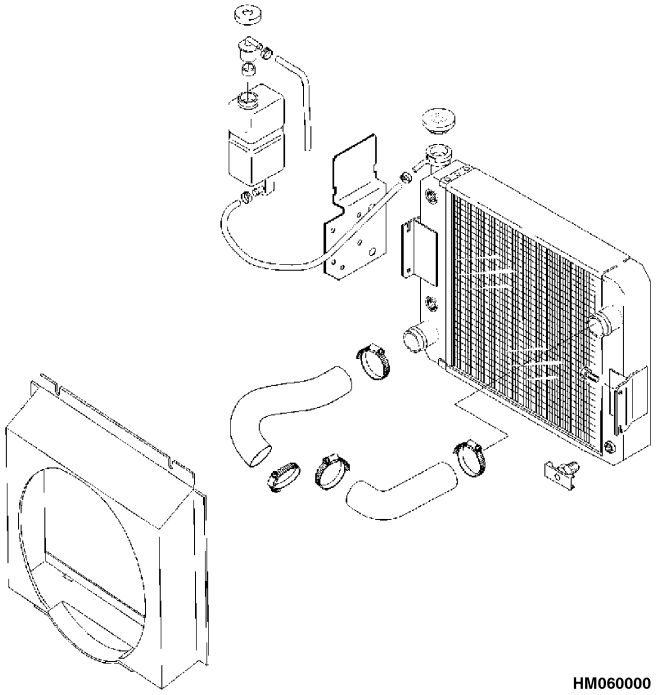
Yale

Maintenance

COOLING SYSTEM

INTERNAL COMBUSTION ENGINE POWERED UNITS



HM060000

Table 1. Movement Rates (Maximum) for Tilt Cylinders (Continued)

Lift Truck Model	Hydraulic Oil Temperature/Mast Tilt Rate			
	20°C (68°F)		60°C (140°F)	
	mm/min	in./min	mm/min	in./min
GDP/GLP80-120DB (GP/GDP/ GLP170-280DB), GDP/GLP130-160EB (GP/GDP/GLP300-360EB)	1.8	0.07	11.7	0.05
GLC60-70CA (GC/GLC/GDC135-155CA)	1.2	0.05	8.2	0.32

Tilt Cylinder Stroke and Mast Tilt Angle Adjustment

Adjust the tilt cylinders as described in the **Mast** section.

Torque Specifications

PISTON ROD NUT

ERP16-20ATF
163 to 190 N•m (120 to 140 lbf ft)

ERC20-30AGF (ERC040-065GH) (A908), ERC20-30AGF (ERC040-065RF/ZF RG/ZTG) (E108), ERP20-30ALF (B216), and ERP20-30ALF (ERP040-060DH) (D216/E216)
150 N•m (110 lbf ft)

ERC35-55HD/HG (ERC070-120HD/HG) (A839) and ERC35-55HG (ERC70-120HH) (B839/C839)
400 to 440 N•m (295 to 325 lbf ft)

GC/GLC030-040AF, GDP/GLP16-20AF (GP/GLP/GDP030-040AF), ERC/P16-20AAF (ERC030-040AF, AG/BG) (A814), and ERC/P16-20AAF (ERC030-040AH) (B814/C814)
163 to 190 N•m (120 to 140 lbf ft)

GC/GLC040-065RG/TG/ZG, GLP/GDP20-30RF/TF (GP/GLP/GDP040-060RG/TG/ZG)
150 N•m (110 lbf ft)

GP/GLP/GDP070-110LG/MG
400 to 440 N•m (295 to 325 lbf ft)

GDP60-70CA (GP/GLP/GDP135-155CA)
407 to 440 N•m (300 to 325 lbf ft)

GLP/GDP165-280DA
950 to 985 N•m (700 to 725 lbf ft)

GLP/GDP300-360EA
1105 to 1140 N•m (815 to 840 lbf ft)

GDP/GLP80-120DB (GP/GDP/GLP170-280DB), GDP/GLP130-160EB (GP/GDP/GLP300-360EB)
950 to 983 N•m (701 to 725 lbf ft)

GP130-160EB (GP300-360EB)
1105 to 1140 N•m (815 to 841 lbf ft)

GC/GLC030-040AF
163 to 190 N•m (120 to 140 lbf ft)

GC/GLC070-120LG/MG
400 to 440 N•m (295 to 325 lbf ft)

GLC60-70CA (GC/GLC/GDC135-155CA)
407 to 440 N•m (300 to 325 lbf ft)

RETAINER

ERP16-20ATF
163 to 176 N•m (120 to 130 lbf ft)

ERC20-30AGF (ERC040-065GH) (A908), ERC20-30AGF (ERC040-065RF/ZF RG/ZG) (E108), ERP20-30ALF (B216), ERP20-30ALF (ERP040-060DH) (D216/E216)
170 to 237 N•m (125 to 175 lbf ft)

ERC35-55HD/HG (ERC070-120HD/HG) (A839) and ERC35-55HG (ERC70-120HH) (B839/C839)
400 to 500 N•m (295 to 370 lbf ft)

General Check and Adjustment

There are no adjustments for the alternator or most regulators. One Delco alternator and the Leece-Neville alternator has a voltage adjustment.

Always check the general condition of the complete system before doing a complete check on each part. Check the general condition of the following parts: (1) battery, (2) battery cables and connections, and (3) alternator and regulator wires and connectors. Also check the condition and tension of the fan belt for the alternator.

CAUTION

NEVER operate the engine if the alternator output BAT terminal is not connected to the battery.

Do not short-circuit or connect jumper wires to any of the alternator terminals unless told to by the procedures.

Make sure polarity is correct before connecting a battery charger or another battery.

Remove the battery cables and clean the terminals and cable connectors. Inspect the insulation on the wires. Make sure all the fasteners and connections are clean and tight. If necessary, use a water and soda solution to clean the top of the battery. Do NOT remove the cell caps or permit the water and soda solution to get in the battery.

WARNING

Put the transmission in NEUTRAL. Apply the parking brake.

CAUTION

Do not change the polarity of the circuits. Do not connect any wires in the circuits, except as described in these instructions. Never connect the wire from the terminal marked BAT to an open circuit.

When connecting a charger or another battery, connect the positive terminals to the positive terminal of the battery. Then connect the negative terminal to a clean metal part of the engine. Disconnect the charger or other battery in the reverse order. Problems in the charging circuit are indicated by one or more of the following:

- The starter motor turns slowly. The battery voltage is low because of low alternator output or a bad battery.
- The specific gravity readings are low. Battery is not fully charged or is damaged.
- The battery uses more than 30 ml (1 oz) of water per cell per month. The alternator output is too high.

The two problems of the charging circuit are low output and high output. Low output causes a low battery and difficult starting. A high output causes heating of the battery and evaporation of water from the electrolyte. The following two checks will find out if the alternator, regulator, or wiring has a charging fault. The two checks will also find out if the charging system has a correct output. Do the following two checks before removal, disassembly, or replacement of alternator or regulator.

NOTE: Information on alternators manufactured outside the United States is in the YRM sections for lift trucks that use those alternators.

5. Remove the armature from the drive end housing. Tilt the armature to disengage the linkage from the drive clutch. On some models it is necessary to remove the linkage before removing the armature.

6. Remove the thrust collar from the armature shaft. Put a metal tube with a 13 mm (0.5 in.) inside diameter over the end of the shaft. See Figure 4. Hit the tube to move the retainer. Remove the snap ring. Remove the drive clutch.

7. Remove the center bearing plate. Remove the seal from the plate.

CLEAN

CAUTION

Never use solvent on the drive clutch, armature, or field windings. Use a cloth to clean these parts.

Use solvent to clean all parts of the starter, except the windings and the drive clutch. Dry the parts with compressed air.

ASSEMBLE

1. Install a new seal in the center bearing plate. See Figure 2 and Figure 5.

2. Lubricate the armature shaft and the bushings with a silicone lubricant.

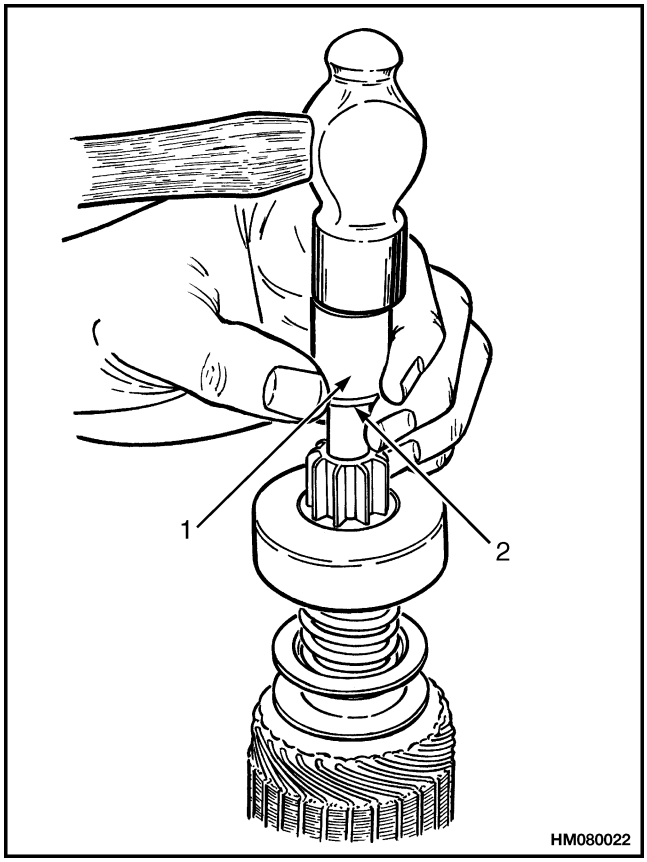
3. Put the center bearing plate, drive clutch, retainer, snap ring, and thrust washer on the armature shaft. Install the snap ring, thrust washer, and retainer as shown in Figure 5.

4. Install the shaft assembly in the drive end housing. Make sure the linkage is engaged in the drive clutch. Install and tighten the four screws for the bearing plate.

5. Install the field frame over the armature. Retract the brush springs and slide the brushes on the commutator.

6. Align the marks and install the thrust washer and the commutator end frame. Install and tighten the through bolts.

7. Make sure the solenoid cover is not damaged. Install the plunger spring and the solenoid. Install and tighten the solenoid mount screws. Connect the field coil strap to terminal M with the screw and lockwasher.



1. METAL TUBE, 13 mm (0.5 in.) INSIDE DIAMETER
2. RETAINER

Figure 4. Retainer Removal

Table 4. Torque Nuts With Nylon Insert

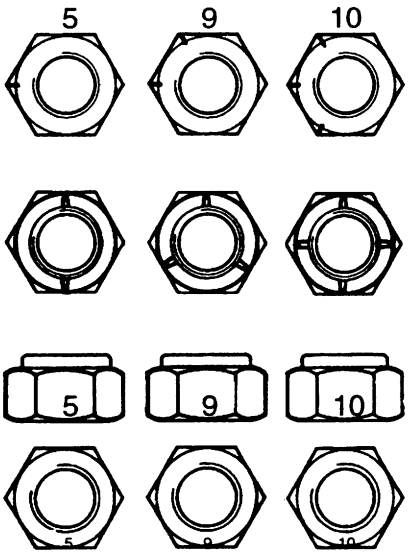
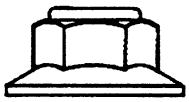
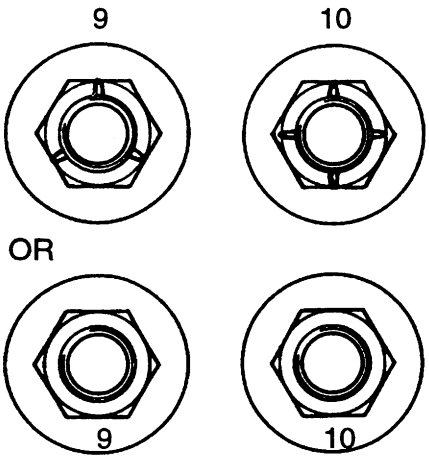
TYPE OF FASTENER	METRIC FASTENERS STRENGTH LEVELS: PROPERTY CLASS	INCH FASTENERS STRENGTH LEVELS: SAE GRADES
 NYLON INSERT PREVAILING TORQUE NUTS		MARKINGS NOT REQUIRED
 NYLON INSERT PREVAILING TORQUE NUTS		MARKINGS NOT REQUIRED HM210069

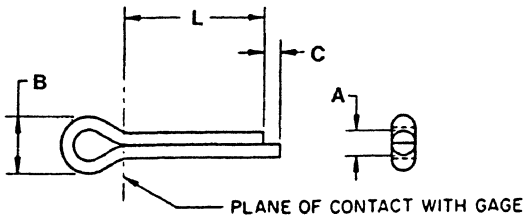
*Table 6. Torque Values for Inch Fasteners**

Size and Pitch		Grade 2[1]		Grade 5[2]		Grade 8[3]	
		lbf ft	N•m	lbf ft	N•m	lbf ft	N•m
1/4 1/4	20 UNC 28 UNF	4 5	6 6	6 7	9 10	9 10	12 14
5/16 5/16	18 UNC 24 UNF	8 9	11 13	13 14	18 20	18 20	25 28
3/8 3/8	16 UNC 24 UNF	15 17	20 23	23 26	31 36	33 37	44 50
7/16 7/16	14 UNC 20 UNF	24 27	33 36	37 41	50 56	52 58	71 79
1/2 1/2	13 UNC 20 UNF	37 41	50 56	57 85	77 115	80 90	110 120
9/16 9/16	12 UNC 18 UNF	53 59	72 80	82 91	110 125	115 130	155 175
5/8 5/8	11 UNC 18 UNF	73 83	99 110	115 130	155 175	160 180	215 245
3/4 3/4	10 UNC 16 UNF	130 145	175 195	200 225	270 300	280 315	380 425
7/8 7/8	9 UNC 14 UNF	125 140	170 185	320 355	435 480	455 500	615 680
1 1	8 UNC 14 UNF	185 210	255 285	485 540	655 735	680 765	925 1,040
1-1/8 1-1/8	7 UNC 12 UNF	265 300	360 405	595 670	805 905	965 1,080	1,310 1,470
1-1/4 1-1/4	7 UNC 12 UNF	375 415	510 565	840 930	1,140 1,260	1,360 1,500	1,850 2,050
1-3/8 1-3/8	6 UNC 12 UNF	490 560	665 760	1,100 1,250	1,490 1,700	1,780 2,040	2,420 2,760
1-1/2 1-1/2	6 UNC 12 UNF	650 735	885 995	1,460 1,650	1,980 2,230	2,370 2,670	3,210 3,620

* Unless otherwise specified [1] Approximately equal to metric Property Class 5.8 [2] Approximately equal to metric Property Class 8.8 [3] Approximately equal to metric Property Class 10.9

Table 8. Cotter Pin Dimensional Data

Nominal Size A	Shank Diameter A		Head Dia. B	Length of Extended Prong C		Recommended Hole Size	
	max	min	min	max	min	min	max
1.00 mm (0.031 in.)	0.90 mm (0.035 in.)	0.70 mm (0.028 in.)	1.50 mm (0.060 in.)	1.52 mm (0.060 in.)	0.25 mm (0.01 in.)	0.91 mm (0.036 in.)	1.37 mm (0.054 in.)
1.60 mm (0.047 in.)	1.20 mm (0.048 in.)	0.90 mm (0.035 in.)	1.50 mm (0.060 in.)	2.54 mm (0.10 in.)	0.51 mm (0.02 in.)	1.50 mm (0.059 in.)	1.78 mm (0.070 in.)
2.00 mm (0.062 in.)	1.50 mm (0.060 in.)	1.30 mm (0.051 in.)	2.40 mm (0.094 in.)	2.54 mm (0.10 in.)	0.76 mm (0.03 in.)	1.90 mm (0.075 in.)	2.18 mm (0.086 in.)
2.50 mm (0.094 in.)	2.30 mm (0.091 in.)	2.10 mm (0.083 in.)	4.00 mm (0.158 in.)	2.54 mm (0.10 in.)	1.00 mm (0.04 in.)	2.41 mm (0.095 in.)	2.95 mm (0.116 in.)
3.20 mm (0.125 in.)	3.00 mm (0.120 in.)	2.70 mm (0.106 in.)	5.10 mm (0.201 in.)	3.30 mm (0.13 in.)	1.52 mm (0.06 in.)	3.12 mm (0.123 in.)	3.76 mm (0.148 in.)
4.00 mm (0.156 in.)	3.80 mm (0.150 in.)	3.50 mm (0.138 in.)	6.50 mm (0.256 in.)	4.06 mm (0.16 in.)	1.78 mm (0.07 in.)	3.94 mm (0.155 in.)	4.55 mm (0.179 in.)
5.00 mm (0.188 in.)	4.60 mm (0.181 in.)	4.40 mm (0.172 in.)	8.00 mm (0.315 in.)	4.06 mm (0.16 in.)	2.03 mm (0.08 in.)	4.93 mm (0.194 in.)	5.33 mm (0.210 in.)
6.30 mm (0.250 in.)	5.90 mm (0.232 in.)	5.60 mm (0.220 in.)	10.3 mm (0.406 in.)	4.06 mm (0.16 in.)	2.03 mm (0.08 in.)	6.22 mm (0.245 in.)	6.96 mm (0.274 in.)
8.00 mm (0.312 in.)	7.50 mm (0.295 in.)	7.00 mm (0.275 in.)	13.1 mm (0.516 in.)	4.06 mm (0.16 in.)	2.03 mm (0.08 in.)	7.85 mm (0.309 in.)	8.28 mm (0.326 in.)
9.50 mm (0.375 in.)	9.50 mm (0.374 in.)	8.40 mm (0.329 in.)	16.6 mm (0.654 in.)	6.35 mm (0.25 in.)	4.06 mm (0.16 in.)	9.45 mm (0.372 in.)	9.73 mm (0.383 in.)
13.0 mm (0.500 in.)	12.4 mm (0.488 in.)	11.9 mm (0.467 in.)	21.7 mm (0.854 in.)	6.35 mm (0.25 in.)	3.05 mm (0.12 in.)	12.62 mm (0.497 in.)	13.21 mm (0.520 in.)
16.0 mm (0.625 in.)	15.4 mm (0.606 in.)	15.0 mm (0.590 in.)	27.0 mm (1.063 in.)	8.89 mm (0.35 in.)	3.05 mm (0.12 in.)	15.80 mm (0.622 in.)	16.28 mm (0.641 in.)



EXTENDED PRONG

HM211587

V8, SOME FOUR- AND SIX-CYLINDER MODELS

Remove

1. Disconnect wire from negative terminal of battery.
2. Unlock holder for secondary wires. See Figure 11. Remove secondary wires by carefully pulling on holder.
3. Disconnect wiring harness for primary wires from side of distributor.
4. Unlock four latch screws that fasten cap to housing. Remove distributor cap from distributor.

NOTE: Some V8-350 models used three screws to fasten the cover. Some V8-350, four- and six-cylinder models use two screws to fasten cover.

5. Remove screws that hold coil cover to distributor cap. Remove cover.

CAUTION

Do not damage the ground wires.

6. Remove four screws that hold coil to distributor cap. Loosen terminals of primary wires by pushing from connector side of cap. Carefully remove coil and primary wires.
7. Check rubber seal, spring, and resistor brush in cap for damage. Check cap for cracks or other damage. Replace parts that are damaged.

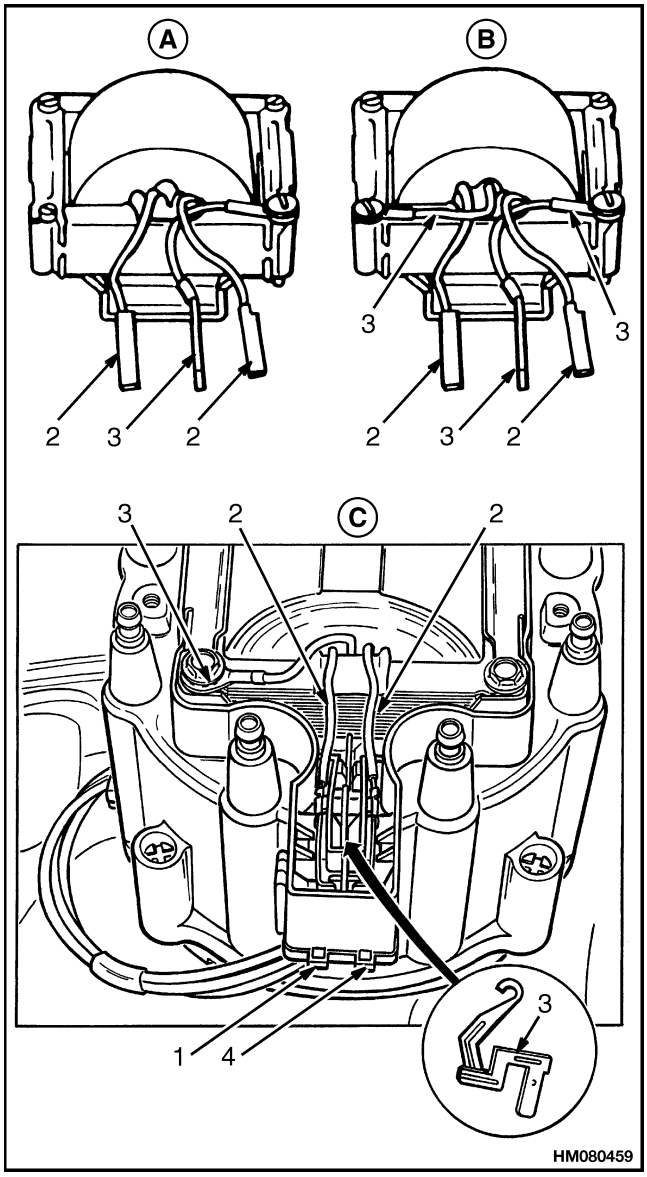
Install

NOTE: On some distributor models, the ground wire must be installed before the coil is installed.

1. If the ground wire was removed, install wire into position.
2. Install resistor brush, spring, and rubber seal in cap. See Figure 11.

NOTE: If the coil is new, make sure the part number is correct.

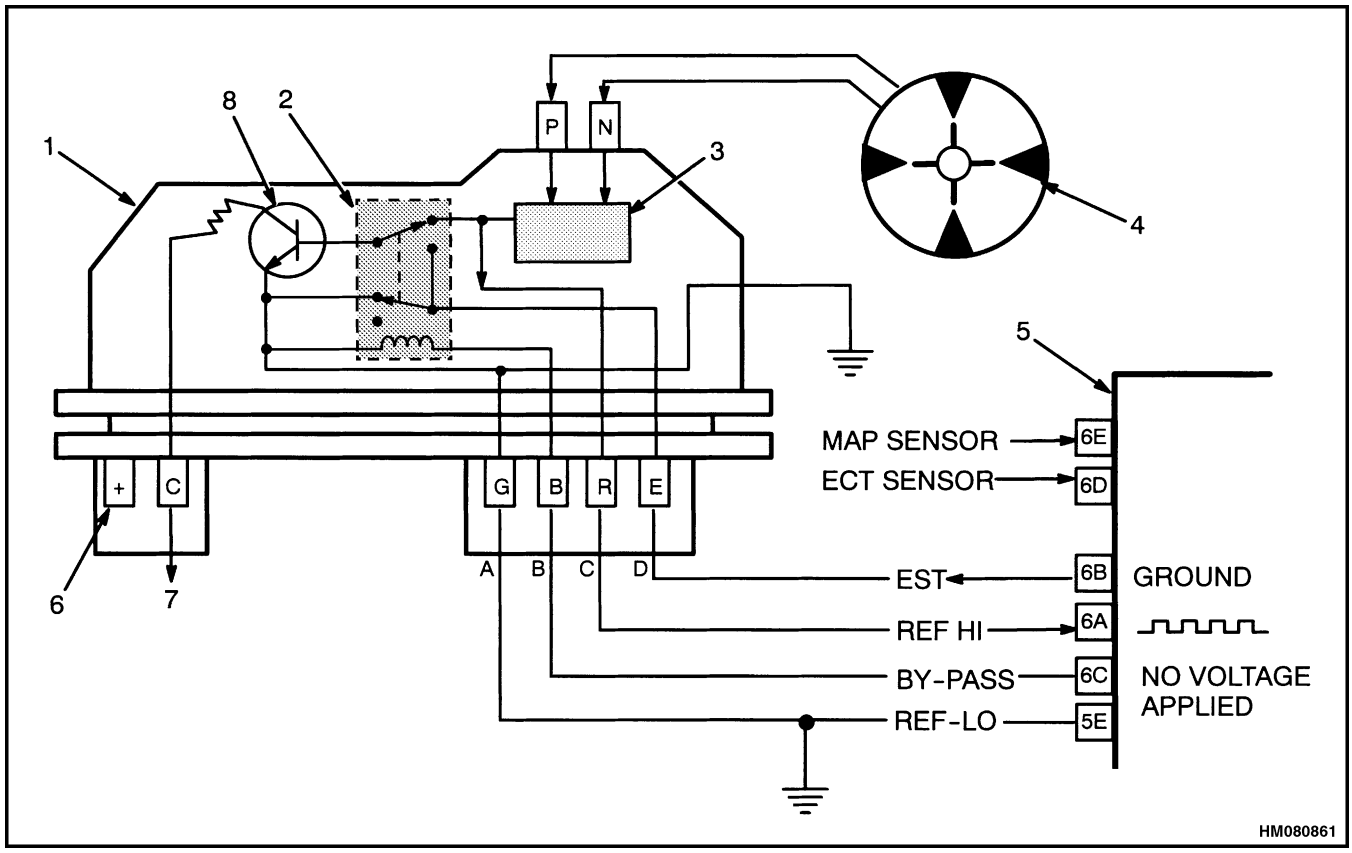
3. Put coil in correct position in cap. Push terminals of primary wires into connector on side of cap.
4. Align terminal(s) of ground wire(s) to hole in coil frame. Install four screws in frame of coil. Tighten screws.



A. DESIGN 1
B. DESIGN 2
C. DESIGN 3

1. TACHOMETER TERMINAL
2. PRIMARY WIRE
3. GROUND WIRE
4. BATTERY TERMINAL

Figure 11. V8 and Some Four- and Six-Cylinder Models Ignition Coil



NOTE: THE NUMBER IN FRONT OF THE PIN DENOTES THE CONNECTOR. FOR EXAMPLE, 6E IS PIN E ON THE 6-PIN CONNECTOR WHILE 5E IS PIN E ON THE 5-PIN CONNECTOR.

1. IGNITION MODULE
2. ELECTRONIC RELAY
3. SQUARE WAVE GENERATOR
4. SENSING COIL
5. MSTS MODULE
6. BATTERY VOLTAGE
7. TO IGNITION COIL
8. TRANSISTOR

Figure 5. Ignition Module When Engine is Being Started

1.
- Turn the key switch to OFF.
- Disconnect the connector at the ECT.
- Turn the key switch to ON (engine OFF).
- Connect a digital voltmeter across the two terminals of the connector to the ECT. Check that the voltage signal is greater than 4 volts.

NO

Circuit for 5V signal is shorted to ground
or
faulty connection at the MSTS module
or
fault in the MSTS module. Make repairs as necessary.

YES

There is a faulty connection or the ECT has a fault. Make repairs as necessary.

COOLANT SENSOR		
TEMPERATURE TO RESISTANCE VALUES (APPROXIMATE)		
°C	°F	OHMS
100	212	180
70	158	450
38	100	1,800
20	68	3,400
4	40	7,500
–7	20	13,500
–18	0	25,000
–40	–40	101,000

HF080121

Figure 23. ECT Sensor Troubleshooting Diagram (High Temperature)

General

This section includes description and operation of the electronic engine control system and its components. Repair and troubleshooting procedures for the system used in the GM 3.0L and 4.3L engines are in the section **Electronic Engine Control Troubleshooting and Repair** 2200 YRM 782.

Engines that have an LPG fuel system use a Microprocessor Spark Timing System (MSTS) or a Carburated Engine Management System (CEMS). They do not have an electronically controlled fuel injection system.

Description and Operation

GENERAL

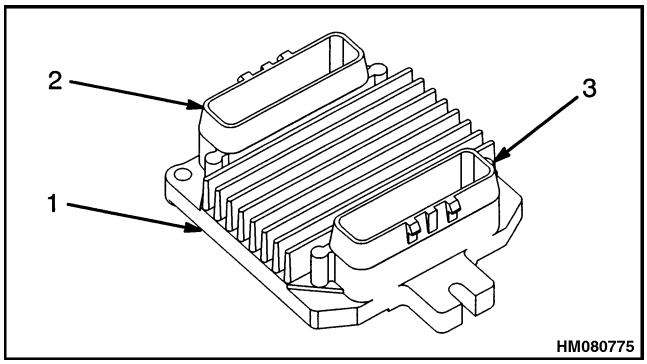
When a carburetor and distributor are used for fuel supply and ignition control, a single adjustment cannot be made to give the best adjustment for all operating speeds and conditions. The use of microprocessors has enabled development of electronic systems that can better control engines that use gasoline or liquid petroleum gas (LPG) during all operating conditions.

An electronic engine control continuously makes adjustments to control spark timing and fuel mixture to the engine. This control provides the following benefits:
- Engine is easier to start and operate during changing conditions.
- An electronic governor is installed for finer engine speed control.
- Electronic monitoring of engine operation as an aid to troubleshooting.

ELECTRONIC CONTROL MODULE (ECM)

The ECM is a small computer that controls ignition timing and fuel supply in a gasoline engine. See Figure 1. An Electronically Erasable Programmable Read Only Memory (EEPROM) is installed in the ECM. This EEPROM is programmed with information for the best operation of the engine according to fuel, temperature, load, and other conditions. The ECM receives signals from sensors on the engine and electronically controls the following systems and components for best fuel use and engine performance:
- A fuel injection system
- Electronic Spark Timing (EST)
- An electronic governor
- Check Engine light
- Idle Air Control (IAC)
- Fuel pump relay
- A serial data link for troubleshooting

Each ECM has a specific program for the model of lift truck in which it is installed. A replacement ECM must have the same part number so that the lift truck will operate correctly.



1. ECM
2. J1 CONNECTOR
3. J2 CONNECTOR

Figure 1. ECM

Diagnostic Connector

The diagnostic connector is connected through a wiring harness to the ECM. See Figure 2. The diagnostic connector is an important link for troubleshooting the operation of the ECM and the electronic engine control system. The diagnostic connector is found in the engine compartment. See Figure 3 and Figure 4. The use of the diagnostic connector is described in the **Electronic Engine Control Troubleshooting and Repair** 2200 YRM 782 section for these engines.

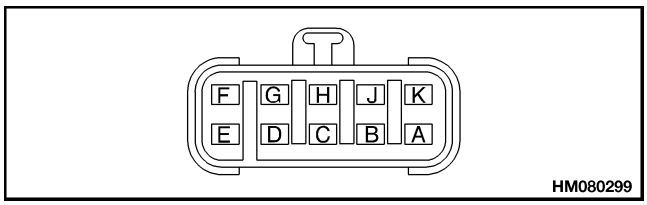


Figure 2. Diagnostic Connector

TABLE OF CONTENTS

A-4 - Fuel Injector Circuit

This troubleshooting chart is used if Figure 13 indicates a fuel injector problem. If both fuel injector circuits indicate a problem, test one circuit at a time. See Figure 14.

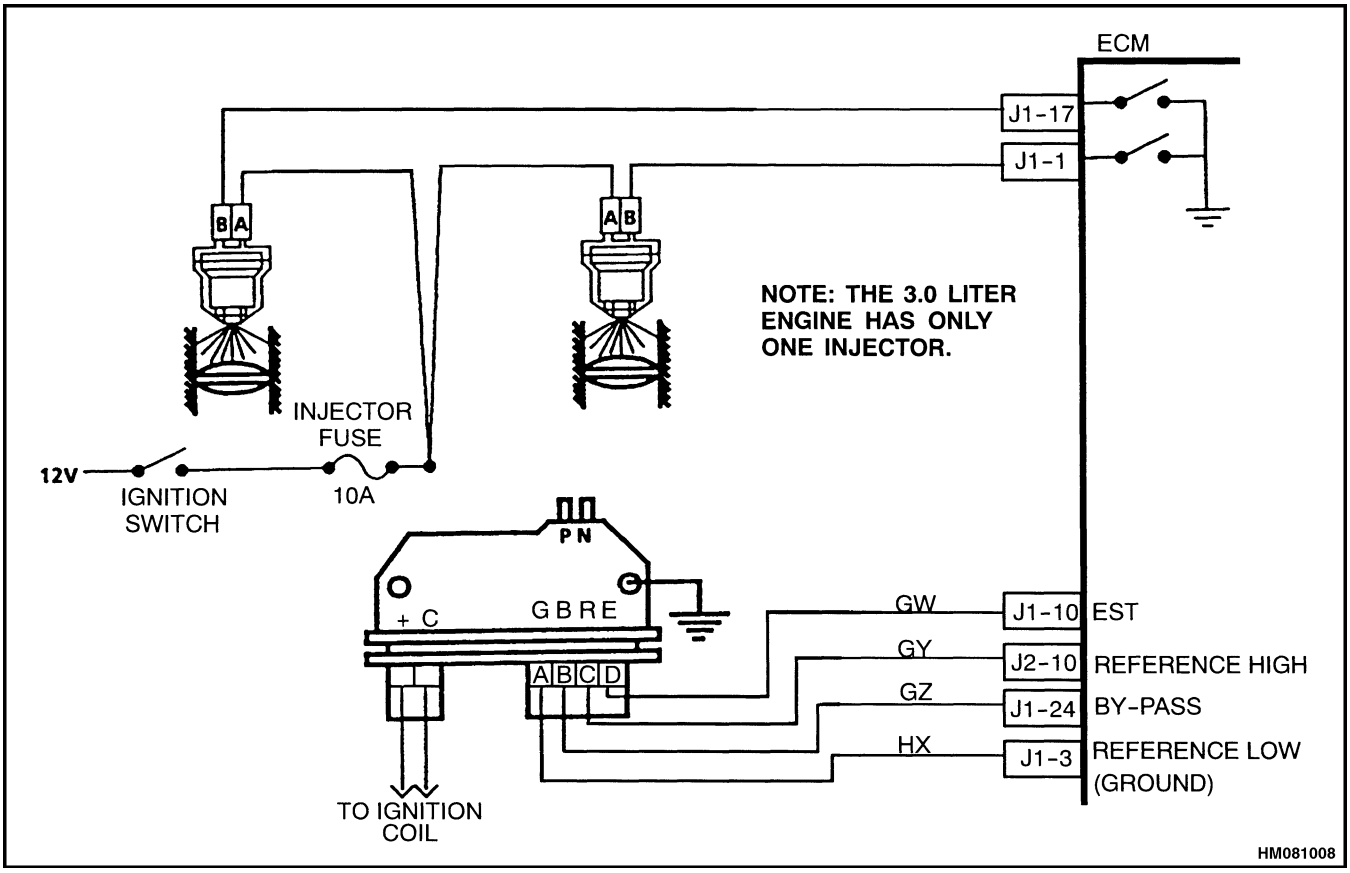


Figure 14. Chart A-4 - Fuel Injector Circuit

TEST DESCRIPTION

The numbers below are a reference to bold numbers in Figure 15.

1. This test will determine if the Ignition Module is generating a reference pulse and check the wires and ECM for a fault. If a 12-VOLT TEST LIGHT is connected to 12 volts and then touched and removed from circuit **GY,** a reference pulse is normally generated. If the fuel injector TEST LIGHT, connected to the fuel injector circuit, momentarily illuminates, the ECM and wires are correct.

2. This step checks for 12 volts to the fuel injector. This test will also determine if there is a short circuit to a voltage source on the ECM side of the circuit.

3. This test checks for a good circuit to the ECM.

DTC 33 Manifold Absolute Pressure (MAP) Sensor Circuit (Signal Voltage High - Low Vacuum)

CIRCUIT DESCRIPTION

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1 to 1.5 volts at closed throttle idle, to 4 to 4.5 volts at Wide Open Throttle (low vacuum). If the MAP sensor fails, the ECM will use a fixed MAP value and use the Throttle Position (TP) Sensor to control fuel delivery. See Figure 34.

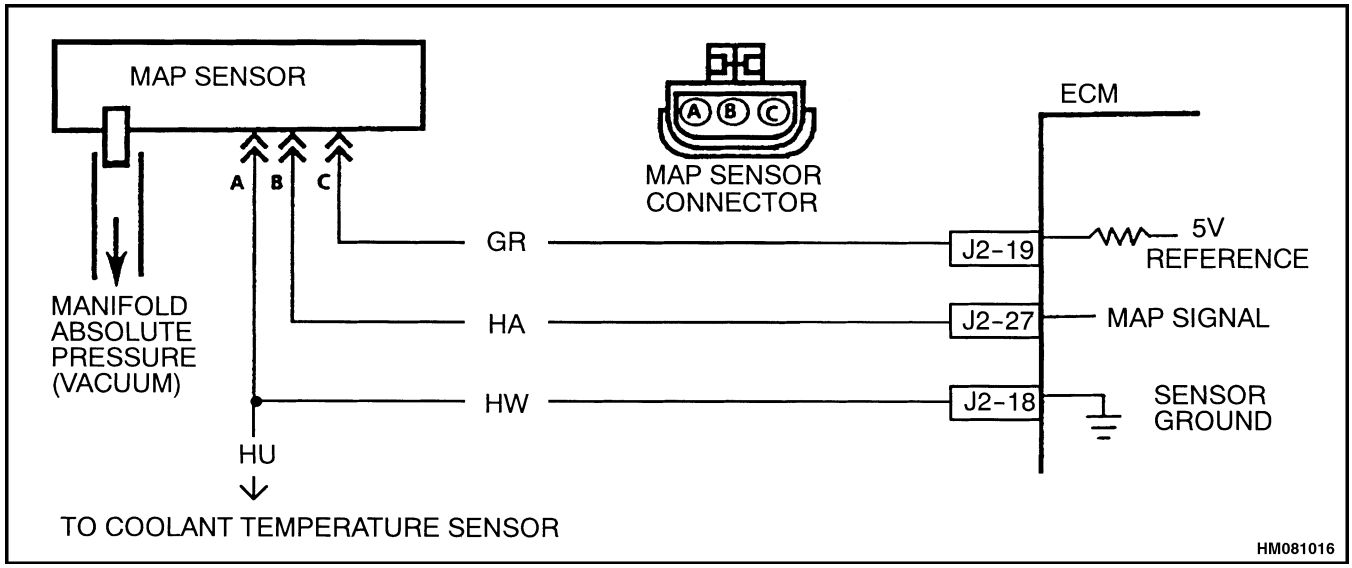


Figure 34. DTC 33 Manifold Absolute Pressure (MAP) Sensor Circuit (Signal Voltage High - Low Vacuum)

TEST DESCRIPTION

The numbers below are a reference to bold numbers in Figure 35.

1. This step will determine if DTC 33 is caused by a current failure or a condition that is not constant.
- A DTC 33 will set if:
  MAP signal is more than 90 kPa (27 inHg) (low manifold vacuum),
  TP Sensor less than 5%,
  These conditions exist longer than 10 seconds.

2. This step causes the conditions for a DTC 33. If the ECM sees the change, ECM and circuits **HA** and **HW** are good.

3. See System Test Charts for complete test of MAP sensor.

OTHER TROUBLESHOOTING CHECKS

- With ignition **ON** and engine stopped, manifold pressure is equal to atmospheric pressure and signal voltage will be high. This information is used by the ECM as an indication of vehicle altitude and is referred to as BARO. Comparison of this BARO reading with a known good vehicle with the same type of sensor is a good way to check accuracy of a sensor. Correct readings will be within 0.4 volts of each other.
- A DTC 33 occurs if either circuit **HW** is open, or if circuit **GR** has a short to voltage or to circuit **HA**.
- If **HW** is open, DTC 33 and DTC 14 will set.
- If DTC 33 is not constant, see Troubleshooting, Poor Operation.

CHECK PCV SYSTEM

CAUTION

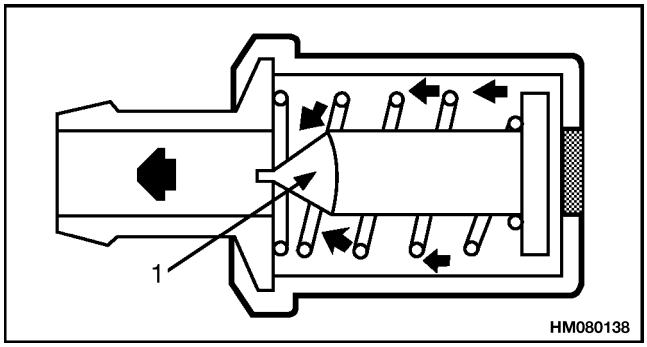
An engine that is operated without any crankcase ventilation can be damaged. Therefore, it is important to replace the PCV valve at intervals shown in the Periodic Maintenance section.

A restriction in PCV valve or hose can cause:
- Rough idle, slow idle speed, oil leaks, or oil in the air cleaner.

A PCV valve or hose that leaks can cause:
- Rough idle, high idle speed, or engine stalls.

If engine has a rough idle, check for a restriction in PCV valve or hose. See Figure 51. Replace parts as described in PCV System Repair.

With this system, fumes are sent into the air filter and into the engine intake manifold.



1. CHECK VALVE NEEDLE

Figure 51. PCV Valve

Fuel System Components Repair

GENERAL

NOTE: The following is general information to be used when working on fuel system:
- Always use new O-rings on fuel line fittings.
- All steel tubing on fuel system must be replaced with original equipment parts.
- All fuel hoses must be replaced with original equipment parts.
- Do not replace any steel fuel tubing with fuel hose. Do not replace any steel fuel tubing with copper or aluminum tubing.
- Some parts of Throttle Body Injector (TBI) can be cleaned in a cleaner such as Yale Carburetor Cleaner or its equivalent. DO NOT clean the following parts: Throttle Position Sensor (TPS), IAC valve, fuel injectors, cover for fuel meter body, ball bearings, or governor assembly.

WARNING

To reduce the risk of fire and personal injury, relieve the fuel system pressure before servicing fuel system components.

After relieving system pressure, a small amount of fuel may be released when servicing fuel lines or connections. To reduce the chance of personal injury, cover fuel line fittings with a shop towel before disconnecting to catch any fuel that may leak out. Place towel in an approved container when disconnect is completed.

FUEL PRESSURE RELIEF PROCEDURE

1. Disconnect negative battery terminal to avoid fuel leakage if an accidental attempt is made to start engine.
2. Loosen fuel filler cap to relieve tank vapor pressure.
3. The internal relief in TBI unit relieves fuel pump pressure when engine is OFF. Therefore, no additional pressure relief procedure is required.

FUEL PUMP REPLACEMENT

WARNING

To reduce the risk of fire and personal injury, do not operate the fuel pump outside of the fuel tank. The pump can make sparks and cause an explosion.

1. Disconnect negative cable at battery.
2. Loosen fuel filler cap to release pressure in fuel tank. See Figure 52.
3. Disconnect fuel lines at access plate on fuel tank. Disconnect wiring harness from TBI.
4. Remove capscrews holding access plate to fuel tank. Remove access plate, fuel pump, and sending unit, if attached.
5. Inspect fittings and fuel lines that are inside fuel tank for damage. Inspect screen for damage.

Legend for Figure 83

A. PUSH-TO-SEAT TERMINAL, MALE

1. TERMINAL
2. LOCK TAB
3. WIRE
4. SEAL
5. REMOVAL TOOL
6. CONNECTOR BODY

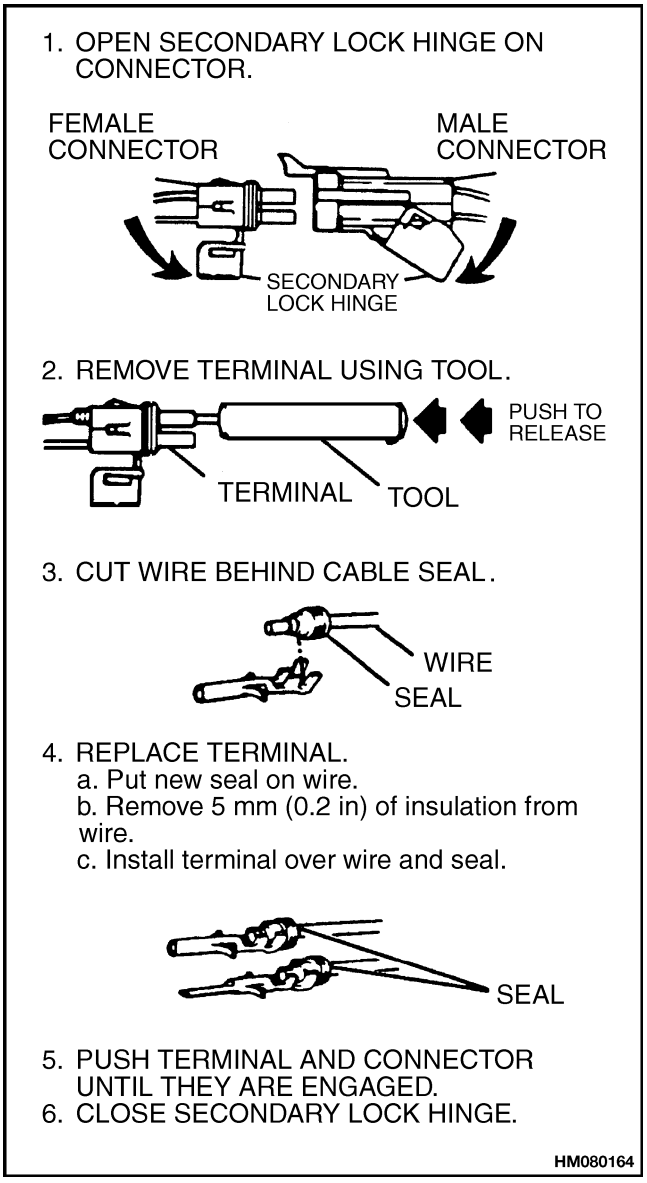


Figure 84. Weather-Pack Terminal Repair

PROCEDURES FOR SPARK PLUGS, SPARK PLUG WIRES, AND BOOTS

NOTE: Use a silicon grease on inside of spark plug boots to make a better weather seal and make spark plug boot easier to remove. The following silicon greases are approved for use:

General Electric®	GE627
Packard®	PM776
Wacker® Silicones	G47

NOTE: The condition of spark plugs removed from engine can show engine operating problems. See Spark Plugs Troubleshooting.

1. Do not damage spark plug wires during removal. Hold wire by boot near end of wire. Rotate boot a half-turn before pulling it and connection from spark plug. Do not use pliers or other tools that can damage boot. Do not pull wires to disconnect spark plug wires. Pull boot, or use a tool made for this purpose.
2. Do NOT put a hole in boot or insulation of spark plug wire. Do NOT try to insert a wire between boot and connector of spark plug wire.
3. Make sure spark plug wires are installed in same locations using clips. Spark plug wires can be damaged or cause poor engine operation if they are not correctly installed.
4. Special care must be used when spark plug boots are installed. Make sure that metal terminal within boot is fully connected to spark plug terminal. Make sure that boot has not moved on wire. If there is boot to wire movement, boot can appear to be fully installed when it is not.
5. Make sure to install insulator in shield at boot of all spark plug wires.

WIRING DIAGRAM

The wiring diagram for the electronic control module is shown in Figure 85. The wiring diagram is followed by tables of pinouts for the ECM connectors J1 and J2. See Table 6 and Table 7.

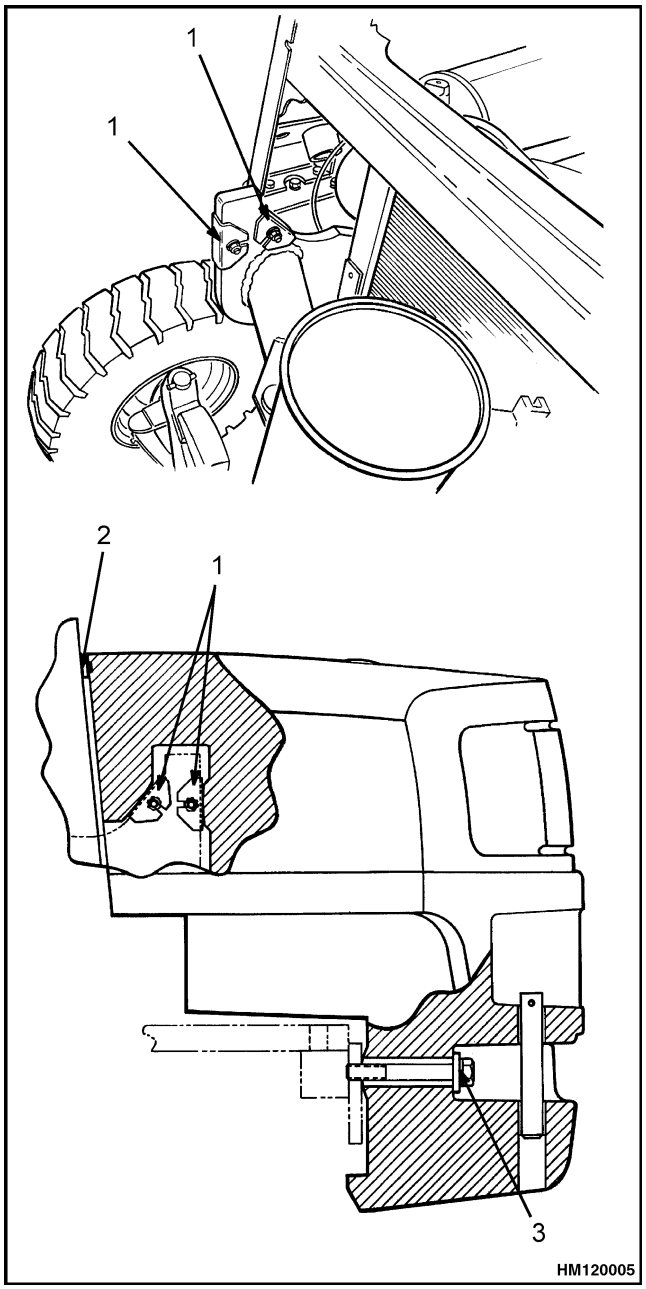


Figure 6. Counterweight Installation

Legend for Figure 6

1. SPACER
2. RUBBER SEAL
3. CAPSCREW

Exhaust System Repair

The muffler is installed inside the cavity of the counterweight. A short exhaust pipe sends the exhaust gases from the lift truck through the grille in the counterweight. See Figure 7, Figure 8, Figure 9 or Figure 10.

An optional catalytic converter can be installed in the exhaust system between the engine and the muffler. See Figure 11. The type of catalytic converter installed depends on the fuel the engine uses. See the **Parts Manual** for your lift truck model.

The GP2.00-3.00RF/TF (GP040-060RG/TG/ZG) series of lift trucks can have an overhead exhaust system. The exhaust pipe is fastened to the top of the counterweight. See Figure 12.

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5. Check air gap and ensure clearance to specification by moving the brass feeler gauge in and out of the gap freely.

NOTE: If the feeler gauge does not move freely, repeat Step 2 through Step 5.

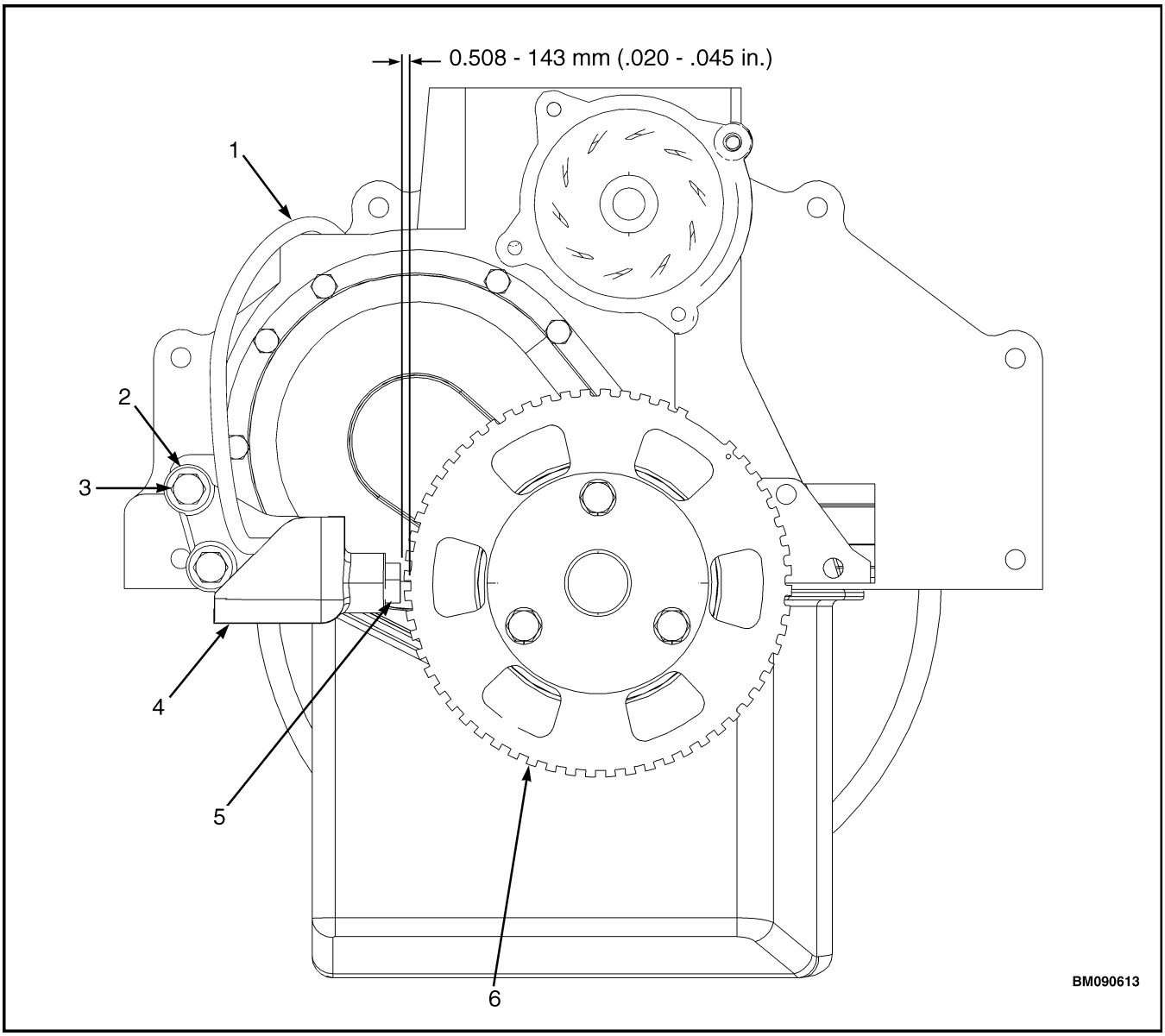
6. Connect crankshaft position sensor connector.

7. Start engine.

8. Perform On-Board Diagnostic system check.

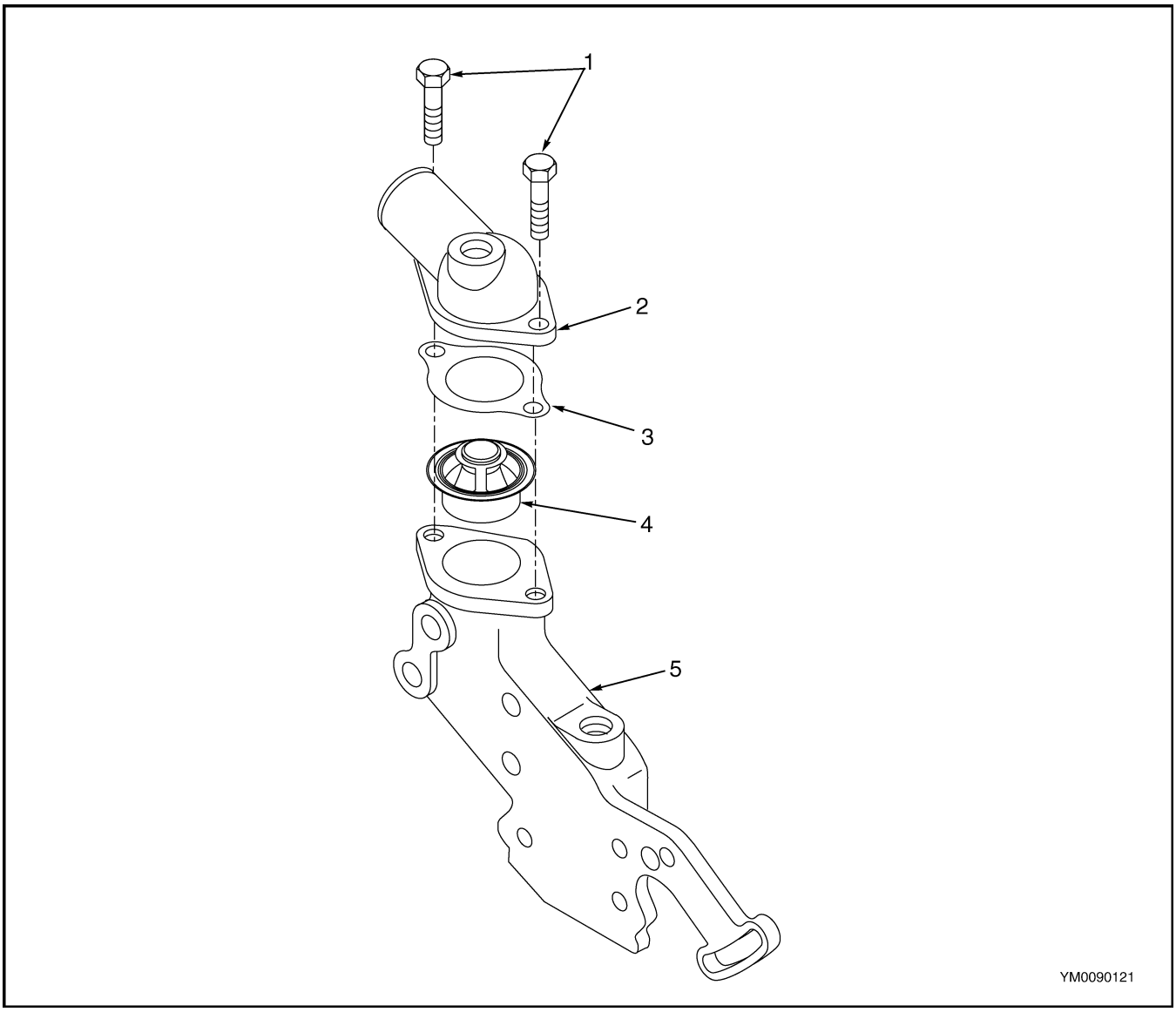
9. Verify there are no DTC codes present and are cleared.

10. Verify engine is in closed loop and no MIL lights are present.



1. CRANKSHAFT POSITION SENSOR CONNECTOR
2. WASHER (2 EA)
3. CAPSCREWS 2 EA)
4. MOUNTING BRACKET
5. CRANKSHAFT POSITION SENSOR
6. TIMING WHEEL

Figure 27. Sensor to Timing Wheel Air Gap



1. CAPSCREWS
2. THERMOSTAT HOUSING (TOP HALF)
3. GASKET
4. THERMOSTAT
5. THERMOSTAT HOUSING (BOTTOM HALF)

Figure 66. Thermostat Components

6. Measure clearance between camshaft and bore in cylinder head as follows:

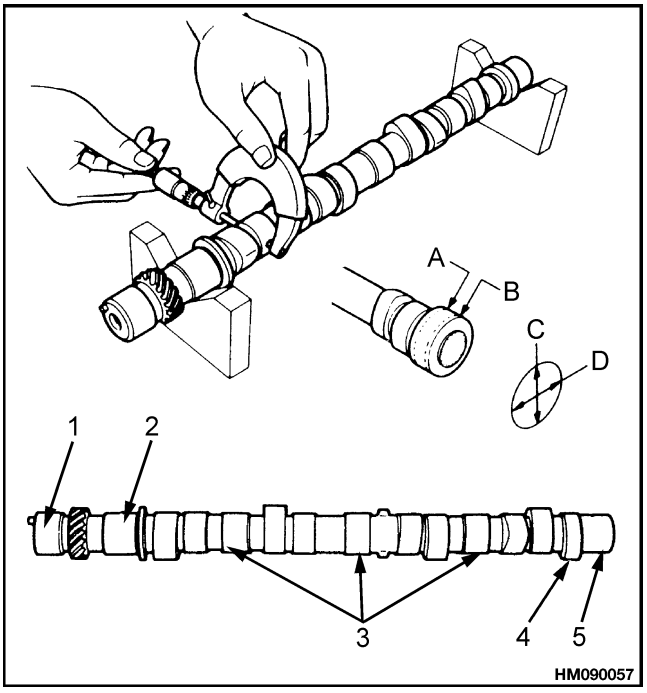
a. Install camshaft in cylinder head.

b. Put plastic gauge material between each camshaft journal and cap. Do not allow camshaft to rotate.

c. Tighten capscrews for caps to 18 to 27 N•m (159 to 239 lbf in). See Figure 12.

Correct clearance for journals No. 1 and 5 is 0.035 to 0.085 mm (0.0014 to 0.0033 in.). Correct clearance for journals No. 2, 3, and 4 is 0.065 to 0.115 mm (0.0026 to 0.0045 in.). If any clearances are greater than 0.15 mm (0.0059 in.), replace cylinder head assembly.

7. Replace camshaft if there is any damage or if it does not meet specifications.



1. FRONT OIL SEAL SURFACE
2. FRONT JOURNAL (NO. 1)
3. CENTER JOURNALS (NOS. 2, 3, AND 4)
4. REAR JOURNAL (NO. 5)
5. FUEL PUMP LOBE

Figure 10. Camshaft Inspection

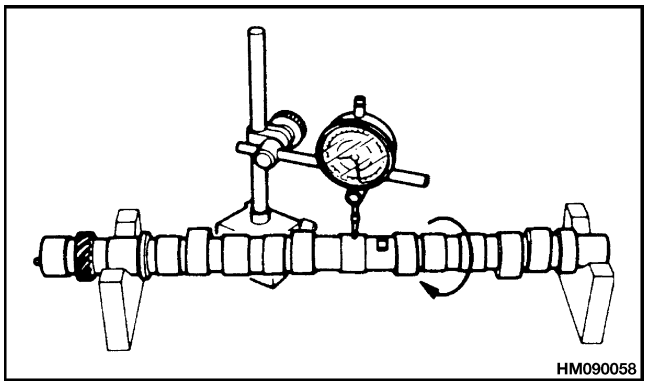
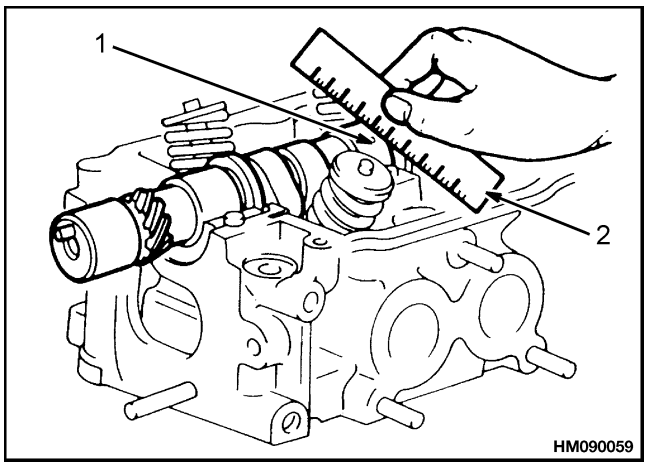


Figure 11. Camshaft Check



1. PLASTIC GAUGE 2. SCALE

Figure 12. Camshaft Clearance Measurement

Valve Guides

1. Measure clearance between valve stems and valve guides. Normal clearance is 0.025 to 0.060 mm (0.001 to 0.002 in.).

If clearance is more than 0.20 mm (0.008 in.), replace valve or valve guide.

2. If replacement is necessary, remove seal from valve guide(s). Then use tool to remove valve guide(s).

3. To install valve guide, install retaining ring on valve guide. Use tool to install valve guide so that retaining ring contacts cylinder head. See Figure 13.

Correct height of valve guide above valve spring seat is 19.1 to 19.6 mm (0.75 to 0.77 in.).

Diameter of Valve Stem (Intake) ..... 8.03 to 8.045 mm (0.3161 to 0.3167 in.)

– Service Limit ..... 7.980 mm (0.3142 in.)

Diameter of Valve Stem (Exhaust) ..... 8.025 to 8.045 mm (0.3159 to 0.3167 in.)

– Service Limit ..... 7.975 mm (0.3140 in.)

Valve Head Thickness (Intake) ..... 0.5 mm (0.020 in.)

Valve Head Thickness (Exhaust) ..... 1.0 mm (0.040 in.)

Valve Face Angle (Intake and Exhaust) ..... 30°

Spring Free Length - Outer FE..... 52.4 mm (2.063 in.)

– Service Limit FE..... 50.8 mm (2.00 in.)

Spring Free Length - Outer F2 ..... 52.2 mm (2.055 in.)

– Service Limit F2 ..... 50.6 mm (1.992 in.)

Spring Free Length - Inner FE..... 45.7 mm (1.799 in.)

– Service Limit FE..... 44.3 mm (1.744 in.)

Spring Free Length - Inner F2..... 47.7 mm (1.878 in.)

– Service Limit F2 ..... 46.3 mm (1.823 in.)

Rocker Arm Shaft Diameter.. 15.966 to 15.984 mm (0.6286 to 0.6293 in.)

Rocker Arm Bore Diameter..... 16.000 to 16.027 mm (0.6299 to 0.6311 in.)

Clearance Between Rocker Arm and Shaft..... 0.016 to 0.061 mm (0.0006 to 0.0024 in.)

CAMSHAFT

Cam Lobes to Production Limit..... 37.102 mm (1.4607 in.)

Cam Lobes to Service Limit..... 36.902 mm (1.4528 in.)

Bearing Journals (Nos. 1 and 5) ..... 31.940 to 31.965 mm (1.2575 to 1.2585 in.)

Bearing Journals (Nos. 2, 3, and 4) ..... 31.910 to 31.935 mm (1.2563 to 1.2573 in.)

Bearing Journal Wear Limit.. 0.05 mm (0.002 in.)

Clearance Between Journals and Bore (Nos. 1 and 5) ..... 0.035 to 0.085 mm (0.0014 to 0.0033 in.)

Clearance Between Journals and Bore (Nos. 2, 3, and 4) ..... 0.065 to 0.115 mm (0.0026 to 0.0045 in.)

End Clearance..... 0.08 to 0.16 mm (0.003 to 0.006 in.)

– Service Limit ..... 0.20 mm (0.008 in.)

CRANKSHAFT

Distortion FE.....less than 0.03 mm (0.0012 in.)

Distortion F2.....less than 0.04 mm (0.0016 in.)

Main Bearing Journal Diameter.....59.937 to 59.955 mm (2.3597 to 2.3604 in.)

– Service Limit .....0.05 mm (0.002 in.)

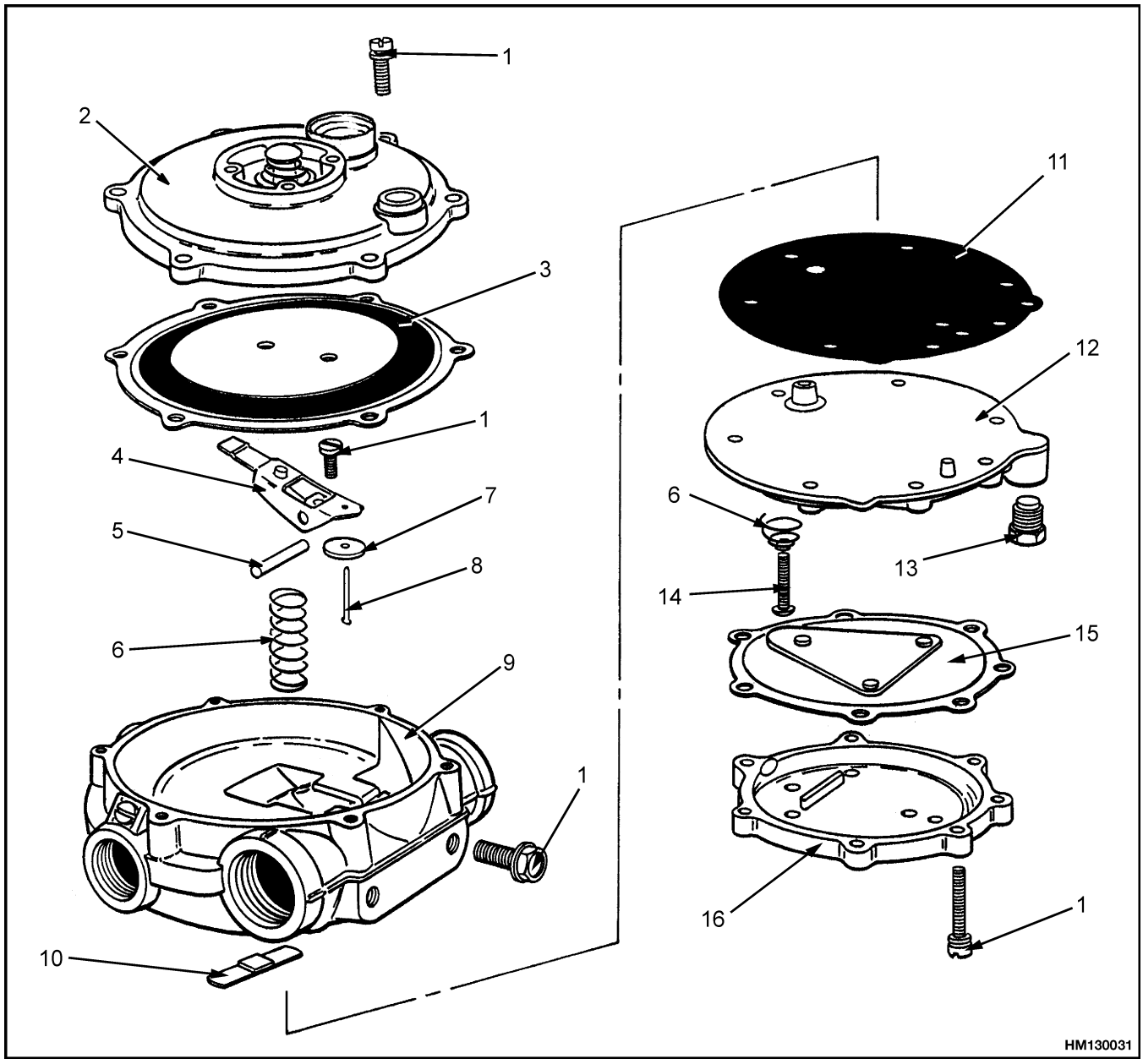
– Grinding Limit.....0.75 mm (0.030 in.)

Clearance Between Journals and Main Bearings ..... 0.031 to 0.049 mm (0.0012 to 0.0019 in.)

– Service Limit .....0.08 mm (0.003 in.)

Connecting Rod Journal Diameter.....50.940 to 50.955 mm (2.0055 to 2.0061 in.)

– Service Limit .....0.05 mm (0.002 in.)



1. SCREW
2. COVER FOR VAPOR VALVE DIAPHRAGM
3. VAPOR VALVE DIAPHRAGM
4. VAPOR VALVE LEVER
5. PIVOT PIN
6. SPRING
7. VAPOR VALVE PAD
8. PIN
9. HOUSING
10. PAD FOR PRESSURE REDUCER VALVE
11. GASKET
12. PLATE
13. PLUG
14. ACTUATING PIN
15. DIAPHRAGM FOR PRESSURE REDUCER VALVE
16. COVER

Figure 12. Vaporizer Parts

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This section is for the following models:

GP/GLP/GDP2.00-3.00RF/TF (GP/GLP/GDP040-060RG/TG/ZG) [A875];
GC/GLC040-065RG/TG/ZG [E187]

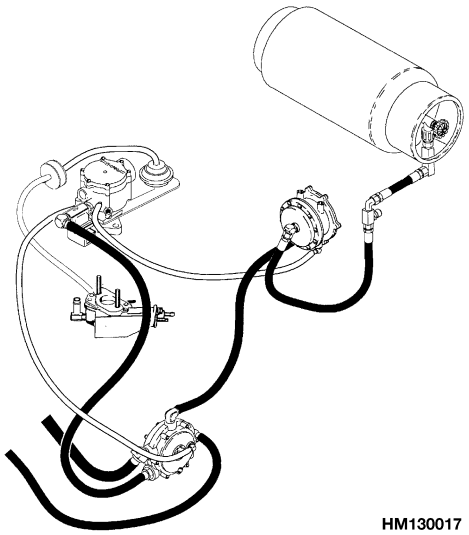
Yale

Maintenance

LPG FUEL SYSTEM

MAZDA FE ENGINE

GP/GLP/GDP16-20AF/BF (GP/GLP/GDP030-040AF/BF) [A810]; GC/GLC040-065RG/TG/ZG [E187]; GP/GLP/GDP2.00-3.00RF/TF (GP/GLP/GDP040-060RG/TG/ZG) [A875]



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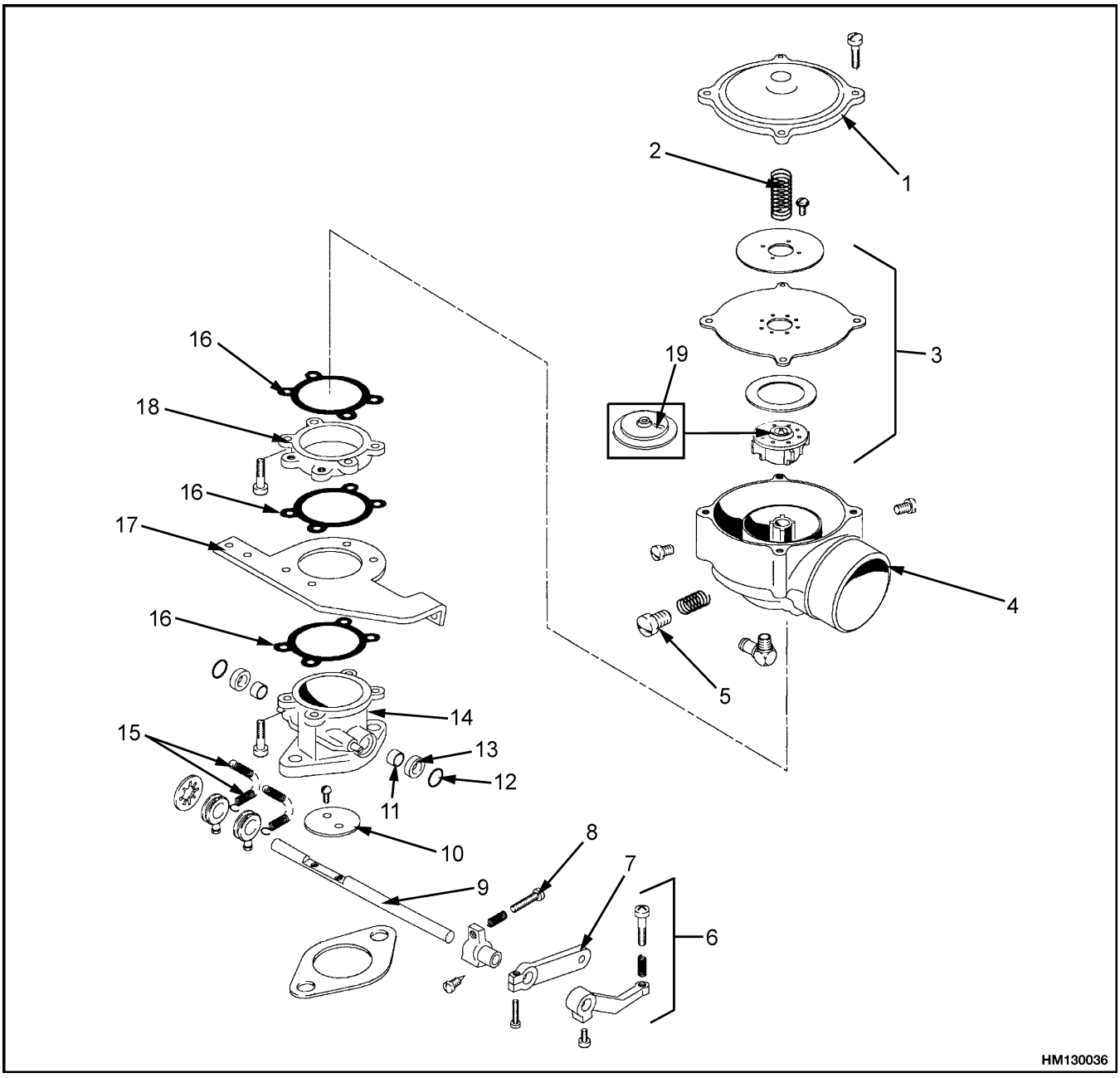
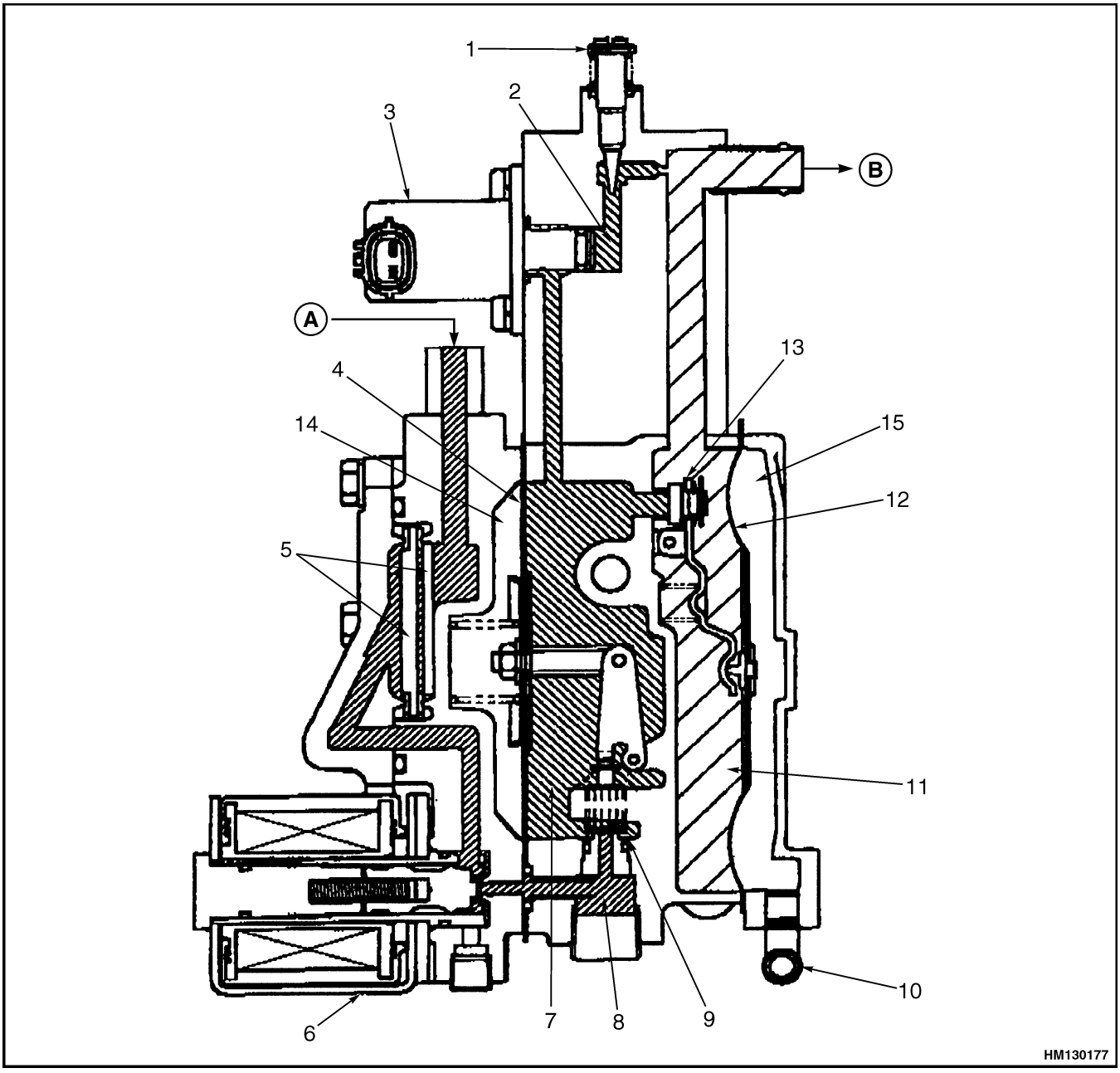
PART NO. 524158746

900 YRM 523



1. COVER
2. SPRING
3. MIXTURE VALVE ASSEMBLY
4. CARBURETOR BODY
5. IDLE MIXTURE SCREW
6. IDLE CONTROL LEVER AND ADJUSTER ASSEMBLY
7. THROTTLE LEVER
8. IDLE SPEED SCREW
9. THROTTLE SHAFT
10. THROTTLE PLATE
11. SEAL
12. RETAINER
13. BEARING
14. THROTTLE BODY
15. SPRINGS
16. GASKETS
17. ATTACHMENT PLATE
18. ADAPTER PLATE
19. POSITION MARK

Figure 16. Carburetor Parts



A. LPG INPUT FROM FUEL TANK

B. LPG OUTPUT TO CARBURETOR

1. IDLE MIXTURE ADJUSTING SCREW
2. CHAMBER D
3. IDLE BYPASS SOLENOID
4. DIAPHRAGM
5. FUEL FILTER
6. MAIN SOLENOID
7. CHAMBER B
8. CHAMBER A
9. INLET VALVE
10. RESONATOR PORT
11. CHAMBER C
12. DIAPHRAGM
13. INLET VALVE
14. VACUUM CHAMBER 1
15. VACUUM CHAMBER 2

Figure 4. Inside the Regulator

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
There is engine hesitation, surge, knocking, or loss of power due to lean or rich fuel/ air mixture. (Cont.)	Coolant hose has become clogged or disconnected, causing regulator to become frozen.	Clear obstruction from coolant hose or reconnect coolant hose.
	Resonator is damaged.	Replace resonator.
	Resonator hose is disconnected or damaged.	Connect resonator hose or replace resonator hose.
	There is no clearance between idle-up adjusting screw and idle-up actuator.	Adjust idle-up adjusting screw.
Engine stops running during deceleration, immediately after engine startup, immediately after acceleration, during a sharp turn, or during load up/down operations due to lean or rich fuel/air mixture.	Main fuel shutoff solenoid valve is clogged.	Clean main fuel shutoff solenoid valve.
	Idle fuel shutoff solenoid valve is clogged.	Clean idle fuel shutoff solenoid valve.
	Fuel hose is damaged.	Replace fuel hose.
	Fuel filter is clogged.	Replace fuel filter and clean tar from regulator.
	Idle mixture adjusting screw may be clogged.	Clean or replace idle mixture adjusting screw as necessary.
	There is tar accumulation in regulator.	Remove drain plug and drain tar from regulator.
	There is an air leak between carburetor and governor.	Replace gasket if it is broken or tighten mounting nuts to correct torque.
	Vacuum hose is either damaged or disconnected.	Replace damaged hose or connect hose that is disconnected.
	Power adjusting screw on carburetor is out of adjustment.	Perform adjustment procedures located in Carburetor Adjustment.
	Idle mixture adjusting screw on regulator may be out of adjustment.	Perform adjustment procedures located in Regulator Adjustment.

Vacuum Switches Repair

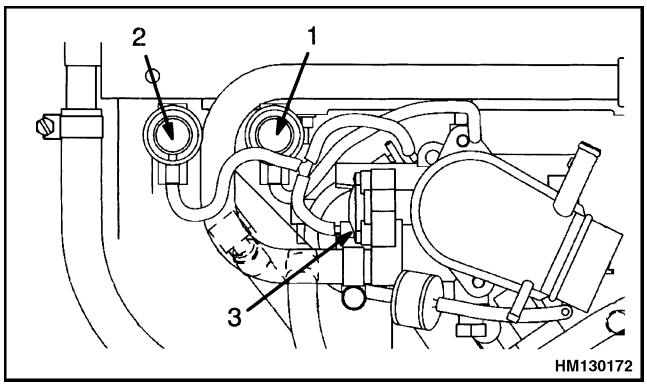
NOTE: Vacuum switch 1 has a white body with a gray top. Vacuum switch 2 has a white body with a white top. This procedure is used for both switches.

REMOVE AND INSTALL

1. Disconnect vacuum hose.
2. Disconnect electrical connector from vacuum switch. See Figure 12.
3. Remove mounting clamp and capscrew. Remove vacuum switch.
4. Install switch in reverse order.

INSPECT

1. Connect an ohmmeter to vacuum switch.
2. Apply vacuum to switch. The contacts of vacuum switch 1 should close at −16.0 to −20.0 kPa (−4.7 to −5.9 inHg). The contacts of vacuum switch 2 should open at −29.0 to −33.3 kPa (−8.5 to −9.8 inHg).
3. Release vacuum. Switch contacts should open.



1. VACUUM SWITCH 1 (IDLE)
2. VACUUM SWITCH 2 (WIDE-OPEN THROTTLE)
3. CARBURETOR

Figure 12. Vacuum Switches

Resistor Repair

REMOVE AND INSTALL

Disconnect electrical connector, then remove mounting screw and resistor. Install resistor in reverse order.

INSPECT

Use an ohmmeter to check resistor for continuity. The coil resistance should be 5.4 to 6.6Ω.

Carburetor and New Regulator Adjustment

IDLE SPEED AND FUEL MIXTURE

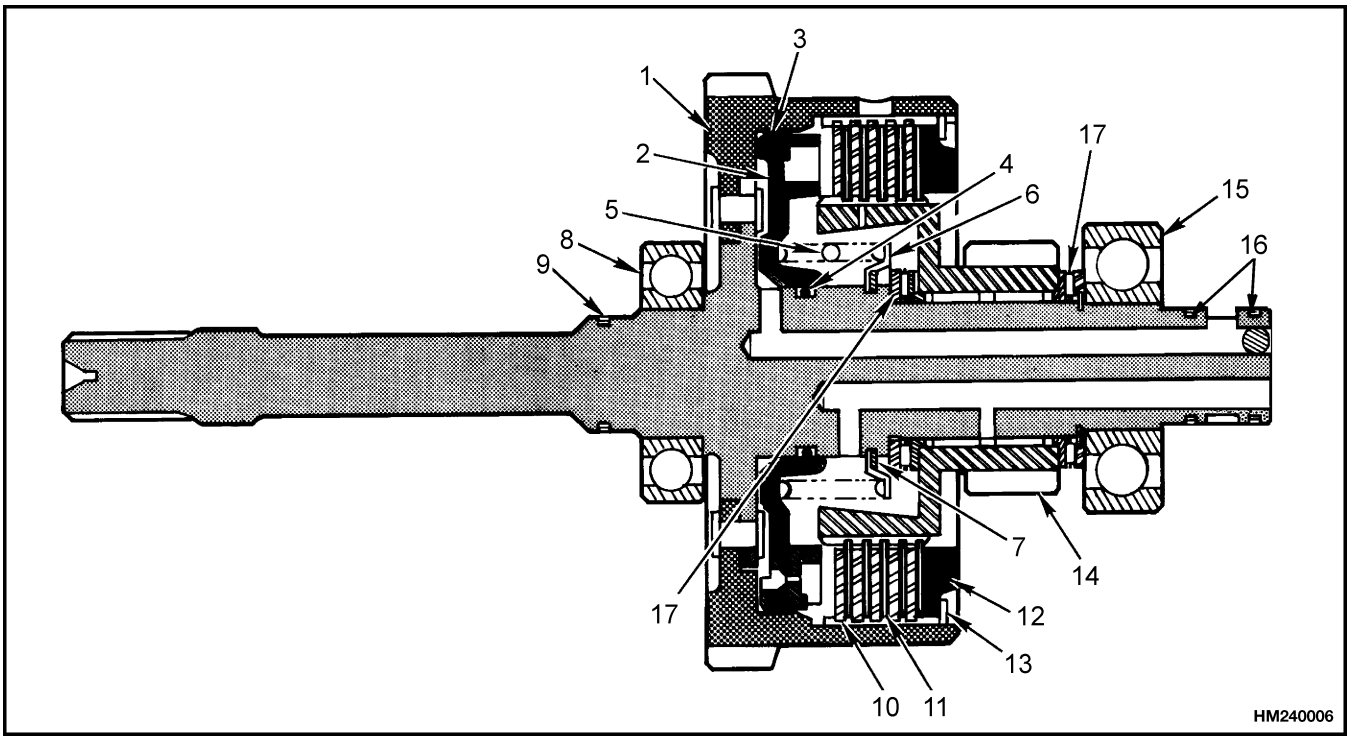
WARNING

LPG can cause an explosion. Do not permit any sparks or open flames in work area.

1. Warm engine, transmission, and hydraulic system to normal operating temperatures. Make sure that idle control actuator is not in contact with idle-up adjusting screw.
2. Check idle speed and engine timing. The timing should be 8° BTDC @ 800 ±25 rpm GM 3.0L Engine, 9° BTDC @ 800 ±25 rpm GP/GLP/GDP2.00-3.00RF/TF (GP/GLP/GDP040-060RG/TG/ZG) and GC/GLC040-065RG/TG/ZG, and 8° BTDC @ 725±25 rpm GC/GLC030-040AF and GP/GLP/GDP030-040AF.
3. If idle speed is not within specifications, adjust idle air bypass adjusting screw on carburetor. See Figure 13 and Figure 14.

NOTE: The following steps are for adjusting the fuel mixture on a new replacement regulator that has not been tamper-proofed. Do not perform this adjustment on an old regulator. A CO% meter will be required.

4. Disconnect electrical connector from fuel injector.



1. CLUTCH HOUSING
2. CLUTCH PISTON
3. PISTON SEAL
4. O-RING
5. CLUTCH SPRING
6. SPRING RETAINER
7. SNAP RING
8. BALL BEARING
9. SEAL RING
10. SEPARATOR DISC
11. FRICTION DISC
12. PRESSURE PLATE
13. SNAP RING
14. OUTPUT GEAR
15. BALL BEARING
16. SEAL RINGS
17. THRUST BEARING ASSEMBLY

Figure 6. Clutch Assembly (Lift Truck Models Without Exedy Clutch Assemblies)

Operation

When the Input (forward) clutch is applied, the power from the engine is sent through the Input (forward) clutch assembly to the output pinion. See Figure 8. The flow of power is from the input shaft (part of the forward clutch housing) through the applied clutch to the forward hub. The gear on the hub of the Input (forward) clutch is engaged with the output gear on the pinion of the differential. The power flows from the applied clutch in the transmission through the pinion to the differential.

The gear on the outside of the Input (forward) clutch housing is engaged with the gear on the outside of the Counter (reverse) clutch housing. The gear on the Counter (reverse) clutch hub is engaged with the output gear on the pinion. These gears are always engaged so that they rotate, but when the Counter (reverse) clutch is released, they do not transfer power.

When the Counter (reverse) clutch is applied, the Input (forward) clutch is released. The flow of power is from the input shaft (forward clutch housing) to the Counter (reverse) clutch housing. The power is transferred through the applied Counter (reverse) clutch to the hub. The hub gear transfers the power to the output gear and pinion. The pinion will rotate in the opposite direction as it did when the Input (forward) clutch was applied. See Figure 8.

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This section is for the following models:

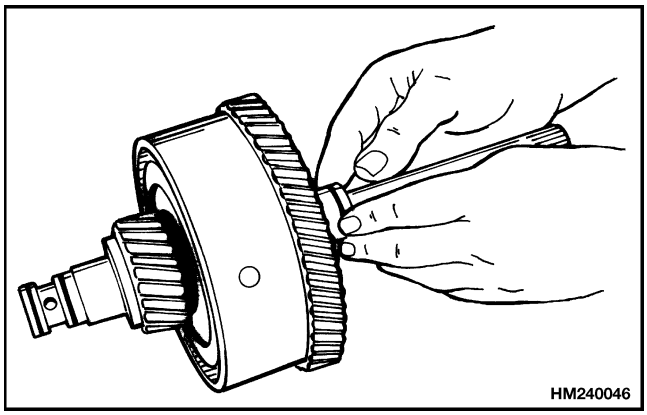
GP/GLP/GDP2.00-3.00RF/TF (GP/GLP/GDP040-060RG/TG/ZG) [A875];
GC/GLC040-065RG/TG/ZG [E187]

STEP 9.
Install the ball bearings on the end of the clutch shaft that goes into the front cover of the transmission. Install the seal rings on the shaft.

STEP 10.
Make sure the special thrust washer is installed after the snap ring as shown in STEP 4. Install the ball bearing in the transmission housing.

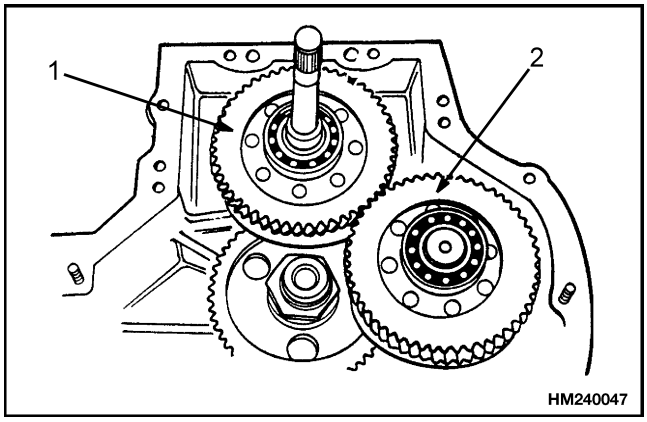
STEP 11.
For lift trucks without Exedy clutch assemblies, install the seal rings. The Input (forward) clutch has one seal ring on the input shaft and two seal rings on the output end of the clutch shaft. The Counter (reverse) clutch only has two seal rings on the output end of the clutch shaft.

For lift trucks with Exedy clutch assemblies, install the seal rings. The Input (forward) clutch has one seal ring on both the input end and output end of the clutch shaft. The Counter (reverse) clutch only has one seal ring on the output end of the clutch shaft.


HM240046

STEP 12.
Install the Input (forward) and Counter (reverse) clutch assemblies in the transmission housing. Make sure the seal rings are not damaged when the clutch shafts are installed in the transmission housing.

STEP 13.
Install the front cover, chain drive arrangement, and the torque converter housing as described in the sections Torque Converter and Housing Repair and Front Cover and Pump Drive Repair.



HM240047

1. INPUT (FORWARD) CLUTCH ASSEMBLY
2. COUNTER (REVERSE) CLUTCH ASSEMBLY

INSTALL

1. Install the torque converter as described in the procedures for the Torque Converter and Housing Repair.

2. Install the transmission to the engine. Install the capscrews at the transmission housing. Tighten the M10 capscrews to 38 N•m (28 lbf ft) and the M12 capscrews to 66 N•m (49 lbf ft).

3. Install the engine and transmission as a unit as described in the section **Frame** 100 YRM 505.

To increase the overlap, loosen the lock nut (15). Turn the capscrew (16) clockwise (as viewed from the top of the lift truck) as much as 1-1/4 turns. Tighten the lock nut (15) when adjustment is complete. See Figure 40.

Neutral Start Switch, Foot Directional Control Pedal Adjustment GP/GLP/GDP2.00-3.00RF/TF (GP/GLP/GDP040-060RG/TG/ZG)

NOTE: Before the neutral start switch is adjusted, make sure the adjustments for the clearance of the brake shoes and the inching/brake pedal overlap are correct.

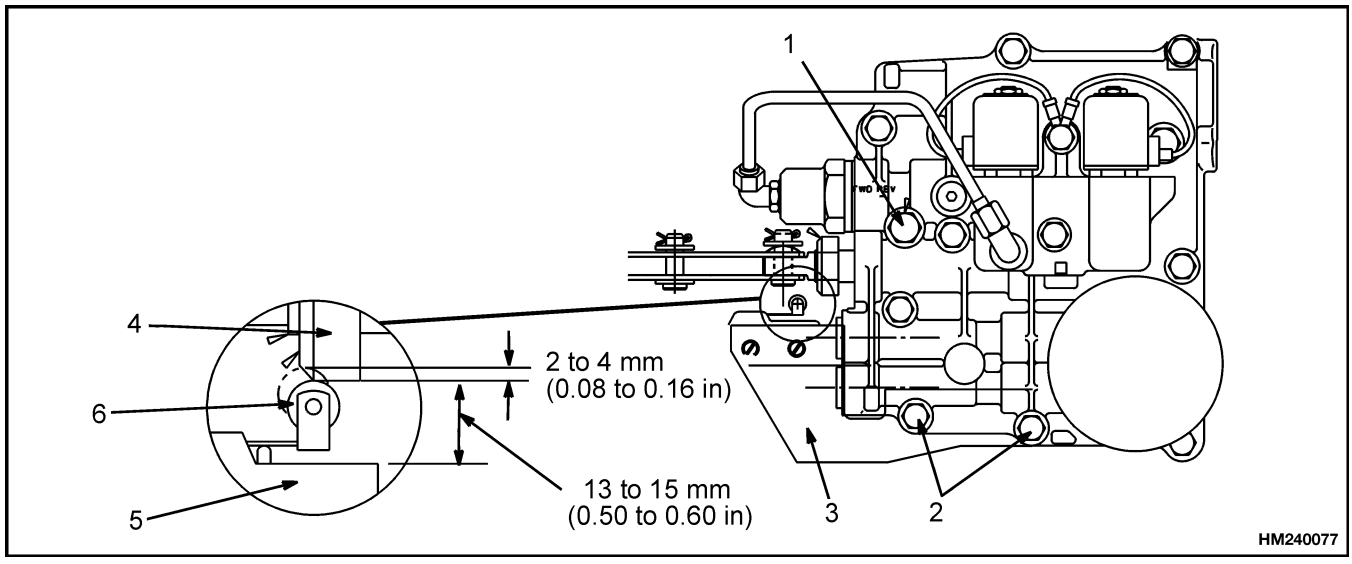
1. Put the lift truck on blocks so that the drive wheels do not touch the ground or any other object. Put blocks at either side of the steer tires to prevent forward or reverse movement of the lift truck.
2. Apply the parking brake.
3. Install a gauge that can measure 2000 kPa (300 psi) at test port for the Input (forward) clutch. See Figure 41.
4. Start the engine. Push on the left side of the Foot Directional Control pedal to put the transmission in **FORWARD**. Release the parking brake.
5. Loosen both capscrews that fasten the bracket for the neutral start switch to the transmission control valve. Do not loosen the two small screws that hold the switch to the bracket.

NOTE: This adjustment permits the inching spool to move an additional 2 to 4 mm (0.08 to 0.16 in.) inside the bore of the transmission control valve before the switch is actuated.

6. Push on the brake pedal until the gauge indicates 0 to 48 kPa (0 to 7 psi) of pressure for the Input (forward) clutch.
7. Hold the brake pedal to maintain the pressure in Step 6. Move the switch bracket so the switch roller touches leading edge of the outside diameter of the neutral start disc. See Figure 41.
8. Adjust the switch bracket [13 to 15 mm (0.50 to 0.60 in.)] so that the switch roller moves enough to actuate the switch.

NOTE: The first movement of the switch, also called free movement, is 2 to 4 mm (0.08 to 0.16 in.). The switch must move this distance before it will actuate.

9. Tighten the capscrews for the switch bracket to 19 N•m (14 lbf ft).



1. TEST PORT FOR INPUT (FORWARD) CLUTCH
2. CAPSCREWS
3. SWITCH BRACKET
4. NEUTRAL START DISC
5. NEUTRAL START SWITCH
6. SWITCH ROLLER

Figure 41. Neutral Start Switch Adjustment (Foot Directional Control Only)

General

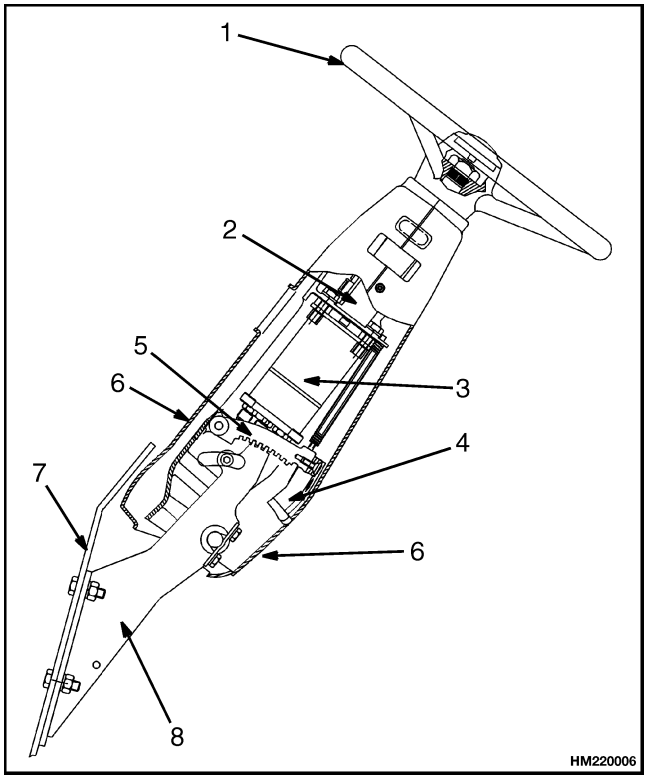
This section has the description and repair procedures for the steering housing and the steering control unit. Additional information on parts of the steering system can be found in the **Steering Axle** and **Hydraulic System** service manual sections for your lift truck.

Description

The steering column assembly uses a steering control unit with hose connections on the bottom of the unit. The steering housing has mounts for the steering column and the steering control unit. The steering wheel is installed on the steering column. See Figure 1. The housing is adjustable and is held in position by a latch. The position of the housing can be changed for operator comfort. The steering housing is also the mount for control levers and some instrument clusters.

The steering system is a hydraulic system that does not have a mechanical connection between the steering wheel and the steering axle. The control of the steering is through a hydraulic circuit.

If the hydraulic pump for the steering system does not operate, steering is still possible. A check valve permits the steering control unit to control the steering cylinder. The lift truck is difficult to steer when the steering pump is not operating, but the steering control unit can operate the steering cylinder and make steering possible.



NOTE: INSTRUMENT CLUSTER NOT SHOWN. GP/GLP/GDP2.00-3.00RF/TF (GP/GLP/GDP040-060RG/TG/ZG) SHOWN.

1. STEERING WHEEL
2. STEERING COLUMN
3. STEERING CONTROL UNIT
4. COLUMN TILT LEVER
5. LATCH
6. COVER
7. COWL
8. MOUNT

Figure 1. Steering Housing Assembly

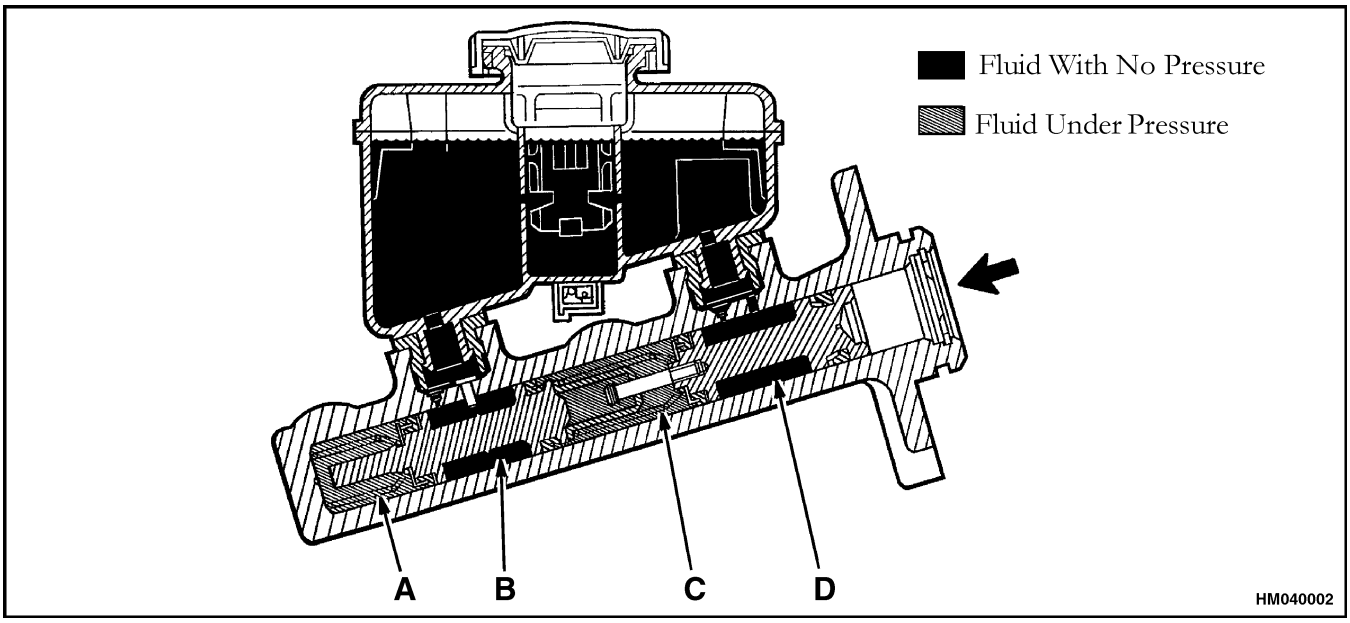


Figure 3. Master Cylinder Brake APPLIED

PARKING BRAKE

The parking brake system uses the service brake shoes. Additional linkage activates the parking brake system. When the lever is moved to apply the parking brake, the cables and linkage expand the brake shoes against the drums. The design of the parking brake linkage adjusts each cable so that the tension is the same when the lever is moved to apply the parking brake.

Service Brakes Repair

REMOVE AND DISASSEMBLE

WARNING

Brake linings can contain dangerous fibers. Breathing the dust from these brake linings is a cancer or lung disease hazard. Do not create dust! Do not clean brake parts with compressed air or by brushing. Use vacuum equipment approved for brake dust or follow the cleaning procedure in this section. When the brake drums are removed, do not create dust.

Do not sand, grind, chisel, hammer, or change linings in any way that will create dust. Any changes to brake linings must be done in a restricted area with special ventilation. Protective clothing and a respirator must be used.

1. Remove the capscrews that hold the axle shaft to the hub. Remove the axle shaft.

2. See the procedure **How to Put Lift Truck on Blocks** in the **Periodic Maintenance** section or the **Operating Manual**. Start the engine and tilt the mast fully backward. Put blocks under the mast. Tilt the mast forward until the wheels just touch the floor. Stop the engine. Put blocks under the frame of the lift truck.

3. Bend the lock plate and remove the nut that holds the axle bearing. Remove the washer and the bearing cone.

WARNING

When the brake shoes are removed, do not create dust in the air. See the Clean procedure in this section.

4. Put grease on the floor so that the wheel assembly will slide easily from the axle tube. Pull the wheel assembly from the lift truck. If the wheel assembly cannot be removed easily, use a small screwdriver to push the adjuster actuator away from the adjuster wheel. Use a brake adjustment tool or a screwdriver to turn the adjuster wheel to loosen the brake shoes. Remove the hub and drum assembly.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
The brakes do not stop the lift truck correctly. (Cont.)	A backplate is damaged.	Install new brake shoes.
	A wheel cylinder is leaking or does not operate correctly.	Repair or install a new wheel cylinder.
	The brake linings do not fit the brake drums.	Install new brake shoes.
	The master cylinder is damaged.	Repair or install a new master cylinder.
	Water or oil is on the brake linings.	Clean linings or install new brake shoes.
One brake does not release.	A brake shoe is damaged.	Install new brake shoes.
	A return spring is wrong.	Install a new spring.
	The brake lines have a restriction.	Install new brake lines.
	A parking brake cable is damaged or needs adjustment.	Adjust or install new brake cable(s).
	The wheel cylinder is damaged.	Repair or install a new wheel cylinder.
	The backplate is worn or damaged.	Install a new backplate.
The brakes do not operate equally.	Oil or brake fluid is on the linings.	Clean linings or install new brake shoes.
	The lining are worn or hard.	Install new brake shoes.
	A wheel cylinder is leaking.	Repair or install a new wheel cylinder.
	The brake shoes are not correctly installed.	Install brake shoes.
	The backplate or brake shoes are damaged.	Install new parts.
	The brake drum is not round.	Repair or install a new brake drum.
	The shoes are adjusted too tightly.	Adjust brake shoes correctly.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
The pump has leaks.	The fittings on the pump are loose or damaged.	Tighten fitting. Install new hoses. remove air from system.
	The capscrews that hold the pump together are loose.	Tighten capscrews to specified torque.
	The seals in the pump are damaged.	Replace seals.
The pressure for the steering system is below specifications.	The relief valve is not adjusted correctly.	Adjust relief valve.
	The relief valve is damaged.	Replace relief valve.
	The pump is worn.	Repair or replace pump.
The flow for the steering system is below specifications.	The flow control valve is damaged.	Repair or replace flow control valve.
	The relief valve is not adjusted correctly.	Adjust relief valve.

Troubleshooting

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
Slow or no movement of cylinders.	Air is in the hydraulic system.	Remove air from hydraulic system.
	The hydraulic pump is worn or damaged.	Repair or replace hydraulic pump.
	Restriction in the hydraulic lines.	Repair hydraulic lines.
	Cylinder seals are damaged.	Repair cylinders.
	Load is greater than capacity.	Reduce load.
	Linkage is disconnected or damaged.	Repair and adjust linkage for control levers.
	Pressure relief valve(s) is not adjusted correctly or is damaged.	Repair or adjust relief valve(s).
	Large leaks between spool and bore.	Replace valve section.
	Spool is not fully extended or retracted.	Adjust linkage to spool.
Oil leaks at the end of a spool.	Seal for spool is damaged.	Replace seal.
	Spool is damaged.	Replace valve section.
	Valve body is damaged.	Replace valve section.
Spool will not move or is difficult to move.	Linkage is disconnected or damaged.	Repair and adjust linkage.
	Return spring is damaged.	Replace spring.
	The spool or bore is damaged.	Replace valve section.
Spool will not return to neutral.	Linkage is disconnected or damaged.	Repair and adjust linkage.
	Return spring is damaged.	Replace spring.
	Dirt between spool and the bore.	Clean valve.
	Spool is bent or damaged.	Replace valve section.
Hydraulic pressure is above specifications.	Pressure relief valve(s) is not adjusted correctly or is damaged.	Repair or adjust relief valve(s).
	Restriction in return line.	Clean or replace return line or filter.

Cluster-Type Display Panel (Internal Combustion) Replacement

REMOVE

CAUTION

To prevent damage to electrical components, disconnect the negative battery cable before doing repairs.

The instrument panel unit can be removed to install a new gauge or a new light bulb. The metal back plate must be removed for access to the sockets that hold the light bulbs for the warning and illumination lights. See Figure 2, Figure 7, and Figure 8. Remove and disassemble the unit as follows:

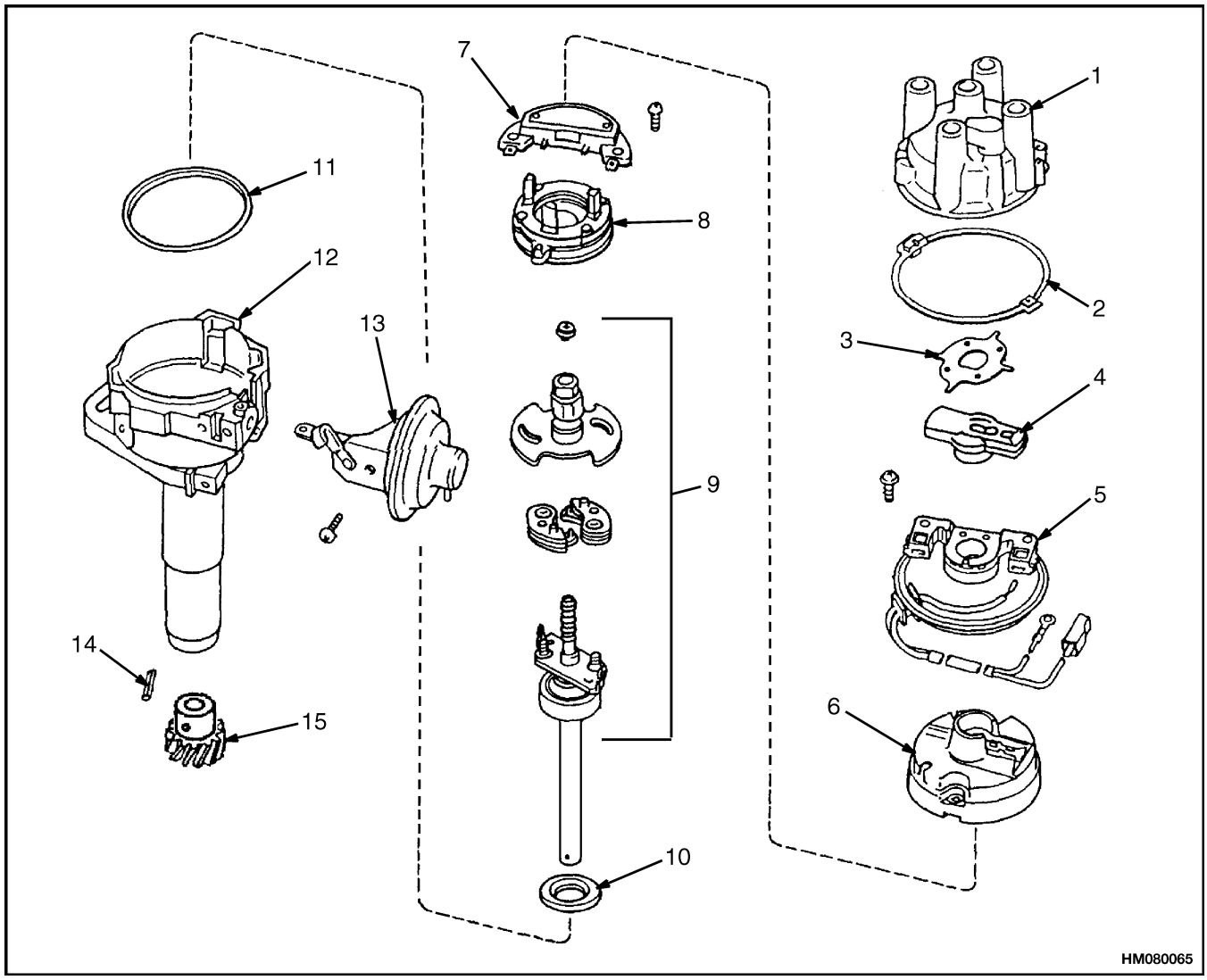
1. Disconnect the battery.
2. Loosen the two screws and nuts that fasten the mount bracket to the cowl.
3. Disconnect the three wire connectors. Carefully lift the unit up through the hole in the panel.

NOTE: DO NOT lift the plastic tabs to remove the hood unless the gauges need replacing. The fuel and coolant temperature gauges are fastened to the printed circuit board with nuts. The hourmeter is fastened to the body with finger nuts near the connector.

4. Remove the five screws that fasten the metal back plate to the gauge body.
5. Turn the socket counterclockwise to remove the socket and light bulb from the printed circuit board.
6. Replace parts in the instrument panel as necessary.

INSTALL

1. Install the parts in the instrument panel that were removed or replaced. If the hood was removed, make sure the seal is installed correctly around the glass so that water does not leak into the gauges. See Figure 2, Figure 7, and Figure 8.
2. Make sure the back plate is correctly aligned for installation of the wire connectors.
3. Install the instrument panel in the lift truck. Connect the wire connectors. Install and tighten the two screws and nuts that hold the instrument panel in the lift truck.
4. Connect the battery. Check that the gauges and indicators operate as described in Table 1.



1. CAP
2. HEAT SINK
3. SIGNAL ROTOR
4. ROTOR
5. PICKUP ASSEMBLY
6. COVER
7. ELECTRONIC MODULE
8. BREAKER ASSEMBLY
9. TIMING ADVANCE UNIT
10. OIL SEAL
11. SEAL
12. HOUSING
13. VACUUM ADVANCE UNIT
14. ROLL PIN
15. DRIVE GEAR

Figure 7. Distributor Parts GP/GLP/GDP16-20AF/BF (GP/GLP/GDP030-040AF/BF), GC/GLC030-040AF, and GLP/GDP16-20AF (GP/GLP/GDP030-040AF)

5. Install cover and pickup assembly. Install rotor and signal rotor.

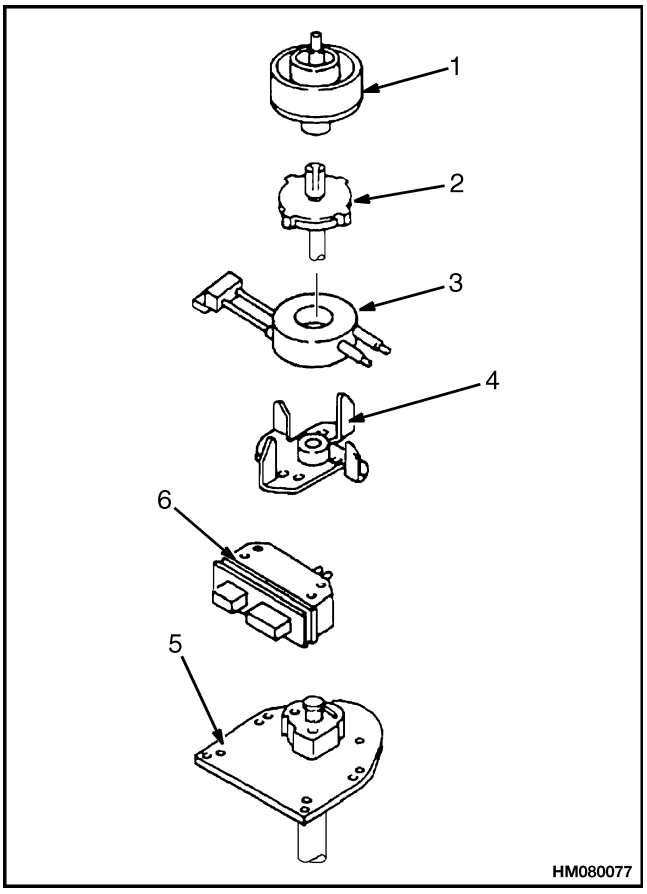
6. Install heat sink and distributor cap.

⚠ CAUTION

If the engine crankshaft has been moved since the distributor was removed, see the repair procedures for the engine to correctly install the distributor. Do not do Step 7.

7. Align marks on engine and distributor housing. Align rotor with mark on the distributor housing and move rotor to correct position. When installation is correct, rotor/distributor housing mark and distributor housing/engine marks will all be correctly aligned. Tighten capscrews that fasten housing to engine.

8. Connect wires to distributor. If necessary, connect spark plug wires to correct spark plugs. Connect vacuum line to vacuum advance mechanism.



1. ROTOR
2. TIMER CORE/SHAFT
3. SENSING COIL
4. POLE PIECE
5. HOUSING
6. IGNITION MODULE

Figure 2. Distributor

The principle of magnetic induction also controls the polarity of the voltage generated in the coil. An increasing magnetic field will generate a voltage in the coil that is the opposite polarity of a magnetic field that is decreasing. This signal pulse causes the integrated circuits in the ignition module to generate a square wave signal. The ignition module and a magnetic pulse generator control the primary circuit to the ignition coil when the engine is started. After the engine is started, the MSTS module receives the square wave signal from the magnetic pulse generator and ignition module as one of the signals to control the EST. The pole piece has the same number of teeth as the engine has cylinders so that a spark voltage is correctly sent to each spark plug as the shaft in the distributor rotates.

IGNITION MODULE

The ignition module is a solid-state electronic device that operates like a fast switch except that it does not have any moving or mechanical parts. See Figure 3. Small electrical pulses from the sensing coil of the pulse generator go to the ignition module.

The MSTS module must always know the speed at which the engine is operating. The engine speed signal is generated by the ignition module. The signal converter in the ignition module changes the signal voltage from the sensing coil to a square wave reference signal to the MSTS module. This square wave reference signal for engine speed is called REF HI. The MSTS module must also have a reference to compare with REF HI. An additional wire between the MSTS module and the ignition module is called "REF LO". The REF HI and REF LO connections give the PROM in the MSTS module the necessary information about engine speed.

The other two wires between the MSTS module and the distributor control the Electronic Spark Timing and are called EST and BYPASS.

NOTE: The ignition module controls spark timing only when the engine is being started. The MSTS module controls the spark timing during engine operation. The ignition module will also control the spark timing if there are some failures in the signals to the MSTS module. This backup mode of operation will often permit operation of the engine so that the lift truck can be moved to an area for repair. The results of the failures in signals to the MSTS module are described in the paragraphs under MSTS Module Corrections.

Distributor Repair

A distributor with a separate ignition coil is used on all MSTS engines. The ignition coil is connected to the rotor in the distributor through a high-voltage wire. The operation of the ignition module and the magnetic pulse generator is described under Operation at the beginning of this section.

When the current in the primary circuit of the ignition coil quickly decreases, the induction in the secondary circuit sends a high-voltage pulse (35,000 volts) to the rotor in the distributor. The rotor is aligned with one of the leads to a spark plug wire and this high-voltage pulse is sent to one of the spark plugs.

REMOVE

CAUTION

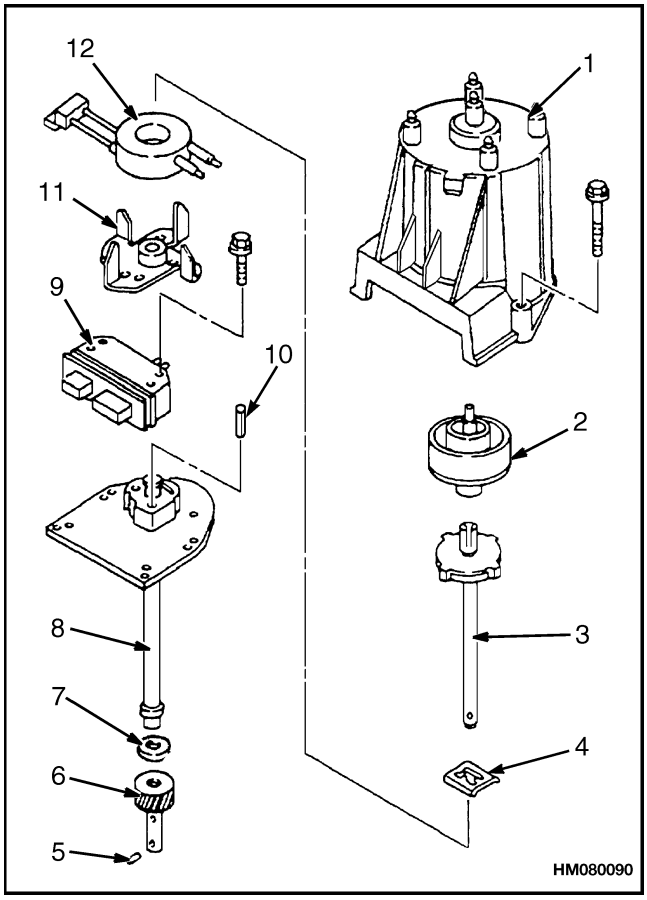
Carefully lift and release the lock tabs on the connectors to the distributor. The lock tabs can be easily broken if too much force is applied with a screwdriver or other tool.

Never permit the TACH CONN. terminal to touch ground. The ignition module or the ignition coil can be damaged.

1. Disconnect the battery negative (ground) cable.
2. If removal of the spark plug wires is not required for the repairs, leave them connected to the distributor cap. Remove the two capscrews that fasten the distributor cap to the distributor. Move the distributor cap away from the work area.
3. Disconnect the distributor four-terminal connector.
4. Disconnect the ignition coil connector.
5. Remove the bolt and clamp that hold the distributor in the engine. Make a note of the positions of the rotor to distributor housing and the distributor to the engine. Slowly pull the distributor from the engine until the rotor just stops turning counterclockwise and make a note of the position of the rotor. This position must be used when the distributor is installed again.

DISASSEMBLE

1. Remove the rotor. See Figure 18. Make a matchmark on the gear and the shaft so they can be assembled in the same position.



1. CAP
2. ROTOR
3. SHAFT/TIMER CORE
4. RETAINER
5. PIN
6. DRIVE GEAR
7. SEAL
8. HOUSING
9. MODULE
10. ALIGNMENT PIN
11. POLE PIECE
12. COIL

Figure 18. Distributor

2. Use a punch to remove the roll pin from the shaft.
3. Remove the gear.
4. Remove the shaft with the timer core from the housing.
5. Remove the retainer from the housing. Use a screwdriver as a pry bar.
6. Disconnect the sensing coil from the ignition module.

TROUBLESHOOTING CHARTS

WARNING

This troubleshooting requires operation of the engine for some tests. Make sure the tests are done carefully to prevent injury:

- **Put the lift truck on a level surface. Lower the carriage and forks and apply the parking brake. Make sure the lift truck cannot move and cause an injury during the tests. Use blocks as necessary to prevent movement of the lift truck.**
- **The fuel system and the engine must operate correctly. Any problems or leaks in the fuel system and the engine must be repaired before doing troubleshooting.**
- **The fan and the drive belts can remove fingers or cause other injuries. Be careful that your hands and tools do not touch the moving fan or the drive belts.**
- **The engine exhaust and other parts of the engine are hot. Do not touch a hot surface and cause a burn.**

CAUTION

Electronic equipment can be damaged if troubleshooting and repairs are not done correctly. The following CAUTIONS must be followed when doing troubleshooting or repairs on an engine with an ECM:

- **Always disconnect the battery negative cable before disconnecting and removing any parts except as described in Troubleshooting.**
- **Never start the engine unless the battery is correctly connected.**
- **Never disconnect the battery from any equipment when the engine is running.**
- **Never disconnect the battery from the charging system when the engine is running.**
- **If the battery must be charged with a battery charger, ALWAYS disconnect the battery from the electrical system.**
- **Make sure all electrical connections are clean and have good electrical contact.**
- **Never connect or disconnect the wiring harness at the ECM when the key switch is ON.**
- **Never disconnect a jumper wire between the terminals of the Diagnostic Link Connector (DLC).**
- **Always disconnect the battery and the ECM connectors if electric-arc-welding must be done on the vehicle.**
- **If the engine compartment is cleaned with steam, make sure any water or steam is not sent toward the ECM or its sensors. The heat and steam can damage the electronic components and cause corrosion in the electrical connections.**
- **Use only the tools and test equipment described in Tools and Test Equipment to prevent damage to good components and to obtain correct test results.**
- **All voltage measurements must be made with a digital voltmeter with a rating of 10 megohm input impedance.**
- **When a test light is used in troubleshooting, the test light must have less than 0.3 amps (300 milliamps) of maximum current flow. A test for a correct test light is shown in Figure 5.**

The troubleshooting charts found in this section are designed to give an efficient method of fault analysis on the electronic engine controls.

TOOLS AND TEST EQUIPMENT

The following tools are necessary for troubleshooting the system:

- Ohmmeter.
- Digital voltmeter. The voltmeter must have a minimum input impedance of 10-megohms. (A digital voltmeter and ohmmeter are normally included in a multimeter test instrument.)
- Tachometer with inductive trigger signal sensor.
- Test light that has a low current draw as described in Figure 5.
- Vacuum pump with a gauge. This vacuum pump is held and operated with the hand. The gauge must be able to indicate a gauge pressure (vacuum) of 34 kPa (10 inHg). (See the Pressure Conversion Chart at the end of this section.)
- Spark tester. The spark tester is used to check the secondary ignition. The spark tester is also called an ST125 and creates a 25-kilovolt load on secondary ignition components.

DTC 14 - Engine Coolant Temperature Sensor Circuit (High Temperature Indicated)

CIRCUIT DESCRIPTION

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies a reference voltage on circuit GQ to the sensor. When the engine is cold, the sensor (thermistor) resistance is high. The ECM will then sense a high signal voltage. See Figure 22.

As the engine warms up, the sensor resistance decreases and the voltage drops. The ECM reads this voltage as a temperature.

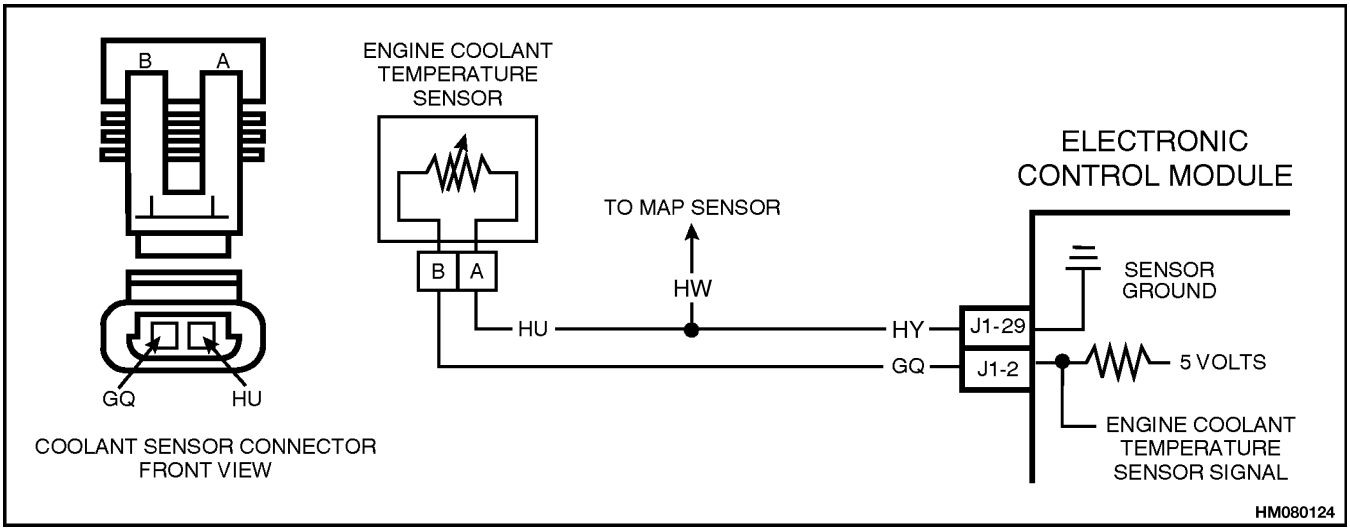


Figure 22. DTC 14 - Circuit Description

TEST DESCRIPTION

The numbers below are a reference to the bold numbers in Figure 23.

1. This test checks to see if DTC 14 was set as result of current failure or intermittent condition. DTC 14 will set if signal voltage indicates a coolant temperature above 135°C (275°F) for 3 seconds.

2. This test causes the conditions for a DTC 15. If the ECM sees the open circuit (high voltage) and displays a low temperature, the ECM and wiring are correct.

OTHER TROUBLESHOOTING CHECKS

Check for the following:

- After the engine is started, the temperature will increase steadily to about 80°C (180°F), then remain there when the thermostat opens.
- If the engine has been allowed to cool to an ambient temperature (overnight), the coolant reading on the SCAN Tool will be that ambient temperature.
- A DTC 14 will occur if circuit GQ has a short circuit to ground.
- Use Table 3 to test the accuracy of the sensor.
- If DTC 14 is not constant, see Troubleshooting, Poor Operation.

Table 3. ECT Sensor - Temp. vs Resistance

°C	°F	Ohms
100	212	177
70	158	467
40	104	1459
20	68	3520
5	41	7280
−10	14	16,180
−20	−4	28,680
−40	−40	100,700

Checks:

Make a careful visual check as described in the earlier paragraphs.

- Fuel injector and TBI for fuel leaks. Use A-7 - Fuel System Troubleshooting.

FAULT: BACKFIRE

Definition:

Fuel explodes in intake manifold, or in exhaust system, making loud noise.

Check:

Make a careful visual check as described in the earlier paragraphs.

IGNITION SYSTEM

- Correct output from ignition coil with spark tester.
- Spark plugs. Remove spark plugs, check for wet or dirty plugs, cracks, wear, wrong gap, damaged electrodes or insulators. Repair or replace as necessary. Also, check spark plug wires.
- Spark plug wires for damage and correct installation. Inspect Ignition Coil assembly.
- Do fuel system tests. Use A-7 - Fuel System Troubleshooting.

ENGINE

- Compression - Look for valves that stick or leak.
- Valve timing. See Engine Service Manual.
- Intake and exhaust manifold passages for restrictions.

Engine Coolant Temperature (ECT) Sensor Test

NOTE: For location of components, complete engine electronic wiring diagrams, and ECM wiring harness connector terminal end views, see illustrations at the end of this section.

The ECT, using the following procedure, can be tested at different temperatures. A volt/ohmmeter, a thermometer, engine coolant, and something to heat the coolant will be needed for the test.

1. Heat the coolant to one of the temperatures shown on the chart.
2. Position the ECT sensor sensing end into the heated coolant.
3. Wait about 60 seconds to allow the coolant to heat the sensor.
4. Test the sensor resistance and compare the reading to those in Table 6.
5. Sensors with a reading within 10 percent of the specifications can be used.

Table 6. ECT Sensor - Temperature vs. Resistance

°C	°F	Ohms
100	212	177
90	194	214
80	176	332
70	158	467

Table 6. ECT Sensor - Temperature vs. Resistance (Continued)

°C	°F	Ohms
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
−5	23	12,300
−10	14	16,180
−15	5	21,450
−20	−4	28,680
−30	−22	52,700
−40	−40	100,700

4. Remove the test light from pin **B** (BYPASS) while the engine is running. If the engine stops, this check shows that the ignition module internally changes the EST circuit to ground. Since there is a jumper wire between pin **D** (EST) to pin **C** (REFERENCE), the REFERENCE signal is also sent to ground and the engine stops.
5. If any tests described in Step 2, Step 3, or Step 4 do not work as indicated, check the wiring harness for a short circuit or an open circuit. If the wiring harness is good, replace the ignition module.
6. When the tests are complete, connect the system for normal operation.

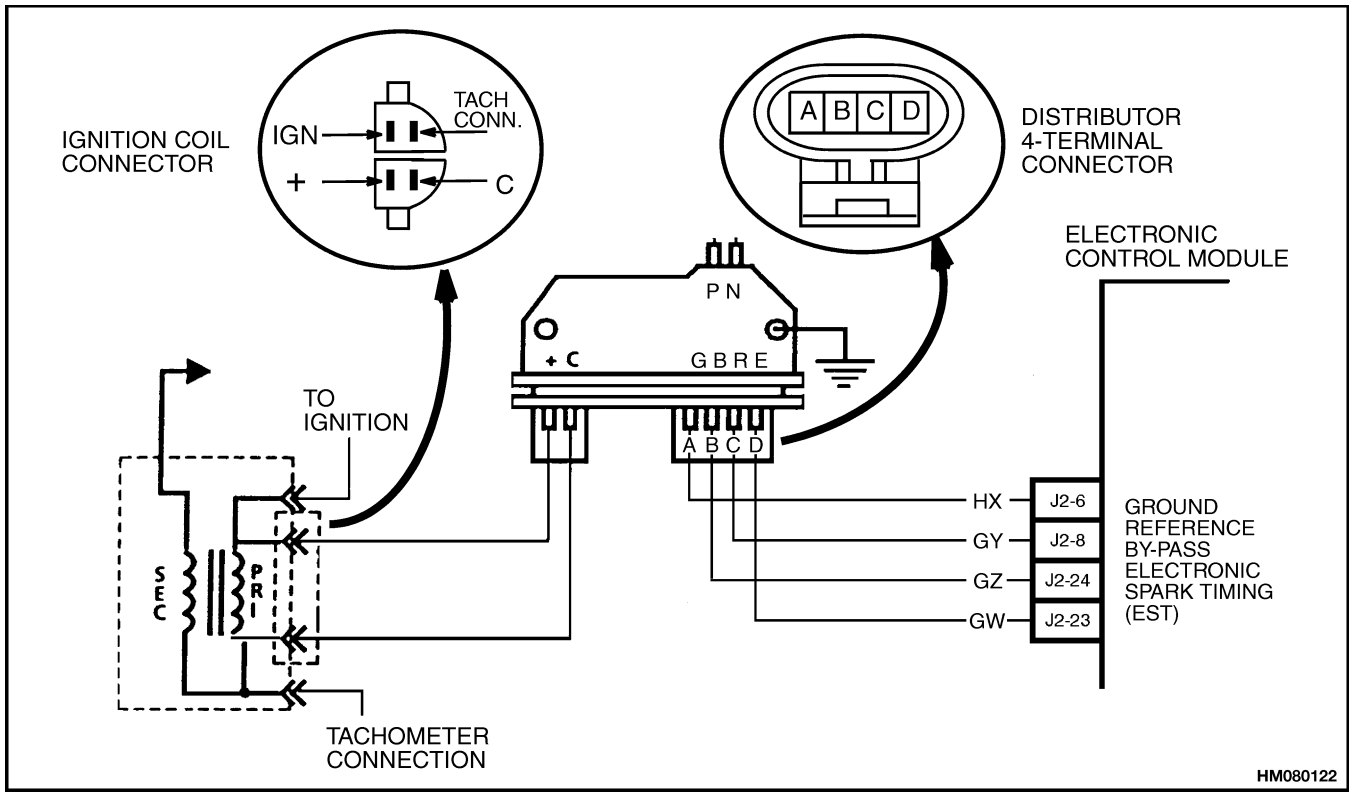


Figure 62. Ignition Module Test

IGNITION MODULE, REPLACE

1. Remove the distributor cap and rotor. See Figure 61.
2. Remove the two screws that hold the ignition module in the distributor.
3. Lift the ignition module and disconnect the connections. Make a note of the connections so that they can be correctly connected again. Remove the ignition module from the distributor.

NOTE: Do not remove the silicon grease from the ignition module or the distributor if the same ignition module will be installed again. If a new ignition module is installed, a small container of silicon grease is in the package. Clean the old silicon grease and apply a new layer of silicon grease to both the ignition module and the distributor housing. This silicon grease is necessary for cooling the ignition module.

4. Connect the connectors in the distributor to the ignition module. Make sure the connectors are the same as when they were removed.
5. Install the ignition module in the distributor.
6. Install the two screws that fasten the ignition module in the distributor.
7. Install the distributor cap and rotor.

General

This section has a description of the electronic engine control system. The troubleshooting and repair procedures for the parts of the electronic engine controls are in the section **Electronic Engine Control - Troubleshooting and Repair** 2200 YRM 611.

Description and Operation

GENERAL

An Electronic Control Module (ECM) is the main component of this control system. The ECM is a small computer that controls the ignition timing and fuel supply in the gasoline engine. The ECM has the information for the best operation of the engine according to the fuel, temperature, load, and other conditions. The ECM has sensors that give information about engine operation and the systems it controls. The ECM can do some diagnosis of itself and of other parts of the system. When a problem is found, the ECM turns on the Malfunction Indicator lamp on the instrument panel and a diagnostic trouble code is stored in the ECM memory.

ELECTRONIC CONTROL MODULE (ECM)

The Electronic Control Module (ECM) is the control center of the fuel injection system. See Figure 1. It constantly monitors the information from the sensors, and controls the components and systems which affect engine operation.

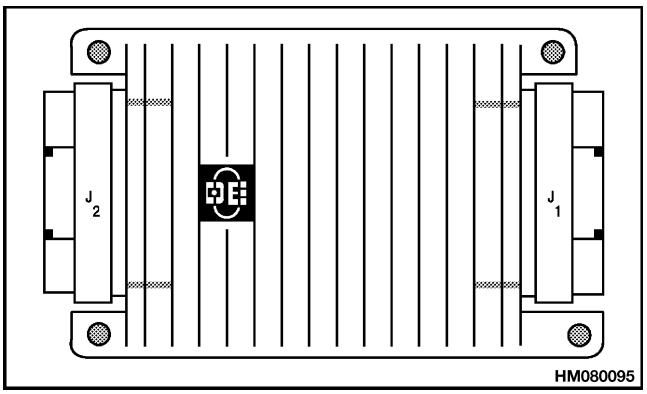
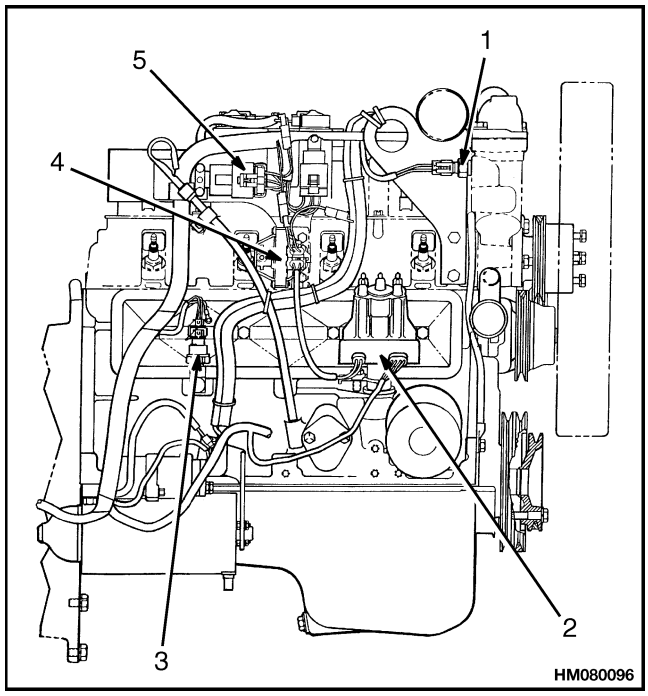


Figure 1. ECM

The ECM also performs the diagnostic function of the system. It can sense problems, activate the Malfunction Indicator lamp, and store a diagnostic trouble code or codes (DTC). The ECM controls the following systems and components for the best fuel use and engine performance (see Figure 2 and Figure 3):

- Fuel Injection System
- Electric Spark Timing (EST)
- An electronic governor
- Check Engine light
- Idle air control (IAC)
- Fuel pump relay
- Diagnostic link connector (DLC) for troubleshooting



1. ENGINE COOLANT TEMPERATURE (ECT) SENSOR
2. DISTRIBUTOR
3. OIL PRESSURE/FUEL PUMP SWITCH
4. IGNITION COIL
5. FUEL PUMP RELAY

Figure 2. Electronic Engine Control Components Arrangement (Side View)

Two lift chains move the carriage. The chains fasten to mounts that are near the top of the lift cylinder shells. The chains go up and over the chain sheaves and connect to the carriage. The chain sheaves are installed at the top crossmember of the inner weldment. When the lift cylinders extend, the lift chains transfer the force from the lift cylinders to the carriage. The inner weldment and carriage can raise a small amount before the overall height of the mast increases. During lifting, the inner weldment moves at the same speed as the lift cylinders. The carriage moves at twice the speed of the inner weldment.

When the lift cylinders retract, the weight of the load, carriage, and inner weldment pushes the oil from the lift cylinders. The oil flows from the lowering control valves in the lift cylinders, through the external lowering control valve to the hydraulic tank.

Each cylinder has a check valve in the bottom of the rod assembly. When the cylinder is fully extended, oil above the piston is forced through the check valve. This action allows the cylinder to fully extend. See Cylinder Cushion During Lowering Sequence.

Legend for Figure 6

NOTE: TYPICAL MAST ASSEMBLY IS SHOWN HERE.

1. OUTER WELDMENT
2. INNER WELDMENT
3. LIFT CHAIN(S)
4. LIFT CYLINDER(S)
5. LOWERING CONTROL VALVE (EXTERNAL)

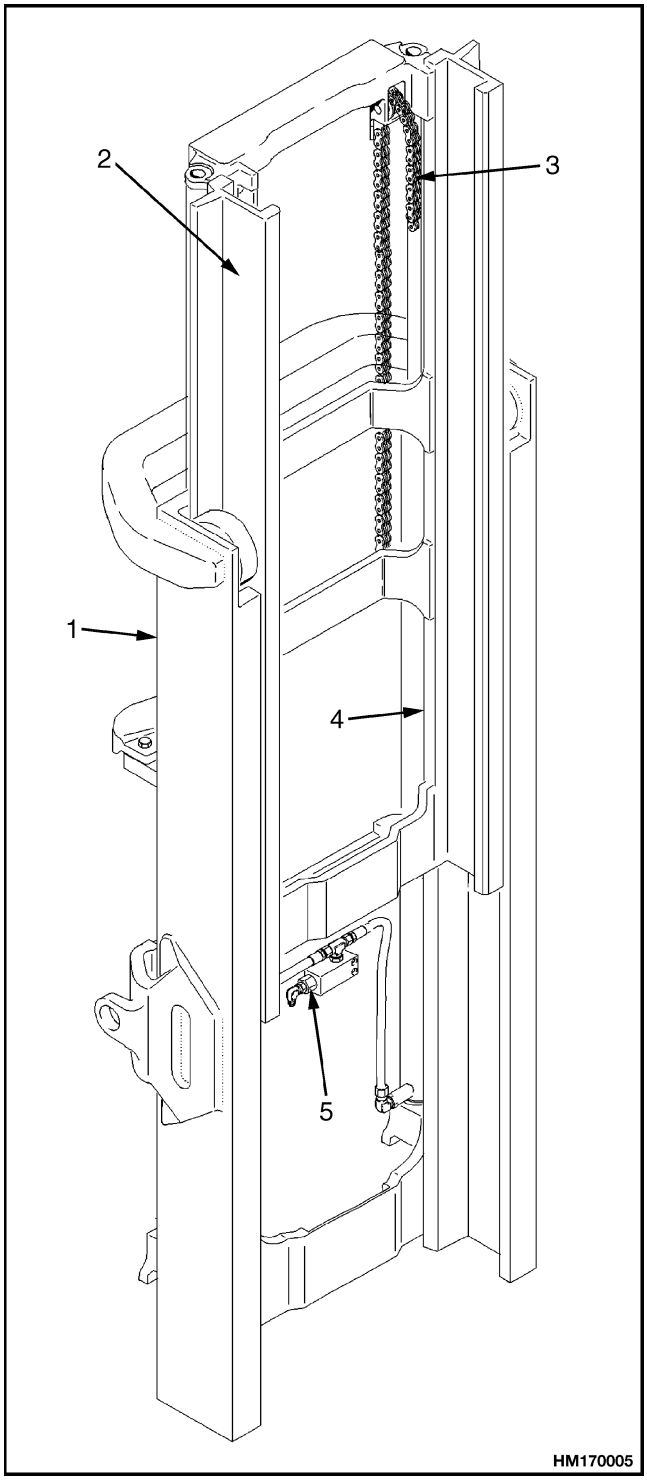
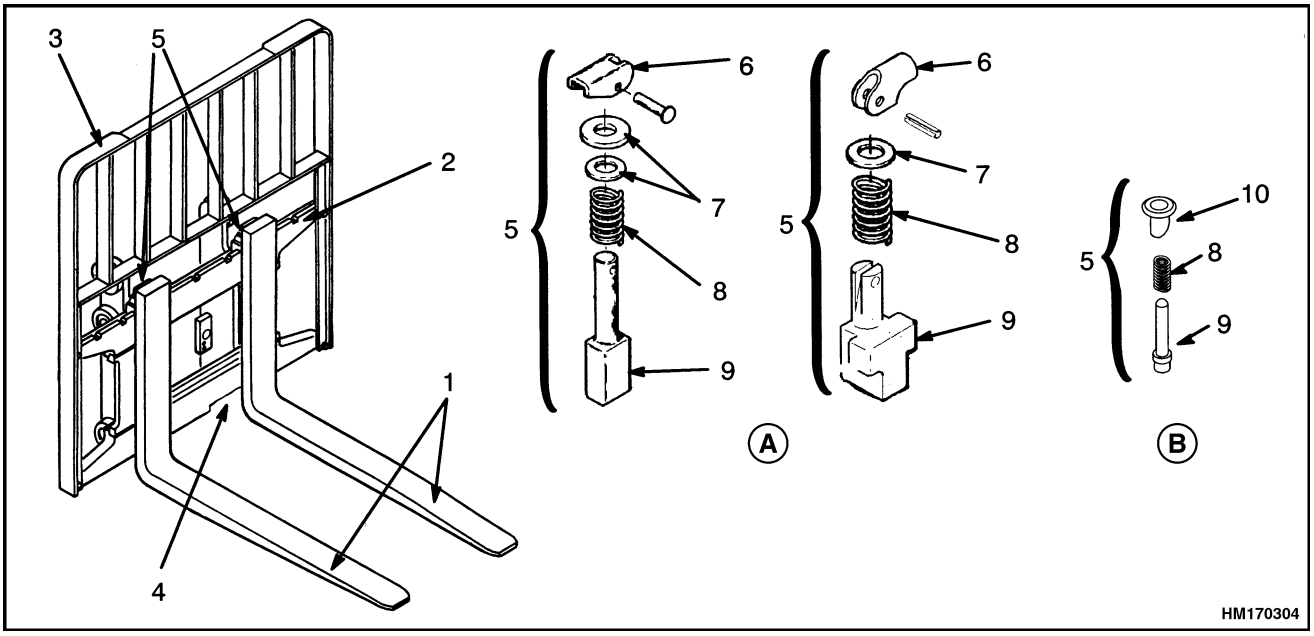


Figure 6. Two-Stage Mast, Limited Free-Lift (LFL)



A. EARLIER MODELS **B.** LATER MODELS

1. FORKS
2. CARRIAGE
3. LOAD BACKREST EXTENSION
4. FORK REMOVAL NOTCH
5. LATCH PIN ASSEMBLY
6. LEVER
7. WASHER
8. SPRING
9. PIN
10. KNOB

Figure 3. Carriage and Forks

THREE-STAGE FFL MAST

Disassemble

WARNING

Always wear the proper protective equipment including eye protection and petroleum-resistant gloves when handling hydraulic oil. Thoroughly wash oil from exposed areas of skin as soon as possible.

Completely lower forks to relieve hydraulic pressure before disassembling any part of the lift pump or disconnecting any hoses.

Hydraulic oil is hot at normal operating temperatures. Be careful when draining the oil.

CAUTION

Protect the hydraulic system from dirt and contaminants when servicing the hydraulic system.

1. Disconnect the main free-lift chains at the crossmember. See Figure 18.

2. Disconnect and remove the hydraulic lines for the main free-lift cylinder. Remove the brackets for the main free-lift cylinder. Remove the main free-lift cylinder.

3. Disconnect the main lift chains from the chain anchors near the top of the main lift cylinders. Disconnect the other end of the main lift chains at the bottom of the inner mast weldment. Push the inner mast weldment toward the bottom of the mast assembly until the bottom load rollers can be seen.

WARNING

The weldments can slide when the mast is moved. A weldment that slides can cause injury. Use a crane to turn the mast slowly and carefully.

4. Remove the strip bearings at the top of the intermediate mast weldment. Remove the load rollers at the bottom of the inner mast weldment. Remove the load rollers at the top of the intermediate mast weldment. Make a note of each shim arrangement and load roller location. The shim arrangements will be approximately the same during assembly.

WARNING

The mast is heavy. The mast can weigh approximately 681 kg (1501 lb). Make sure all lifting devices (hoists, cables, chains, slings, etc.) are suitable and of adequate capacity to lift the mast.

5. Slide the inner mast weldment halfway out of the top of the intermediate mast weldment. Connect a crane with a capacity of at least 681 kg (1501 lb) to the center of the inner mast weldment. See Figure 17. Slide the inner mast weldment out of the intermediate mast weldment until the stub shafts are in the notches of the intermediate mast weldment. Remove the inner mast weldment from the intermediate mast weldment.

WARNING

Be careful when removing or installing snap rings. These snap rings can come loose during removal or installation with enough force to cause an injury. Always use the correct snap ring pliers, and wear eye and face protection during removal or installation.

6. Remove the snap rings and washers at the top of the main lift cylinders. Remove the nut, bolt, and spacer at the mount near the top of each main lift cylinder.

7. Push the intermediate mast weldment to disengage the main lift cylinders. Remove the main lift cylinders.

8. Slide the intermediate mast weldment from the bottom of the outer mast weldment approximately 30 cm (12 in.). Remove the strip bearings at the top of the outer mast weldment. Remove the snap rings and load rollers from both weldments. Make a note of each shim arrangement and load roller location. The shim arrangements will be approximately the same during assembly.

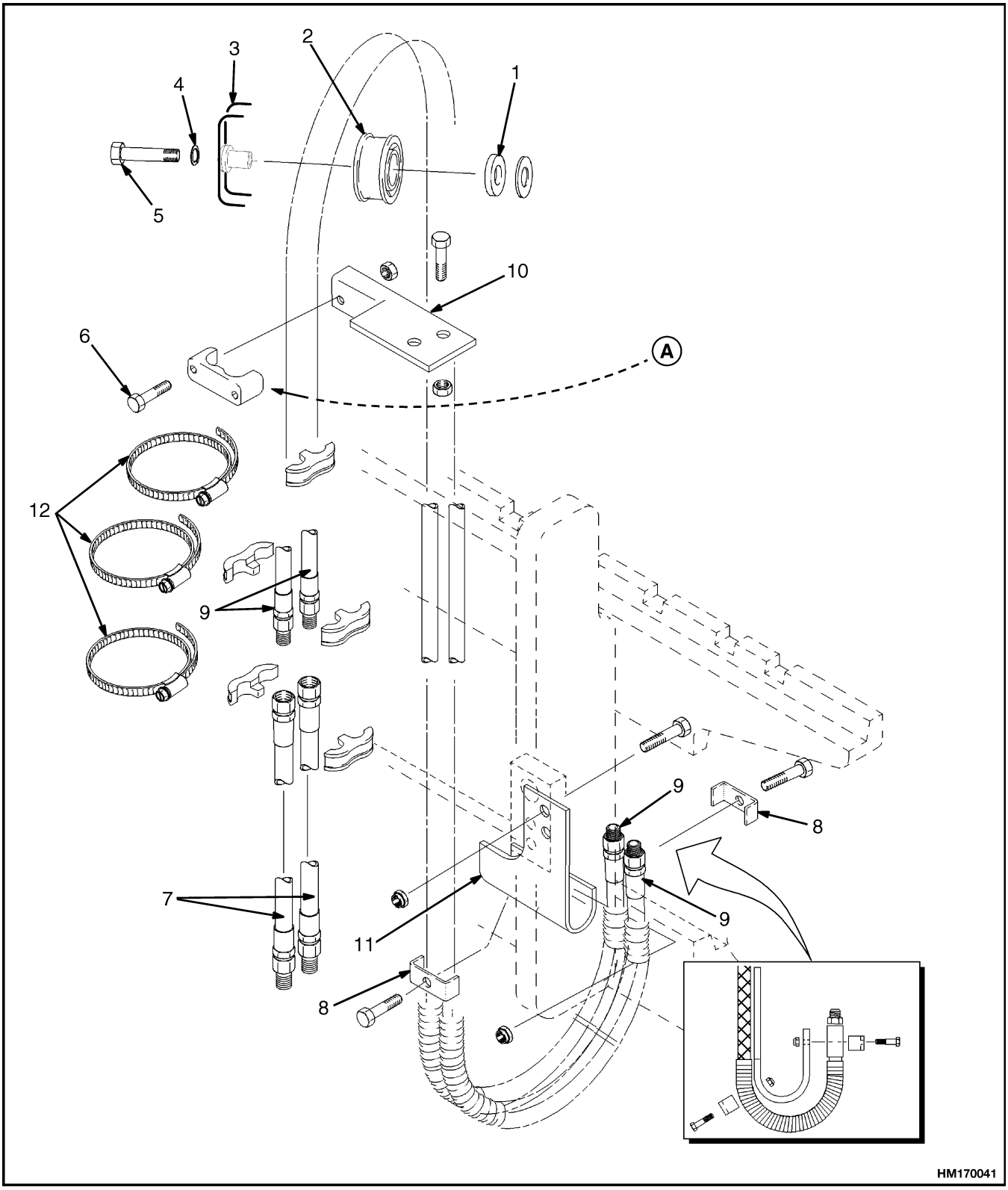


Figure 28. Header Hoses, Two-Stage Limited Free-Lift Mast

Header Hose Arrangement

NOTE: This is the Header Hose Arrangement for GP/GLP/GDP16-20AF/BF (GP/GLP/GDP030-040AF/BF), GC/GLC030-040AF, GLP/GDP16-20AF (GP/GLP/GDP030-040AF), ERC/P16-20AAF (ERC030-040AF, AG/BG) (A814), ERC/P16-20AAF (ERC030-040AH) (B814), and ERP1.60-1.80-2.00ATF (ERP030-040TH) models.

NOTE: Hoses have a service life that is determined by application and time. All hoses must be inspected at the intervals specified in the **Maintenance Schedule** for the hydraulic system. Install a new hose if the hose is worn, damaged, soft or hard, and no longer flexible. If necessary, make a comparison to a new hose that is the correct replacement for the hose you are inspecting.

Some lift trucks have auxiliary hydraulic equipment that is attached to the carriage. Examples of auxiliary equipment are a sideshift carriage or a roll clamp. These auxiliary functions require arrangements of header hoses for their operation.

TWO-STAGE LFL MAST, NEW HOSE INSTALL

WARNING

Before working on or near the mast, see Safety Procedures When Working Near Mast in this section.

NOTE: This procedure is for the four-function option. The three-function option will have hoses **A** and **B** only.

NOTE: The lift chains and carriage height must be correctly adjusted before the header hoses can be adjusted. See the section Lift Chains Adjustment for adjustment procedures.

1. Mark each hose with a single letter: **A**, **B**, **C**, or **D**. See Figure 29, Figure 37, and Figure 38.
2. Use a calculator to calculate dimension **E**. See Figure 37.
3. Clamp the end of the hose (the smaller fitting) that attaches to the carriage in a vise (do NOT clamp on the threads), and pull on the other end until the hose is straight. Do NOT apply enough force to stretch the hose. See Figure 37.
4. Mark all the hoses with dimension **E** (all measurements are made from the carriage end of the hose [the smaller fitting]). See Figure 37.
5. Attach the hoses to the carriage brackets with the clamps. See Figure 38.
6. Place the hoses at the location of the hose sheave. The hose sheave and stub shaft must be assembled on to the hose before they are attached to the mast. Tighten the mounting hardware to 66 N•m (49 lbf ft).

Tilt Cylinders Adjustment

WARNING

When the tilt cylinders have tilt limit spacers, make sure they are installed during installation procedures. Without the tilt limit spacers, the mast can tilt too much and cause an accident or serious injury.

Check the tilt cylinder stroke by slowly tilting the mast fully forward and backward several times. Both tilt cylinders must stop their stroke at the same time. Adjust the rod ends as shown in Figure 45, Figure 46, and Figure 47. There must be no twist in the mast weldments.

1. Adjust the stroke of the tilt cylinders WITHOUT tilt limit spacers as follows:

   a. Adjust the rod ends to 15 mm (0.6 in.) for all tilt cylinders shown in Figure 45, and 32.00 mm (1.25 in.) for all tilt cylinders shown in Figure 47.

   b. Slowly tilt the mast backward until one cylinder rod stops. On the opposite cylinder, loosen the capscrews on the rod end. Measure the distance from the end of cylinder to the back end of the rod end. Use a wrench and turn the cylinder rod IN until the dimension starts to decrease, then stop. Repeat this procedure until both cylinder rods stop at the same position within 1.00 mm (0.04 in.). After the adjustments are complete, tighten the capscrews on the rod ends.

   c. Tilt the mast fully backward and measure the tilt angle. (See the nameplate for tilt angles.) If necessary, adjust both rod ends equally for the correct angle.

2. Adjust the stroke of the tilt cylinders WITH tilt limit spacers as follows:

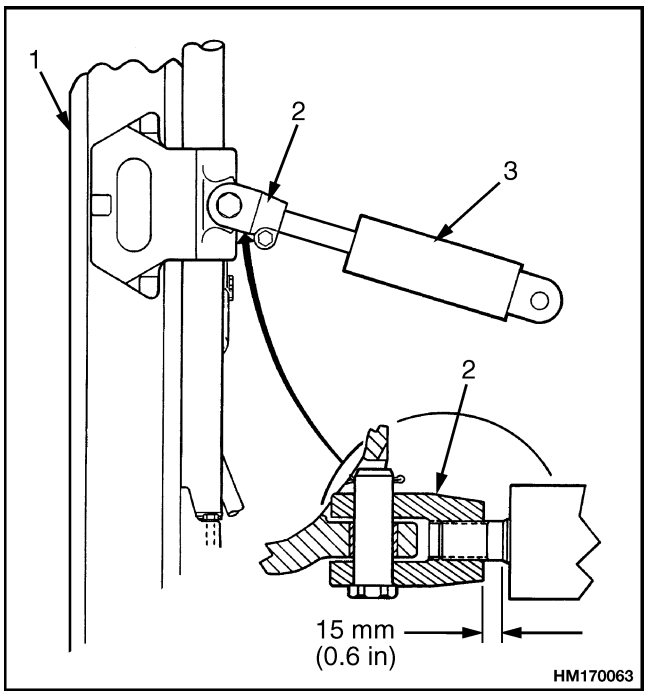
   a. Adjust the rod ends to 15.0 mm (0.6 in.) for all tilt cylinders as shown in Figure 46.

   b. Slowly tilt the mast forward until one cylinder rod stops. On the opposite cylinder, loosen the capscrews on the rod end. Use a wrench and turn the cylinder rod IN as necessary. Repeat this procedure until both cylinder rods stop at the same position within 1.00 mm (0.04 in.).

   c. Slowly tilt the mast backward until one rod end just contacts the spacer. Add shims to fill the gap at the opposite rod end until both rod ends contact the spacers within 0.50 mm (0.02 in.).

   d. After the adjustments are complete, tighten the capscrews on the rod ends.

   e. Tilt the mast fully backward and measure the tilt angle. (See the nameplate for tilt angles.) If necessary, add an equal number of shims to both rods for the correct angle.



NOTE: THE END OF THE ROD IS EVEN WITH THE FRONT FACE OF THE ROD END.

1. MAST
2. ROD ENDS
3. TILT CYLINDER

Figure 45. Tilt Cylinder Adjustment for GP/GLP/GDP16-20AF/BF (GP/GLP/GDP030-040AF/BF), GC/GLC030-040AF, GLP/GDP16-20AF (GP/GLP/GDP030-040AF), and ERC/P12-16-20AAF (ERC030-040AG/BG) (A814), and ERC/P16-20AAF (ERC030-040AH) (B814)

Table 1. Maintenance Schedule (Continued)

Item No.	Item	8 hr/ 1 day	250 hr/ 6 wk	500 hr/ 3 mo	1000 hr/ 6 mo	2000 hr/ 1 yr	Procedure or Quantity	Specification
	Engine Speed Idle Speed GM 3.0L (Aisan Closed Loop)		X				Adjust as Required	775 to 825 rpm
	Engine Speed Idle Speed GM 3.0L (Aisan Open Loop)		X				Adjust as Required	775 to 825 rpm
	Engine Speed Idle Speed Mazda XA and HA Powershift Transmission		X				Adjust as Required See	700 to 750 rpm
	Engine Speed Governed Speed Mazda FE (Gasoline)		X				Adjust as Required	2350 to 2550 rpm
	Engine Speed Governed Speed Mazda F2 (Gasoline)		X				Adjust as Required	2700 to 2800 rpm
	Engine Speed Governed Speed Mazda FE (IMPCO)		X				Adjust as Required	2600 to 2700 rpm
	Engine Speed Governed Speed Mazda FE and F2 (Aisan Closed Loop)		X				Adjust as Required	2700 to 2800 rpm
	Engine Speed Governed Speed Mazda FE and F2 (Aisan Closed Loop)		X					2700 to 2800 rpm
	Engine Speed Governed Speed GM 3.0L (Gasoline and LPG [IMPCO])		X				Adjust as Required	2850 to 2950 rpm
	Engine Speed Governed Speed GM 3.0L (Aisan Open Loop) GC/GLC040-065RG/ TG/ZG		X					2800 ±50 rpm
	Engine Speed Governed Speed GM 3.0L (Aisan Open Loop) GLP040-060RG/ TG/ZG		X					2900 ±50 rpm
X=Check C=Change L=Lubricate CIL=Check Indicator Light during operation								

FORKS

WARNING

Never repair damaged forks. Do not heat, weld, or bend the forks. Forks are made of special steel using special methods. Replace damaged forks.

1. Check heel and attachment points of forks with a penetrant or magnetic particle inspection.

2. Measure thickness of forks at a vertical section where there is no wear. This thickness is dimension X. Now measure thickness at heel of fork (Figure 7). If the thickness of the heel is not greater than 90% of dimension X, replace fork.

LIFT CHAINS

Lubrication

WARNING

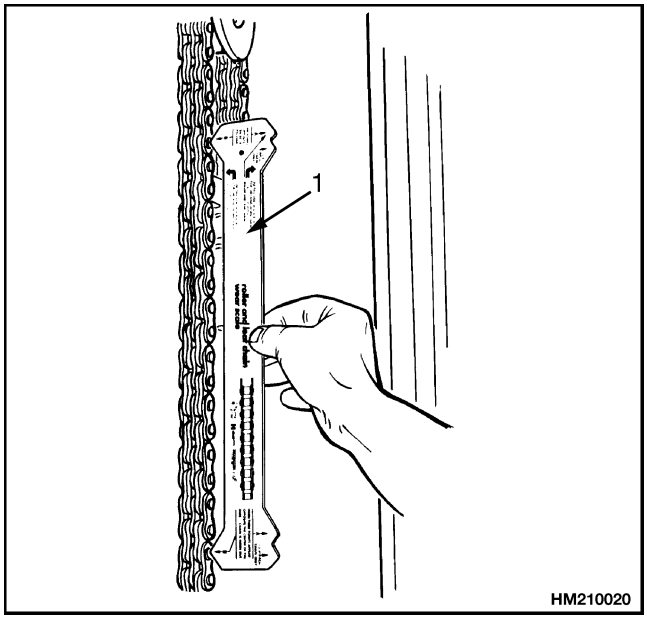
When working on or near the mast, see Safety Procedures When Working Near Mast in this section.

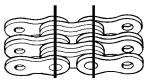
Do not repair a worn or damaged lift chain. If a lift chain is worn or damaged, both lift chains must be replaced.

Lubricate lift chains with SAE 30 engine oil. The best procedure is to remove the chains from the lift truck and soak them in engine oil. Be sure to clean any grease or dirt from chains before lubricating. DO NOT USE STEAM TO CLEAN THE LIFT CHAINS.

Wear, Check

If a section of chain is 3% longer than a similar section of new chain, the chain is worn and must be replaced. Measure chain for wear where it moves over sheaves. If a chain scale is available, check lift chains as shown in Figure 23. If a chain scale is not available, measure 20 links of chain. Measure from the center of a pin to the center of another pin 20 pitches away. Compare the length with the chart in Figure 23. Replace the chain if the length of 20 links of the worn section is more than the wear limit.



Pitch 	Total Length of 20 Links (Pitch) of New Chain	Wear Limit (The Maximum Length of 20 Links)
12.7 mm (0.50 in.)	254.0 mm (10.0 in.)	261.6 mm (10.3 in.)
15.9 mm (0.63 in.)	317.5 mm (12.5 in.)	327.0 mm (12.9 in.)
19.1 mm (0.75 in.)	381.0 mm (15.0 in.)	392.4 mm (15.4 in.)
25.4 mm (1.00 in.)	508.0 mm (20.0 in.)	523.3 mm (20.6 in.)

NOTE: INSTRUCTIONS FOR MEASURING CHAIN WEAR ARE SHOWN ON CHAIN WEAR SCALE.

1. CHAIN WEAR SCALE

Figure 23. Lift Chains Check

Lift and Tilt System Leak Check

LIFT CYLINDER, LEAK CHECK

1. Operate hydraulic system. Put a capacity load on forks and raise and lower load several times. Lower load and tilt mast forward and backward several times. Check for leaks.

2. Raise carriage and load 1 m (3 ft). If the carriage slowly lowers when the control valve is in the **NEUTRAL** position, there are leaks inside the hydraulic system. The maximum speed the carriage is allowed to lower is 50 mm (2 in.) per 10 minutes when the hydraulic oil is 30°C (86°F). If the oil temperature is 70°C (158°F), the maximum speed the carriage can lower is 150 mm (6 in.) per 10 minutes.

3. Check lift cylinder for internal leaks. Remove load from forks. Install gate valve in supply line between main control valve and mast. Put a capacity load on forks again. Raise carriage 1 m (3 ft). Close gate valve. If the carriage or mast weldments lower slowly, the seals in the lift cylinders have leaks.

4. If the carriage does not move, open gate valve and check movement again. If the carriage lowers when the gate valve is open, check for leaks in hydraulic lines and fittings. If no leaks are found, the main control valve can be worn or damaged. Remove load from forks.

TILT CYLINDER, LEAK CHECK

1. Put a capacity load on forks. Slowly tilt mast forward. If the mast continues to slowly tilt forward when the control valve is in the **NEUTRAL** position, there are leaks inside the hydraulic system. The maximum speed the mast is allowed to tilt forward when there are internal leaks in the lift system is 15 mm (0.6 in.) per 10 minutes (measured at rod in the tilt cylinder). The maximum speed is measured when the hydraulic oil is 30°C (86°F). If the oil temperature is 60°C (140°F), the maximum speed the carriage can lower is 68 mm (3 in.) per 10 minutes.

2. If the leak rate is greater than the specifications, remove load from mast. Install a valve between port at front of tilt cylinder and hydraulic line. Put load on forks again. Close valve. If the mast tilts slowly forward, the cylinder seals are leaking.

3. If the mast does not move, open gate valve and check movement again. If the mast moves forward when the gate valve is open, check for leaks in hydraulic lines and fittings. If no leaks are found, the main control valve can be worn or damaged. Remove load from forks when checks are complete.

Charging Battery

If the battery becomes discharged and requires a booster battery to start the engine, follow these procedures carefully when connecting the jumper cables:

1. Always connect positive jumper cable to positive terminal of discharged battery and negative jumper cable to negative terminal.

2. Always connect jumper cable that is the ground cable last.

3. Always connect jumper cables to discharged battery before connecting them to booster battery.

Item	Quantity
Fuel Tank	
Mazda FE Engine	44.3 liter (11.7 gal)
Mazda F2 Engine	44.3 liter (11.7 gal)
GM 3.0L Engine	39.4 liter (10.4 gal)
Mazda XA Diesel	54.5 liter (14.4 gal)
Mazda HA Diesel	54.5 liter (14.4 gal)
Brake Fluid	0.2 liter (0.4 pt)

Electrical System

GASOLINE/LPG

Item	Mazda FE and F2 Engines	GM 3.0L Engine
All Models	12-volt, negative ground	12-volt, negative ground
Alternator Output (Hot)	37 amps @ 2700 rpm	56 amps @ 2600 rpm
Ignition Timing		
Gasoline	0° BTDC	Electronic Timing
LPG	9° BTDC	Electronic Timing
Spark Plugs	ND W9 EXR-U	AC R44 LTSMA
Spark Plug Gap	0.8 mm (0.031 in.)	1.1 mm (0.043 in.)

DIESEL

Item	Mazda XA Diesel	Mazda HA Diesel
GDP20-30RF/TF (GDP040-060RG/TG/ZG)	12 volt, negative ground	12 volt, negative ground
Alternator Output (Hot)	56 amps @ 2800 rpm	56 amps @ 2200 rpm

BRAKE SYSTEM

Wheel Cylinder Capscrews
18 to 27 N•m (159 to 239 lbf in)

Back Plate-to-Axle Mount Capscrews
GC040-065RG/TG 255 N•m (188 lbf ft)
GP20-30RF/TF (GP040-060RG/TG/ZG)
225 N•m (166 lbf ft)

MAST

Lift Cylinder Mount Bolts
53 N•m (40 lbf ft)

Mast Pivot Capscrews
90 N•m (66 lbf ft)

STEERING SYSTEM

Axle Mount Capscrews
88 N•m (65 lbf ft)

Steering Cylinder Mount
GC040-065RG/TG 121 N•m (89 lbf ft)
GP20-30RF/TF (GP040-060RG/TG/ZG)
225 N•m (166 lbf ft)

Tie Rods GC040-065RG/TG Only
163 N•m (120 lbf ft)

Lower Spindle Cap GC040-065RG/TG Only
44 N•m (32 lbf ft)

Kingpin Nut GP20-30RF/TF (GP040-060RG/TG/ZG) Only
90 N•m (66 lbf ft) initial
34 N•m (25 lbf ft) final

Wheel Bearings
200 N•m (150 lbf ft) initial
34 N•m (25 lbf ft) final

Wheel Nuts GP20-30RF/TF (GP040-060RG/TG/ZG) Only
Two-Piece Wheels 237 to 305 N•m (175 to 225 lbf ft)
Three-Piece Wheels 155 N•m (115 lbf ft)

DRIVE AXLE

Back Plate-to-Axle Mount Capscrews
GC040-065RG/TG 255 N•m (188 lbf ft)
GP20-30RF/TF (GP040-060RG/TG/ZG)
225 N•m (166 lbf ft)

Axle Mounts GC040-065RG/TG
Torque Wrench on Head of Bolt 780 N•m (575 lbf ft)
Torque Wrench on Nut of Bolt 715 N•m (527 lbf ft)

Axle Mounts GP20-30RF/TF (GP040-060RG/TG/ZG)
Torque Wrench on Head of Bolt 540 N•m (400 lbf ft)
Torque Wrench on Nut of Bolt 473 N•m (350 lbf ft)

Spindle-to-Differential Housing Capscrews
GP20-30RF/TF (GP040-060RG/TG/ZG)
Only 66 N•m (50 lbf ft)

Axle Housings to Differential Housing
GC040-065RG/TG Only 90 N•m (66 lbf ft)

Differential Housing to Diff. Adapter Housing
GC040-065RG/TG Only 38 N•m (28 lbf ft)

Axle Shaft Capscrews
GC040-065RG/TG 90 N•m (66 lbf ft)
GP20-30RF/TF (GP040-060RG/TG/ZG)
98 N•m (72 lbf ft)

Wheel Nuts
GC040-065RG/TG 237 to 305 N•m (175 to 225 lbf ft)
GP20-30RF/TF (GP040-060RG/TG/ZG)
490 to 510 N•m (361 to3760 lbf ft)

Wheel Bearing Lock Nuts
GP20-30RF/TF (GP040-060RG/TG/ZG)
205 N•m (150 lbf ft) initial
GP20-30RF/TF (GP040-060RG/TG/ZG)
35 N•m (25 lbf ft) final
GC040-065RG/TG 205 N•m (150 lbf ft) initial
GC040-065RG/TG 35 N•m (25 lbf ft) final
GC040-065RG/TG Newer Models 68 N•m
(50 lbf ft) initial
GC040-065RG/TG Newer Models 3 N•m
(27 lbf in) final

TRANSMISSION AND DIFFERENTIAL

Control Valve Capscrews
19 N•m (168 lbf in)

Front Cover Capscrews
38 N•m (28 lbf ft)

Torque Converter Drive Plate Capscrews
GC040-065RG/TG 38 N•m (28 lbf ft)
GP20-30RF/TF (GP040-060RG/TG/ZG)
45 N•m (33 lbf ft)

Torque Converter Housing
GP20-30RF/TF (GP040-060RG/TG/ZG)
Only 38 N•m (28 lbf ft)

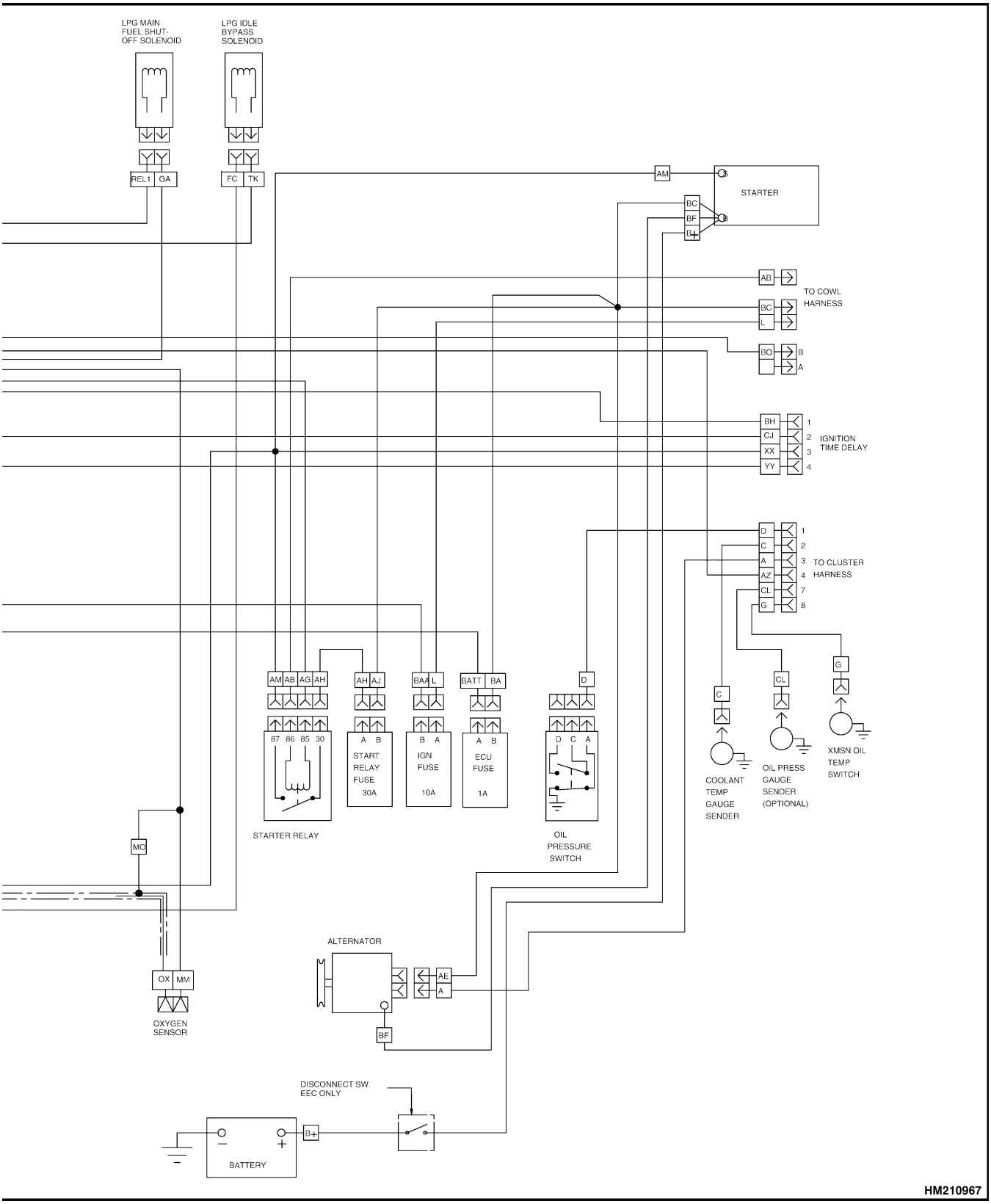
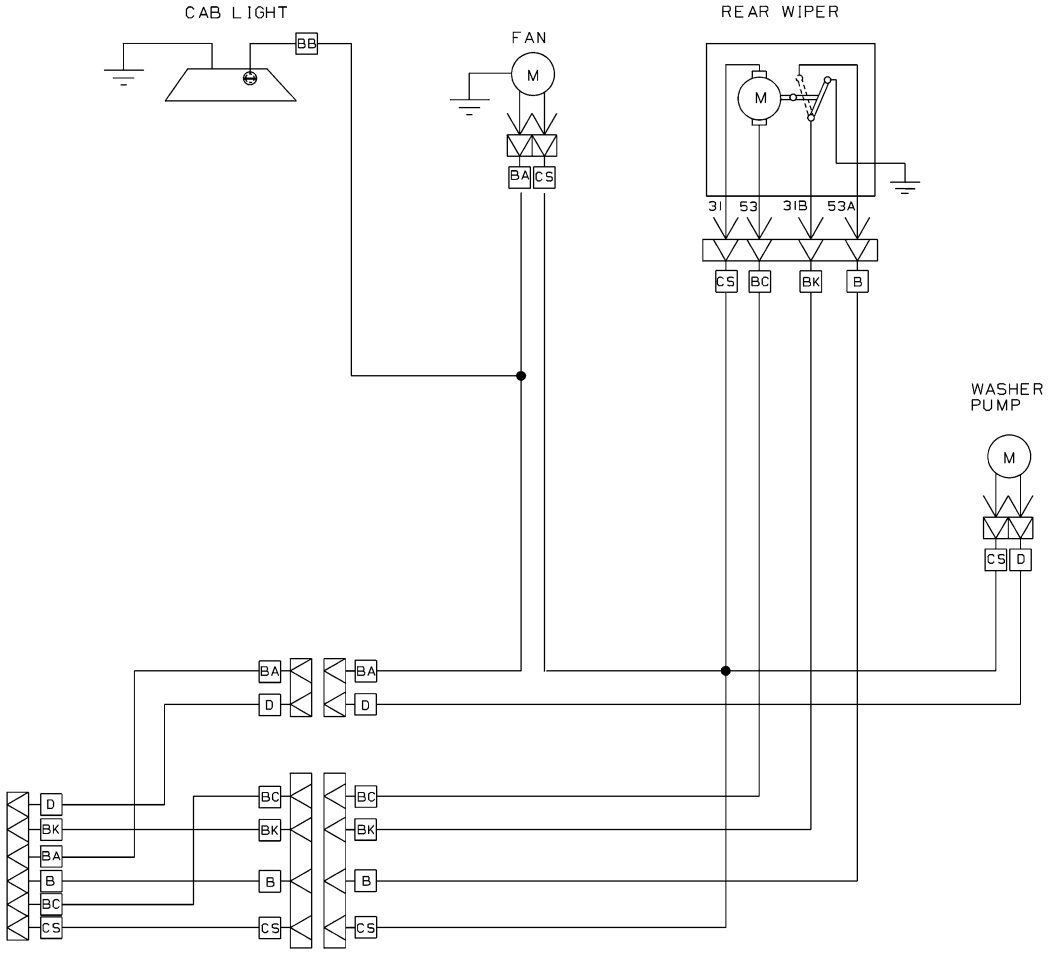


Figure 6. GM 3.0L Engine Wiring Harness LPG Closed Loop (Sheet 1 of 2)

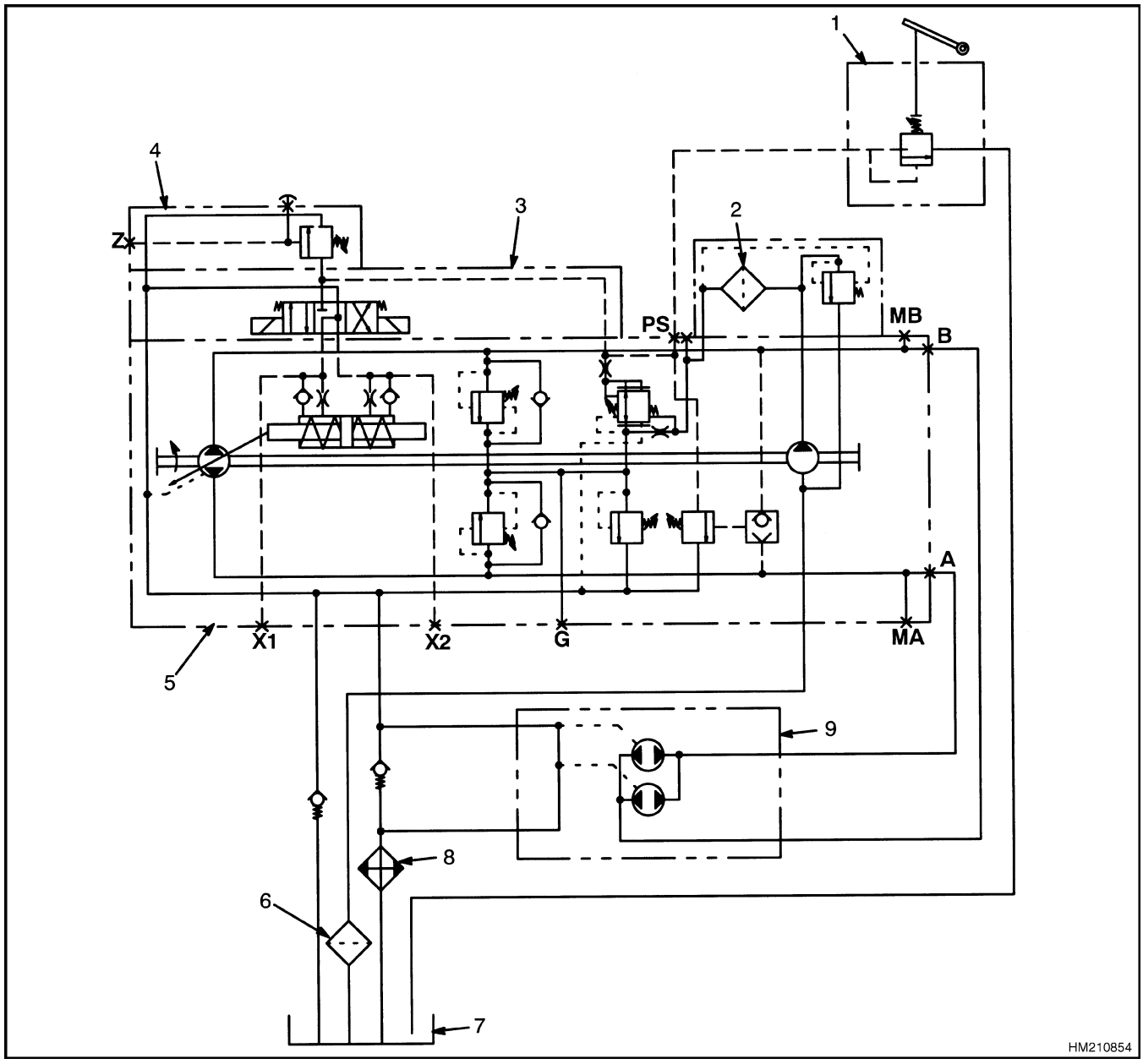


ELECTRICAL WIRE CODES

WIRE	COLOR	GAUGE
A	BROWN	16
B	BROWN	16
C	BRN/WHITE	18
D	BLK/WHITE	18
BA	RED/YELLOW	16
BB	WHITE	18
BC	ORANGE	18
BD	RED	16
BF	RED/YELLOW	16
BG	BROWN	14
BH	WHITE	16
BJ	ORANGE	16
BK	ORANGE/BLK	18
CR	DARK GREEN	16
CS	BLACK	16
EE	BLACK	16
FD	YELLOW/RED	16

HM210086

Figure 18. Cab Wiring Schematic



1. THROTTLE CONTROL
2. TRANSMISSION FILTER
3. DIRECTION CONTROL VALVE
4. BRAKE INCHING VALVE
5. HYDROSTATIC TRANSMISSION PUMP
6. SCREEN
7. TRANSMISSION RESERVOIR
8. OIL COOLER
9. WHEEL MOTORS

Figure 29. Hydraulic Schematic for Hydrostatic Drive System

Camshaft Repair

REMOVE

NOTE: The camshaft is normally removed during disassembly of the engine. Use the following procedures to remove the camshaft while the engine is assembled.

1. Remove the valve cover. See Figure 1. Remove the rocker arm assembly and the push rods. Remove the fuel pump from the engine block.
2. Remove the oil pan and the oil pump.
3. Remove the timing gear cover. See Figure 1.
4. Turn the engine upside down to keep the tappets from falling out.
5. Remove the capscrews for the camshaft timing gear. Remove the capscrews and thrust plate for the camshaft. Pull the camshaft from the engine.

INSPECT AND REPAIR

1. Check the camshaft for cracks or damage.
2. Measure the height of the camshaft lobes. The minimum height of the intake and exhaust lobes are 42.478 mm (1.6724 in.). Measure the camshaft journals at four points; **A, B, C, and D.** See Figure 22. The minimum dimensions for the journals are shown in Table 1.

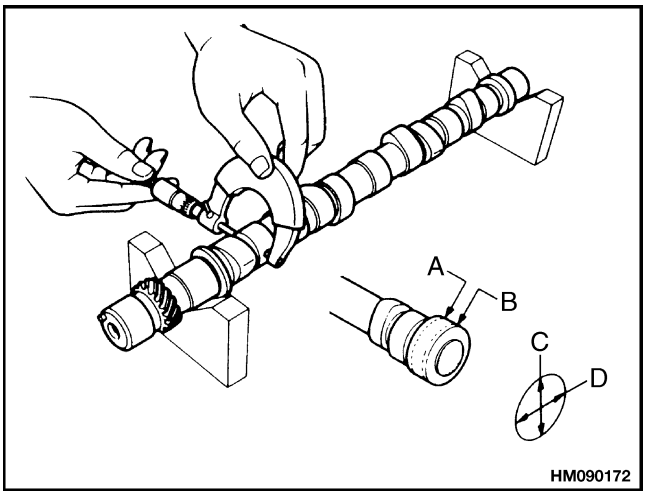


Figure 22. Camshaft Inspection

Table 1. Camshaft Journal Diameters

Camshaft	Journal Diameter	Limit
No. 1	51.910 to 51.940 mm (2.0437 to 2.0449 in.)	51.902 mm (2.0434 in.)
No. 2	51.660 to 51.690 mm (2.0339 to 2.0350 in.)	51.652 mm (2.0335 in.)
No. 3	51.410 to 51.440 mm (2.0240 to 2.0252 in.)	51.402 mm (2.0237 in.)
No. 4	51.160 to 51.190 mm (2.0142 to 2.0154 in.)	51.152 mm (2.0139 in.)

3. Check the camshaft to make sure it is straight. Put the front and rear journals in V blocks and rotate the camshaft one complete turn. See Figure 23. The maximum amount that the dial indicator can indicate is 0.08 mm (0.0003 in.).
4. Measure the clearance between the camshaft journals and the bore in the engine block. See Figure 24. The correct clearance between a journal and its corresponding bore is 0.145 mm (0.0057 in.). If any of the clearances are greater than the specifications, replace the engine block or camshaft as necessary.

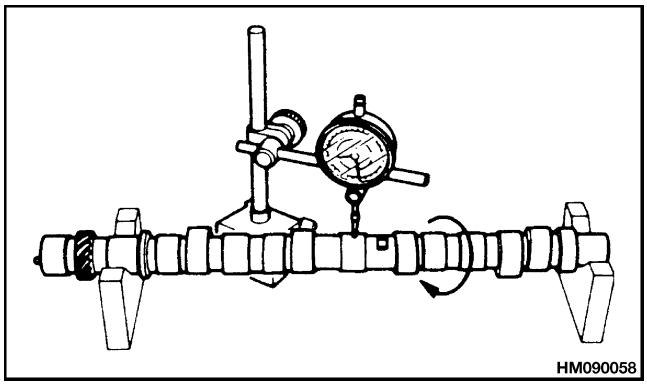
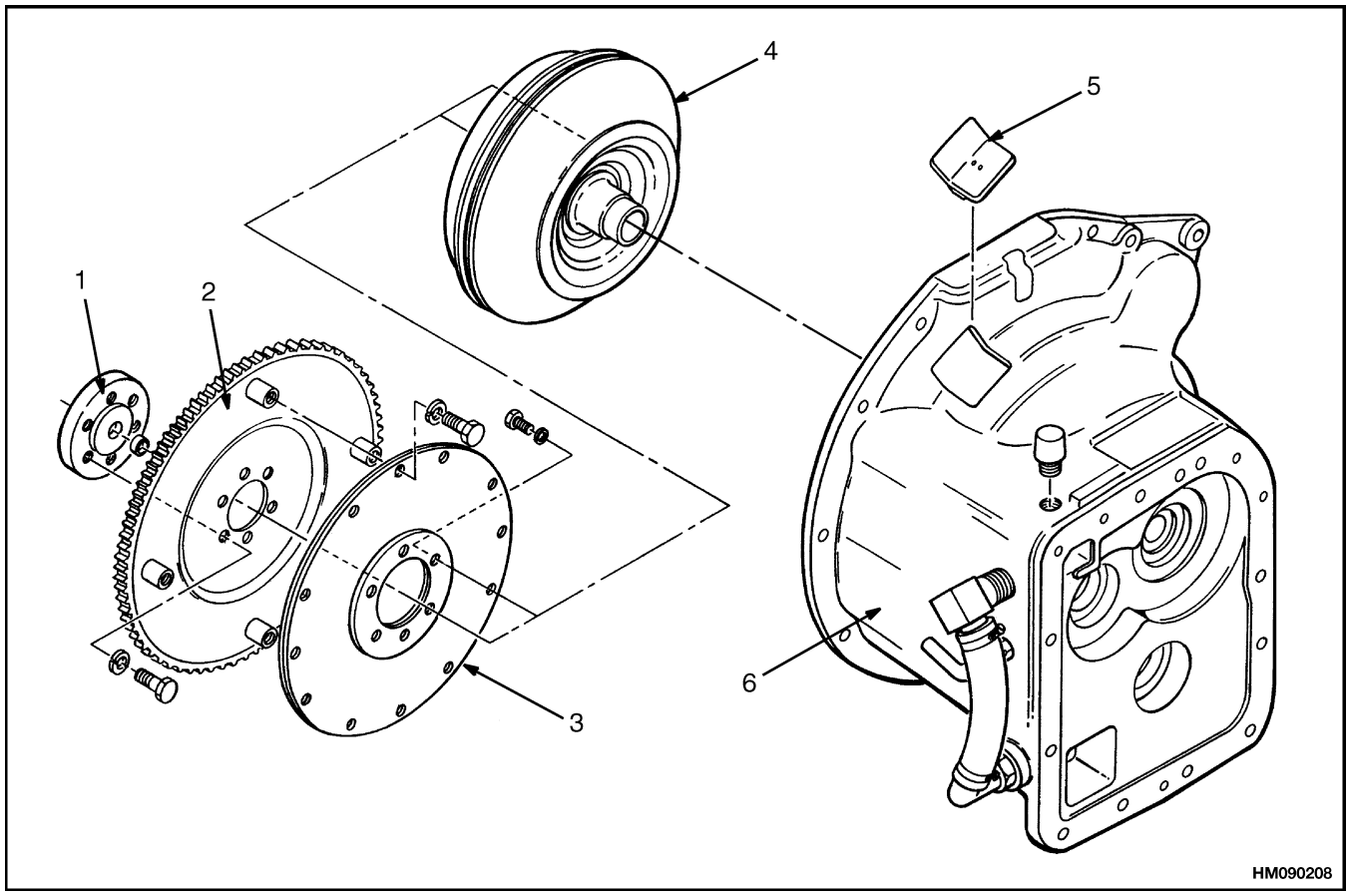


Figure 23. Camshaft Check



1. FLANGE
2. FLYWHEEL
3. DRIVE PLATE
4. TORQUE CONVERTER
5. ACCESS COVER
6. TORQUE CONVERTER HOUSING

Figure 68. Flywheel and Torque Converter

Alternator Repair

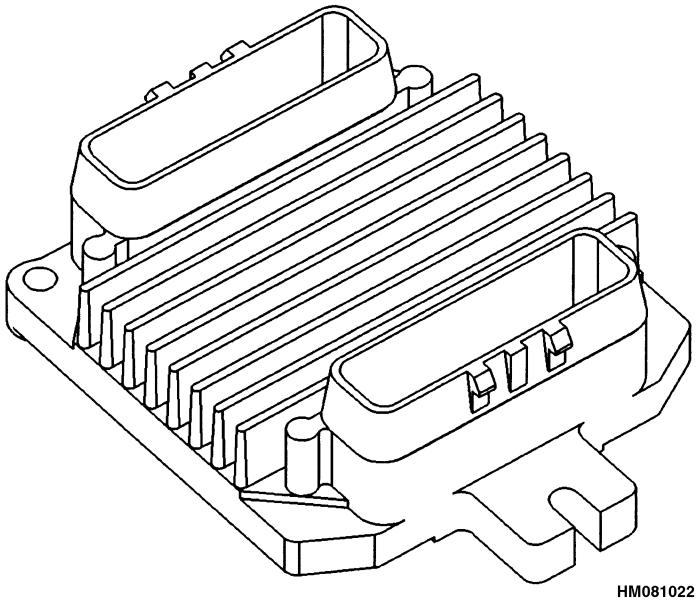
Repair service information for the alternator can be found in the service manual **Electrical System**, **Mazda XA and HA Diesel Engines** 2200 YRM 550.

Yale

Maintenance

ELECTRONIC ENGINE CONTROL

DESCRIPTION AND OPERATION
MEFI-4



HM081022

PART NO. 524162462

2200 YRM 1016

Presssure Conversion Chart

Vacuum and pressure readings often cause confusion because everyone does not use the same point of reference. Absolute pressure is gauge pressure plus atmospheric pressure. Standard atmospheric pressure is also called the standard barometric pressure and is equal to 101.325 kPa (14.695 psi) or 29.92 inHg at sea level. The reference point for these measurements is zero pressure or an absolute vacuum. The following formula is used in converting inches of mercury to kilopascals: inHg x 3.37685 = kPa.

Service people normally use gauge pressure as the reference point, which does not add the atmospheric pressure. The reference point for gauge pressure is atmospheric pressure. It is important to know when reading a pressure chart whether the units are given in absolute pressure or gauge pressure.

The gauges used by most service people indicate gauge pressure. However, most gauges calibrated in a metric scale (kilopascals) and used to measure less than atmospheric pressure normally indicate absolute pressure as shown in the chart. A gauge calibrated in inHg and used to measure a vacuum begins at zero and increases its indication as the vacuum increases.

Table 5. Voltage and Pressure Chart

ATMOSPHERIC PRESSURE		5-VOLT REFERENCE				
		4.80	4.90	5.00	5.10	5.20
kPa	inHg	MAP SENSOR SIGNAL VOLTAGE				
64.35	19.0	2.75	2.80	2.86	2.92	2.97
66.04	19.5	2.83	2.89	2.95	3.01	3.07
67.73	20.0	2.92	2.98	3.04	3.10	3.16
69.43	20.5	3.00	3.07	3.13	3.19	3.25
71.12	21.0	3.09	3.15	3.22	3.28	3.35
72.81	21.5	3.18	3.24	3.31	3.37	3.44
74.51	22.0	3.26	3.33	3.40	3.47	3.53
76.20	22.5	3.35	3.42	3.49	3.56	3.63
77.89	23.0	3.43	3.51	3.58	3.65	3.72
79.59	23.5	3.52	3.59	3.67	3.74	3.81
81.28	24.0	3.61	3.68	3.76	3.83	3.91
82.97	24.5	3.69	3.77	3.85	3.92	4.00
84.67	25.0	3.79	3.86	3.94	4.01	4.09
86.36	25.5	3.86	3.94	4.03	4.11	4.19
88.05	26.0	3.95	4.03	4.11	4.20	4.28
89.75	26.5	4.04	4.12	4.20	4.29	4.37
91.44	27.0	4.12	4.20	4.29	4.38	4.47
93.13	27.5	4.21	4.30	4.38	4.47	4.56
94.83	28.0	4.29	4.38	4.47	4.56	4.65
96.49	28.5	4.38	4.47	4.56	4.65	4.75
98.19	29.0	4.47	4.56	4.65	4.75	4.84
99.88	29.5	4.55	4.65	4.74	4.84	4.93

Table 14. Ignition System Troubleshooting (Continued)

Step	Action	Value	Yes	No
9	**1.** Disconnect the four-terminal ignition module connector located on the distributor. **2.** Remove the distributor cap and disconnect the sensing coil from the ignition module, which is located under the timer core. **3.** Connect a voltmeter from the TACH Connector to ground. **4.** Turn ignition switch to **ON**, leaving the engine **OFF**. **5.** Insulate the probe on the test light to 6 mm (0.24 in.) from the tip. **6.** Connect the uninsulated probe of the test light to a 1.5- to 8-volt DC power supply. **7.** Check the voltmeter when the insulated probe of the test light is touched to terminal **P** of the ignition module. Is there a voltage decrease?		Go to Step 10.	Go to Step 21.
10	Using a spark tester, check for spark from the coil wire when the test light is removed from terminal **P**. Is there spark?		Go to Step 11.	Go to Step 12.
11	Check the rotating timer core to see if it is magnetized. Is the rotating timer core magnetized?		Go to Step 22.	Go to Step 23.
12	Replace the ignition coil and repeat Step 10. Is there spark?		System is correct.	Go to Step 24.
13	Check for fuel supply to engine. Check spark plugs. Check for other faults not in the ignition system. Is action complete?		Verify repair.	
14	Replace sensing coil. Is action complete?		Verify repair.	
15	Inspect the distributor cap for water, cracks, or other damage. If the distributor cap is in good condition, replace the distributor rotor. Is action complete?		Verify repair.	
16	Repair the pink wire from the ignition module **+** terminal to the **+** terminal on the ignition coil. Is action complete?		Verify repair.	

Table 26. DTC 51 Calibration Checksum Failure

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?		Go to Step 2.	Go to On-Board Diagnostic (OBD) System Check.
2	**1.** Install Diagnostic Trouble Code (DTC) tool. **2.** Using Clear DTC Procedure, Clear DTC 51. **3.** Turn ignition **ON**, leaving engine OFF. **4.** Switch DTC tool to "service mode," or ON. Does DTC 51 reset?		Go to Step 3.	Refer to Diagnostic Aids.
3	Replace or reprogram faulty ECM and verify DTC does not reset. Is action complete?		Verify repair.	

DTC 81 Fuel Pump Relay Driver Circuit High, Low, or Open

CIRCUIT DESCRIPTION

The Engine Control Module (ECM) controls the relay by grounding the control circuit via an internal switch called a driver. The primary function of the driver is to supply the ground for the controlled component. This driver has a fault line that the ECM monitors. When the ECM commands the relay ON, the voltage of the control circuit should be low, near 0 volt. When the ECM commands the relay OFF, the voltage should be high, near battery voltage. If the fault detection circuit senses a voltage other than what the ECM expects, the fault line status changes, causing the DTC to set.

The relay controls the high current flow to the fuel pump. This allows the ECM driver only to have to control the relatively low current used by the relay. See Figure 26.

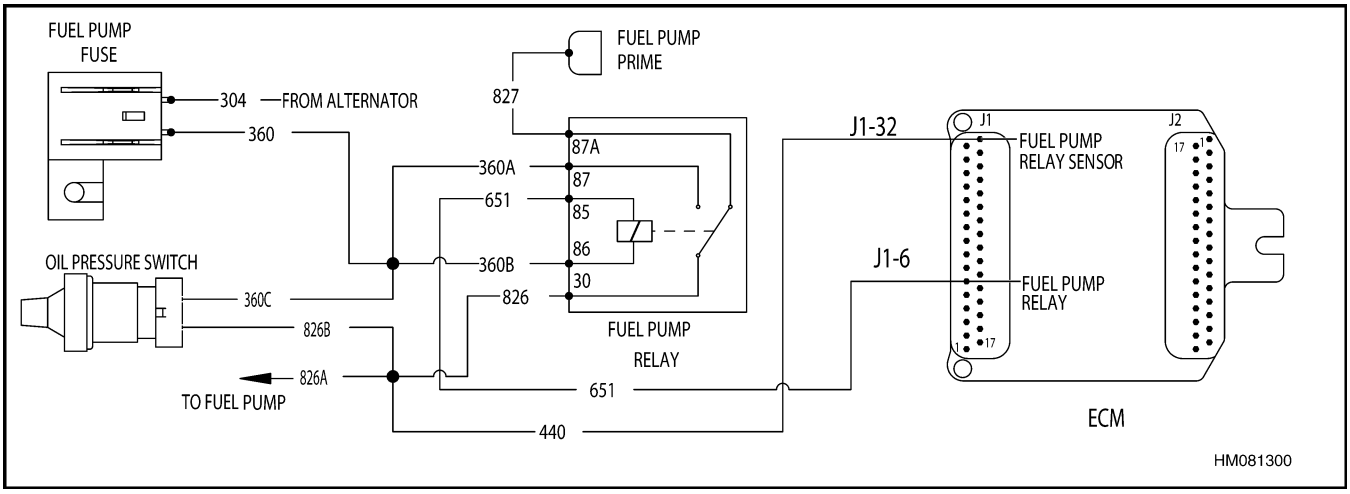


Figure 26. Fuel Pump Relay Driver Circuit

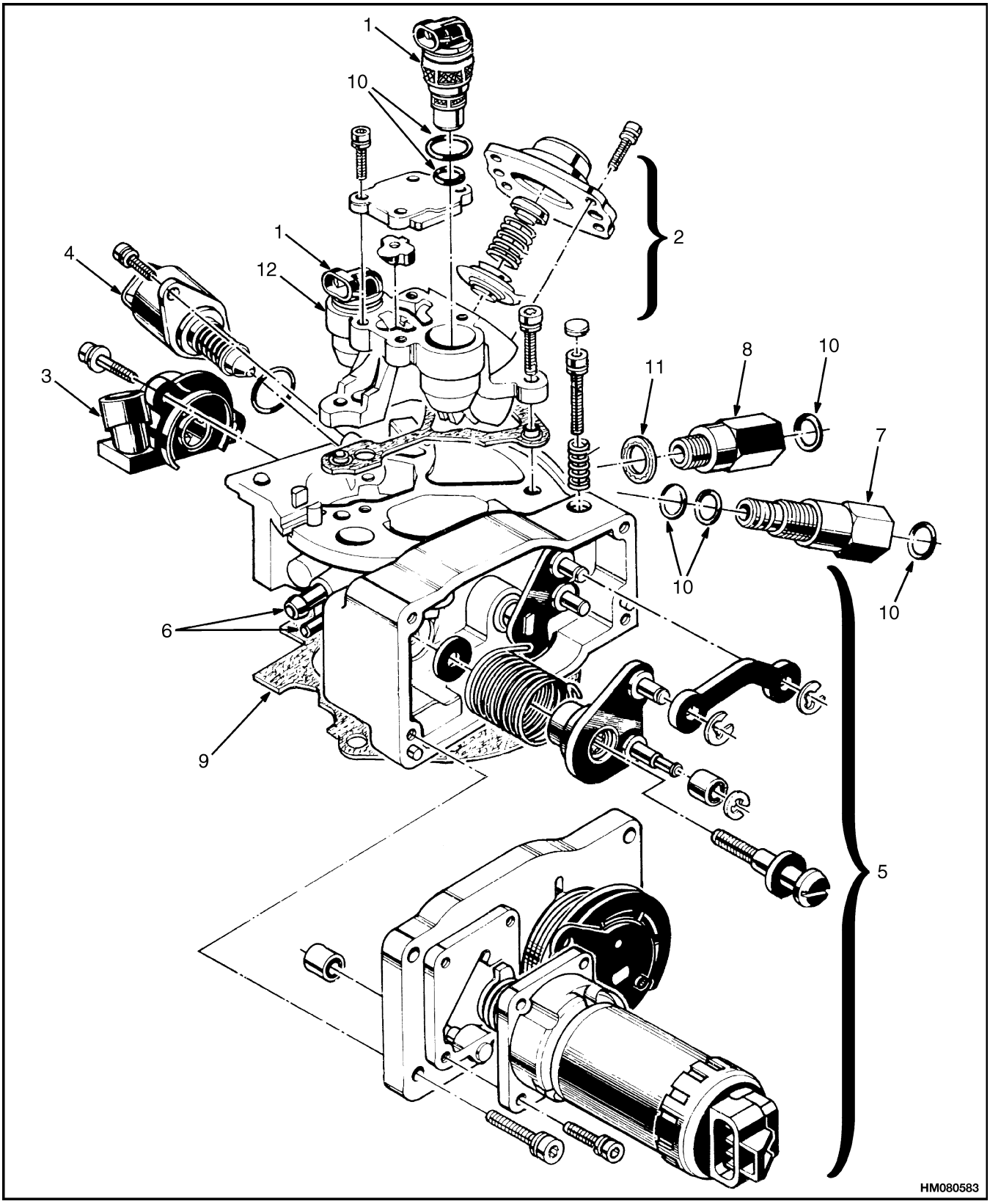


Figure 40. Assembly View of Throttle Body Injection (TBI) Unit for 4.3 Liter Engine

Table 35. ECM Connector J1 Identification (Continued)

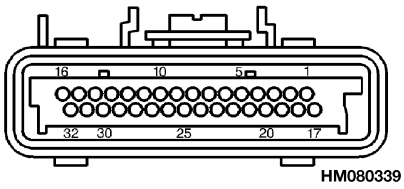
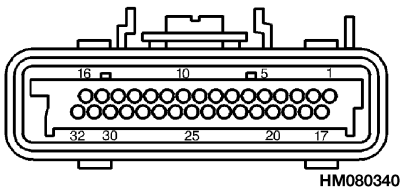
Pin No.	Ckt No.	Function	To Pin
30	425	Idle Air Control (IAC) Coil "B" High	B
31	426	Idle Air Control (IAC) Coil "A" Low	C
32	440	Fuel Pressure Relay Sense	
 HM080339			

Table 36. ECM Connector J2 Identification

Pin No.	Ckt No.	Function	To Pin
1	358	Battery Feed	
2	428	5 Volt Reference	
3	649	Sensor Ground	
4		Not Used	
5		Not Used	
6		Not Used	
7	430	Engine Coolant Temperature	
8	429	Manifold Absolute Pressure (MAP)	
9		Not Used	
10	439	Serial Data	
11		Not Used	
12		Not Used	
13		Not Used	
14		Not Used	
15	437	Bypass	B
16	435	Reference High	C
17		Not Used	
18	650	Reference Low	A
19	112	Ignition Feed	
 HM080340			

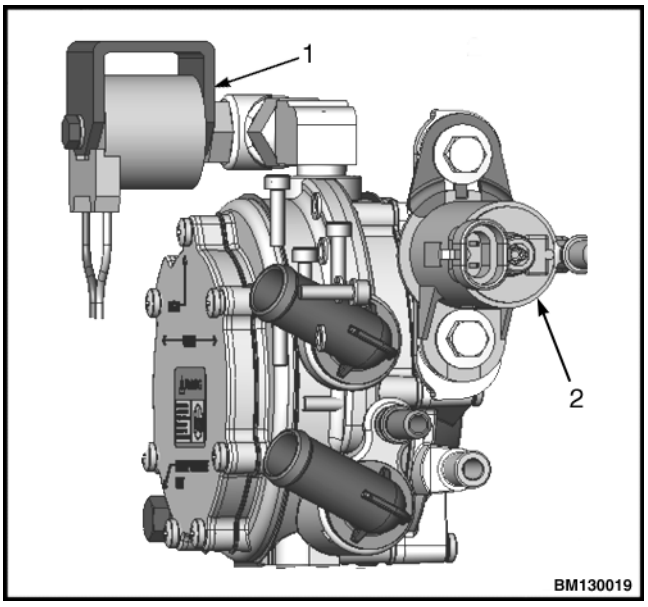
valve opens during cranking and run cycles of the engine. The lock-off supply voltage is controlled by the ECM.

LOW PRESSURE REGULATOR (LPR)

CAUTION

The LPR is an emission control device. Components inside the regulator are specifically calibrated to meet the engine emissions requirements and should never be disassembled or rebuilt. If the LPR fails to operate, replace with a YALE approved part.

The LPR is a combination vaporizer, pressure-regulating device. The LPR is a negative pressure two-stage regulator that is normally closed when the engine is not running. When the engine is cranking or running, a partial vacuum is created in the fuel line which connects the regulator to the mixer. This partial vacuum opens the regulator, permitting fuel to flow to the mixer. See Figure 4.



1. LPL
2. PRESSURE TRIM VALVE (PTV)

Figure 4. Low Pressure Regulator and LPL

Propane fuel enters the primary port of the LPR and passes through the primary jet and into the primary/exchanger chamber. As the propane passes through the heat exchanger, the fuel expands and creates pressure inside the chamber. The pressure rises as the fuel expands. When the pressure rises above 10.34 kPa (1.5 psi), sufficient pressure is exerted on the primary diaphragm to cause the diaphragm plate to pivot and press against the primary valve pin thus closing off the flow of fuel. This action causes the flow of fuel into the regulator to be regulated. When the engine is cranking, sufficient vacuum will be introduced into the secondary chamber from the mixer, drawing the secondary diaphragm down onto the spring-loaded lever and opening the secondary valve allowing vaporized fuel to pass to the mixer. Increased vacuum in the secondary chamber increases the downward action on the secondary lever causing it to open wider, allowing more fuel to flow to the mixer.

The regulator, utilized on this emission-certified engine, is equipped with a PTV which is directly mounted to the regulator. See Figure 4. This solenoid is a 12-volt normally closed solenoid. The function of this solenoid is to regulate a specific amount of venturi vacuum to the atmospheric side of the secondary diaphragm. By introducing vacuum to the top side of the secondary diaphragm during regulator operation, the amount of fuel being delivered to the mixer can be trimmed or reduced to allow for correction to the air/fuel ratio for closed loop fuel control. The solenoid receives a reference signal from the ECM which causes the solenoid to be pulsed fast or slow depending on the amount of fuel to be trimmed.

AIR FUEL MIXER

CAUTION

The air/fuel mixer is an emission control device. Components inside the mixer are specifically calibrated to meet the engines emissions requirements and should never be disassembled or rebuilt. If the mixer fails to operate, replace with a YALE approved part.

The air valve mixer is an air/fuel metering device and is completely self-contained. The mixer is an air valve design, utilizing a relatively constant pressure drop to draw fuel into the mixer from cranking to full load. The mixer is mounted in the air stream ahead of the throttle control device. See Figure 5.

When the engine begins to crank, it draws in air with the air valve covering the inlet, and negative pressure begins to build. This negative pressure signal is communicated to the top of the air valve chamber through four vacuum ports in the air valve assembly. A pressure/force imbalance begins to build across the air valve diaphragm between the air valve vacuum chamber and the atmospheric pressure below the diaphragm. The air valve vacuum spring is calibrated to generate from 101.6 mm (4 in.) of water column at start to as high as

4. Start engine and check for leaks.

FTV HOSE REPLACEMENT

Remove

1. Using a small screwdriver, push locking clips back on FTV connection at FTV and LPR.

2. Remove the hose and discard.

Install

CAUTION

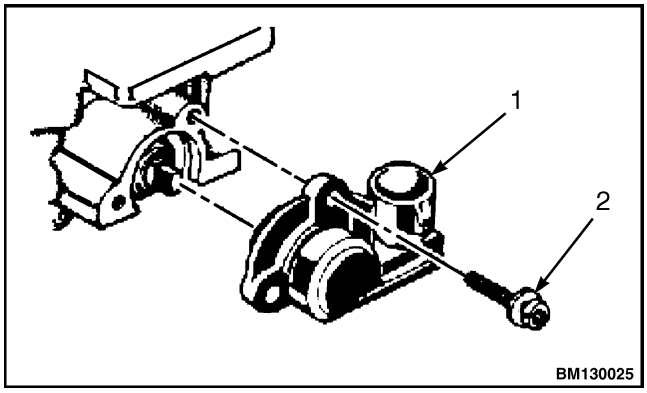
FTV hoses are specifically designed. DO NOT use any hose material. Only use YALE approved parts.

1. Install hose at the FTV and LPR and push locks in place.

2. Start engine and check for leaks.

THROTTLE POSITION SENSOR (TPS) REPLACEMENT

Refer to Figure 24 and Table 1 for the replacement procedures of the TPS.



1. TPS 2. SCREW

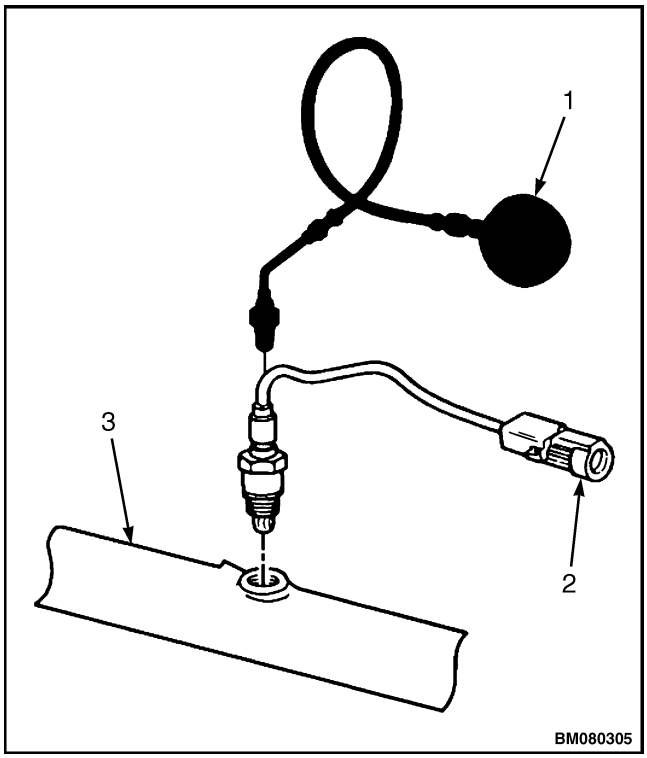
Figure 24. Throttle Position Sensor (TPS)

Table 1. TPS Replacement Procedure

Step	Action	Value(s)	Yes	No
1	Were you instructed to replace the TPS from a DTC.		Go to step 2.	Go to On-Board Diagnostics System Check in the section **Electronic Control Module (ECM) Diagnostic Troubleshooting**, **GM 3.0L and 4.3L EPA Compliant Engines** 2200 YRM 1090.
2	• Key **OFF**. • Disconnect the negative battery cable and the throttle body governor motor connector. Are they disconnected?		Go to step 3.	
3	• Disconnect the TPS wire harness connector and remove the two mounting screws using a 3mm hex tool. Is the wiring harness disconnected and the mounting screws removed?		Go to step 4.	

Check at Heated Exhaust Gas Oxygen Sensor (HEGO)

1. Carefully remove the HEGO. Refer to Heated Exhaust Gas Oxygen (HEGO) Sensor Replacement, Remove.
2. Install exhaust back pressure test gauge in place of the HEGO. See Figure 32.
3. With the engine idling at normal operating temperature, observe the exhaust system back pressure reading on the gauge. Reading should not exceed 8.6 kPa (1.25 psi).
4. Increase engine speed to 2000 rpm and observe gauge. Reading should not exceed 20.7 kPa (3 psi).
5. If the back pressure at either speed exceeds specification, a restricted exhaust system is indicated.
6. Inspect the entire exhaust system for a collapsed pipe, heat distress, or possible internal muffler failure.
7. If there are no obvious reasons for the excessive back pressure, the catalytic converter is suspected to be restricted and should be replaced using current recommended procedures.



1. BACK PRESSURE GAUGE
2. OXYGEN SENSOR (O_2S)
3. EXHAUST MANIFOLD

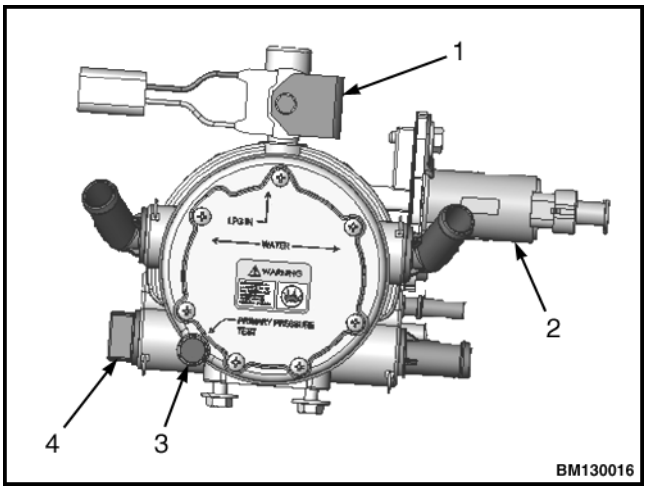
Figure 32. Exhaust Back Pressure Gauge

LPG System Diagnosis

FUEL SYSTEM DESCRIPTION

The ECM receives information from various engine sensors in order to control the operation of the FTV and the LPL solenoid. The LPL solenoids prevent fuel flow unless the engine is cranking or running. LPG is stored in the tank and delivered under pressure to the system as a liquid. During key **ON**, the LPL receives a 2-second prime pulse from the ECM which allows LPG to flow from the tank through fuel filter and fuel lines to the LPR at pressures up to 21.5 kPa (312 psi). See Figure 33.

In the LPR, the fuel is vaporized and the pressure is reduced in two stages. The first stage reduces the pressure to approximately 13.8 to 27.6 kPa (2 to 4 psi). The second stage reduces the pressure to approximately negative 38.1 mm (1.5 in.) of water column (WC).



1. LPL
2. PRESSURE TRIM VALVE
3. PRIMARY TEST PORT
4. SECONDARY TEST PORT

Figure 33. Low Pressure Regulator Assembly

Table 12. Hard Start (Continued)

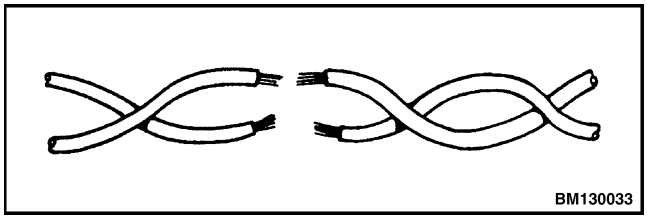
Checks	Action
Engine Mechanical Checks	**CAUTION** **The LPG fuel system works on a fumigation principle of fuel introduction and is more sensitive to intake manifold leakage than the gasoline fuel supply system.** • Check for the following: – Vacuum leaks – Improper valve timing – Low compression – Bent pushrods – Worn rocker arms – Broken or weak valve springs – Worn camshaft lobes. • Check the intake and exhaust manifolds for casting flash.
Exhaust System Checks	• Check the exhaust system for a possible restriction: – Inspect the exhaust system for damaged or collapsed pipes. – Inspect the muffler for signs of heat distress or for possible internal failure. • Check for possible plugged catalytic converter. Refer to Restricted Exhaust System Diagnosis.

Table 13. Cuts Out or Misses

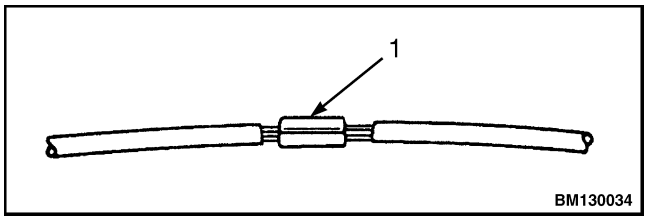
Checks	Action
Definition: A surging or jerking that follows engine speed, usually more pronounced as the engine load increases which is not normally felt above 1500 rpm. The exhaust has a steady spitting sound at idle, low speed, or hard acceleration for the fuel starvation that can cause the engine to cut-out.	
Preliminary Checks	Refer to Table 9.
Ignition System Checks	• Start the engine. • Wet down the secondary ignition system with water from a spray bottle, and look/listen for arcing or misfiring as you apply water. • Check for proper ignition output voltage. • Check for a cylinder misfire. • Verify that the spark plugs are correct. Refer to the **Parts Manual** for your lift truck. • Remove the spark plugs in these cylinders and check for the following conditions: – Insulation cracks – Wear – Improper gap – Burned electrodes – Heavy deposit • Visually/Physically inspect the secondary ignition for the following: – Ignition wires for arcing, cross-firing and proper routing – Ignition coils for cracks or carbon tracking

Twisted Leads Repair

STEP 1.
Locate damaged wire and remove insulation as required.



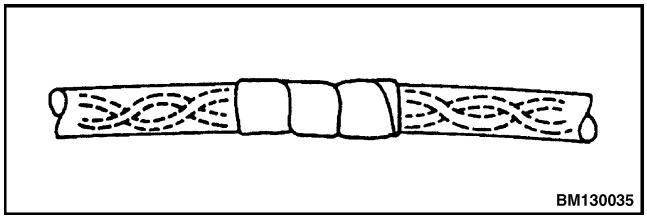
STEP 2.
Splice the two wires together using splice clips and rosin core solder. See Figure 36.



1. SPLICE AND SOLDER

STEP 3.
Cover splice with tape to insulate from other wires.

STEP 4.
Twist and tape with electrical tape.



Graphing and Data Logging

Graphing the values and voltages can be a very useful tool in doing intermittent diagnosis. The system diagnostic monitoring software includes graphing and data logging capability. These features enhance the ability to diagnose and repair possible problems with the system. The graphing feature allows sensor inputs and select control output variables to be plotted in real-time while the engine is running. See Figure 3.

To plot a variable, you must first TAG the variable you wish to plot. To do this, use the mouse to highlight the variable, and then right click.

Next press the P key or double click the Plot/Log button to invoke the plotting feature. You may change the desired time interval for each display screen. The default is 10 seconds. This can be increased or decreased as necessary to display the desired results. You can also change the sample rate.

You are now ready to plot. Simply click the START button to observe the plotted variables. The plot sweeps across the screen from left to right. To pause the display screen press the SPACE BAR at any time during plotting. To continue plotting simply press the SPACE BAR again. To stop the plotting feature simply click the STOP button. To exit the plotting screen click the CLOSE button. The range of each variable is listed along the left side of the display and the time is listed along the bottom of the screen.

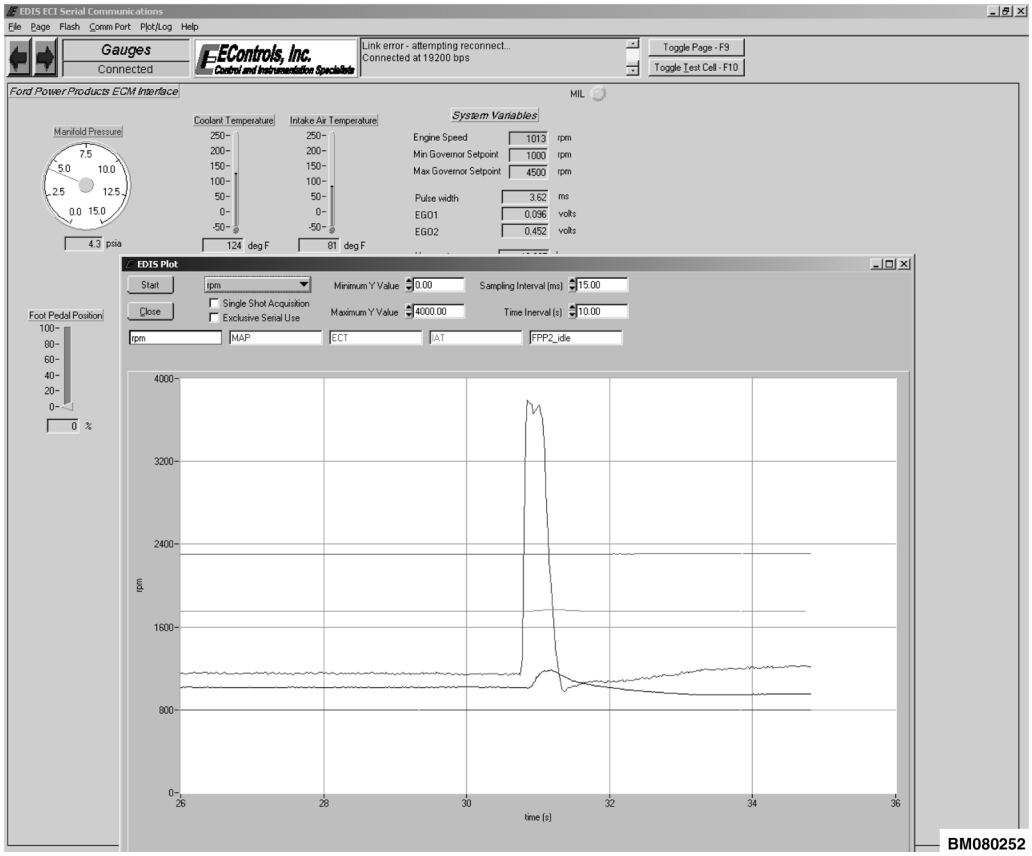


Figure 3. Graphing and Data Logging Screen

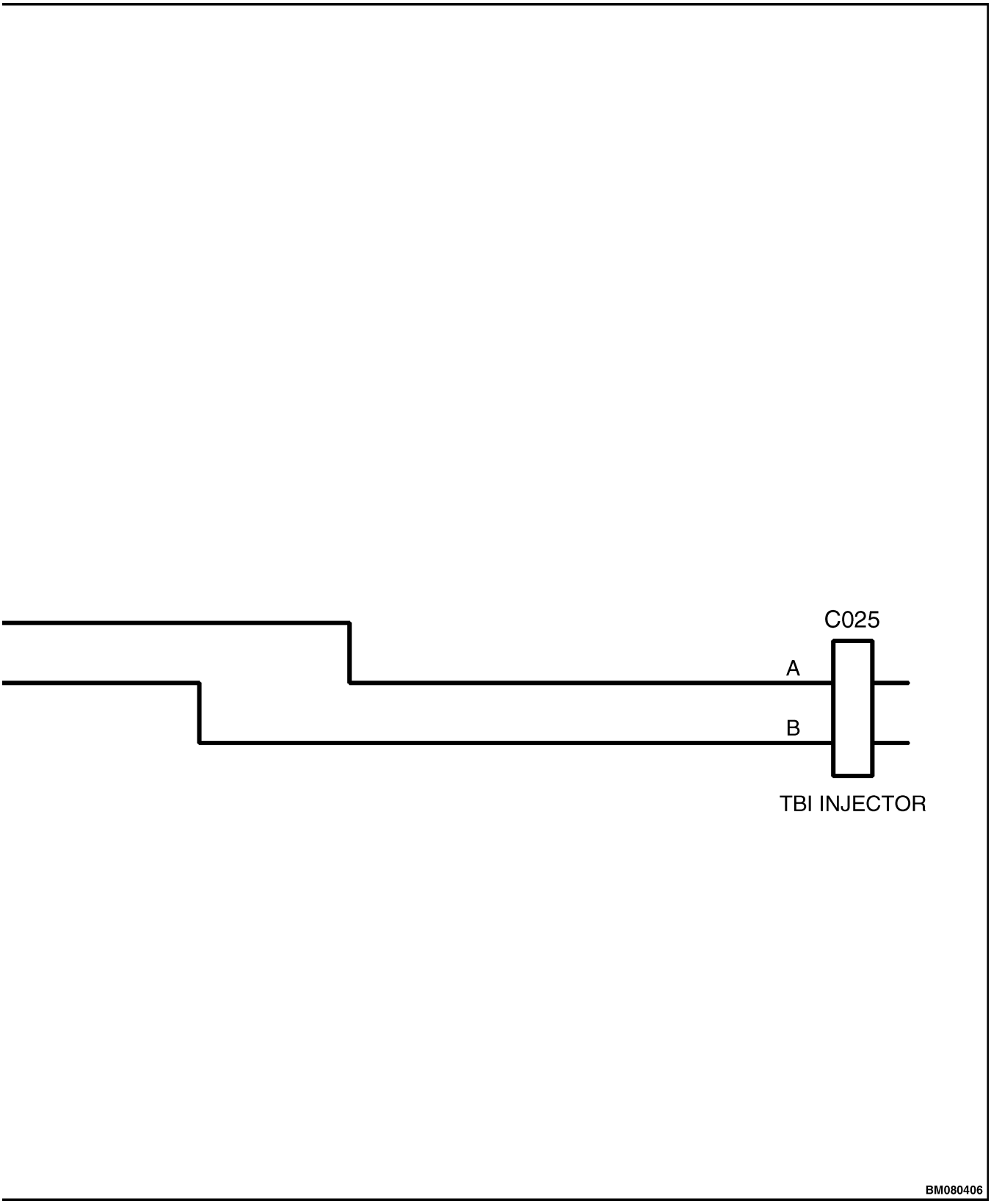


Figure 10. 3.0L Gasoline Jump Harness

Table 36. DTC 124 - ECT Higher Than Expected 2

Step	Action	Value(s)	Yes	No
1	Did you perform the On-board diagnostics (OBD) system check?		Go to step 2.	Go to On-Board Diagnostics System Check/Malfunction Indicator Lamp.
2	• Key **ON**. • Laptop computer connected in system data mode. • Warm engine to normal operating temperature, then run the engine above 1000 rpm for 60 seconds. Does laptop computer display ECT temperature of 112.8°C (235°F) or greater with the engine running over 500 rpm?		Go to step 3.	Intermittent problem. Go to Preliminary and Intermittent Checks.
3	• Verify with a temperature gauge that the engine coolant is over 112.8°C (235°F). Does the temperature gauge indicate 112.8°C (235°F) or greater?		Repair the cooling system.	Go to step 4.
4	Verify ECT circuit function. Follow diagnostic test procedure for DTC 122 - ECT Voltage Low.			

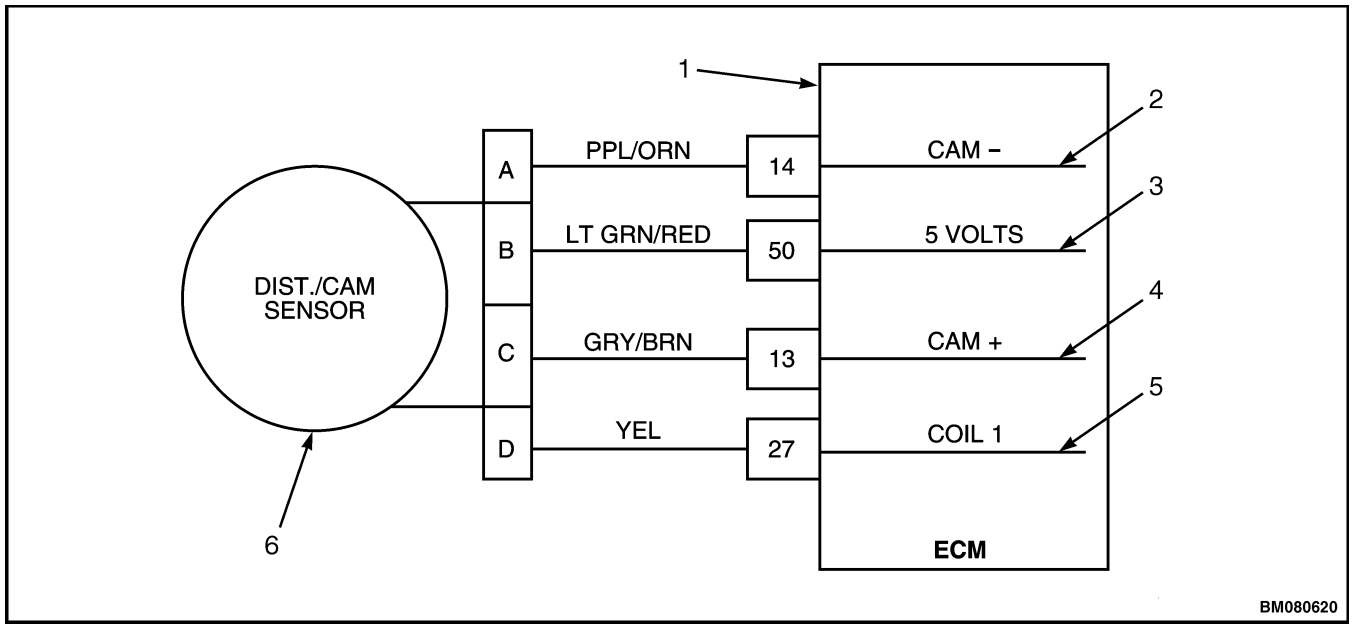
DTC 145 - CAMSHAFT SENSOR NOISE

Circuit Description

The camshaft position sensor (CKP) is used to synchronize the fuel and ignition systems. This fault will set if the ECM detects erroneous pulses from the camshaft position sensor (CKP) causing invalid cam re-sync. See Figure 28.

Conditions for Setting the DTC

- Camshaft position sensor.
- Check condition - engine cranking or running.
- Fault condition - one invalid cam re-sync for greater than 700ms.
- MIL - on for active fault and for 10 seconds after active fault.
- Adaptive - disabled for the remainder of the key **ON** cycle.



1. ELECTRONIC CONTROL MODULE
2. CAM –
3. 5 VOLTS
4. CAM +
5. COIL 1
6. DISTRIBUTOR/CAMSHAFT SENSOR

Figure 28. Camshaft Sensor Circuit

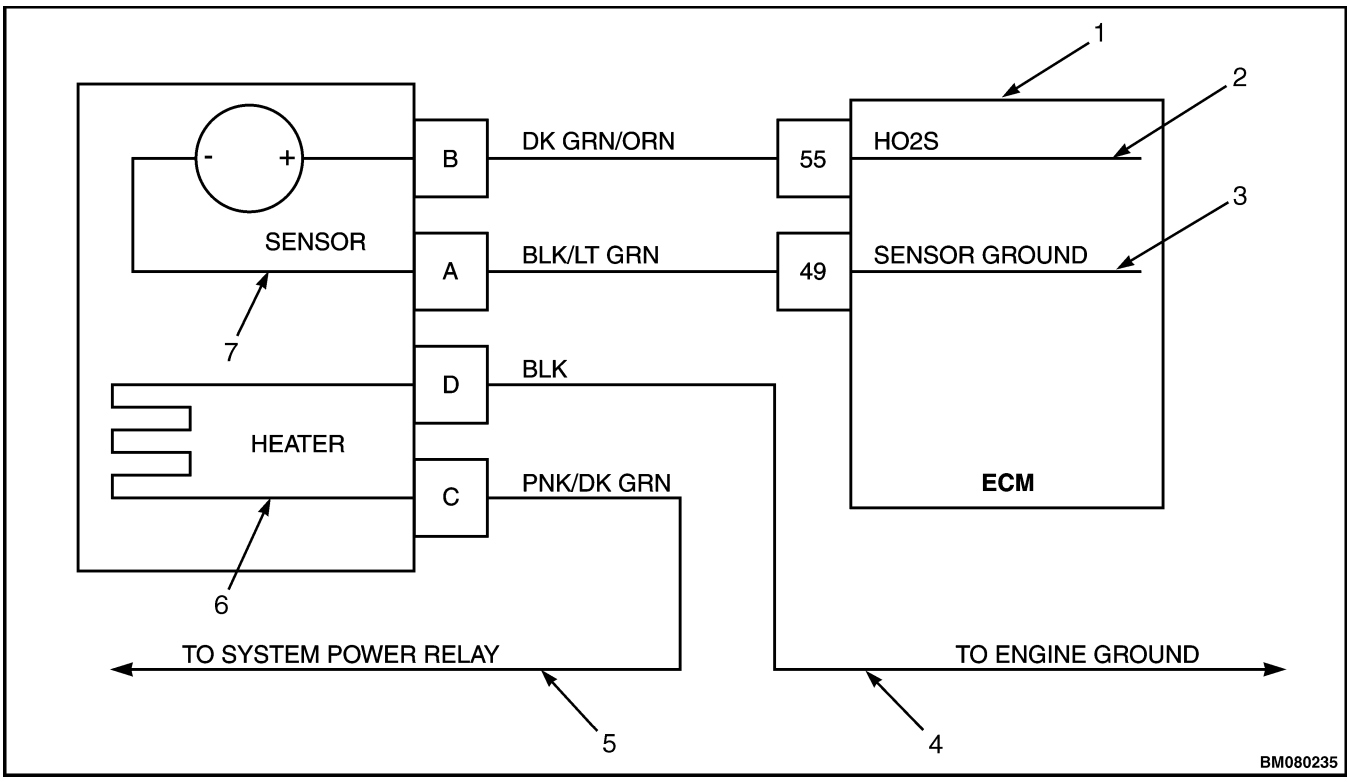
Table 44. DTC 145 - Camshaft Sensor Noise

Step	Action	Value(s)	Yes	No
1	Did you perform the On-board diagnostics (OBD) system check?		Go to step 2.	Go to On-Board Diagnostics System Check/Malfunction Indicator Lamp.
2	• Check that the ECM ground terminals G1 and G2 are clean and tight. Are the ground terminals G1 and G2 clean and tight?		Go to step 3.	Repair the circuit as necessary. Refer to Wire Harness Repair. Go to step 11.

Exhaust leaks - if there is an exhaust leak, outside air can be pulled into the exhaust and past the 0_2 sensor causing a false lean condition.

Fuel quality - Contaminated or spoiled fuel can cause the fuel system to be lean.

Ground problem - ECM grounds must be good battery or engine ground.



1. ELECTRONIC CONTROL MODULE (ECM)
2. HEATED OXYGEN SENSOR (HO_2S)
3. SENSOR GROUND
4. TO ENGINE GROUND
5. TO SYSTEM POWER RELAY
6. HEATER
7. SENSOR

Figure 36. Heated Oxygen Sensor Circuit

DTC 514 - RTI 1 LOSS

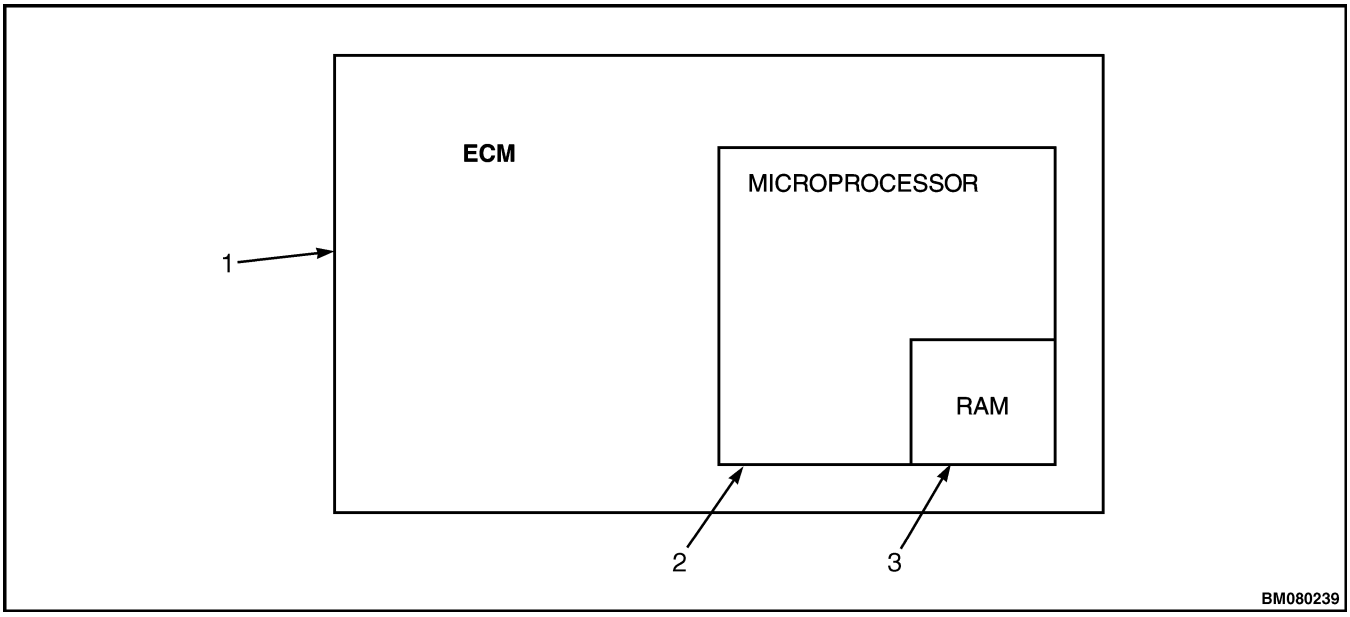
Circuit Description

The ECM runs checks that must be verified each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase. See Figure 45.

During this active fault, power derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20 percent. This is enforced until the fault is manually cleared.

Conditions for Setting the DTC

- Electronic control module.
- Check condition - key **ON**.
- Fault condition - internal microprocessor error.
- MIL - on until code is cleared by technician.
- Adaptive - disabled for the remainder of the key **ON** cycle.
- Closed loop - enabled.
- Power derate - level 2 until fault is cleared manually.



1. ELECTRONIC CONTROL MODULE (ECM)
2. MICROPROCESSOR
3. RAM

Figure 45. ECM Microprocessor

DTC 631 - TPS1 SIGNAL VOLTAGE HIGH

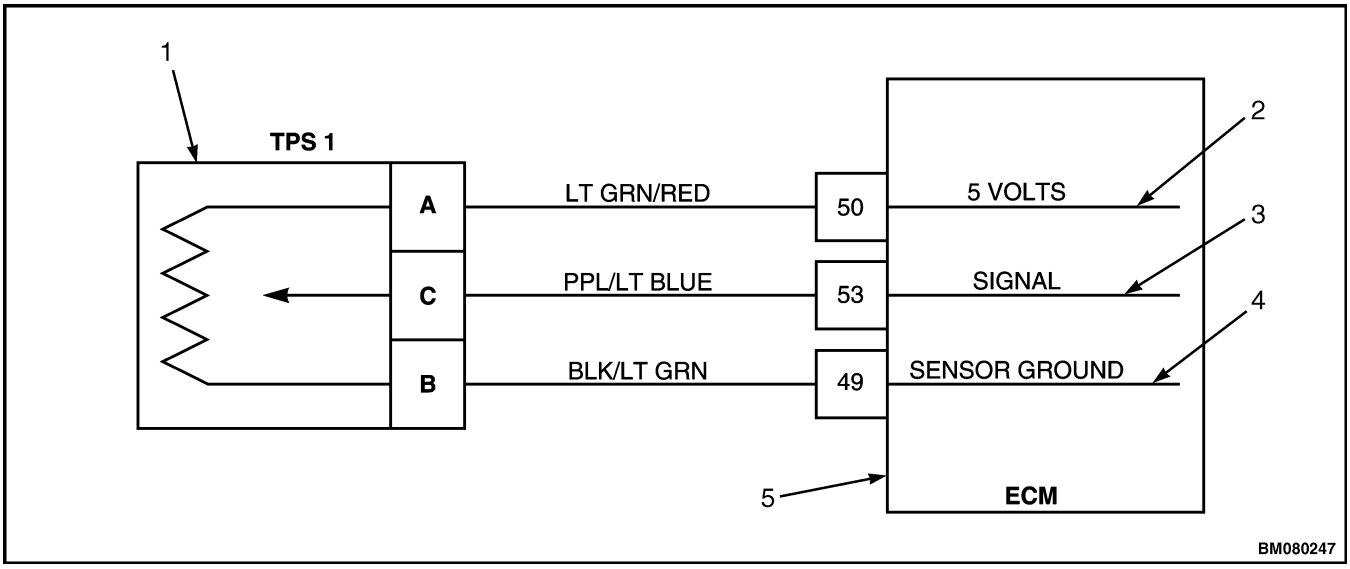
Circuit Description

The ECM uses a variable resistor to determine throttle plate position based on signal voltage, and is connected to the throttle shaft. Less opening results in higher voltage, and greater opening in lower voltage. The TPS value is used by the ECM to determine if the throttle is opening as commanded. See Figure 54.

This fault will set if voltage is above 4.8 volts for 0.3 seconds or longer while the engine is cranking or running. The MIL lamp will be on during the active fault and for 3 seconds after the active fault. Forced idle and low rev limit are enforced during this fault.

Conditions for Setting the DTC

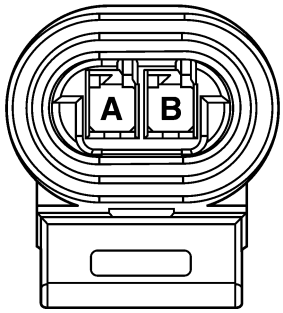
- Throttle position sensor No. 1.
- Check condition - cranking or running.
- Fault condition - TPS sensor voltage exceeds 4.8 for 0.30 seconds or longer.
- MIL - on during active fault.
- Forced idle.
- Low rev limit.



1. THROTTLE POSITION SENSOR (TPS) NO. 1
2. 5 VOLTS
3. SIGNAL
4. SENSOR GROUND
5. ELECTRONIC CONTROL MODULE (ECM)

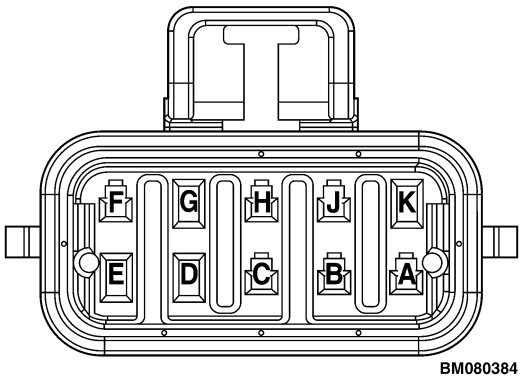
Figure 54. TPS1 Circuit

Table 97. Alternator Connector C021



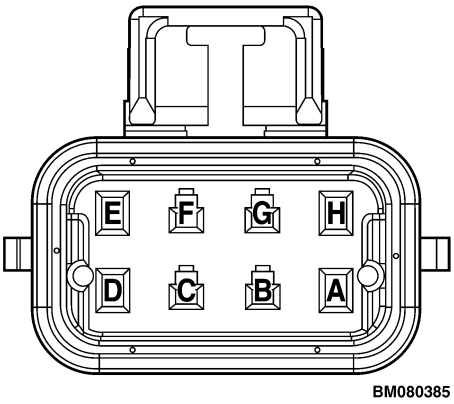
Pin	Wire Color	Function
A	Red	Battery +
B	Pink/Dark Green	Power Relay C017

Table 98. Instrument Panel Connector C022



Pin	Wire Color	Function
A	Pink	VSW
B	Dark Blue	FPP
C	Purple/Yellow	IVS
D	Black/Light Green	Analog Return
E	Not Used	Not Used
F	Light Blue/Black	MIL
G	Light Green/Red	VREF
H	Not Used	Not Used
J	Light Blue/Pink	Start In (Interrupt Type)
K	Pink/Black	Start In (Autocrank)

Table 99. Instrument Panel Connector C023



Pin	Wire Color	Function
A	Light Blue/White	Aux Out 2A
B	Tan/Dark Green	Aux In PD1
C	Yellow/Light Green	Tachometer
D	Tan/Brown	Fuel Select
E	Grey/Dark Blue	Governor Select
F	Blue/Pink	Can +
G	Blue/White	Can –
H	Purple/Dark Blue	Aux Out 1

Table 114. DTC 112 - IAT Low Voltage (Motorola® TMAP) (Continued)

Step	Action	Value(s)	Yes	No
7	• Replace the ECM. Is the replacement complete?		Go to step 8.	
8	• Remove all test equipment except the laptop computer. • Connect any disconnected components, fuses, etc. • Using the laptop computer, clear DTC information from the ECM. • Turn the ignition **OFF** and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature. • Observe the MIL. • Observe engine performance and driveability. • After operating the engine within the test parameters of DTC 112, check for any stored codes. Does the engine operate normally with no stored codes?		System OK.	Go to On-Board Diagnostics System Check/ Malfunction Indicator Lamp.

Table 122. DTC 131 - MAP HIGH PRESSURE (Motorola® TMAP)

Step	Action	Value(s)	Yes	No
1	Did you perform the On-board diagnostics (OBD) system check?		Go to step 2.	Go to On-Board Diagnostics System Check/Malfunction Indicator Lamp.
2	• Key **ON**, engine running. • Laptop computer connected in system data mode. Does laptop computer display MAP pressure of 14.0 psia or greater with the engine idling?		Go to step 3.	Intermittent problem. Go to Preliminary and Intermittent Checks.
3	• Key **OFF**. • Disconnect the TMAP sensor connector. • Turn the key to the **ON** position. Does the laptop computer display MAP pressure less than 0.05 psia?		Go to step 4.	Go to step 6.
4	• Probe TMAP sensor connector ground circuit pin A with a test light connected to battery voltage. Does the test light come on?		Go to step 5.	Go to step 8.
5	• Check TMAP mechanical connection for correct mounting or possible damage causing leakage. Is the TMAP sensor mechanical connection OK?		Go to step 6.	Go to step 10.
6	• Key **OFF**. • Disconnect ECM connector and inspect terminals for damage, corrosion, or contamination. Is the connection OK?		Go to step 7.	Repair the circuit as necessary. Refer to Wire Harness Repair. Go to step 11.
7	• Replace TMAP sensor. Is the repair complete?		Go to step 11.	
8	• Disconnect ECM connector and check for continuity between TMAP connector sensor ground pin A and ECM sensor ground pin 49. Do you have continuity between them?		Go to step 9.	Repair the circuit as necessary. Refer to Wire Harness Repair. Go to step 11.

Table 129. DTC 142 - Crank Sync Noise (Continued)

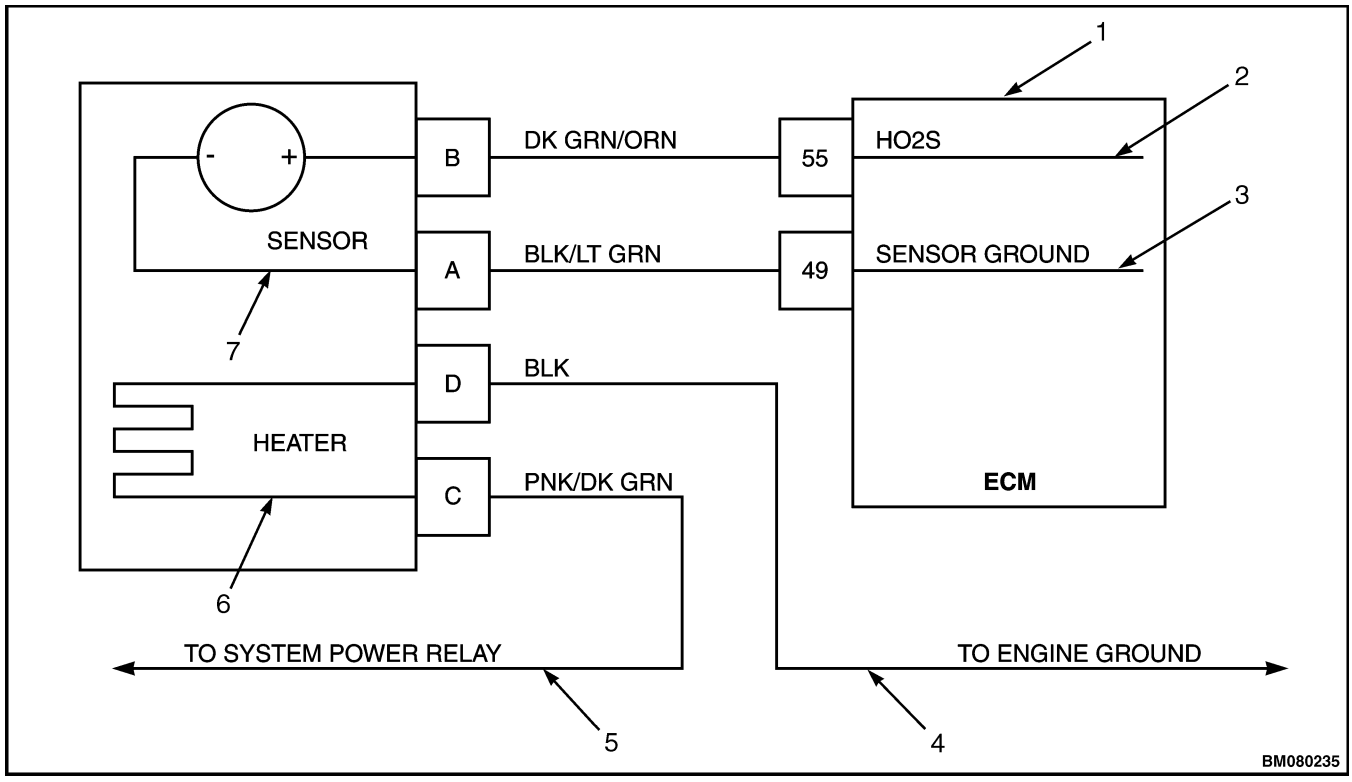
Step	Action	Value(s)	Yes	No
3	• Key **ON** and engine **OFF**. • Disconnect the crankshaft position sensor (CKP) connector C009. • Using a DVOM check for voltage at the CKP sensor connector pin A and engine ground. Do you have voltage?	5.0 volts	Go to step 4.	Repair the circuit as necessary. Refer to Wire Harness Repair. Go to step 11.
4	• Key **OFF**. • Disconnect ECM connector C001. • Using a DVOM check for continuity between CKP connector pin B and ECM connector pin 12. Do you have continuity between them?		Go to step 5.	Repair the circuit as necessary. Refer to Wire Harness Repair. Go to step 11.
5	• Using a DVOM check for continuity between CKP connector pin C and ECM connector pin 11. Do you have continuity between them?		Go to step 6.	Repair the circuit as necessary. Refer to Wire Harness Repair. Go to step 11.
6	• Inspect the CKP connector C009 terminals for damage, corrosion or contamination. Did you find a problem?		Repair the circuit as necessary. Refer to Wire Harness Repair. Go to step 11.	Go to step 7.
7	• Inspect the ECM connector C001 terminals 11, 12, and 50 for damage, corrosion or contamination. Did you find a problem?		Repair the circuit as necessary. Refer to Wire Harness Repair. Go to step 11.	Go to step 8.
8	• Replace CKP sensor. Pay special attention to CKP sensor reluctor wheel inspection. Is the replacement complete?		Go to step 10.	
9	• Replace the ECM. Is the replacement complete?		Go to step 11.	

Diagnostic Aids

Always diagnose any other ECM codes that are present before beginning this diagnostic procedure.

Fuel system - high secondary fuel pressure can cause the system to run rich. A worn fuel mixer, faulty pressure trim valve (PTV) or fuel trim valve (FTV) can also cause the system to run rich.

Fuel quality - a drastic variation in fuel quality (very high butane content) may cause the system to run rich. Be sure that the specified HD- 5 or HD-10 motor fuel grade propane is used.



1. ELECTRONIC CONTROL MODULE (ECM)
2. HEATED OXYGEN SENSOR (HO_2S)
3. SENSOR GROUND
4. TO ENGINE GROUND
5. TO SYSTEM POWER RELAY
6. HEATER
7. SENSOR

Figure 93. Heated Oxygen Sensor Circuit

DTC 513 - A/D LOSS

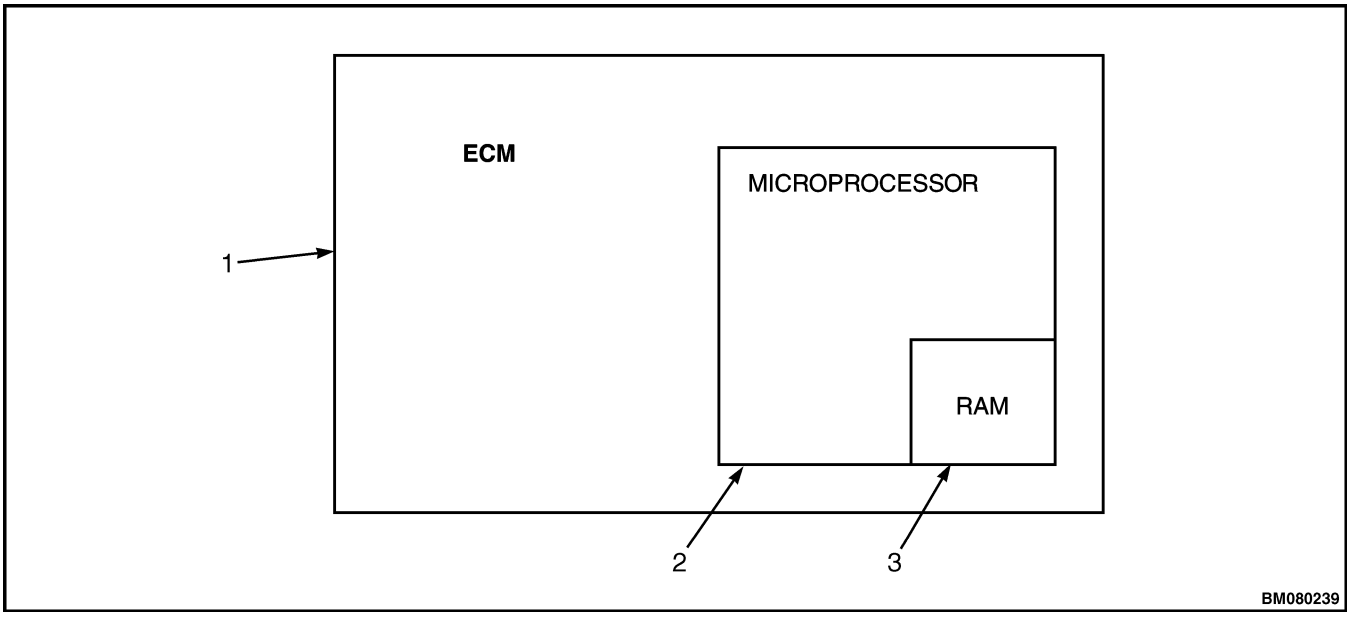
Circuit Description

The ECM has checks that must be verified each time an instruction is executed. Several different things can happen within the microprocessor that will cause this fault. The ECM will reset itself in the event this fault is set, and the MIL will be on until the code is cleared. This fault should be erased after diagnosis by removing battery power. It will not self-erase. See Figure 102.

During this active fault, power derate (level 2) will be enforced. When this is enforced, maximum throttle position will be 20 percent. This is enforced until the fault is manually cleared.

Conditions for Setting the DTC

- Electronic control module.
- Check condition - key **ON**.
- Fault condition - internal microprocessor error.
- MIL - on until code is cleared by technician.
- Adaptive - disabled for the remainder of the key **ON** cycle.
- Closed loop - enabled.
- Power Derate - level 2 until fault is cleared manually.



1. ELECTRONIC CONTROL MODULE (ECM)
2. MICROPROCESSOR
3. RAM

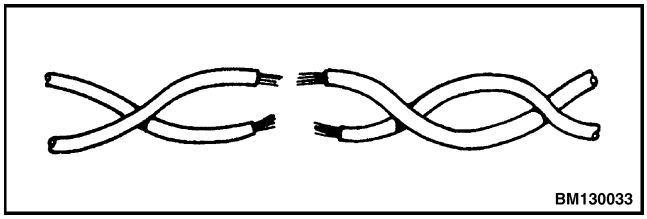
Figure 102. ECM Microprocessor

Table 155. DTC 612 - FPP Low Voltage

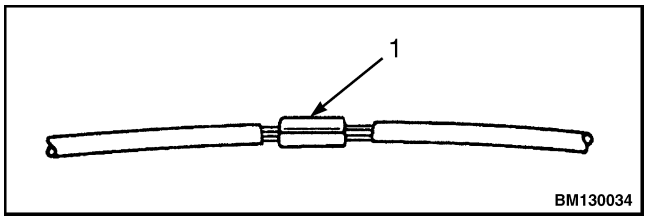
Step	Action	Value(s)	Yes	No
1	Did you perform the On-board diagnostics (OBD) system check?		Go to step 2.	Go to On-Board Diagnostics System Check/Malfunction Indicator Lamp.
2	• Key **ON** and engine **OFF**. • Laptop computer connected in system data mode. Does the laptop computer display FPP voltage of 0.2 volts or less with the foot pedal in the idle position?		Go to step 7.	Go to step 3.
3	• Slowly depress the foot pedal while observing FPP voltage. Does laptop computer FPP voltage ever drop below 0.2 volts?		Go to step 4.	Intermittent problem. Go to Preliminary and Intermittent Checks.
4	• Key **OFF**. • Disconnect FPP sensor connector. • Inspect connector and wire terminals for damage, corrosion or contamination. Did you find a problem?		Repair the circuit as necessary. Refer to Wire Harness Repair. Go to step 18.	Go to step 5.
5	• Key **ON**. • Using a DVOM, check for voltage at the FPP sensor connector between 5-volt reference pin A and FPP sensor ground pin B. Do you have voltage between them?	5.0 volts	Go to step 6.	Repair the circuit as necessary. Refer to Wire Harness Repair. Go to step 18.
6	• Replace FPP sensor. Refer to the section **Electronic Controlled LPG/Gasoline Fuel System**, **GM 3.0L and 4.3L EPA Compliant Engines** 900 YRM 1088. Is the replacement complete?		Go to step 18.	
7	• Key **OFF**. • Disconnect FPP sensor from wire harness. • Jumper 5-volt reference circuit pin A and FPP signal circuit pin C together. • Key **ON**. Does laptop computer display FPP voltage of 4.8 volts or greater?		Go to step 8.	Go to step 9.

Twisted Leads Repair

STEP 1.
Locate damaged wire and remove insulation as required.



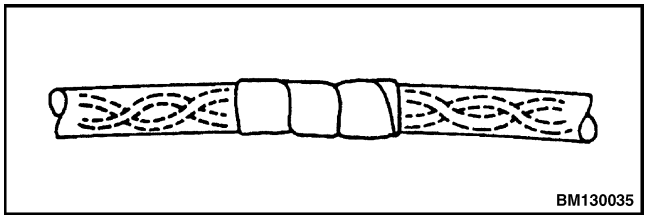
STEP 2.
Splice the two wires together using splice clips and rosin core solder. See Figure 118.



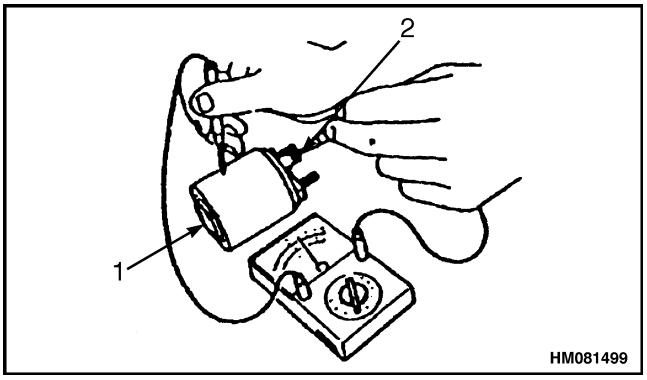
1. SPLICE AND SOLDER

STEP 3.
Cover splice with tape to insulate from other wires.

STEP 4.
Twist and tape with electrical tape.



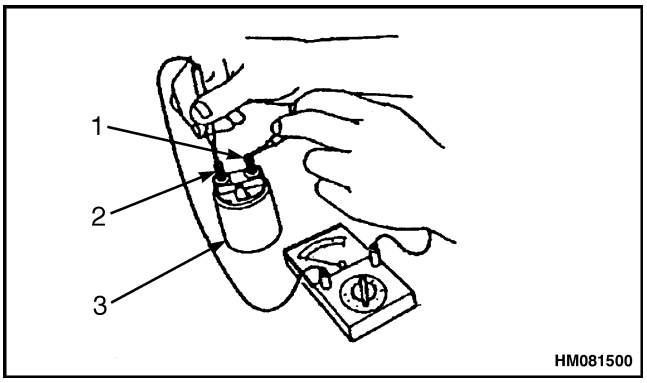
2. Using an ohmmeter, check for continuity between terminal S and the body of the magnetic switch. See Figure 20. If there is no continuity, replace the magnetic switch.



1. MAGNETIC SWITCH CASE
2. TERMINAL S

Figure 20. Magnetic Switch Case Continuity Check

3. Using an ohmmeter, check for continuity between terminals M and B and the magnetic switch. See Figure 21. If there is continuity, replace the magnetic switch.



1. TERMINAL M
2. TERMINAL B
3. MAGNETIC SWITCH CASE

Figure 21. Magnetic Switch Terminals M and B Check

ASSEMBLE

NOTE: Step 1 through Step 10 refers to Figure 13.

NOTE: Coat all sliding parts with grease before installation.

1. Install the lever on the pinion set.

2. Install the pinion set in the front cover.

3. Install the disk and lever cover into the front cover.

4. Install the three planetary gears on the pins located inside the internal gear assembly.

5. Coat the packing and thrust ball with grease, and install them into the pinion set.

6. Install the armature in the yoke.

NOTE: The yoke has an alignment tang to aid in the proper installation.

7. Install the armature and yoke on the front cover.

8. Install the brushes in the rear cover.

9. Install the rear cover on the yoke and armature.

10. Install the magnetic switch in the front cover.

11. Connect the wire from the rear cover of the starter to the M terminal of the magnetic switch.

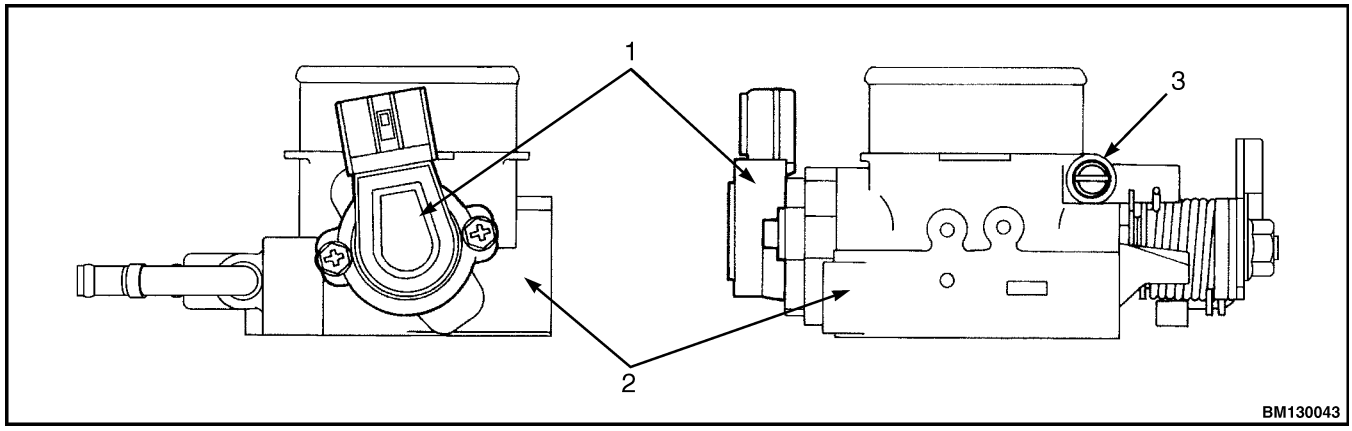
Legend for Figure 2

A. TO ENGINE COOLANT PIPE (CYLINDER BLOCK RIGHT SIDE)
B. TO THERMOSTAT OUTLET HOUSING
C. TO POSITIVE CRANKCASE VENTILATION (PCV) VALVE

1. INTAKE MANIFOLD
2. ELECTRONIC GOVERNOR
3. THROTTLE BODY
4. IDLE AIR CONTROL (IAC) VALVE

Throttle Body

The throttle body assembly consists of a throttle position (TP) sensor and a throttle body (built in throttle valve). An air adjusting screw (AAS) for adjusting the idle speed has been installed on the throttle body. See Figure 3.



1. THROTTLE POSITION (TP) SENSOR
2. THROTTLE BODY
3. AIR ADJUSTING SCREW (AAS)

Figure 3. Throttle Body

Idle Air Control (IAC) Valve

The IAC valve, controlled by the ECU signal, adjusts the intake air amount that bypasses the throttle valve. The air, which bypasses the throttle valve, flows through the IAC valve from inlet port (air hose side) to outlet port (intake manifold side).

The IAC valve is composed of a housing, plunger, and solenoid coil. See Figure 4.

When a signal from the ECU reaches the IAC valve, the plunger is pulled back to allow bypass air into the outlet port.

Electronic Governor

The electronic governor is installed between the throttle body and the intake manifold. The electronic governor is controlled by the governor control unit (GCU) signal and helps control the maximum speed of the engine.

The electronic governor is composed of an electronic governor sensor and throttle control motor. The throttle control motor drives the electronic governor and adjusts the opening and closing angle of the throttle valve through the gear based on the signal of the GCU. The electronic governor sensor detects the governor position and inputs it to the GCU. See Figure 5.

Service Code P0103 MAF Sensor Signals: Too High Input Voltage to ECU

FAILURE DETECTION CONDITION

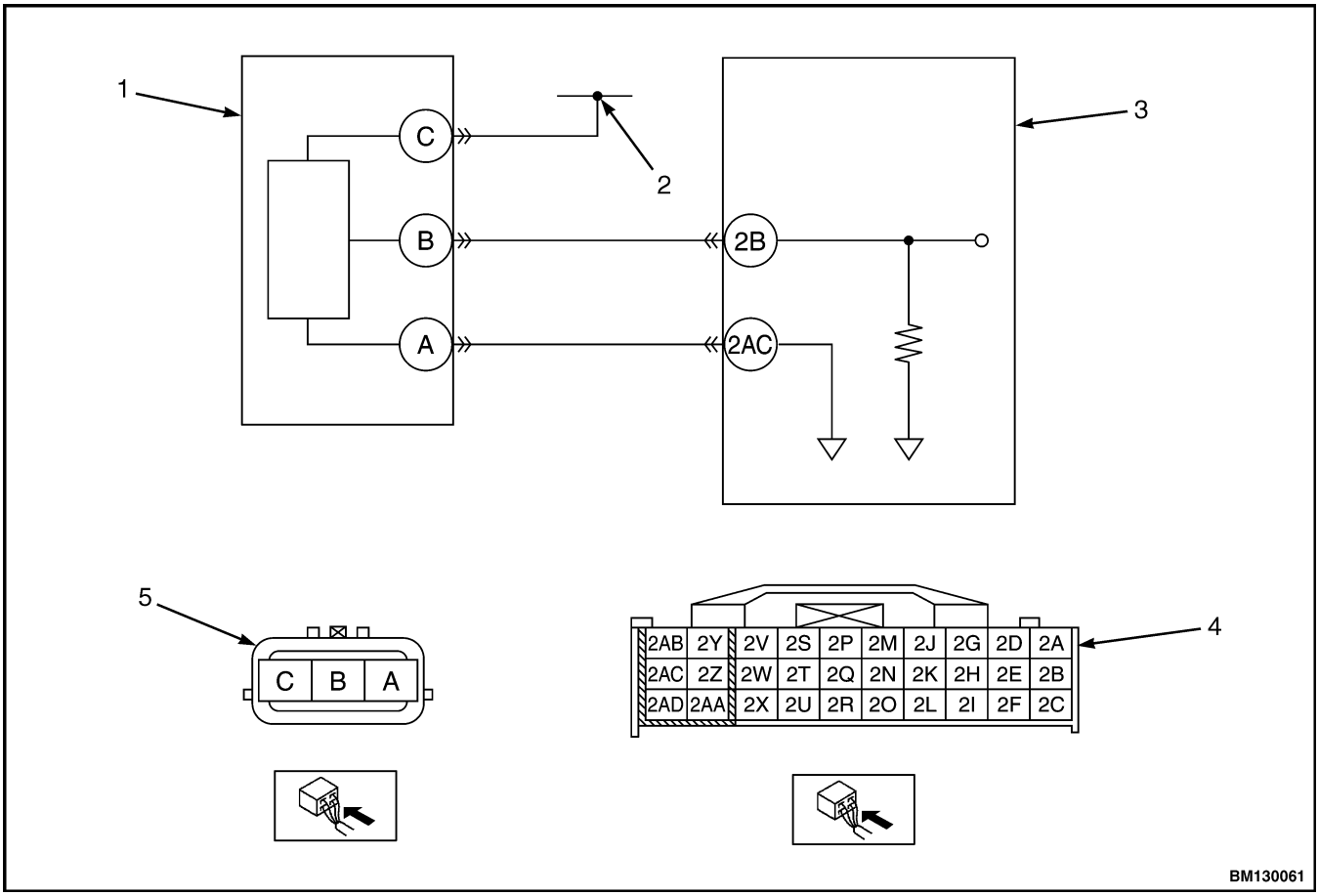
- ECU 2B terminal voltage is at over 4.84 volts during the engine operation.

FAIL/SAFE

- Determine the filling efficiency, depending on the throttle position.
- Inhibit the purge control.
- Fix the spark timing at 6 degrees CA.

POSSIBLE SOURCES

Refer to Figure 22 for the following:
- MAF sensor failure.
- Connector or terminal failure.
- Harness breakage between MAF sensor A terminal and Ground.
- Harness between MAF sensor B terminal to ECU 2B terminal short-circuits to power supply system.



1. MAF SENSOR
2. POWER RELAY
3. ECU
4. CONNECTOR AT ECU HARNESS SIDE
5. CONNECTOR AT MAF SENSOR HARNESS SIDE

Figure 22. MAF Sensor Wiring Diagram

Data Monitor

DATA MONITOR CHECK

The Operational Condition (Reference) data, shown in Table 12, was taken after the engine adjustment.

Table 12. Monitor Item Chart

Monitor Item	Unit/Operation	Operational Condition (Reference)	Items to be Checked When Failure Occurs	ECU Terminal
APRMDES	RPM	• No load: 775 to 825 RPM • Electric devices ON: 750 to 850 RPM • P/S ON: 950 to 1050 RPM	• Examine the following monitor items: – ALTT V, CPP/PNP, ECT, IAT, MAF, PSP, RPM, test, TP. • Check IAC valve.	-
ECT	°C (°F)	• ECT of 20°C (68°F): 20°C (68°F) • ECT of 80°C (176°F): 80°C (176°F)	• Check ECT sensor.	2M
	V	• ECT of 20°C (68°F): Approximately 3.0 V • ECT of 80°C (176°F): Approximately 0.9 V		
FP	ON/OFF	• Ignition switch ON: OFF • Cranking or idling: ON	• Check fuel pump relay.	4Q
FUELPW 1-4	ms	• Ignition switch ON: 0 ms • Idling: 2.5 ms	• Check the following monitor items: – ACCS, ACSW, BOO, CPP/PNP, ECT, IAT, MAF, O2 S11, PSP, TP, VPWR, RPM	4W, 4Z, 4AC, 4AD
IAC	%	• Ignition switch ON: 10 % • Idling (ECT 90°C (194°F), electric devices OFF): Approximately 13.5 to 16.5 % • Idling and TEN terminal ON (ECT 90°C (194°F), electric devices OFF): Approximately 20 to 22 %.	• Check the following monitor items: – CPP/PNP, ECT, IAT, PSP, test, TP, RPM	4Y, 4AB
IAT	°C (°F)	• IAT of 20°C (68°F): 20°C (68°F) • IAT of 30°C (86°F): 30°C (86°F)	• Check IAT sensor.	2E
	V	• IAT of 20°C (68°F): Approximately 2.3 V • IAT of 30°C (86°F): Approximately 1.8 V		
LOAD	%	• Idling after engine warm up: Approximately 24 %	• Follow the service code check procedure.	-
LONGFT 1	%	• Idling after engine warm up: From -15 to +15	• Conduct the service code check procedure.	-

Table 20. HO_2S Signal

ECU terminal	2G (positive) —2H (negative)
Oscilloscope setting	200 mV/DIV (Y), 500 ms/DIV (X), DC range
Vehicle condition	Idle after warm up

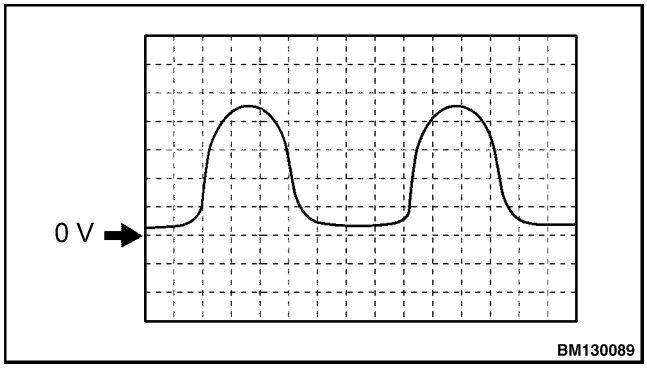
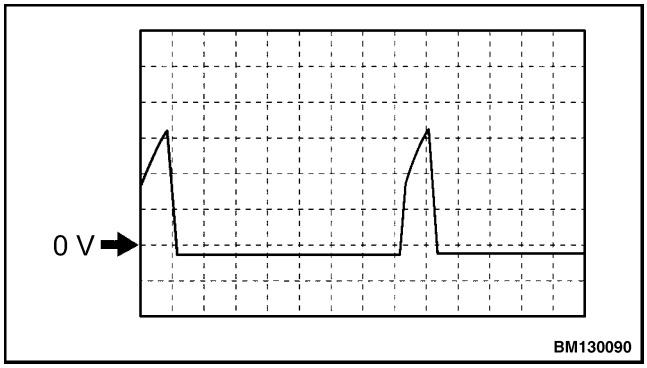


Table 21. IGT Signal

ECU terminal	4K (positive) —ground (negative)
Oscilloscope setting	1 V/DIV (Y), 5 ms/DIV (X), DC range
Vehicle condition	Idle after warm up



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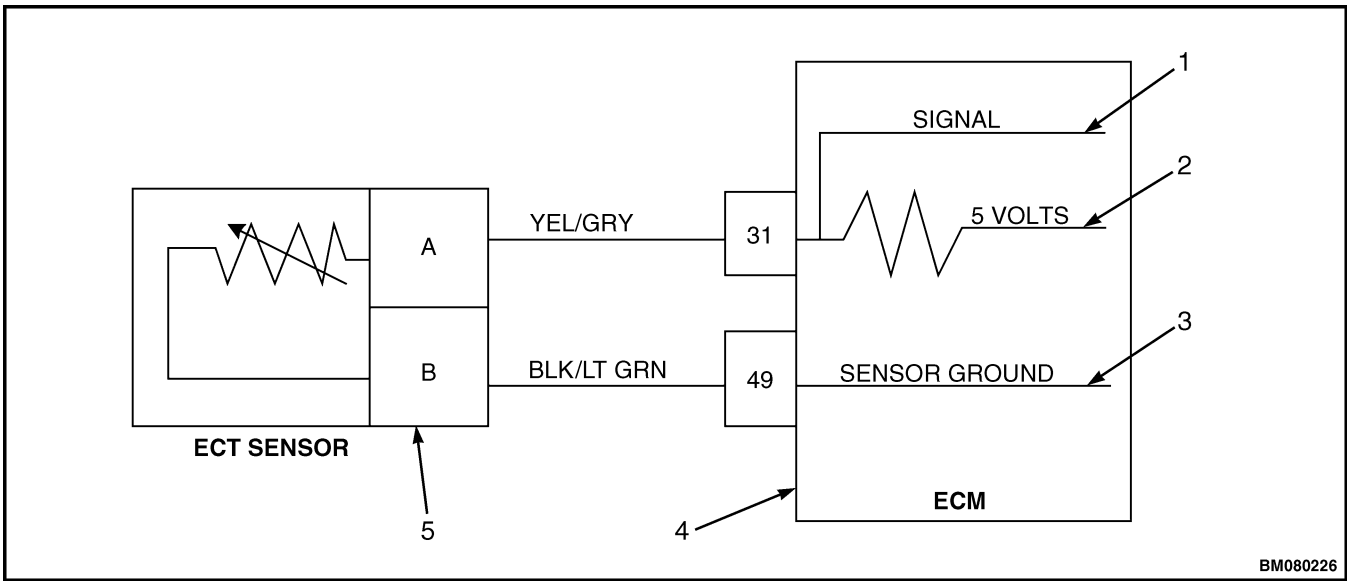

1. SIGNAL
2. 5 VOLTS
3. SENSOR GROUND
4. ELECTRONIC CONTROL MODULE (ECM)
5. ENGINE COOLANT TEMPERATURE (ECT) SENSOR

Figure 8. ECT Sensor Circuit

Table 7. DTC 122 - ECT Low Voltage

Step	Action	Value(s)	Yes	No
1	Did you perform the On-board diagnostics (OBD) system check?		Go to step 2.	Go to On-Board Diagnostics System Check/Malfunction Indicator Lamp.
2	• Key **ON**. • Laptop computer connected in system data mode. • Does laptop computer display ECT voltage of 0.05 or less?		Go to step 3.	Intermittent problem. Go to Preliminary and Intermittent Checks.
3	• Key **OFF**. • Disconnect ECM wire harness connector. • Key **ON**. Does the laptop computer display ECT voltage of 4.9 volts or greater?		Go to step 4.	Go to step 5.
4	• Replace ECT sensor. Is the replacement complete?		Go to step 8.	

Table 15. DTC 511 - COP Failure

Step	Action	Value(s)	Yes	No
1	Did you perform the On-board diagnostics (OBD) system check?		Go to step 2.	Go to On-Board Diagnostics System Check/Malfunction Indicator Lamp.
2	• Key **ON** and engine running. • Laptop computer connected in system data mode. • Clear system fault code. Does DTC 511 reset with the engine idling?		Go to step 3.	Intermittent problem. Go to Preliminary and Intermittent Checks.
3	• Check all ECM power and ground circuits. Refer to the **Diagrams** section for your lift truck. Are the power and ground circuits OK?		Go to step 4.	Repair the circuit as necessary. Refer to Wire Harness Repair. Go to step 5.
4	• Replace the ECM. Is the replacement complete?		Go to step 5.	
5	• Remove all test equipment except the laptop computer. • Connect any disconnected components, fuses, etc. • Using the laptop computer, clear DTC information from the ECM. • Turn the ignition **OFF** and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature. • Observe the MIL • Observe engine performance and driveability. • After operating the engine within the test parameters of DTC 511, check for any stored codes. Does the engine operate normally with no stored codes?		System OK.	Go to On-Board Diagnostics System Check/Malfunction Indicator Lamp.

Table 25. DTC 611 - FPP High Voltage (Continued)

Step	Action	Value(s)	Yes	No
14	• Key **OFF**. • Disconnect ECM connector. • Check continuity between FPP sensor connector ground pin 2 and ECM connector FPP sensor ground pin 49. Do have continuity between them?		Go to step 10.	Repair the circuit as necessary. Refer to Wire Harness Repair. Go to step 15.
15	• Remove all test equipment except the laptop computer. • Connect any disconnected components, fuses, etc. • Using the laptop computer clear DTC information from the ECM. • Turn the ignition **OFF** and wait 30 seconds. • Start the engine and operate the vehicle to full operating temperature. • Observe the MIL. • Observe engine performance and driveability. • After operating the engine within the test parameters of DTC 611, check for any stored codes. Does the engine operate normally with no stored codes?		System OK.	Go to On-Board Diagnostics System Check/Malfunction Indicator Lamp.