlier in this Group.

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Level 12 ECU - T19 - Throttle Not Calibrated Properly

Throttle Calibration

Throttle calibration is necessary to allow the ECU to learn the range of the throttle. It is done when a new ECU or a new throttle has been installed.

This code will set if:

- The ECU detects an improper throttle calibration range.

If this code sets, the following will occur:

- Throttle position will not match percent throttle.

If this code sets:

- Diagnose other DTCs first.
- If no other DTCs are found, perform throttle sensor diagnostics.
  - **For 310G Backhoe Loaders**, see THROTTLE POSITION SENSOR TEST (S.N. XXXXXX—) in Section 9015, Group 120 of TM1885.
  - **For 310SG/315SG Backhoe Loaders**, see THROTTLE POSITION SENSOR TEST (S.N. XXXXXX—) in Section 9015, Group 120 of TM1883.

04
160
81

RG40854,0000118 –19–28JAN02–1/1

❸ **Pump Solenoid Supply Circuit Check**	*NOTE: For wiring and theory of operation information, see DTC SPN 1076 FMI 6 PUMP SOLENOID CIRCUIT SEVERELY SHORTED supporting information.* 1. Ignition OFF 2. Disconnect pump solenoid connector and ECU connector 3. Using a multimeter, measure resistance between terminal K2 of the harness side of the ECU connector and: • A good ground • All other terminals in the ECU connector	**Measurement greater than 20,000 ohms:** GO TO ❹ **Measurement less than 20,000 ohms:** Pump solenoid supply wire shorted – – –1/1

04
160
,202

❹ **Pump Solenoid Return Circuit Check**	*NOTE: For wiring and theory of operation information, see DTC SPN 1076 FMI 6 PUMP SOLENOID CIRCUIT SEVERELY SHORTED supporting information.* 1. Ignition OFF 2. Disconnect pump solenoid connector and ECU connector 3. Using a multimeter, measure resistance between terminal A3 of the harness side of the ECU connector and: • A good ground • All other terminals in the ECU connector	**Measurement greater than 20,000 ohms:** GO TO ❺ **Measurement less than 20,000 ohms:** Pump solenoid return wire shorted – – –1/1

❺ **Injection Pump Check**	*NOTE: For wiring and theory of operation information, see DTC SPN 1076 FMI 6 PUMP SOLENOID CIRCUIT SEVERELY SHORTED supporting information.* 1. Remove and install new injection pump. See REMOVE INJECTION PUMP and INSTALL INJECTION PUMP in Section 02, Group 090 of this manual. 2. Ignition ON, engine running. 3. Read DTCs using DST or SERVICE ADVISOR.	**SPN 1076 FMI 6 reoccurs:** Faulty ECU **SPN 1076 FMI 6 does not reoccur:** Problem repaired – – –1/1

Forwarders - Sensor Specifications

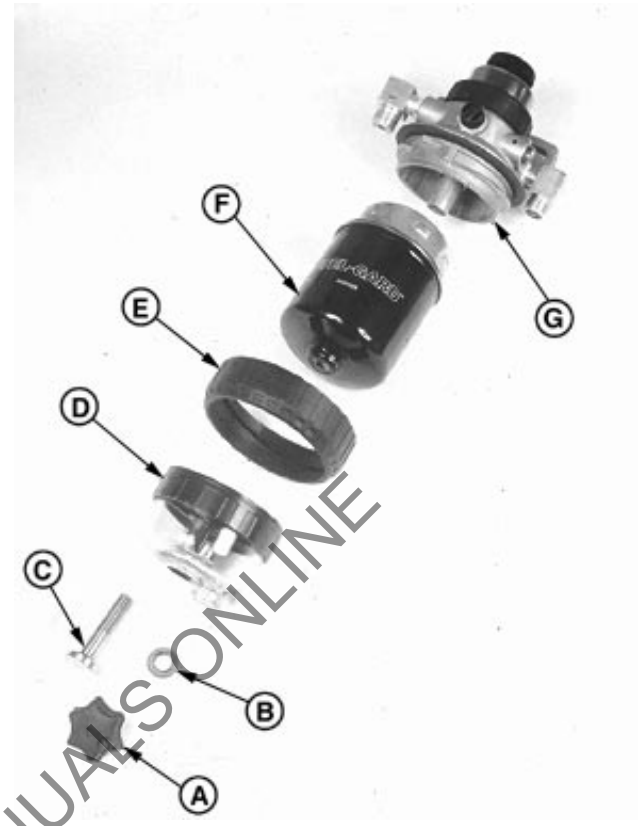
The specifications shown below are voltage, pressure, and temperature parameters that the Engine Control Unit (ECU) uses to determine whether a Diagnostic Trouble Code (DTC) is set for a given sensor.

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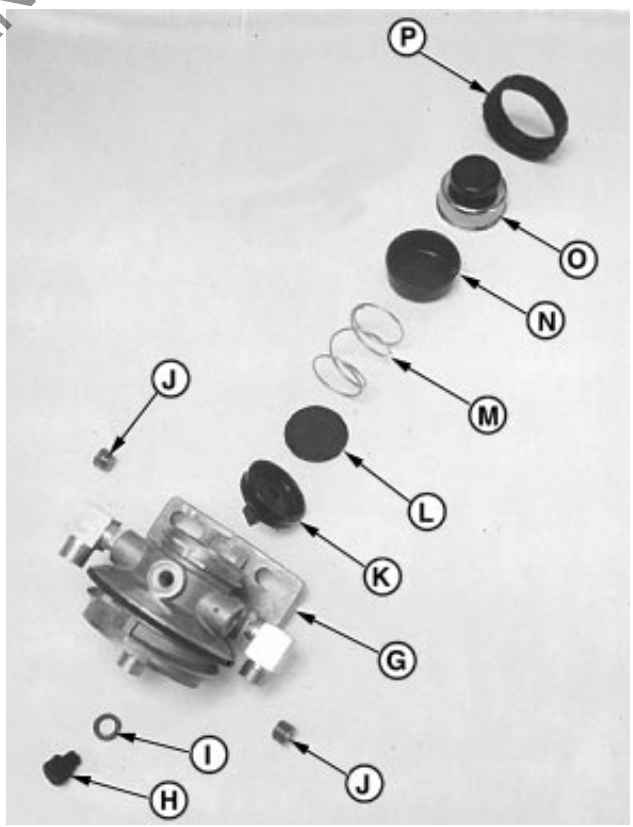
RG40854,0000158 –19–21FEB02–1/2

Fuel Pre-Filter/Water Bowl Assembly (Optional)

A—Drain Adapter
B—Packing
C—Cap Screw
D—Water Bowl
E—Retaining Ring
F—Filter Element
G—Filter Base with Seal Ring
H—Vent Plug
I—Packing
J—Plug (2 used)
K—Diaphragm
L—Spring Seat
M—Spring
N—Spring Cover
O—Pump Knob
P—Retaining Ring



RGT7751HR –UN–19NOV97



RGT7751HS –UN–19NOV97

Primary Filter/Water Bowl Assembly

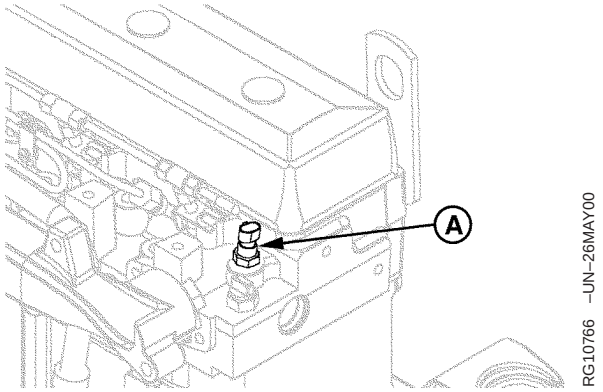
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RG,35,JW7623 –19–21JAN02–1/1

Loss of Coolant Temperature Sensor

The Loss of Coolant Temperature sensor is located in the rear of the cylinder head (A) on some applications using this engine.

The ECU monitors loss of coolant temperature for engine protection purposes. For more information on engine protection and derate programs see, ENGINE PROTECTION or DERATE PROGRAMS later in this Group.

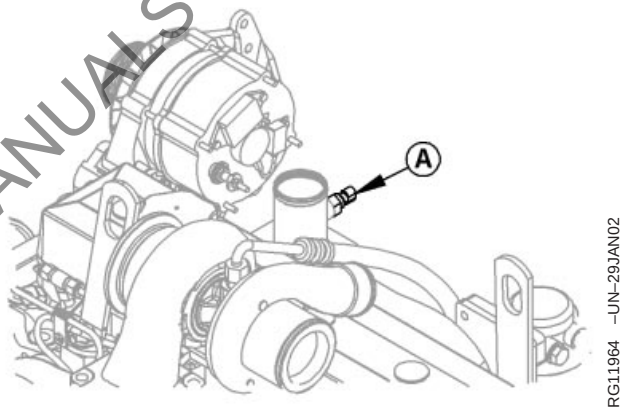


A—Loss of Coolant Temperature Sensor

RG40854,0000025 –19–03DEC01–3/5

Manifold Air Temperature (MAT) Sensor

The Manifold Air Temperature (MAT) sensor is located in the cross over tube (A) or in the intake manifold. The MAT sensor measures intake air temperature to help the ECU calculate the correct fueling and for cold starting. The ECU also monitors manifold air temperature for engine protection purposes. For more information on engine protection and derate programs, see ENGINE PROTECTION or DERATE PROGRAMS later in this Group. This sensor is optional and is not included on all applications.



A—MAT Sensor

Continued on next page

RG40854,0000025 –19–03DEC01–4/5

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⓾ **CAN High and Low Voltage Test**	*NOTE: For wiring information, see D2 - DIAGNOSTIC GAUGE DOES NOT COMMUNICATE WITH ECU supporting information.* 1. Ignition OFF 2. Reconnect ECU connector 3. Ignition ON 4. Using a multimeter, measure voltage between a good chassis ground and: • Terminal B in the diagnostic gauge connector • Terminal G in the diagnostic gauge connector	**Both measurements between 1.5 - 3.5 V:** Faulty ECU connection OR Faulty diagnostic gauge connection OR Faulty diagnostic software/computer configuration OR Faulty ECU **Either measurement less than 1.5 V or greater than 3.5 V:** CAN wiring shorted to ground or power OR Faulty ECU – – –1/1

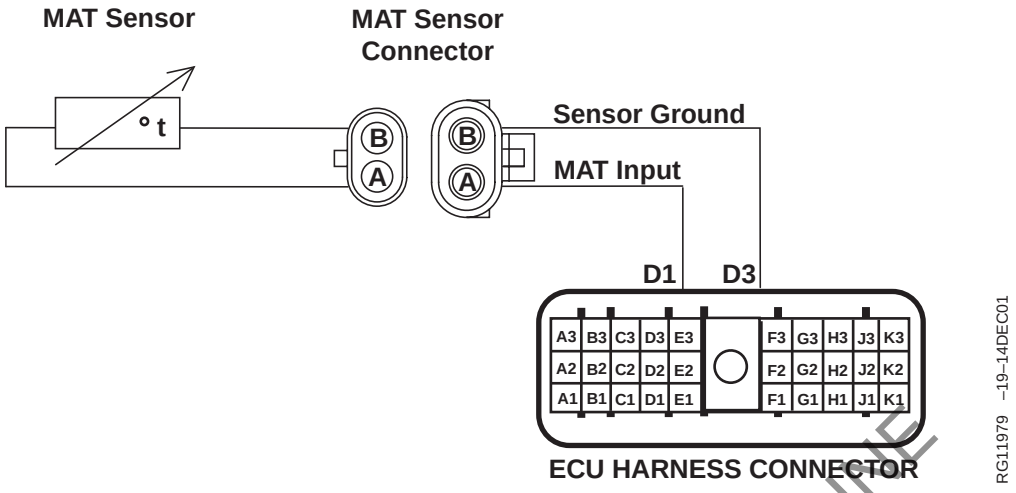
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000105.16 — Manifold Air Temperature Moderately High



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NOTE: Wiring schematic shows OEM engine applications only. For wiring on other applications, see APPLICATION SPECIFICATIONS in Section 06, Group 210 of this manual.

MAT (Manifold Air Temperature) Sensor

- The MAT sensor is a thermistor (temperature sensitive resistor) mounted in the intake manifold. The MAT sensor is used to measure the temperature of the intake air. The MAT sensor's variable resistance causes the input voltage to the ECU to vary. Higher intake air temperatures result in lower MAT input voltages to the ECU; lower temperatures result in higher voltages. For further MAT sensor information, see MEASURING TEMPERATURE in Section 03, Group 140.

DTC 000105.16 will set if:

- The ECU senses MAT on OEM applications above 100°C (212°F) for "H engines" and 120°C (248°F) for "T engines". For MAT specifications on other applications, see APPLICATION SPECIFICATIONS in Section 06, Group 210 of this manual.

If DTC 000105.16 sets, the following will occur:

- Engine protection is enabled. See ENGINE PROTECTION in Section 03, Group 140 of this manual.
  - With Shutdown Feature: The ECU does not use shutdown feature with this code.
  - With Derate Feature: On OEM applications, the engine derates 2% per minute until the engine is running at 80% of full power. For non-OEM applications, see APPLICATION SPECIFICATIONS in Section 06, Group 210 of this manual.

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❸ **ECU and ECU Connector Test**	*NOTE: For wiring and theory of operation information, see DTC 000627.04 ECU UNSWITCHED POWER MISSING supporting information.* 1. Ignition OFF 2. Disconnect ECU connector 3. Using a multimeter, measure voltage between a good chassis ground and terminal K1	**Voltage is substantially less than battery voltage:** GO TO ❹ **Voltages are at or near battery voltage on both terminals:** Faulty ECU connection OR Faulty ECU – – –1/1

❹ **Battery Voltage Check**	*NOTE: For wiring and theory of operation information, see DTC 000627.04 ECU UNSWITCHED POWER MISSING supporting information.* Using a multimeter, measure battery voltage at the battery terminals.	**Voltage within specification for battery:** Faulty ECU power supply fuse OR Faulty ECU connection OR Open or short in ECU power circuit **Voltage substantially less than battery voltage:** Faulty battery or charging system – – –1/1

04
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,226

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001076.13 — Pump Current Decay Time Invalid

ECU detects high resistance in the pump solenoid.

RG41221,00000EF –19–24JAN03–1/1

001076.13 Pump Current Decay Time Invalid Diagnostic Procedure

– – –1/1

❶ **Connection Check**	**IMPORTANT: Do not force probes into connector terminals or damage will result. Use JT07328 Connector Adapter Test Kit to make measurements in connectors. This will ensure that terminal damage does not occur.** *NOTE: For wiring and theory of operation information, see DTC 001076.13 PUMP CURRENT DECAY TIME INVALID supporting information.*	**No faulty connection(s):** GO TO ❷ **Faulty connection(s):** Repair faulty connection(s)

– – –1/1

❷ **Intermittent Fault Test**	*NOTE: For wiring and theory of operation information, see DTC 001076.13 PUMP CURRENT DECAY TIME INVALID supporting information.* 1. Connect the DST or SERVICE ADVISOR™. For instructions on connecting to the DST or SERVICE ADVISOR™, see CONNECTING TO DIAGNOSTIC SCAN TOOL (DST) OR SERVICE ADVISOR earlier in this Group. 2. Ignition ON, engine OFF 3. Start the ECU communication software 4. Make note of any DTCs, then clear all DTCs 5. Ignition ON, engine cranking or running 6. Read DTCs using DST or SERVICE ADVISOR™.	**001076.13 reoccurs:** GO TO ❸ **001076.13 does not reoccur:** Problem is intermittent. If no other codes are present, see INTERMITTENT FAULT DIAGNOSTICS, earlier in this Group.

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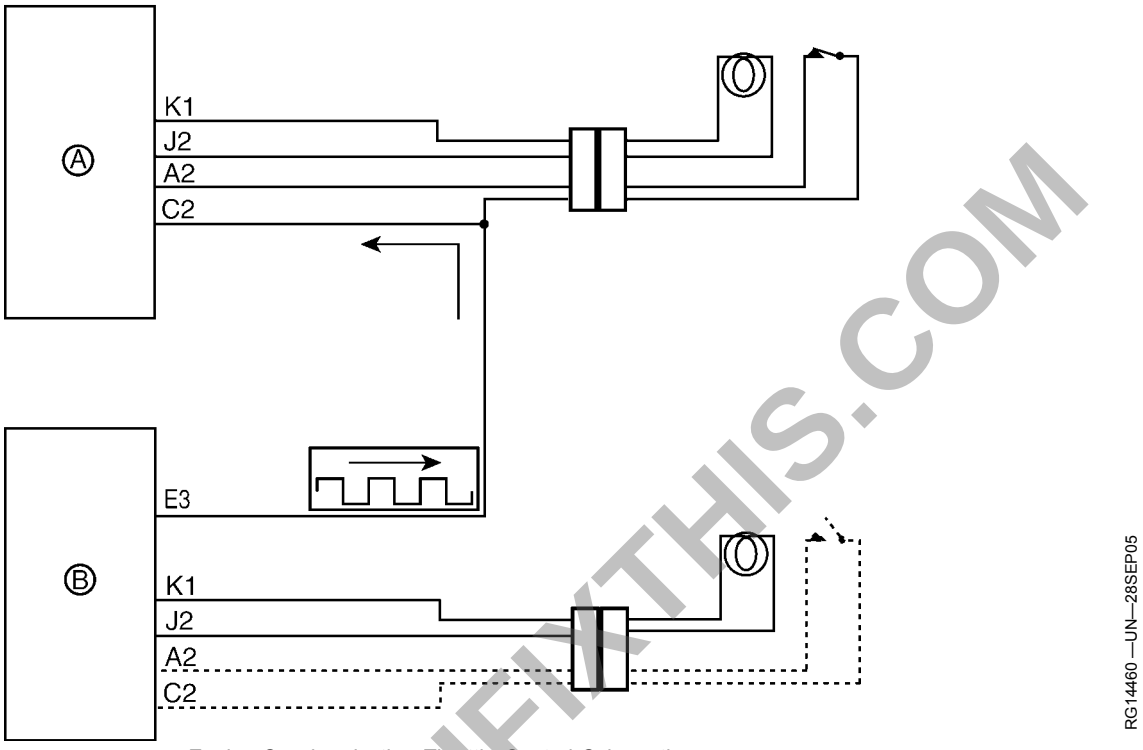
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Engine Synchronization Throttle Control



Engine Synchronization Throttle Control Schematic

Two marine engines, having separate ECUs, are configured such that their speeds can be matched, one to the other. The ECU of either engine may be designated as lead ECU through the Trim Options page.

IMPORTANT: Both ECUs must not be programmed to be lead, nor both ECUs programmed to be follower.

Synchronized engine operation is enabled when the Synchronize Enable Switch of the Follower ECU (A) is closed. This provides the path for system voltage (switched) (A2) to command follower ECU to enable synchronized engine operation (C2).

Once the operation is enabled, ECUs provide potential (G2) and ground (A2) for Synchronize Enable lights, which come on, and remain on. Follower engine ECU tachometer output is disabled. It no longer responds to its throttle. It continuously receives lead-engine (B) tachometer output (E3), which it uses to cause the follower engine to match the speed of the lead engine.

In order to achieve and maintain synchronous engine speed operation:

- Both engine speeds must be within 100 rpm, or less, of each other.
- Individual throttle command values must be within 5% of each other.
- Both engine speed signal values must be 975 rpm, or more.

When attempting Synchronous engine operation, if one or more of the above conditions are not met, Synchronize Enable lights continuously flash on and off, until the failing condition(s) has (have) been corrected.

Synchronize Enable lights test occurs at key ON – lights briefly come on. For this test to happen, ignition key must have been OFF for at least thirty seconds, prior to turning it back on

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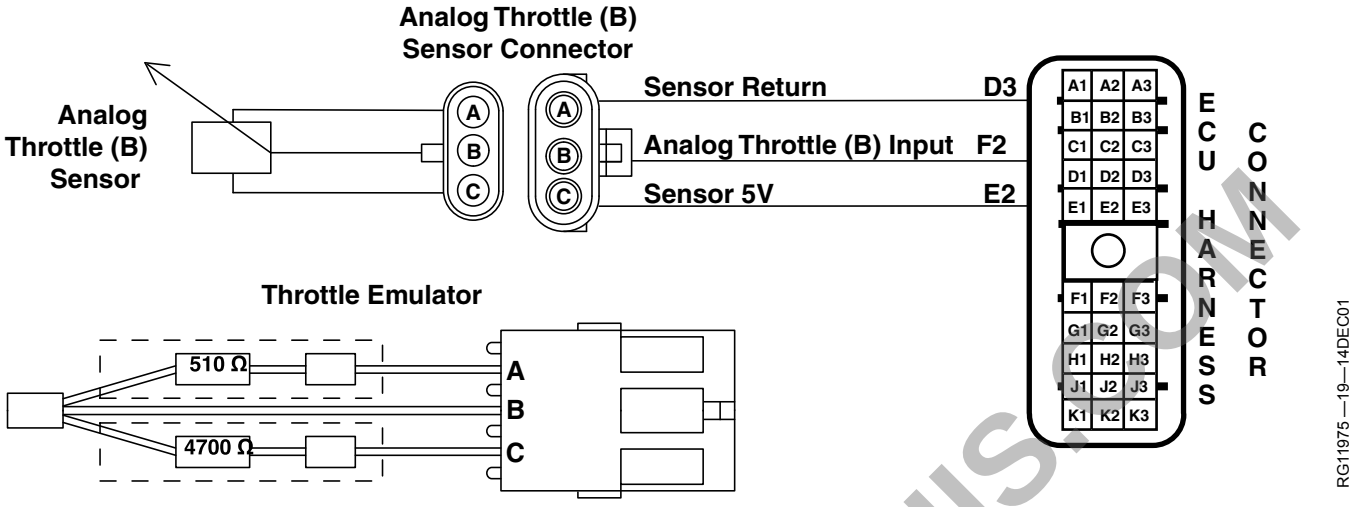
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T5 - Analog Throttle (B) Input High



NOTE: Wiring schematic shows OEM engine applications only. For non-OEM engine wiring information, see APPLICATION SPECIFICATIONS in Section 06, Group 210 of this manual.

Analog Throttle Position Sensor

- The analog throttle position sensor is a variable resistor (potentiometer) used to measure the position of the throttle. The throttle input voltage normally varies between 1.0 and 4.0 volts depending on throttle position. Analog throttle voltage at low idle will be approximately 1.0 volt and 4.0 volts at high idle. The ECU has the ability to learn different voltages for low and high idle, so the voltage range may change per application.

This code will set if:

- The analog throttle (B) input voltage exceeds the sensor's high voltage specification. The voltage is higher than what is physically possible for the throttle lever to achieve.
  - For OEM applications, the high analog throttle (B) input voltage specification is 4.7 volts.
  - For non-OEM applications, see APPLICATION SPECIFICATIONS in Section 06, Group 210 of this manual for the high analog throttle (B) input voltage specification.

If this code sets, the following will occur:

- If more than one throttle is available, the ECU will ignore the input from the analog throttle, and will use the input values from another throttle.
- If the analog throttle is the only throttle or all additional throttles are also faulted, the ECU will use a default "limp-home" throttle value that will only allow idle engine speed.

RG40854,000009A -19-07DEC01-1/1

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❹ **Fuel Pressure Ground Circuit Open Test**	Probe fuel pressure sensor ground (Terminal A) in sensor harness connector with a test light connected to battery voltage.	**Light ON:** Faulty fuel pressure sensor OR Faulty ECU connection OR Faulty ECU **Light OFF:** Open in fuel pressure sensor ground circuit OR Faulty ECU connection OR Faulty ECU	

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000110.15 — Engine Coolant Temperature High Least Severe

The ECU senses ECT above specification.

RG40854,00000BC -19-07SEP05-1/4

000110.15 Engine Coolant Temperature High Least Severe Diagnostic Procedure

RG40854,00000BC -19-07SEP05-2/4

1 Connection Check	**IMPORTANT: Do not force probes into connector terminals or damage will result. Use JT07328 Connector Adapter Test Kit to make measurements in connectors. This will ensure that terminal damage does not occur.** *NOTE: For wiring and theory of operation information, see DTC 000110.15 ENGINE COOLANT TEMPERATURE HIGH LEAST SEVERE supporting information* Perform a preliminary inspection of the ECU connector, the Engine Coolant Temperature (ECT) sensor connector, and any connectors in between them. Look for dirty, damaged, or poorly positioned terminals.	**No faulty connection(s):** GO TO 2 **Faulty connection(s):** Repair faulty connection(s)

RG40854,00000BC -19-07SEP05-3/4

2 Engine Coolant Temperature (ECT) Sensor and Circuit Test	*NOTE: For wiring and theory of operation information, see DTC 000110.15 ENGINE COOLANT TEMPERATURE HIGH LEAST SEVERE supporting information* Under the conditions where DTC 000110.15 occurs, using a temperature gauge, verify that engine coolant temperature is above the least severe ECT specification. *NOTE: On OEM applications, the least severe ECT specification is 108°C (226°F). For the least severe ECT specification on other applications, see APPLICATION SPECIFICATIONS in Section 06, Group 210 of this manual.*	**ECT above 108°C (226°F):** Engine overheating problem. See 4.5L/6.8L - C1 - ENGINE COOLANT TEMPERATURE ABOVE NORMAL in Section 04, Group 150 of 4.5 L & 6.8 L Diesel Engines Base Engine Manual (CTM 104). **ECT significantly less than 108°C (226°F):** Verify that ECT sensor input and ground circuits are OK. If ECT sensor circuits are OK, replace ECT sensor and retest

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000637.10 — Crank Position Input Pattern Error

The ECU detects an improper pattern on the crank position input.

RG40854,000010A -19-23SEP05-1/10

000637.10 Crank Position Input Pattern Error Diagnostic Procedure

RG40854,000010A -19-23SEP05-2/10

1 Connection Check	**IMPORTANT: Do not force probes into connector terminals or damage will result. Use JT07328 Connector Adapter Test Kit to make measurements in connectors. This will ensure that terminal damage does not occur.** *NOTE: For wiring and theory of operation information, see DTC 000637.10 CRANK POSITION INPUT PATTERN ERROR supporting information.* Perform a preliminary inspection of the ECU connector, the crank position sensor connector, and any other connector. Look for dirty, damaged, or poorly positioned terminals.	**No faulty connection(s):** GO TO 2 **Faulty connection(s):** Repair faulty connection(s)

RG40854,000010A -19-23SEP05-3/10

2 Intermittent Fault Test	*NOTE: For wiring and theory of operation information, see DTC 000637.10 CRANK POSITION INPUT PATTERN ERROR supporting information.* 1. Connect to the DST or SERVICE ADVISOR. 2. Ignition ON, engine OFF 3. Start the ECU communication software 4. Read DTCs using the DST orSERVICE ADVISOR™. 5. Make note of any DTCs, then clear all DTCs 6. Ignition ON, engine running 7. Read DTCs using the DST orSERVICE ADVISOR™.	**000637.10 reoccurs:** GO TO 3 **000637.10 does not reoccur:** Problem is intermittent. If no other codes are present, see INTERMITTENT FAULT DIAGNOSTICS, earlier in this Group.

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RG40854,000010A -19-23SEP05-4/10

3 Crank Position Sensor Test	*NOTE: For wiring and theory of operation information, see DTC 000637.10 CRANK POSITION INPUT PATTERN ERROR supporting information.* 1. Ignition OFF 2. Disconnect crank position sensor connector 3. Using a multimeter, measure resistance between both terminals of the crank position sensor.	**Between 2500 and 3500 ohms:** GO TO 4 **Below 2500 ohms or above 3500 ohms:** Faulty crank position sensor

Continued on next page

RG40854,000010A -19-23SEP05-5/10

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❷ **Intermittent Fault Test**	1. Connect to the DST or SERVICE ADVISOR. 2. Ignition ON, engine OFF 3. Start the ECU communication software 4. Make note of any DTCs, then clear all DTCs 5. Ignition ON, engine cranking or running 6. Read DTCs using the DST or SERVICE ADVISOR™.	**002000.06 reoccurs:** GO TO ❸ **002000.06 does not reoccur:** Problem is intermittent. If no other codes are present, see INTERMITTENT FAULT DIAGNOSTICS, earlier in this Group.

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RG40854,000005A -19-13AUG10-4/9

❸ **Pump Solenoid Check**	1. Ignition OFF 2. Disconnect pump solenoid connector and ECU connector 3. Using a multimeter, measure resistance between terminals of injector pump solenoid.	**Measurement between 0.15 and 0.25 ohms:** GO TO ❹ **Measurement not between 0.15 and 0.25 ohms:** Pump solenoid faulty. GO TO ❼

RG40854,000005A -19-13AUG10-5/9

❹ **Pump Solenoid Check**	1. Ignition OFF 2. Disconnect pump solenoid connector and ECU connector 3. Using a multimeter, measure resistance between one terminal of injector pump solenoid and a good ground. 4. Using a multimeter, measure resistance between the other terminal of injector pump solenoid and a good ground.	**Measurement greater than 20,000 ohms:** GO TO ❺ **Measurement less than 20,000 ohms:** Pump solenoid faulty. GO TO ❼

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