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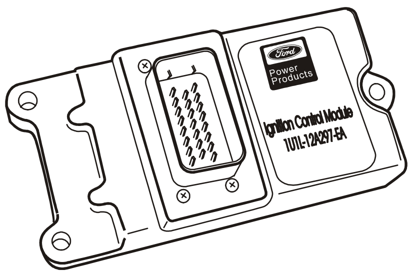
GENERAL INFORMATION

EPM/ICM and Sensors



Ignition Control Module (ICM)

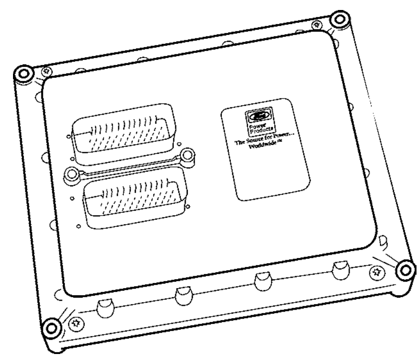
The Ignition Control Module (ICM) has the following features:

- Programmable emergency warning/shut-down feature for high water temperature, low oil pressure, etc.
- Starter lockout.
- Programmable overspeed protection.
- Automatic altitude compensation.
- Diagnostic software allows viewing of active faults with on-demand diagnostics to assist technicians and reduce equipment downtime.
- Shut-down output that will send a ground signal when the ICM shuts down due to low oil, high ECT or rev-limit.

Engine Performance Module (EPM)

The Engine Performance Module (EPM) has the following features:

- Programmable four speed electronic governing, throttle-by-wire or variable speed control governing.
- Programmable emergency warning/shut-down feature for high water temperature, low oil pressure, etc.
- Starter lockout.
- Auto crank
- Programmable overspeed protection.
- Automatic altitude compensation.
- Sequential port fuel injection (gasoline) with pressure regulator to precisely control fuel delivery.



- Dry fuel lockout controlled by the EPM produces a reliable transition when switching fuels.
- Certified closed loop dry fuel control.
- Configurable inputs available based on customer requirements.
- Configurable outputs available based on ECT, RPM or MAP signals and customer requirements.
- Diagnostic software allows viewing of historical and active faults with on-demand diagnostics to assist technicians and reduce equipment downtime.

The Engine Performance Module (EPM) engine control system is a complete engine control system for Ford industrial engines running on gasoline, propane or natural gas. Each module can be set up to run an engine on any two of the three fuels in certified closed-loop control, with virtually transparent on-the-fly fuel switching.

Each module can also be set up to run on a variety of electronic governing:

- It can be programmed to provide up to four specific speeds with use of a matching toggle switch.
- It can be programmed to provide an infinite variety of speeds (with customer-specified minimum and maximum) based on a variable signal input.
- It can be an electronic replacement for a throttle cable with maximum speed governing (throttle-by-wire).
- Or it can switch between throttle-by-wire and a second fixed or variable input based on a neutral/ parking brake signal.

With the EPM system, a laptop and a communications cable, diagnosis becomes simpler. The technician can either view engine data with a real time graphing program, or store that data into a numeric data file.

Every time a fault is set, the laptop will give you detailed information about the fault, including:

- when it happened
- if the fault still exists
- a list of essential engine data from the time of the fault.

It can also display a 10 second graph of critical engine data, from 8 seconds before the fault occurred to two seconds after. And if you only want to view engine parameters and fault codes, all you need is a Personal Digital Assistant (PDA) and our easy to load software and a communications cable.

With many OEMs using control modules to control their machinery, the new EPM has the ability to communicate engine data to and receive commands from other control modules through a Controller Area Network (CAN) link, with messages written in the J1939 protocol. This allows large amounts of data to move throughout the machine through only two wires, and can be used to run some module based gauge packages.

The EPM also carries auxiliary features that can be programmed to control OEM devices, allowing the OEM to eliminate components from their machinery.

The EPM is also equipped with multiple safety and protection devices that protect the user and engine from hazards such as:

- over speed
- over temperature
- over voltage
- low oil pressure
- unauthorized tampering
- over cranking starter motor.

The EPM controls the following:

- Fuel metering system
- Ignition timing
- On-board diagnostics for engine functions

The EPM constantly observes the information from various sensors. The EPM controls the systems that affect engine performance. The EPM performs the diagnostic function of the system. It can recognize operational problems, alert the operator through the Malfunction Indicator Lamp (MIL), and store diagnostic trouble codes (DTC's). DTC's identify the problem areas to aid the technician in making repairs.

The EPM supplies either 5 or 12 volts to power various sensors or switches. The power is supplied through resistances in the EPM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, a digital voltmeter with at least 10 meg-ohms input impedance is required to ensure accurate voltage readings. The EPM controls output circuits such as the fuel injectors, electronic governor, etc., by controlling the ground or the power feed circuit through transistors or other solid state devices.

The EPM is designed to maintain exhaust emission levels to government mandated standards while providing excellent operation and fuel efficiency. The EPM monitors numerous engine functions via electronic sensors such as the throttle position (TP) sensor and the heated oxygen sensor (HO2S).

EPM Inputs (operating conditions read)

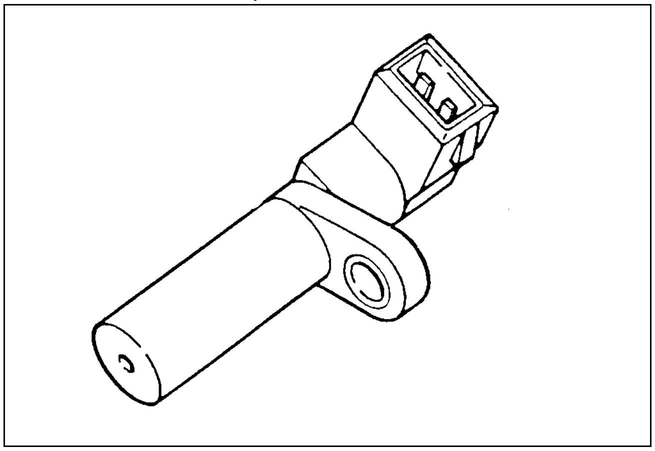
- Engine Coolant Temperature
- Crankshaft Position
- Exhaust Oxygen Content
- Manifold Absolute Pressure
- Battery Voltage
- Throttle Position / Electronic Actuator
- Fuel Pump Voltage
- Intake Air Temperature
- Camshaft Position

EPM Outputs (systems controlled)

- Fuel control
- Electronic Throttle Control
- Electric Fuel Pump
- Diagnostics - Malfunction Indicator Lamp (check engine lamp)
- Diagnostics - Data Link Connector (DLC)

Crankshaft Position (CKP) Sensor

The Crankshaft Position (CKP) Sensor provides a signal used by the Engine Performance Module (EPM) to calculate the ignition sequence. The sensor initiates the reference pulses which the EPM uses to calculate RPM and crankshaft position.

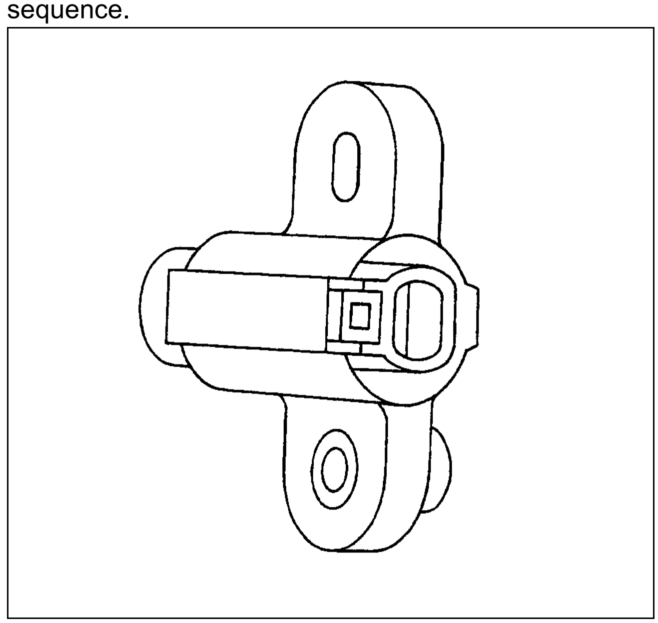


Camshaft Position (CMP) Sensor

The Camshaft Position (CMP) Sensor uses a variable reluctor sensor to detect camshaft position. The CMP signal is created as piston #1 is a pre-determined number of degrees after top dead center on the power stroke.

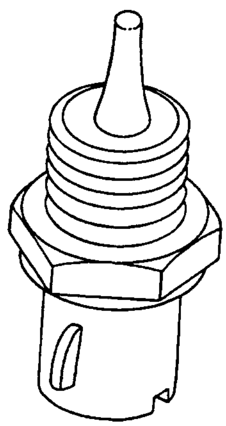
The Camshaft Position (CMP) Sensor sends a CMP signal to the EPM. The EPM uses this signal as a “sync pulse” to trigger the injectors in the proper sequence. The EPM uses the CMP signal to indicate the position of the #1 piston during its power stroke. The CMP uses a Hall Effect sensor to measure piston position. This allows the EPM to calculate true sequential fuel injection (SFI) mode of operation. If the EPM detects an incorrect CMP signal while the engine is running, DTC 245 will set.

If the CMP signal is lost while the engine is running, the fuel injection system will shift to a calculated sequential fuel injection mode based on the last fuel injection pulse, and the engine will continue to run. As long as the fault (DTC 244) is present, the engine can be restarted. It will run in the previously established injection sequence.



Engine Coolant Temperature (ECT) Sensor

The Engine Coolant Temperature (ECT) Sensor is a thermistor (a resistor which changes value based on temperature) mounted in the engine coolant stream. Low coolant temperature produces a high resistance of 100,000 ohms at -40°C (-40°F). High temperature causes a low resistance of 70 ohms at 130°C (266°F). The EPM supplies a 5 volt signal to the ECT sensor through resistors in the EPM and measures the voltage. The signal voltage will be high when the engine is cold and low when the engine is hot. By measuring the voltage, the EPM calculates the engine coolant temperature. Engine coolant temperature affects most of the systems that the EPM controls.

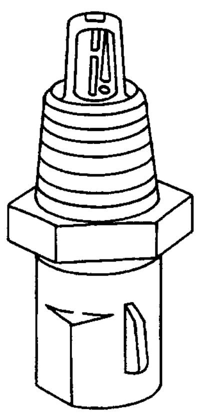


After engine start-up, the temperature should rise steadily to about 85°C (185°F). It then stabilizes when the thermostat opens. If the engine has not been run for several hours (overnight), the engine coolant temperature and intake air temperature displays should be close to each other. A fault in the engine coolant sensor circuit will set a DTC 221 or DTC 222.

TEMP. C°	TEMP. F°	NOM Rt, (OHMS)	NOM E_{OUT} (VOLTS)
-40	-40	925,021	4.54
-35	-31	673,787	4.50
-30	-22	496,051	4.46
-25	-13	368,896	4.41
-20	-4	276,959	4.34
-15	5	209,816	4.25
-10	14	160,313	4.15
-5	23	123,485	4.02
0	32	95,851	3.88
5	41	74,914	3.71
10	50	58,987	3.52
15	59	46,774	3.32
20	68	37,340	3.09
25	77	30,000	2.86
30	86	24,253	2.62
35	95	19,716	2.39
40	104	16,113	2.15
45	113	13,236	1.93
50	122	10,926	1.72
55	131	9,061	1.52
60	140	7,548	1.34
65	149	6,332	1.18
70	158	5,335	1.04
75	167	4,515	.91
80	176	3,837	.79
85	185	3,274	.70
90	194	2,804	.61
95	203	2,411	.53
100	212	2,080	.47
105	221	1,801	.41
110	230	1,564	.36
115	239	1,363	.32
120	248	1,191	.28
125	257	1,044	.25
130	266	918	.22
135	275	809	.19
140	284	715	.17
145	293	633	.15
150	302	563	.14
Voltage values calculated for VREF = 5 volts (may vary ± 15% due to sensor and VREF variations)			

Intake Air Temperature (IAT) Sensor

The Intake Air Temperature (IAT) Sensor is a thermistor which changes its resistance based on the temperature of air entering the engine. Low temperature produces a high resistance of 100,000 ohms at -40°C (-40°F). High temperature causes a low resistance of 70 ohms at 130°C (266°F). The EPM supplies a 5 volt signal to the sensor through a resistor in the EPM and monitors the signal voltage. The signal voltage will be high when the incoming air is cold and low when the incoming air is hot. By measuring the voltage, the EPM calculates the incoming air temperature. The IAT sensor signal is used to adjust spark timing according to the incoming air density.



The diagnostic software can be used to display the temperature of the air entering the engine. The temperature should read close to the ambient air temperature when the engine is cold, and rise as engine compartment temperature increases. If the engine has not been run for several hours (overnight), the IAT sensor temperature and engine coolant temperature should read close to each other. A failure in the IAT sensor circuit will set DTC 211 or DTC 212.

Specifications

- Range of Measurement: -40°C (-40°F) to 125°C (57°F)
- Measurement Accuracy: ±3°C
- Resolution: 0.6°C max.
- Output Range: 4.8 % min. to 91% max. of VREF
- Current Draw: <5mA from VREF
- Load Impedance: >100 kohms

Temp. C°	Temp. F°	Minimum Resistance (ohms)	Maximum Resistance (ohms)
-40	-40	749,130	1,020,270
-20	-04	253,035	289,365
0	+32	88,801	101,159
20	+68	34,925	39,655
40	+104	15,148	17,150
60	+140	7,137	8,061
100	+212	1,948	2,190
120	+248	1,107	1,245

Heated Oxygen Sensor (HO2S)

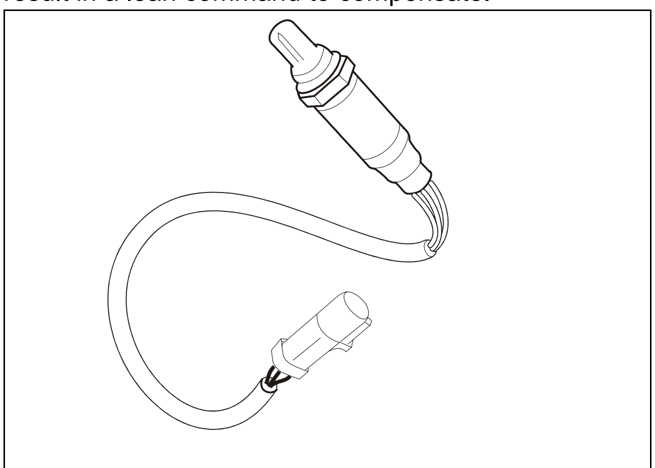
The Heated Oxygen Sensor (HO2S) is mounted in the exhaust stream where it can monitor the oxygen content of the exhaust gas. The oxygen present in the exhaust gas reacts with the sensor to produce a voltage output. This voltage should constantly fluctuate from approximately 100mV to 900 mV, when the engine is running in closed loop fuel control.

The Heated Oxygen Sensor (HO2S) voltage can be monitored on an IBM PC compatible computer with diagnostic software. By monitoring the voltage output of the oxygen sensor, the EPM calculates the pulse width command for the injectors to produce the proper combustion chamber mixture.

The 4-wire HO2S indicates whether the air/fuel ratio is rich or lean with respect to stoichiometry. The signal from this sensor contains valid air/fuel ratio information only when the sensor element has reached its normal operating temperature. The 4-wire HO2S also has an isolated case ground which goes to Signal Return (SIGRTN) either in the processor (as a dedicated HO2S ground) or as a jumper to SIGRTN in the wiring harness.

Low HO2S voltage indicates a lean mixture which will result in a rich command to compensate.

High HO2S voltage indicates a rich mixture which will result in a lean command to compensate.



Specifications

- Accuracy of measurement: ±1.5%
- Operating Temp. Range: 350°C to 850°C (sensor tip)
- Sensor Response Time: 300-1500 msec.
- Heater Current Draw: 1 A steady state
- Voltage Output:
  0 - 450 mV (lean exhaust gas)
  450 - 1000 mV (rich exhaust gas)

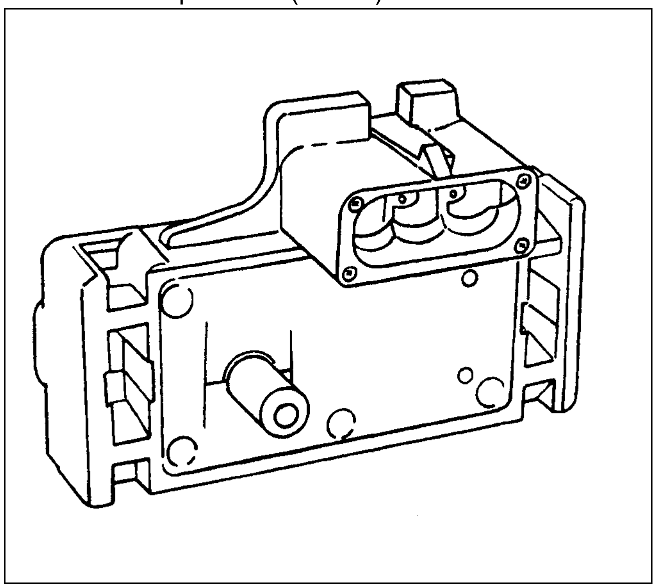
Manifold Absolute Pressure (MAP) Sensor

The Manifold Absolute Pressure (MAP) Sensor responds to changes in intake manifold pressure (vacuum). The MAP sensor signal voltage to the EPM varies from below 2 volts at idle (high vacuum) to above 4 volts with the ignition ON, engine not running or at wide-open throttle (low vacuum).

The MAP sensor consists of a pressure sensing element (capacitor) and signal conditioning electronics. The capacitor has a vacuum/pressure reference which results in one surface (diaphragm) of the capacitor being partially deflected. Further changes in pressure produce corresponding changes in the deflection of the diaphragm and therefore a change in capacitance. This capacitance change is converted to a frequency by the conditioning electronics.

The MAP sensor is used to determine the following:

- Engine vacuum level for engine control purposes.
- Barometric pressure (BARO).



Specifications:

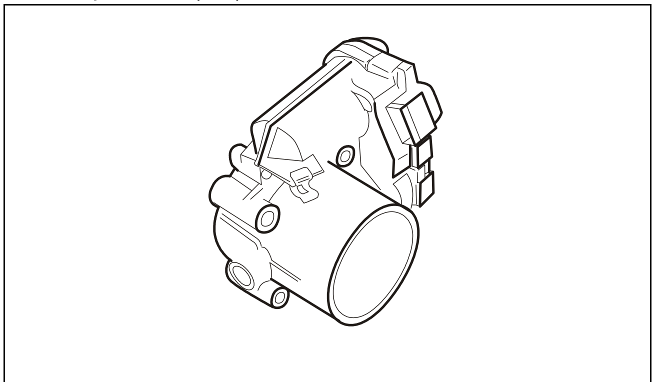
- Range of Measurement: 1.7 - 15.2 psi.
- Measurement Accuracy: ± 0.2 psi
- Sensor Response Time: 3-15 msec.
- Resolution: 0.02 psi

Present design: Silicon Capacitive Absolute Pressure (SCAP) sensor with a maximum operating temperature of 100°C. The output is a 50% duty cycle wave form whose frequency is proportional to the pressure input.

Throttle Position (TP) Sensor / Electronic Actuator

The Throttle Position (TP) Sensor is a dual track rotary potentiometer that uses a variable resistive element which is packaged inside a plastic housing. The resistive element varies linearly and is directly proportional to the throttle plate angle. The EPM applies reference voltage and ground to the sensor and monitors the sensor's ratio metric output voltage to determine precise throttle position. The electronic actuator has two TP outputs that the EPM monitors.

The Electronic Actuator consists of a throttle body, an electronically-actuated throttle plate, and a built-in throttle position (TP) Sensor.



The Electronic Actuator also acts as an idle air control (IAC) valve. Changes in engine load are detected by the EPM by comparing manifold absolute pressure (MAP) with throttle position. When the EPM detects a change in engine load, it can adjust idle speed by changing the PWM signal to the actuator.

As the throttle valve opens, the output increases so that at wide open throttle (WOT), the output voltage should be above 4 volts.

The EPM calculates fuel delivery based on throttle valve angle (operator demand). A hard failure in the TP sensor 5 volt reference or signal circuits for greater than 2 consecutive seconds will set a DTC 531 or DTC 533. A hard failure with the TP sensor ground circuit for more than two consecutive seconds may set DTC 532. If any (TP) DTC is set the EPM will shut down the engine immediately.

Specifications:

- Range of Measurement: 0-85° (angular)
- Measurement Accuracy: ±2% of VREF
- Resolution: 0.5° max.

Fuel System Components - Gasoline

The fuel metering system is made up of the following parts:

- The fuel injectors
- The fuel rail
- The fuel pressure regulator/filter assembly
- The EPM
- The Crankshaft Position (CKP) Sensor
- The Camshaft Position (CMP) Sensor
- The fuel pump
- The fuel pump relay
- Heated Oxygen (HO2S) Sensor
- Manifold Absolute Pressure (MAP) Sensor

The basic function of the air/fuel metering system is to control the air/fuel delivery to the engine. Fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each intake valve.

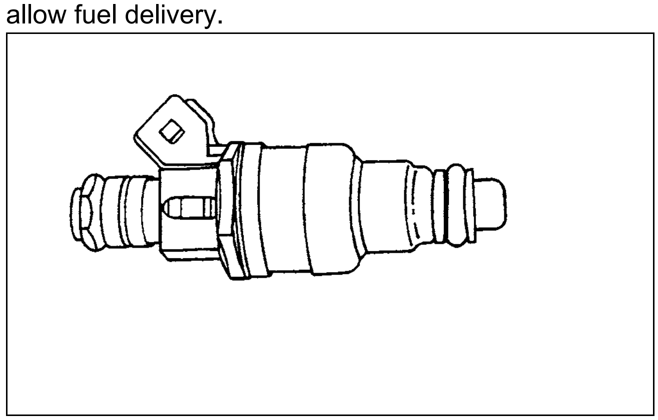
The fuel metering system starts with the fuel in the fuel tank. The fuel is drawn up to the fuel pump through a pre-filter. The electric fuel pump then delivers the fuel to the fuel rail through an in-line fuel filter. The pump is designed to provide fuel at a pressure above the pressure needed by the injectors. A fuel pressure regulator in the fuel filter assembly keeps fuel available to the fuel injectors at a constant pressure. A return line delivers unused fuel back to the tank.

The main control sensor is the heated oxygen sensor (HO2S) located in the exhaust system. The HO2S tells the EPM how much oxygen is in the exhaust gas. The EPM changes the air/fuel ratio to the engine by controlling the amount of time that the fuel injector is "ON". The best mixture to minimize exhaust emissions is 14.7 parts of air to 1 part of gasoline by weight, which provides the most efficient combustion. Because of the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a "closed loop" system.

The EPM monitors signals from several sensors in order to determine the fuel needs of the engine. Fuel is delivered under one of several conditions called "modes". All modes are controlled by the EPM. Refer to "Open Loop and Closed Loop Operation" for more information.

Fuel Injector

The Electronic Fuel Injection (EFI) fuel injector is a solenoid operated device controlled by the EPM. The EPM energizes the solenoid, which opens a valve to allow fuel delivery.

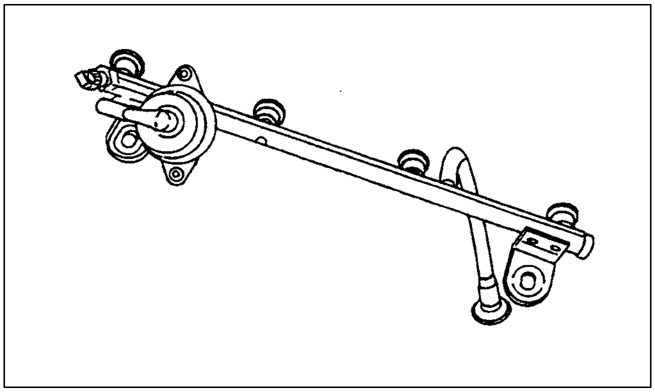


The fuel is injected under pressure in a conical spray pattern at the opening of the intake valve. Excess fuel not used by the injectors passes through the fuel pressure regulator before being returned to the fuel tank.

A fuel injector which is stuck partly open will cause a loss of fuel pressure after the engine is shut down, causing long crank times.

Fuel Rail

The fuel rail is mounted to the top of the engine and distributes fuel to the individual injectors. Fuel is delivered to the fuel inlet tube of the fuel rail by the fuel lines.

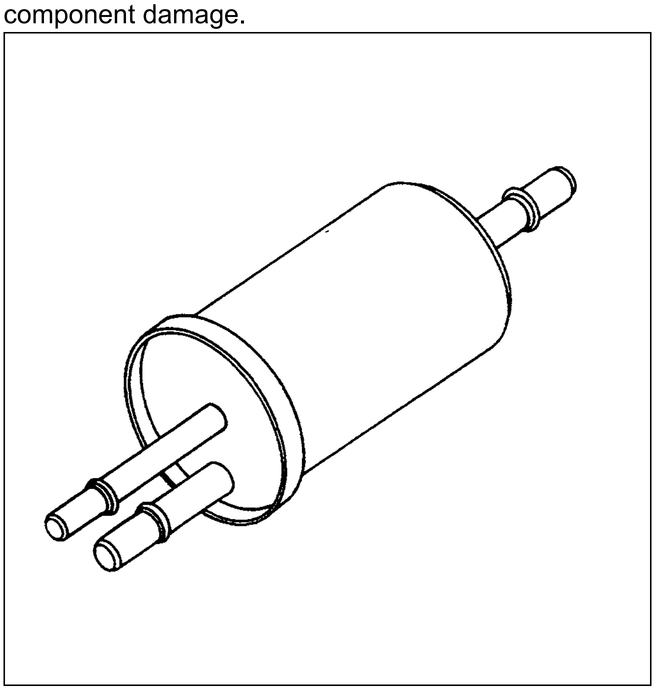


Fuel Pressure Regulator

The fuel pressure regulator is a relief valve mounted in the fuel filter. It provides a constant fuel pressure of 441 kPa (64 psi).

If the pressure is too low, poor performance and a DTC 121 or 141 will set. If the pressure is too high, excessive odor and/or a DTC 122 or 142 will result.

When replacing the fuel filter, be sure to use an identical filter/regulator assembly. A standard fuel filter does not regulate pressure and could cause engine problems or component damage.



Fuel Pump Electrical Circuit

When the key is first turned “ON”, the EPM energizes the fuel pump relay for two seconds to build up the fuel pressure quickly. If the engine is not started within two seconds, the EPM shuts the fuel pump off and waits until the engine is cranked. When the engine is cranked and crankshaft position signal has been detected by the EPM, the EPM supplies 12 volts to the fuel pump relay to energize the electric fuel pump.

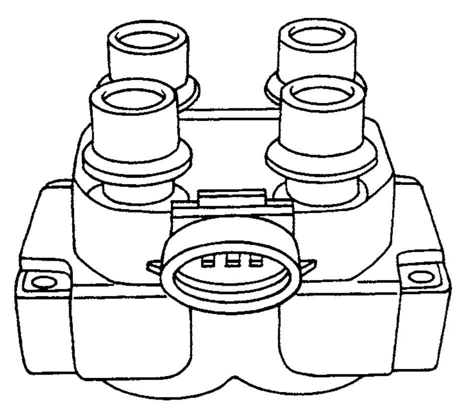
An inoperative fuel pump will cause a “no-start” condition. A fuel pump which does not provide enough pressure will result in poor performance.

Electronic Ignition

The electronic ignition system controls fuel combustion by providing a spark to ignite the compressed air/fuel mixture at the correct time. To provide optimum engine performance, fuel economy, and control of exhaust emissions, the EPM controls the spark advance of the ignition system. Electronic ignition has the following advantages over a mechanical distributor system:

- No moving parts
- Less maintenance
- Remote mounting capability
- No mechanical load on the engine
- More coil cooldown time between firing events
- Elimination of mechanical timing adjustments
- Increased available ignition coil saturation time

The electronic ignition system uses a coil pack with one ignition coil for each two cylinders in the engine. Each cylinder is paired with its opposing cylinder in the firing order, so that one cylinder on compression fires simultaneously with the opposing cylinder on exhaust. The spark that occurs in the cylinder on the exhaust stroke is referred to as a “waste spark”.



The primary coils in the coil pack are triggered by the “ignition coil feed#1” and ignition coil feed #2” signals from the EPM.

Open Loop and Closed Loop Operation

NOTE: No DTC will be set unless engine has operated in closed loop status for more than 6 seconds.

The EPM will operate in the following two modes:

- Open loop
- Closed loop

When the engine is first started, the system is in “open loop” operation. In open loop, the EPM ignores the signal from the Heated Oxygen Sensor (HO2S). It uses a pre-programmed routine to calculate the air/fuel ratio based on inputs from the TP, ECT, MAP & CKP sensors.

The system remains in open loop until the following conditions are met:

- The ECT has reached 95°F (35°C).
- 15 seconds has elapsed since starting the engine.

After these conditions are met, the engine is said to be operating in “closed loop”. In closed loop, the EPM continuously adjusts the air/fuel ratio by responding to signals from the HO2S (except at wide-open throttle). When the HO2S reports a lean condition (low sensor signal voltage), the EPM responds by increasing the “on” time of the fuel injectors, thus enriching the mixture. When the HO2S reports a rich condition (high sensor signal voltage), the EPM responds by reducing the “on” time of the fuel injectors, thus leaning out the mixture.

Adaptive Learn

Adaptive Learn is a fuel correction coefficient that is derived from the closed loop correction and is stored in the EPM’s memory.

The normal purpose of the Adaptive Learn is to compensate fuel flow for the following:

- Fuel composition variance
- Engine wear
- Component variation
- Component degradation

The EPM system will operate in closed loop plus adaptive learn when the ECT reaches 165°F.

NOTE: The adaptive learn coefficient will get erased if battery power falls below 9.5 volts.

EPM/ICM Service Precautions

The EPM/ICM is designed to withstand normal current draws associated with engine operation. When servicing the EPM, observe the following guidelines:

- Do not overload any circuit.
- When testing for opens and shorts, do not ground or apply voltage to any of the EPM/ICM’s circuits unless instructed to do so.
- When measuring voltages, use only a digital voltmeter with an input impedance of at least 10 megohms.
- Do not employ any non-standard practices such as charging the battery with an arc welder.
- Take proper precautions to avoid static damage to the EPM/ICM. Refer to “electrostatic Discharge Damage” for more information.

Use of Circuit Testing Tools

Do not use a test light to diagnose the engine electrical systems unless specifically instructed by the diagnostic procedures. A test light can put an excessive load on an EPM/ICM circuit and result in component damage. For voltage measurements, use only a digital voltmeter with an input impedance of at least 10 megohms.

Electrostatic Discharge Damage

Electronic components used in the EPM/ICM are often designed to carry very low voltage. Electronic components are susceptible to damage caused by electrostatic discharge. Less than 100 volts of static electricity can cause damage to some electronic components. By comparison, it takes as much as 4000 volts for a person to feel the spark of a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are by friction and induction.

An example of charging by friction is a person sliding across a seat.

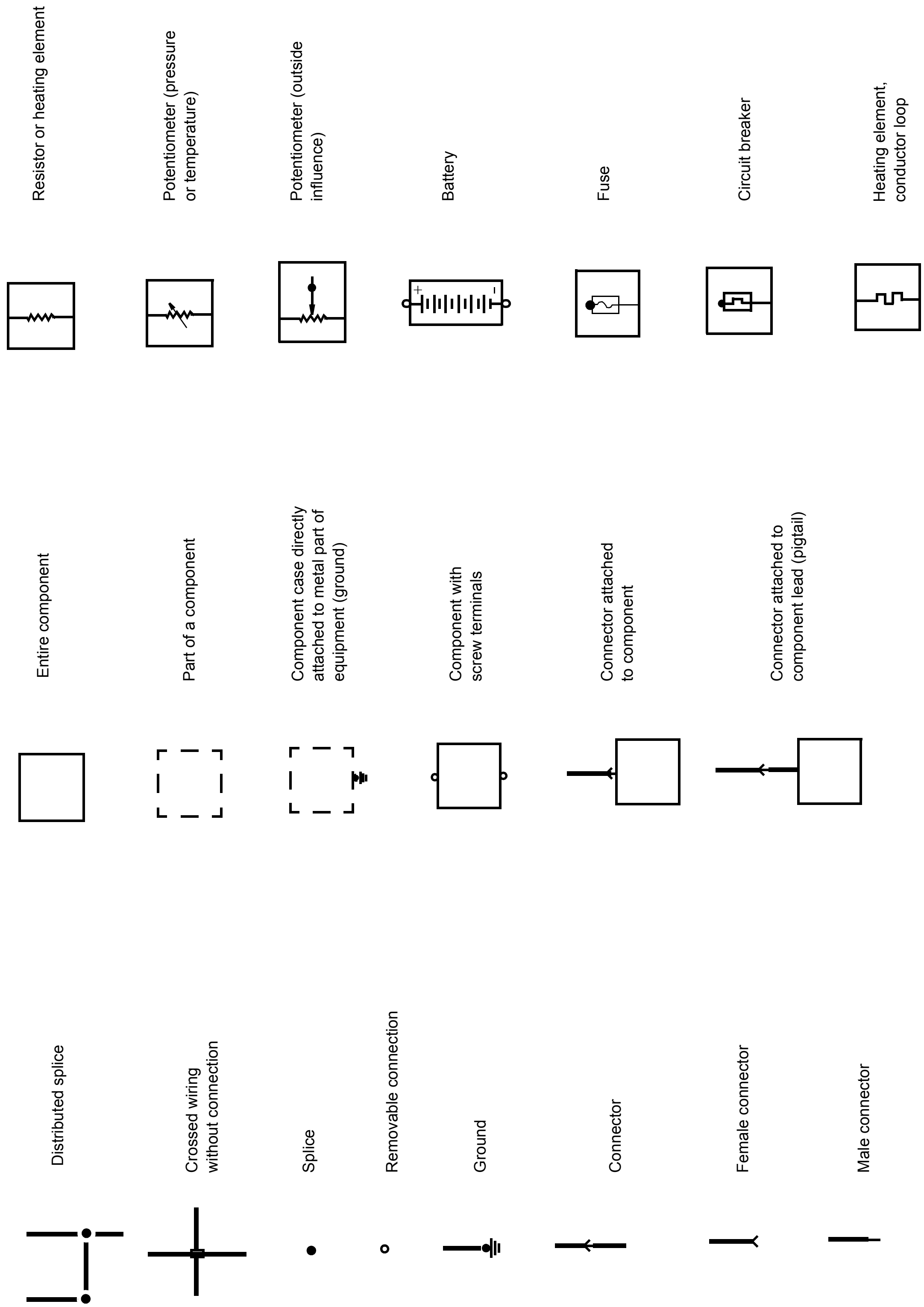
Charge by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges can cause damage, therefore it is important to use care when handling and testing electronic components.

CAUTION: To prevent possible electrostatic discharge damage, follow these guidelines:

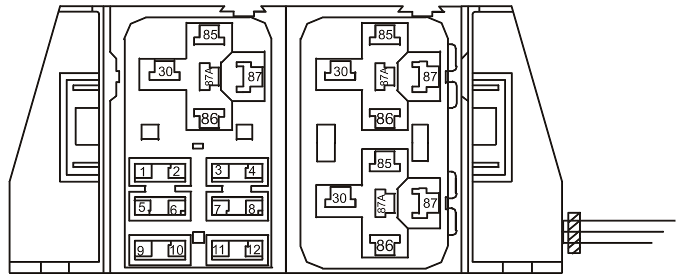
- Do not touch the EPM/ICM connector pins or soldered components on the EPM/ICM board.
- Do not open the replacement part package until the part is ready to be installed.
- Before removing the part from the package, ground the package to a known good ground on the equipment.
- If the part has been handled while sliding across a seat, while sitting down from a standing position, or while walking a distance, touch a known good ground before installing the part.

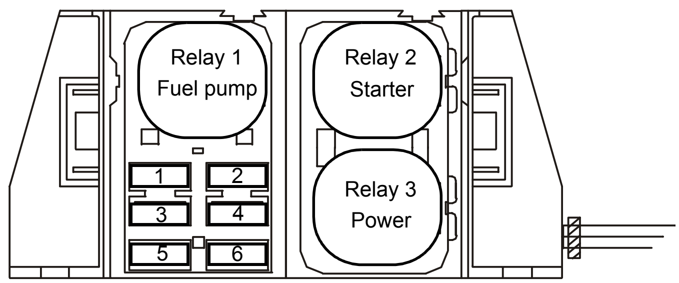
Diagrams and Schematics

Symbols



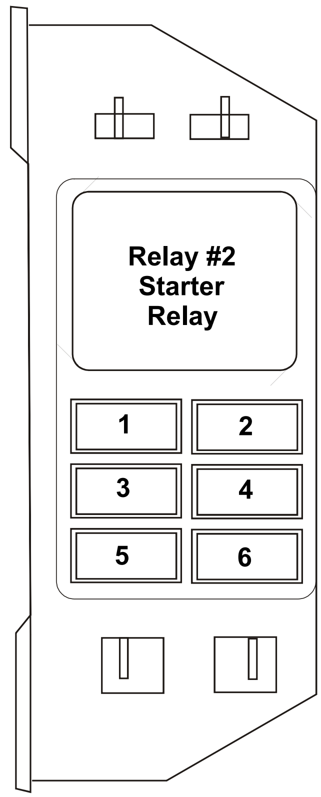
EPM Fuse and Relay Information





Fuse	Amps	Circuits protected
1	30	Ground
2	5	VSW - Relays, EPM,
3	20	VBAT - EPM
4	15	Fuel pump
5	15	EPM, trim valve, coil, lockoff solenoid
6	-	Not used

ICM Fuse and Relay Information

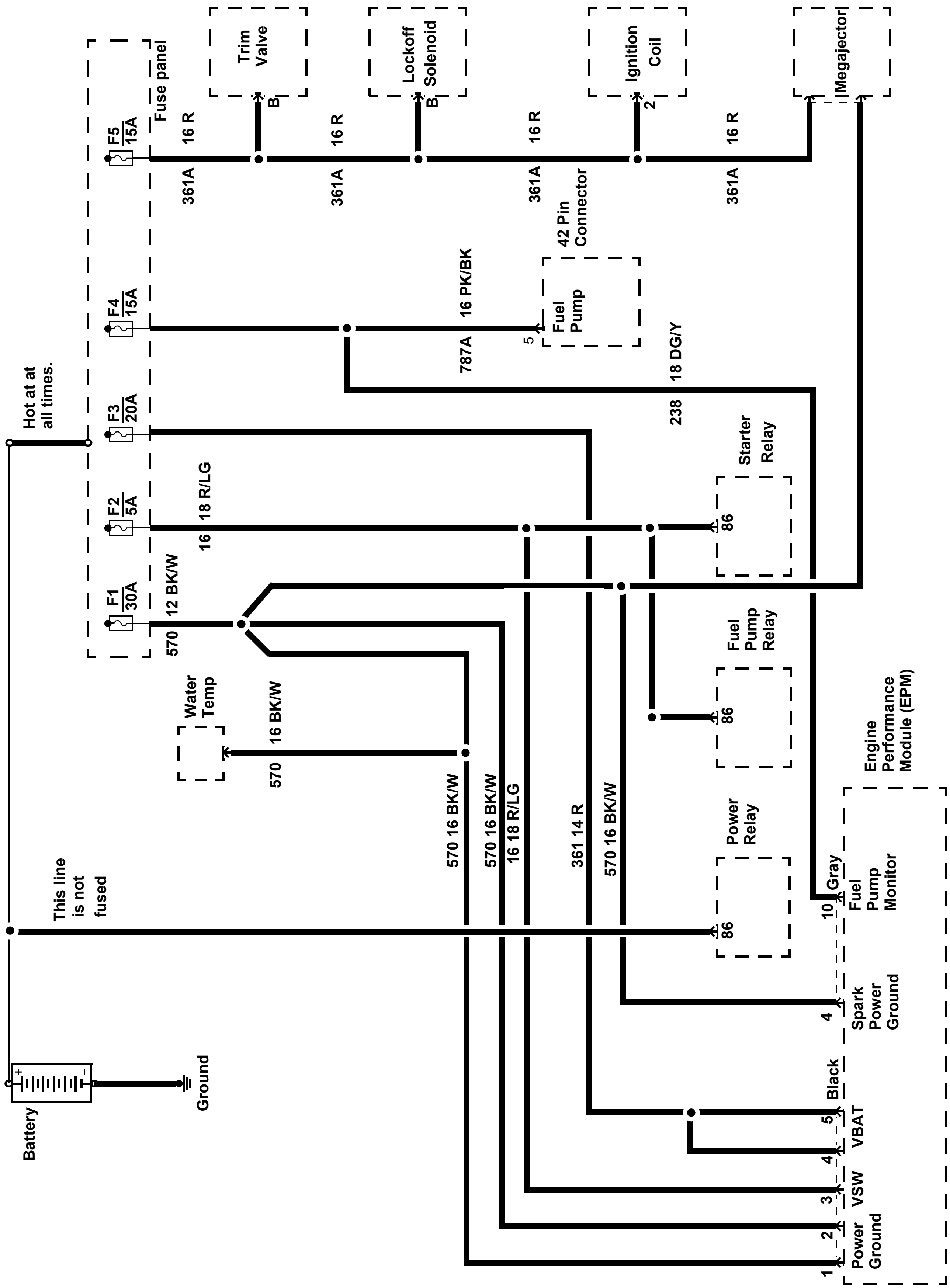


Fuse	Amps	Circuits protected
1	10	Ignition Voltage to ICM, Starter Relay and Ignition Coil
2	-	Not used
3	-	Not used
4	-	Not used
5	-	Not used
6	-	Not used

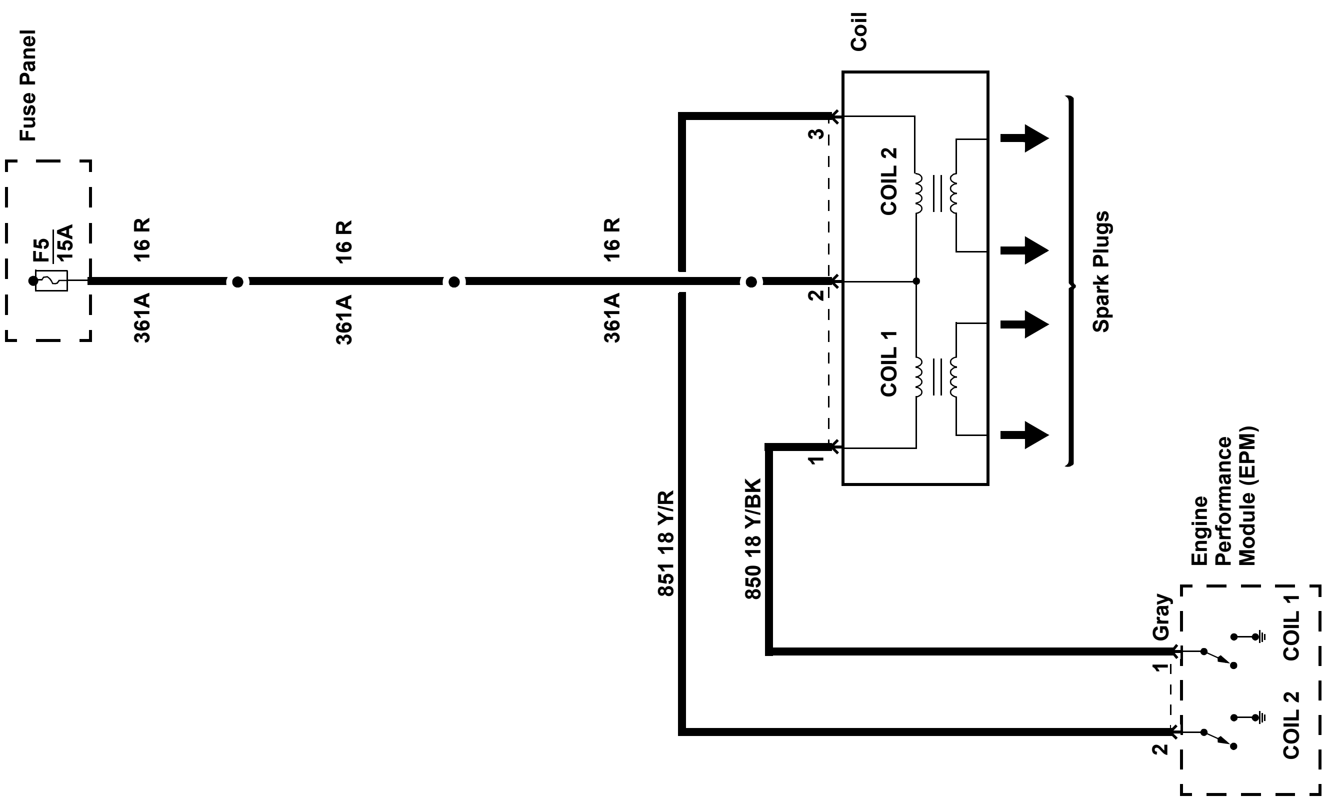
Wire Colors

Symbol	Color
BK	BLACK
BN	BROWN
BU	BLUE
DB	DARK BLUE
DG	DARK GREEN
GN	GREEN
GY	GRAY
LB	LIGHT BLUE
LG	LIGHT GREEN
NA	NATURAL
OG	ORANGE
PK	PINK
RD	RED
SR	SILVER
TN	TAN
VT	VIOLET
WH	WHITE
YE	YELLOW

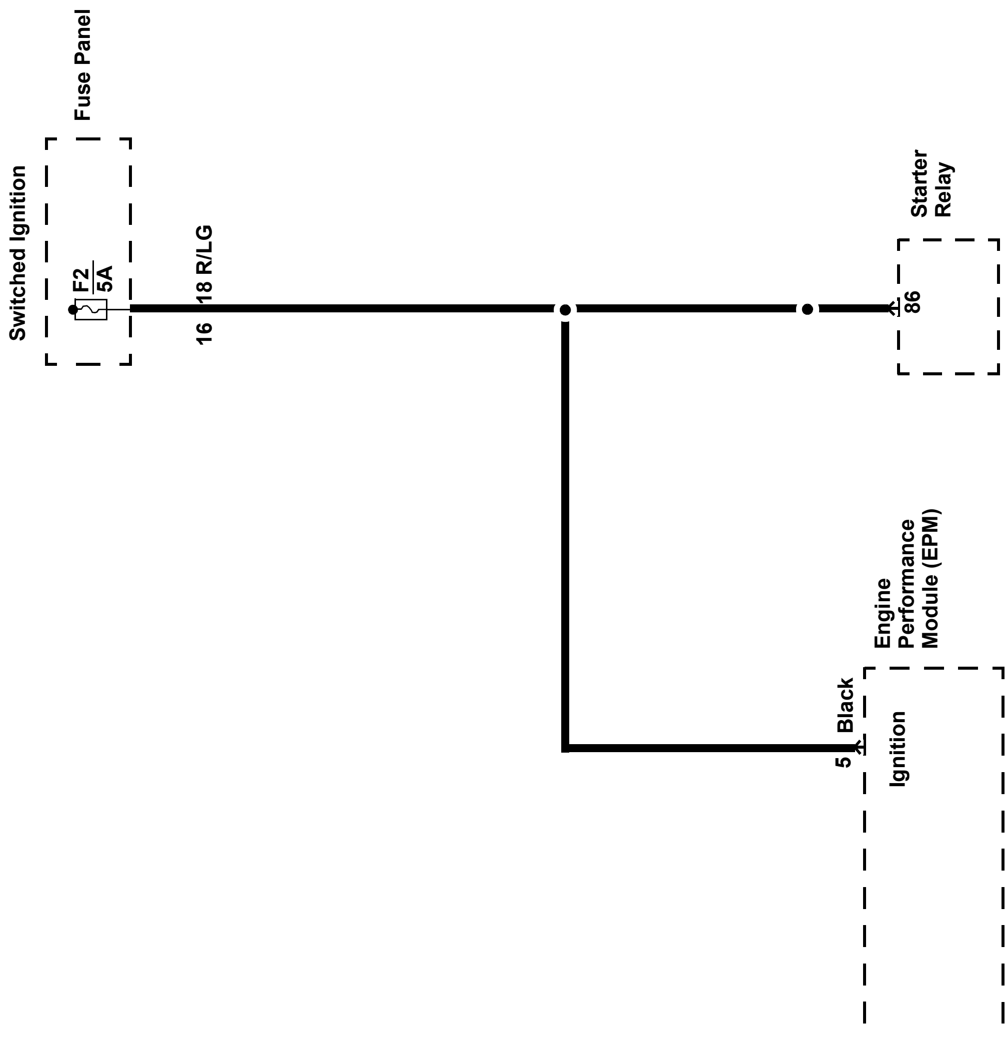
Power Distribution - EPM



Engine Ignition - EPM

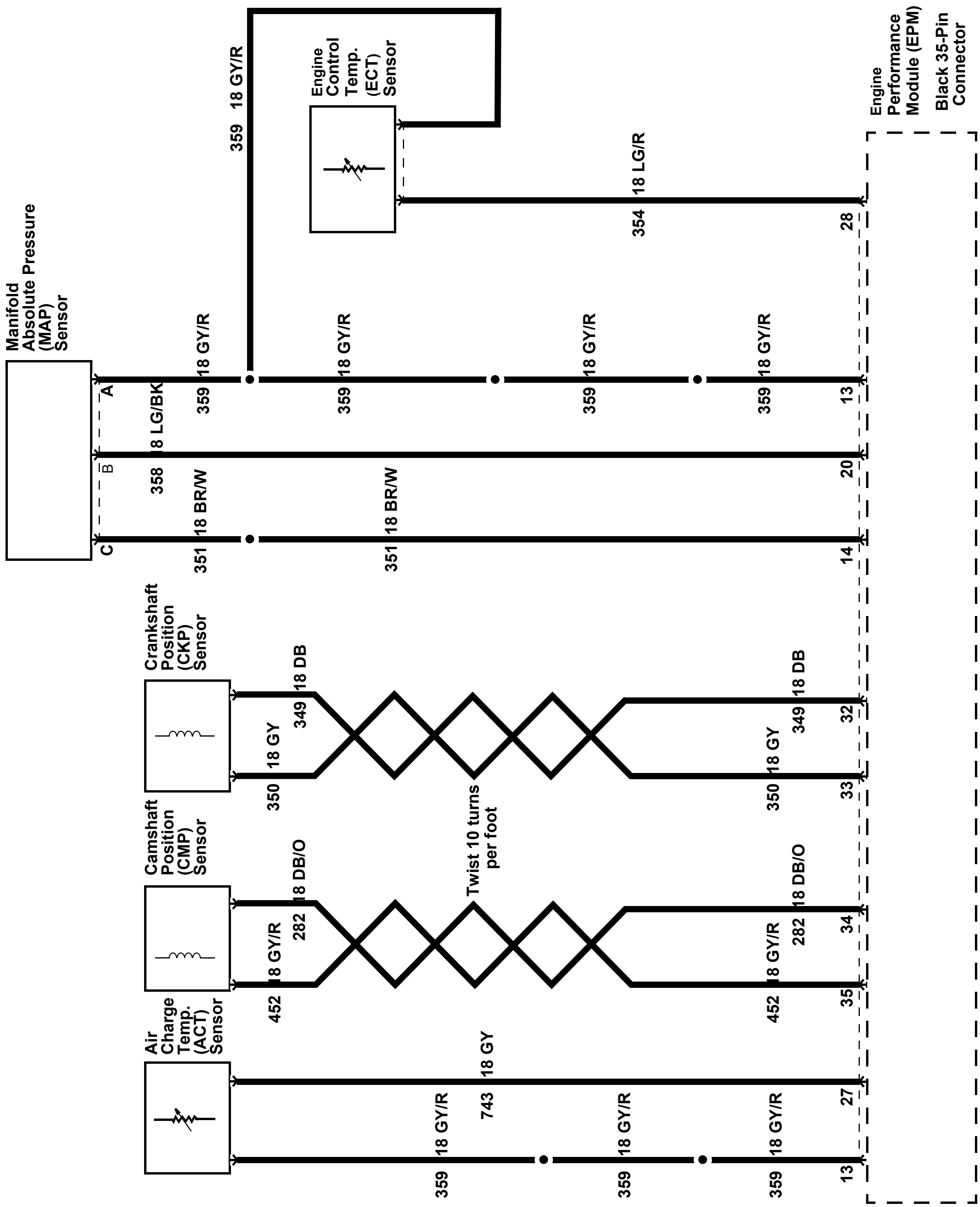


Starting System - EPM

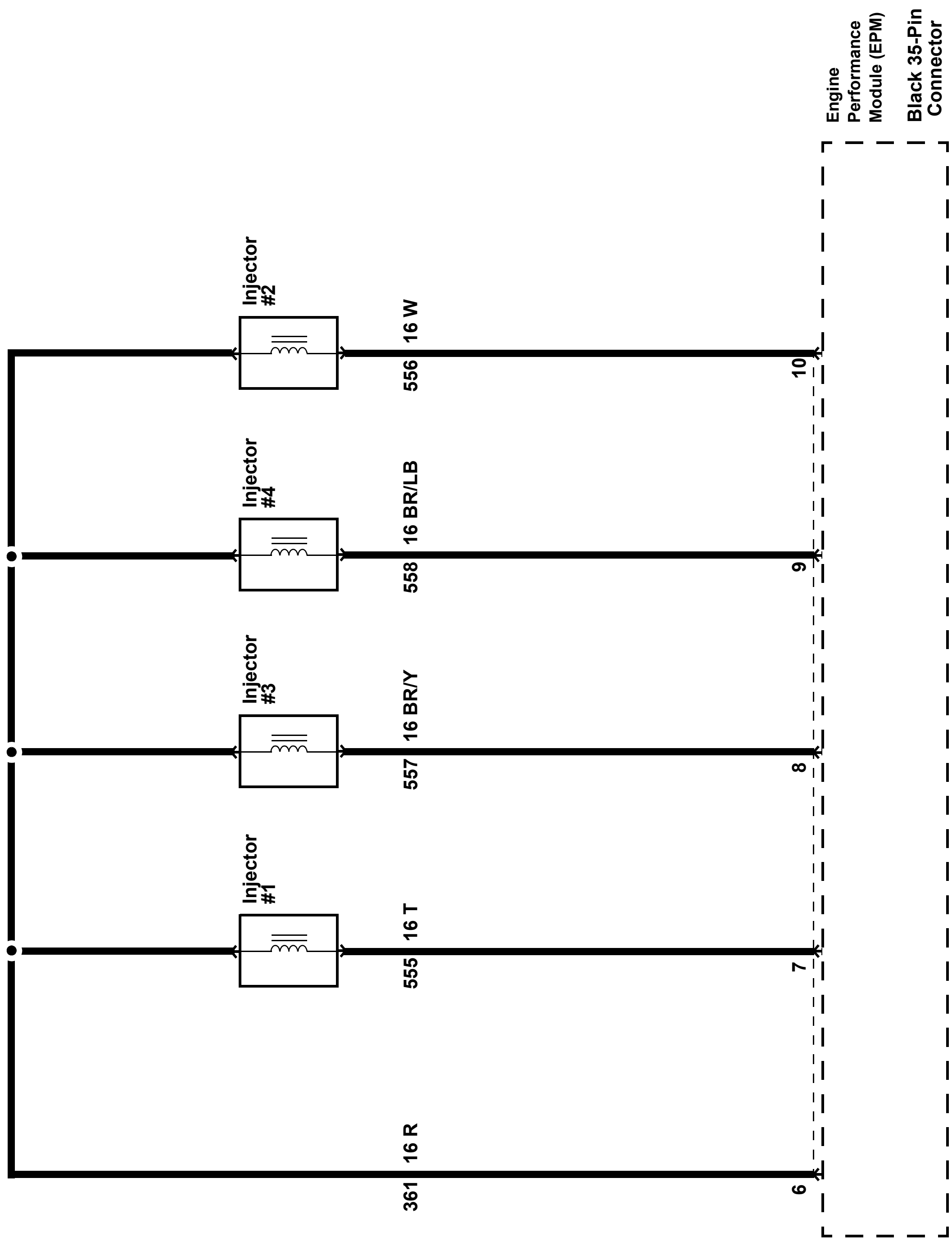


Charging System - EPM

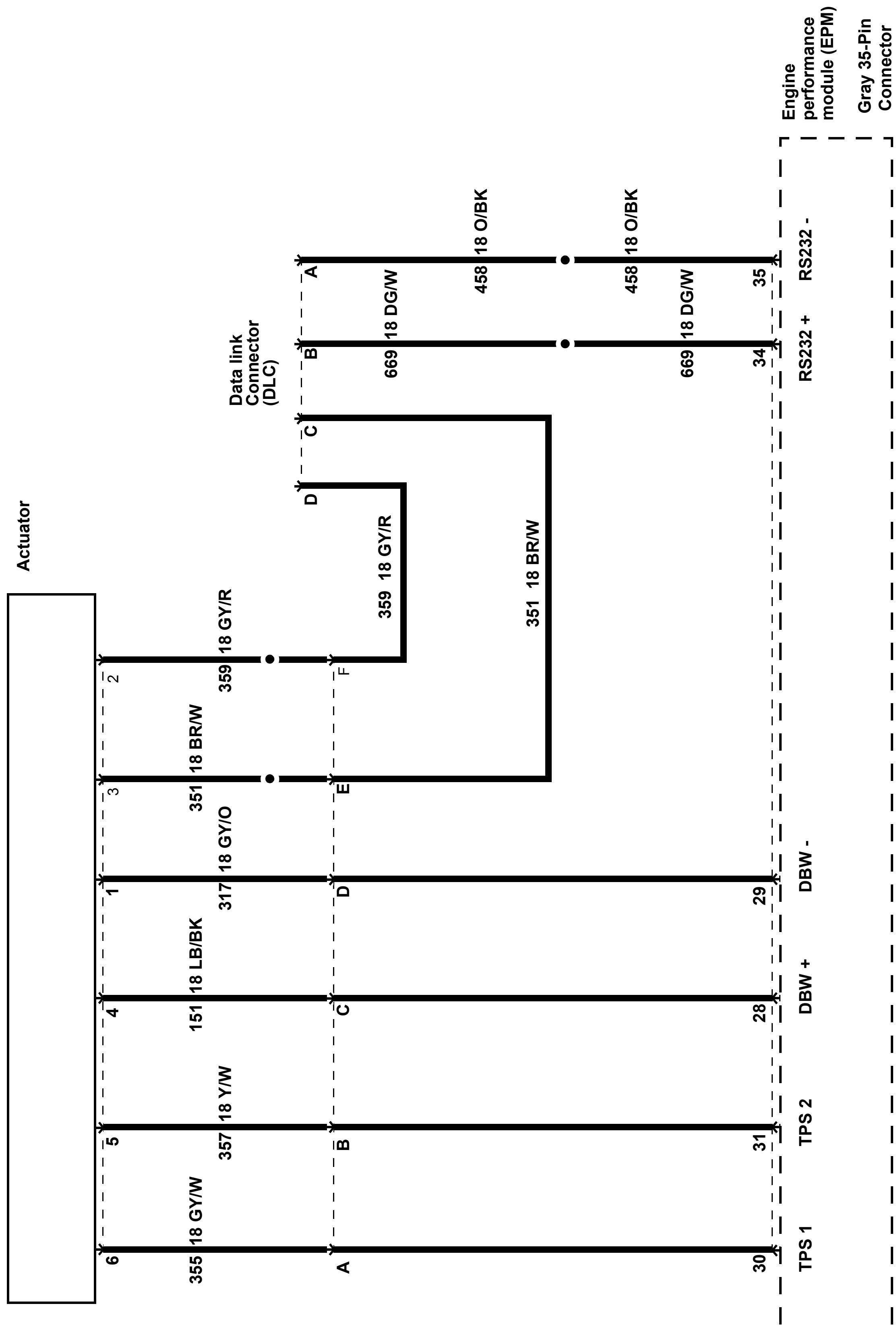
Engine Controls - Sensors - EPM



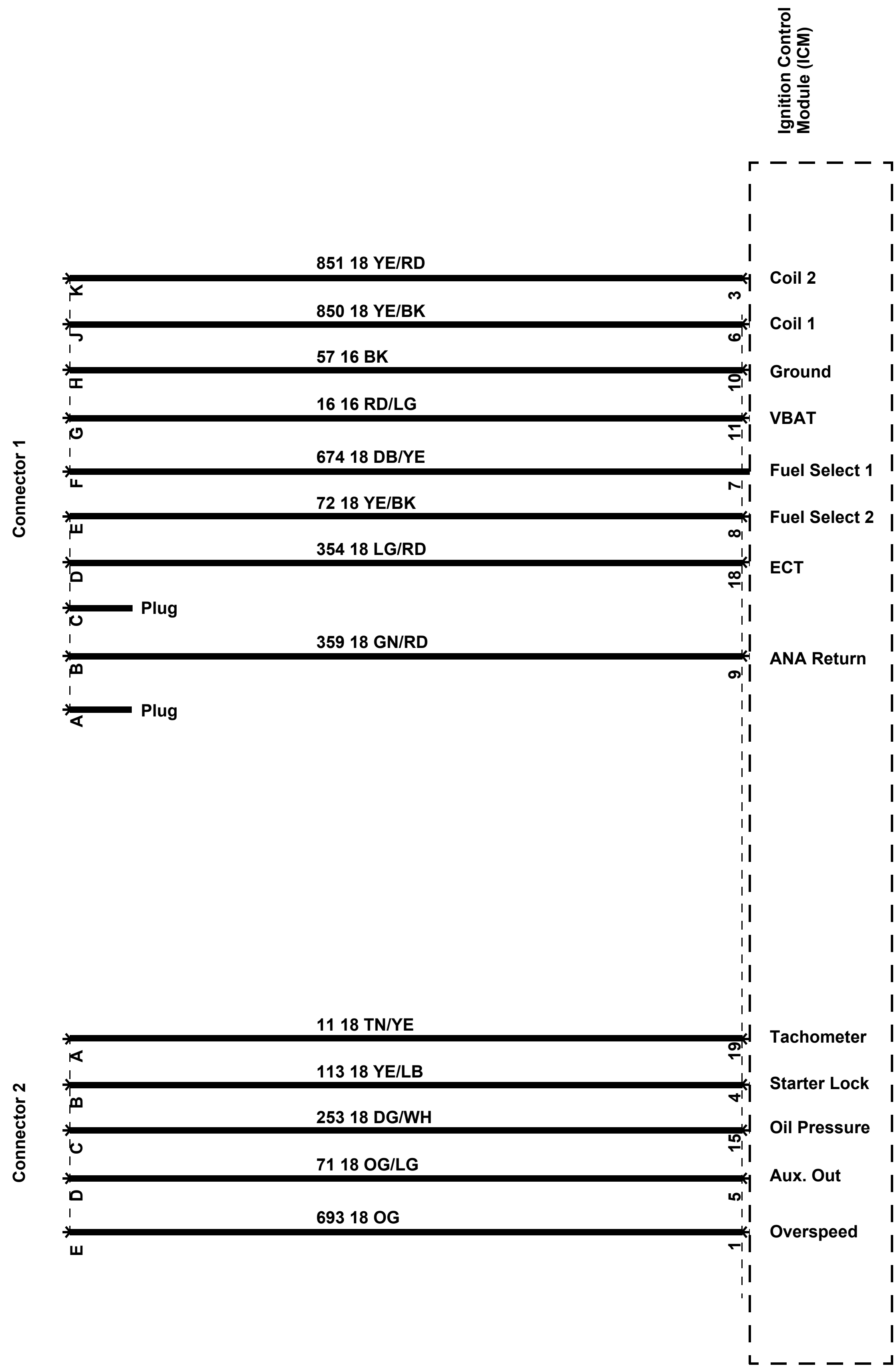
Engine Controls - Injectors - EPM



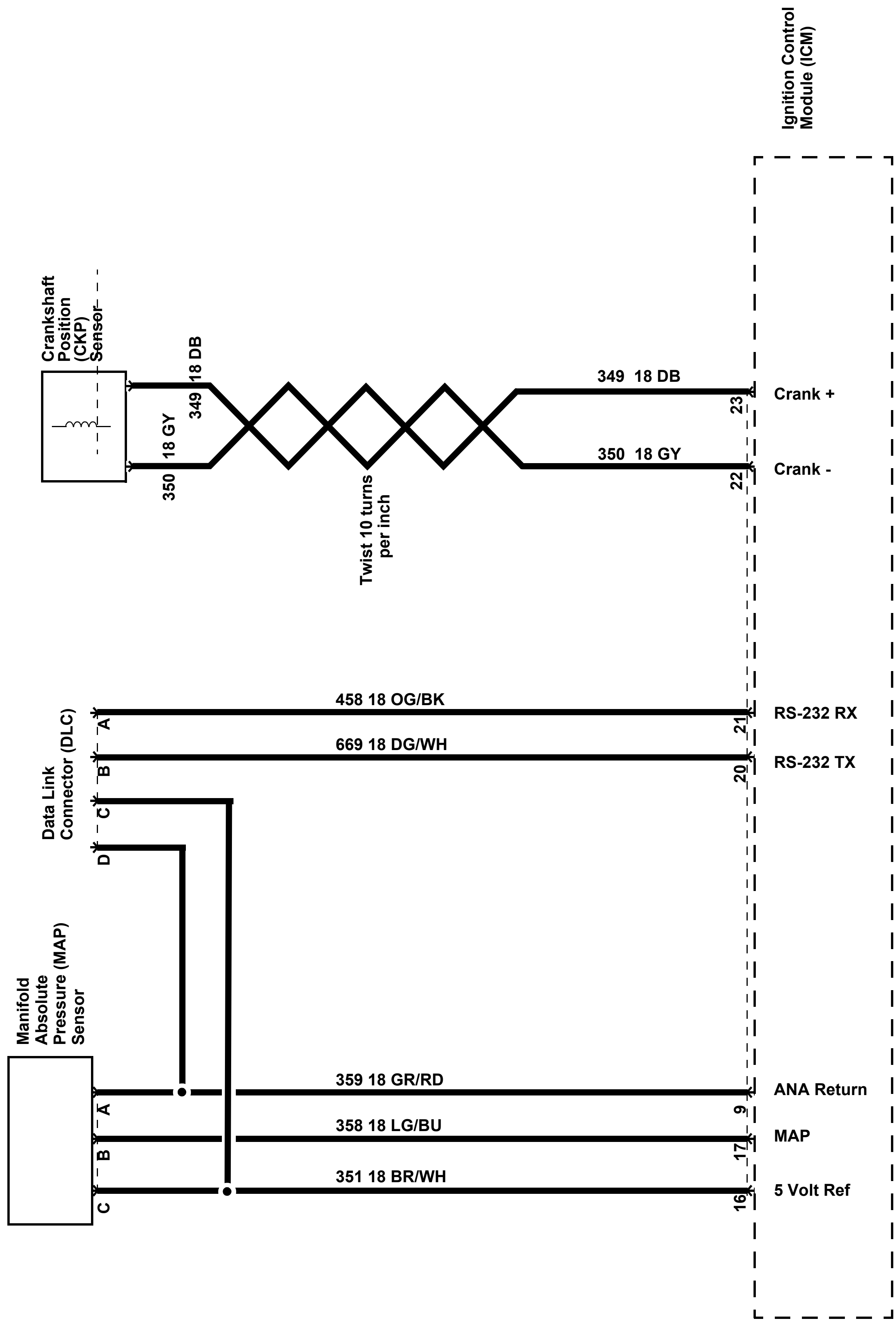
Engine Controls - Actuator / Data Link Connector (DLC) - EPM



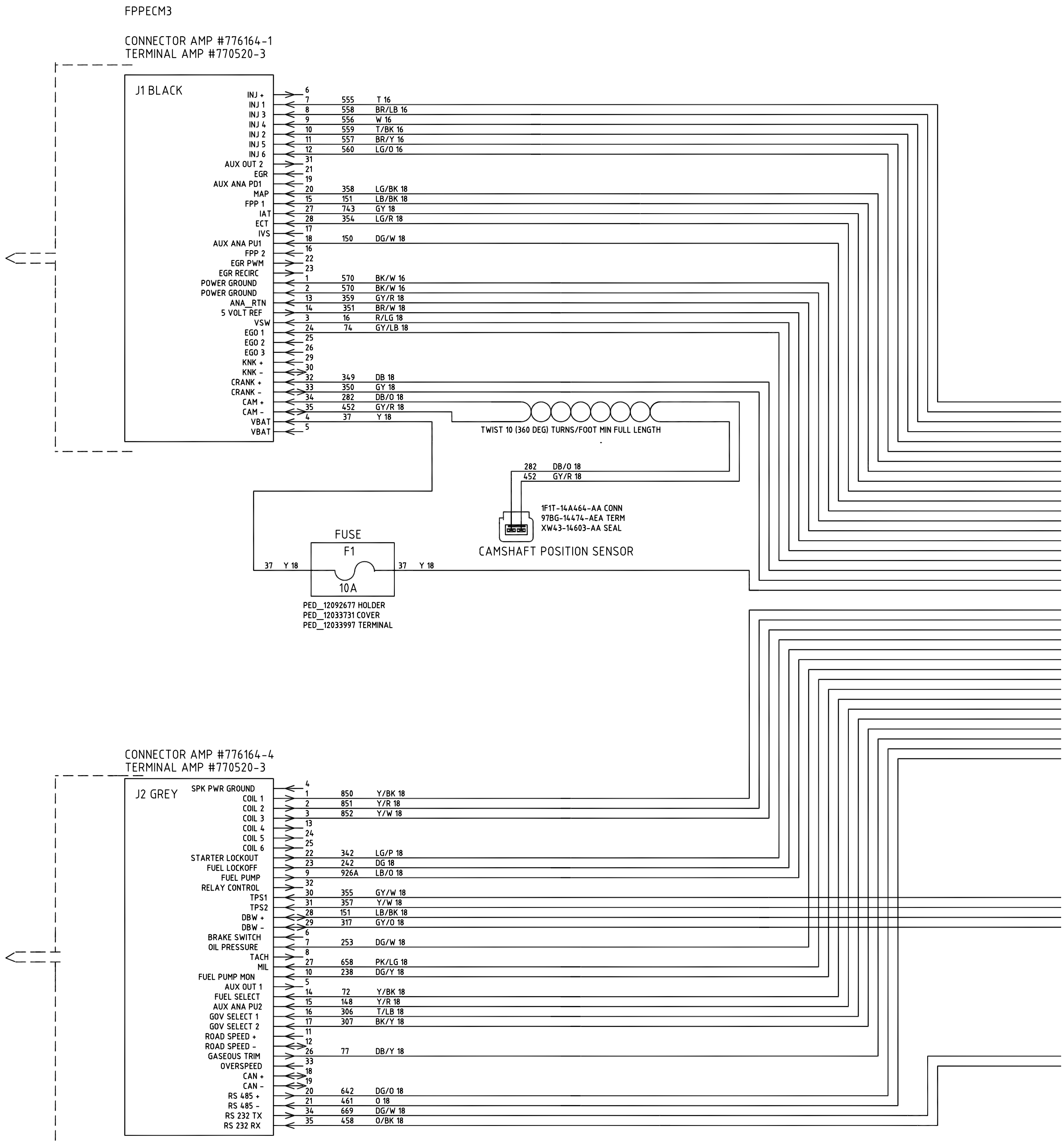
Engine Controls - Connectors - ICM Jumper Patch Harness



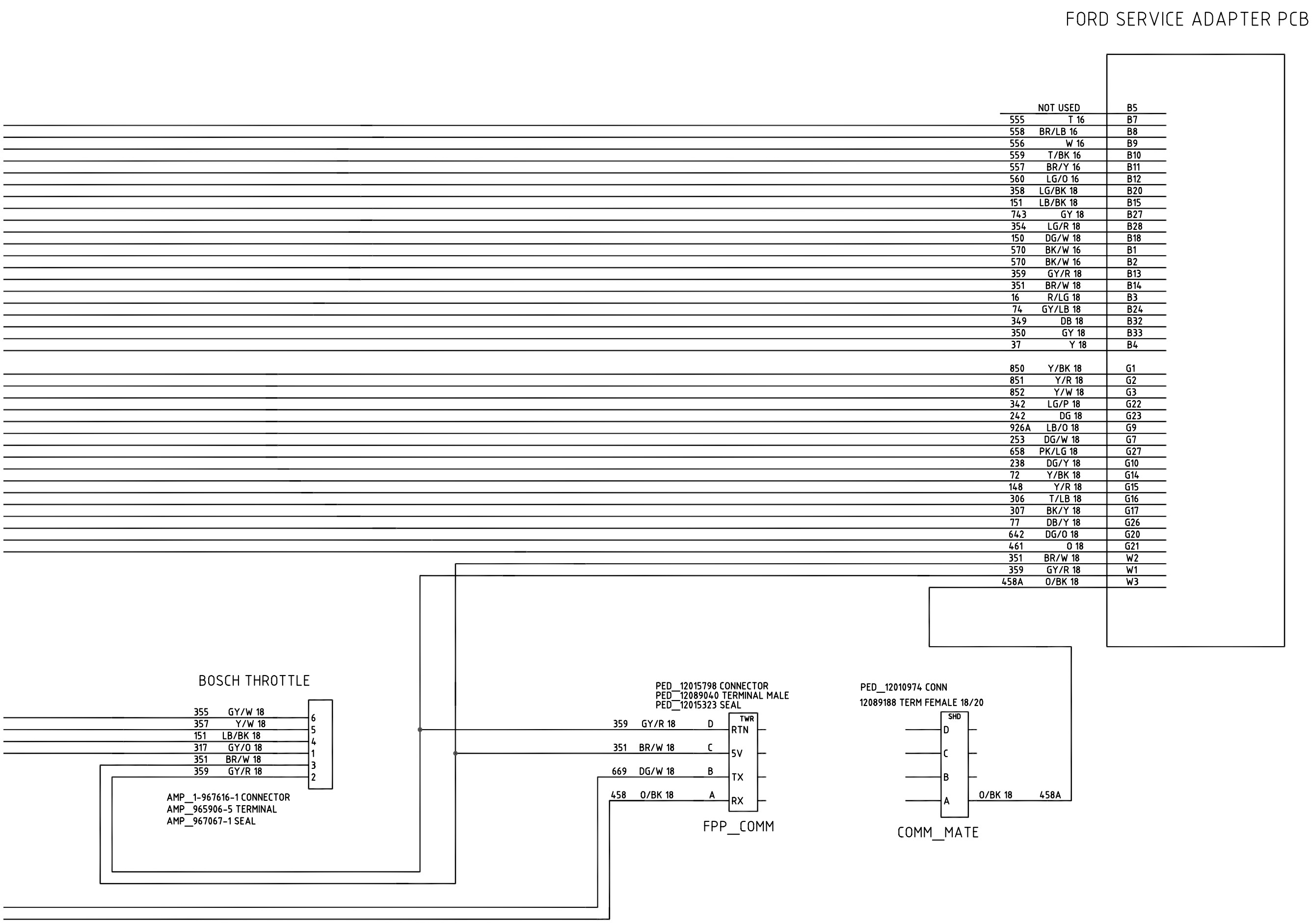
Engine Controls - Sensors & Data Link Connector (DLC) - ICM Jumper Patch Harness



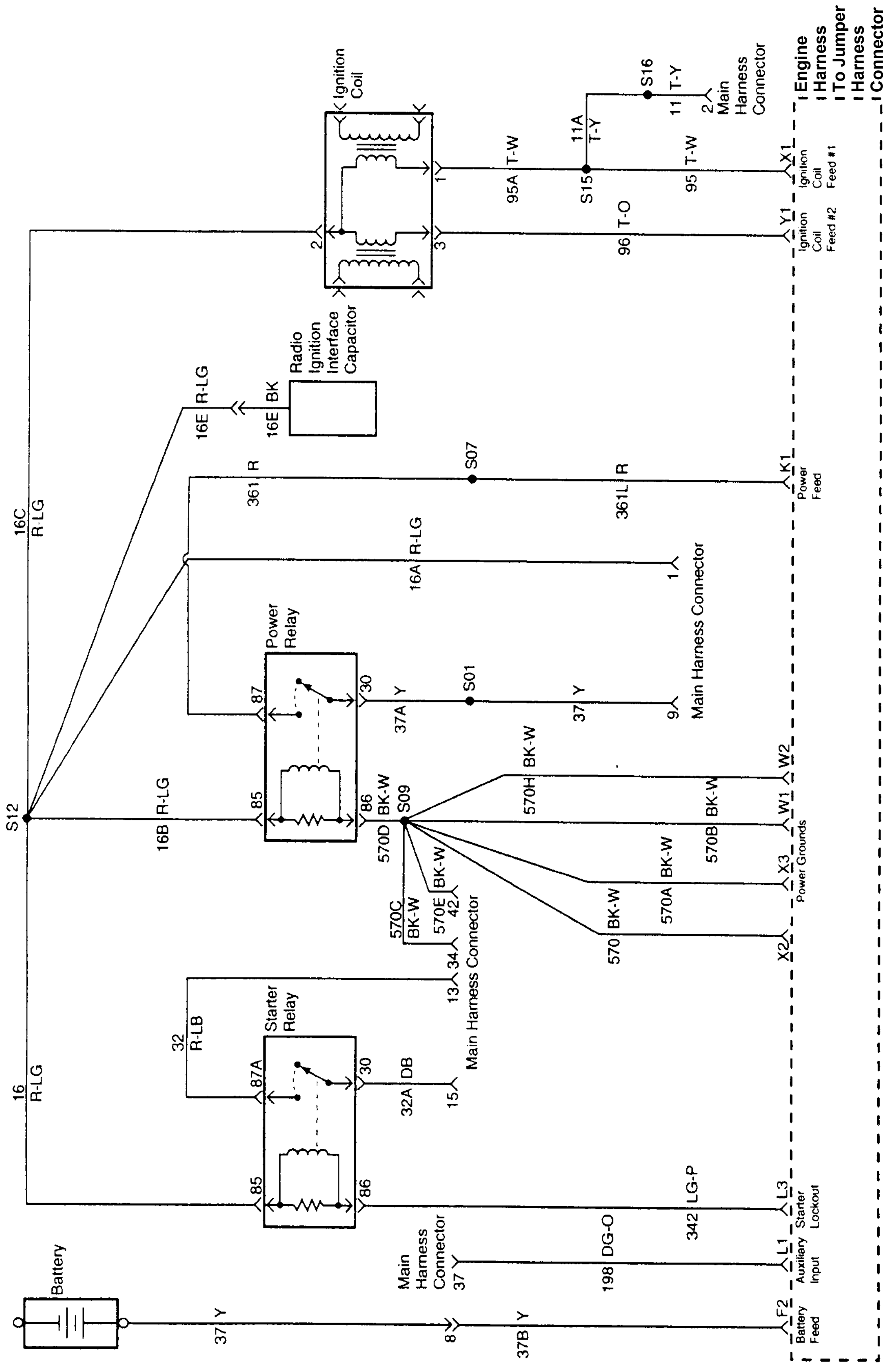
ECM To EPM Conversion Harness Adapter (1 of 2)



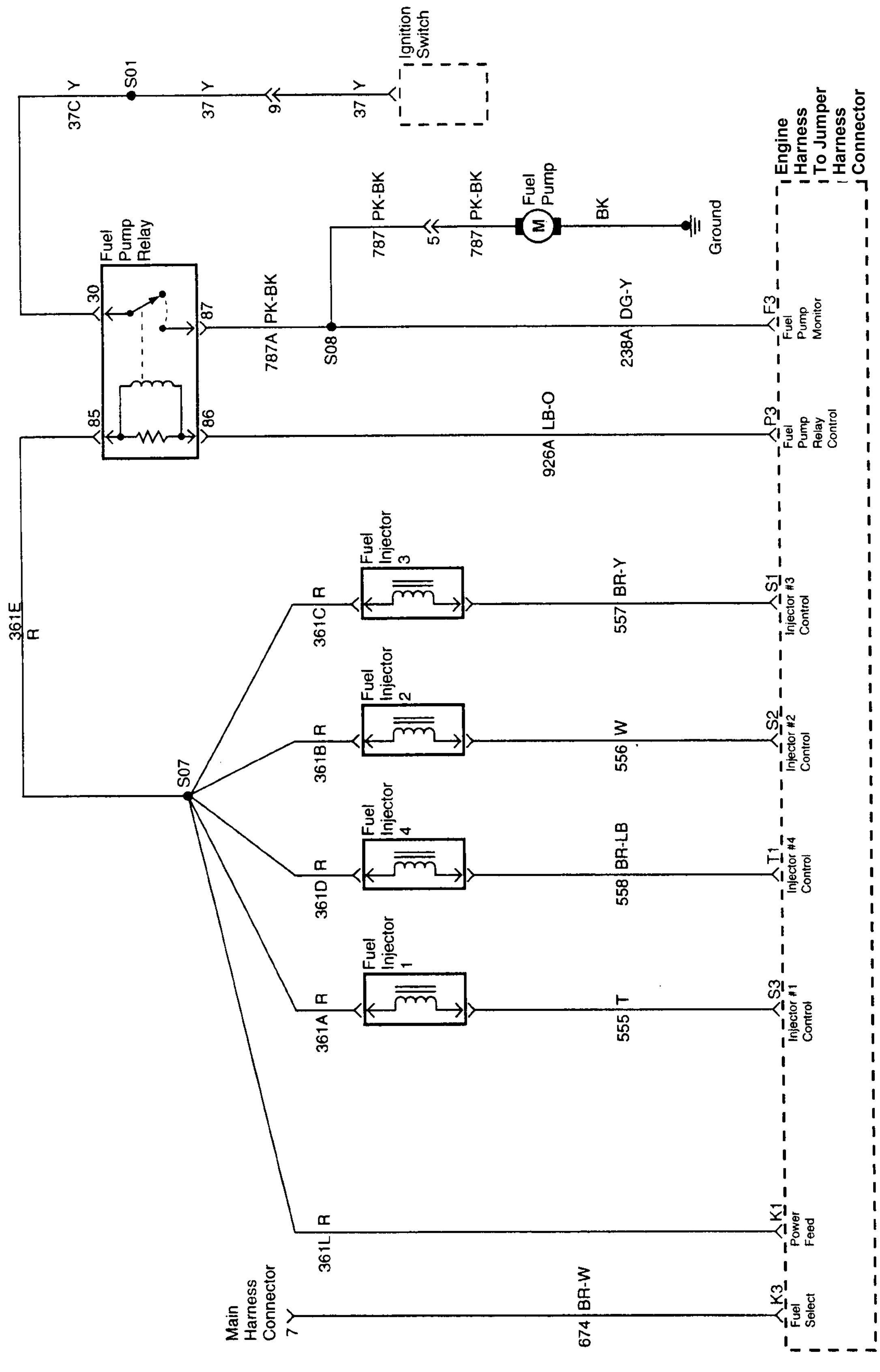
ECM To EPM Conversion Harness Adapter (2 of 2)



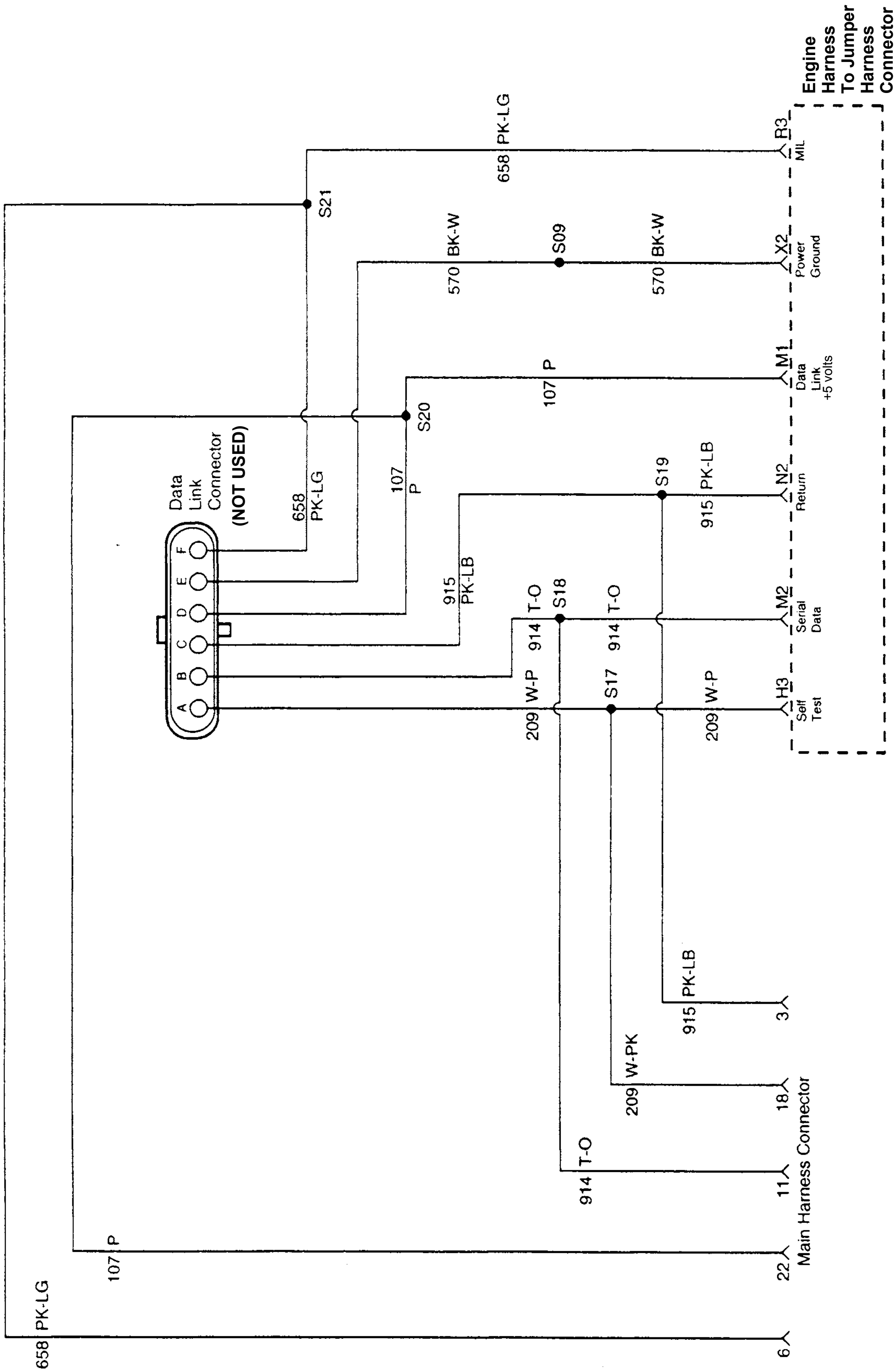
ECM to EPM Engine Wiring Diagram (1 of 5)



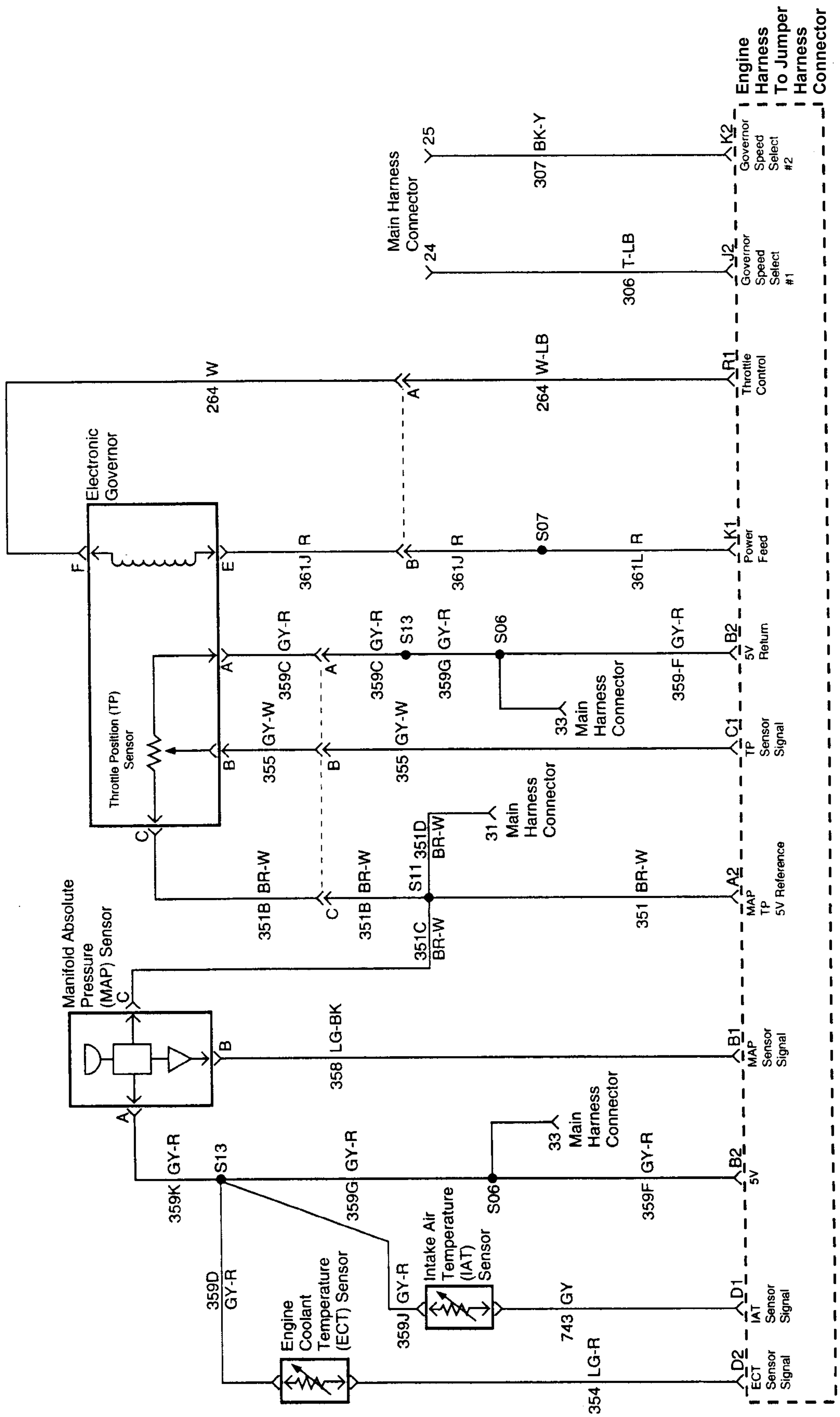
ECM to EPM Engine Wiring Diagram (2 of 5)



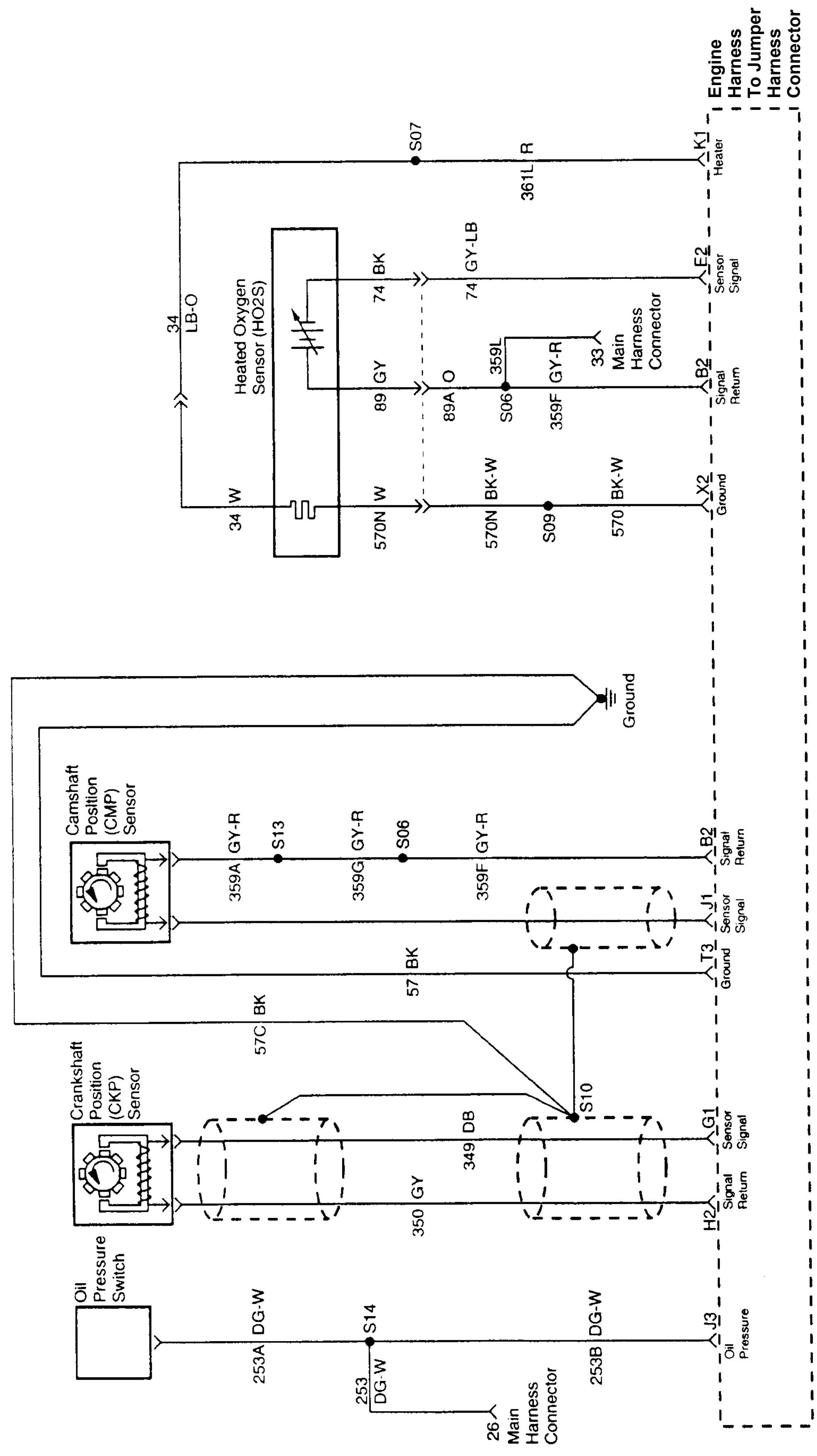
ECM to EPM Engine Wiring Diagram (3 of 5)



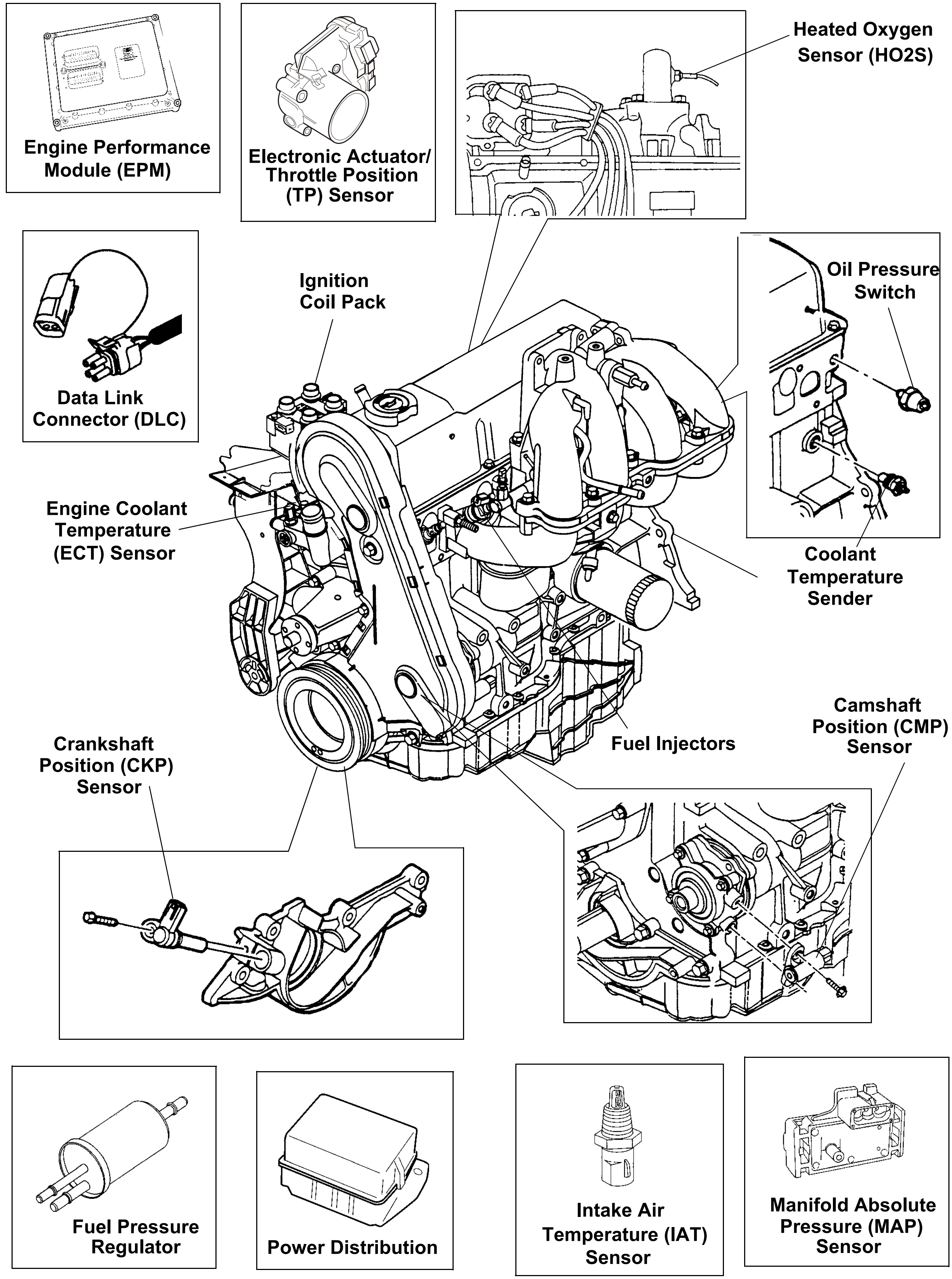
ECM to EPM Engine Wiring Diagram (4 of 5)



ECM to EPM Engine Wiring Diagram (5 of 5)

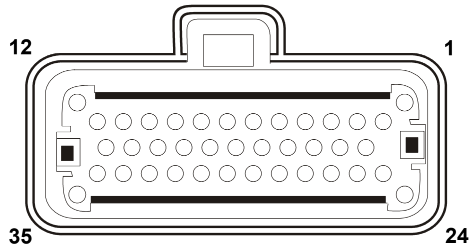


Engine Component Locator View



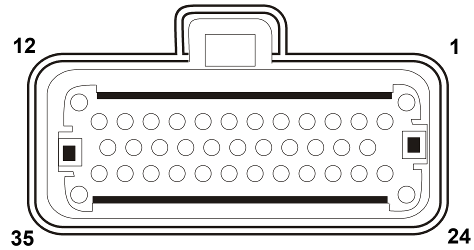
Connector End Views

EPM Connector C2 (Gray)



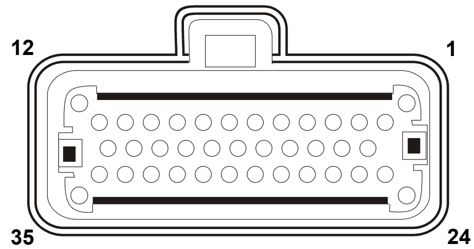
Pin	Circuit	Circuit Function
1	850 YE/BK	Coil 1 ground output
2	851 YE/RD	Coil 2 ground output
3	-	Not used
4	570 BK/WH	Power ground
5	71 OG/LG	Aux. out 1
6	511 LG/RD	Brake switch input
7	253 DG/WH	Oil pressure input
8	11 TN/YL	Tachometer output
9	926A LB/OR	Enable fuel pump relay
10	238 DG/YL	Fused fuel pump 12V monitor
11	169 LG/BK	Vehicle Speed Sensor (VSS) (+)
12	172 LB/RD	Vehicle Speed Sensor (VSS) (-)
13	-	Not used
14	72 YL/BK	Fuel select
15	148 YL/RD	Aux. analog pull-up circuit #2
16	306 TN/LB	Gov select 1
17	307 BK/YL	Gov select 2
18	662 DG/PK	Can bus positive (+)
19	459 OR/LG	Can bus negative (-)
20	642 DG/OR	RS 485 positive (+)
21	461 OR	RS 485 negative (-)
22	342 LG/VT	Starter lockout
23	242 DG	Fuel lockoff
24	-	Not used
25	-	Not used
26	77 DB/YL	Gaseous trim (vacuum control)
27	658 PK/LG	MIL light ground
28	151 LB/BK	Drive by wire positive (+)
29	317 GY/OR	Drive by wire ground (-)
30	355 GY/WH	Throttle Position Sensor (TPS) 1
31	357 YL/WH	Throttle Position Sensor (TPS) 2
32	15 RD/YL	Coil and heated oxygen sensor power relay ground output
33	349A DB	Overspeed
34	669 DG/WH	RS 232 positive (+) TX
35	458 OR/BK	RS 232 negative (-) RX

EPM Connector C3 (Black)



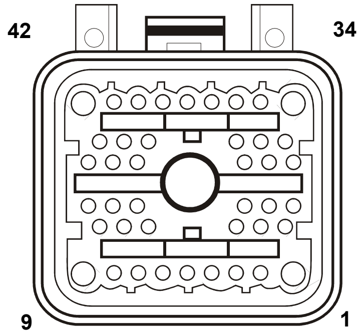
Pin	Circuit	Circuit Function
1	570 BK/WH	Power ground
2	570 BK/WH	Power ground
3	16 RD/LG	Fused ignition voltage
4	361 RD	Fused VBAT (12 volts)
5	361 RD	Fused VBAT (12 volts)
6	361 RD	Fuel injector power
7	555 TN	Fuel injector #1 ground
8	557 BR/YL	Fuel injector #3 ground
9	558 BR/LB	Fuel injector #4 ground
10	556 WH	Fuel injector #2 ground
11	-	Not used
12	-	Not used
13	359 GY/RD	Signal return TMAP, ECT, foot pedal, HEGO, throttle communication
14	351 BR/WH	VREF (5 volt output)
15	151 LB/BK	Foot Pedal Position (FPP) 0-5 volt input #1
16	114 LB/YL	Foot Pedal Position (FPP) 0-5 volt input #2
17	307 BK/YL	Idle Validation Switch (IVS) input
18	150 DG/WH	Aux. analog pull up circuit
19	198 DG/OR	Aux. analog pull down circuit
20	358 LG/BK	Manifold Absolute Pressure (MAP) sensor input
21	18 OR/YL	Exhaust Gas Recirculation (EGR) input
22	352 BR/LG	EGR Pulse Width Modulation (PWM) output
23	360 BR/PK	Exhaust Gas Recirculation (EGR) output
24	74 GY/LB	HO2S 1 (0-1 volt input)
25	392 RD/LG	HO2S 2 - Catalyst Monitor
26	-	Not used
27	743 GY	Intake Air Temperature (IAT) sensor input
28	354 LG/RD	Engine Coolant Temperature (ECT) sensor input
29	-	Not used
30	-	Not used
31	-	Not used
32	349 DB	Crankshaft Position (CKP) sensor (+)
33	350 GY	Crankshaft Position (CKP) sensor (-)
34	282 DB/OR	Camshaft Position (CMP) sensor (+)
35	452 GY/RD	Camshaft Position (CMP) sensor (-)

ICM Connector C2 (Gray)



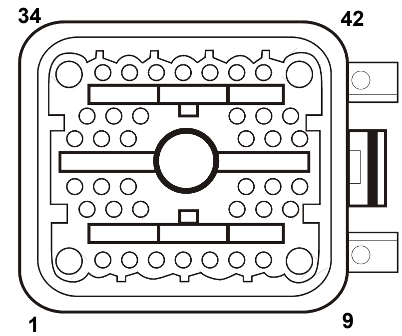
Pin	Circuit	Circuit Function
1	11 TN/YL	Tachometer output
2	-	Not used
3	851 YE/RD	Coil 2 ground output
4	71 OG/LG	Aux. out 1
5	342 LG/VT	Starter lockout
6	850 YE/BK	Coil 1 ground output
7	674 DB/YE	Fuel Select #1
8	6 YE/BK	Fuel select #2
9	359 GY/RD	Signal return
10	570 BK	Ground
11	16 RD/LG	VBAT Power
12	-	Not used
13	-	Not used
14	198 DG/OG	Auxiliary IN
15	253 DG/WH	Oil pressure input
16	351 BN/WH	5 Volt reference
17	358 LG/BL	Manifold Absolute Pressure (MAP) Input
18	354 LG/RD	Engine Coolant Temperature (ECT) Input
19	349A DB	Overspeed
20	669 DG/WH	RS 232 positive (+) Transmit
21	458 OR/BK	RS 232 negative (-) Receive
22	350 GY	Crank negative (-)
23	349 DB	Crank positive (+)

EPM Connector C1F



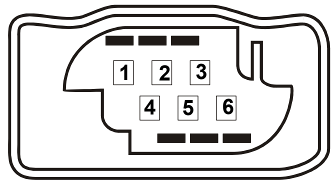
Pin	Circuit	Circuit Function
1	16 RD/LG	Ignition voltage
2	11 TN/YL	Tachometer output
3	461 OG	RS 485 (-)
4	511 LG/RD	Brake switch input
5	787A PK/BK	To fuel pump: 12 volt output
6	658 PK/LG	Malfunction Indicator Light (MIL) output
7	72 YL/BK	Fuel select input
8	-	Not used
9	37 YL	Battery voltage input
10	148 YL/RD	Auxiliary analog pull up circuit 2
11	DG/OG	RS 485 (+)
12	114 LB/YL	Secondary throttle control 0-5 volt variable input FPP2
13	32 RD/LB	Starter Solenoid Output
14	151 LB/BK	Primary throttle control 0-5 volt variable input FPP1
15	32A RD/LB	12 volts in start/non auto crank system
16	39 RD/WH	Water temperature output
17	-	Not used
18	458 OG/BK	RS 232 - (Self Test Input)
19	-	Not Used
20	669 DG/WH	RS 232 (+)
21	71 OG/LG	Aux Out 1
22	-	Not used
23	307 BK/YL	Governor select #2
24	306 TN/LB	Governor select #1
25	307 BK/YL	Idle validation switch (ivs) input
26	253 DG/WH	Oil pressure warning light output *Only use with 5 volt supplied light.
27	-	Not used
28	662 DG/PK	Can bus communications (+)
29	459 OR/LG	Can bus communications (-)
30	349A DB	Overspeed
31	351 BN/WH	5 volt vref output
32	198 DG/OR	Aux. analog pull down circuit
33	359 GY/RD	Auxilary signal return
34	570 BK/WH	Power ground
35	169 LG/BK	Vehicle Speed Sensor (+)
36	172 LB/RD	Vehicle Speed Sensor (-)
37	150 DG/WH	Aux. analog pull up circuit
38	18 OR/YL	Exhaust Gas Recirculation (EGR) input
39	32 RD/LB	12 Volts in start - Auto crank only
40	352 BN/LG	Pulse Width Modulation (PWM) output
41	360 BN/PK	Exhaust Gas Recirculation (EGR) output
42	-	Not used

EPM Connector C1M



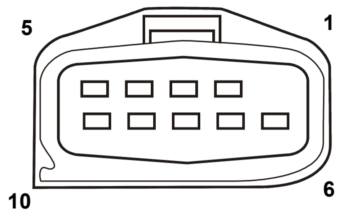
Pin	Circuit	Circuit Function
1	16 RD/LG	Ignition voltage
2	11 TN/YL	Tachometer output
3	461 OG	RS 485 (-)
4	511 LG/RD	Brake switch input
5	787A PK/BK	To fuel pump: 12 volt output
6	658 PK/LG	Malfunction Indicator Light (MIL) output
7	72 YL/BK	Fuel select input
8	-	Not used
9	37 YL	Battery voltage input
10	148 YL/RD	Auxiliary analog pull up circuit 2
11	DG/OG	RS 485 (+)
12	114 LB/YL	Secondary throttle control 0-5 volt variable input FPP2
13	32 RD/LB	Starter Solenoid Output
14	151 LB/BK	Primary throttle control 0-5 volt variable input FPP1
15	32A RD/LB	12 volts in start/non auto crank system
16	39 RD/WH	Water temperature output
17	-	Not used
18	458 OG/BK	RS 232 - (Self Test Input)
19	-	Not Used
20	669 DG/WH	RS 232 (+)
21	71 OG/LG	Aux Out 1
22	-	Not used
23	307 BK/YL	Governor select #2
24	306 TN/LB	Governor select #1
25	307 BK/YL	Idle validation switch (ivs) input
26	253 DG/WH	Oil pressure warning light output *Only use with 5 volt supplied light.
27	-	Not used
28	662 DG/PK	Can bus communications (+)
29	459 OR/LG	Can bus communications (-)
30	349A DB	Overspeed
31	351 BN/WH	5 volt vref output
32	198 DG/OR	Aux. analog pull down circuit
33	359 GY/RD	Auxilary signal return
34	570 BK/WH	Power ground
35	169 LG/BK	Vehicle Speed Sensor (+)
36	172 LB/RD	Vehicle Speed Sensor (-)
37	150 DG/WH	Aux. analog pull up circuit
38	18 OR/YL	Exhaust Gas Recirculation (EGR) input
39	32 RD/LB	12 Volts in start - Auto crank only
40	352 BN/LG	Pulse Width Modulation (PWM) output
41	360 BN/PK	Exhaust Gas Recirculation (EGR) output
42	-	Not used

Actuator Pigtail to Actuator



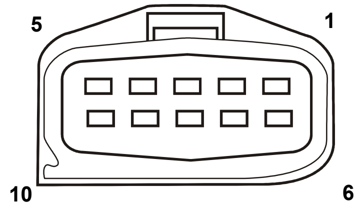
Pin	Circuit	Circuit Function
1	317 GY/OG	Drive-by Wire Negative (-)
2	359 GY/RD	Signal Return
3	351 BN/WH	VREF (5 volts) Input
4	151 LB/BK	Drive-by Wire Positive (+)
5	357 YE/WH	Throttle Position Sensor (TPS) 2
6	355 GY/WH	Throttle Position Sensor (TPS) 1

Drive By Wire Harness Connector 2U1L-12B476-AA



Pin	Circuit	Circuit Function
1	-	Not Used
2	-	Not Used
3	-	Not Used
4	-	Not Used
5	-	Not Used
6	307 BK/YE	IVS Signal
7	361 BK	IVS Ground
8	151 GY/WH	FPP1
9	359 GY/RD	Analog Return
10	351 BN/WH	+5V Reference

EPM/IPM Foot Pedal Connector C5

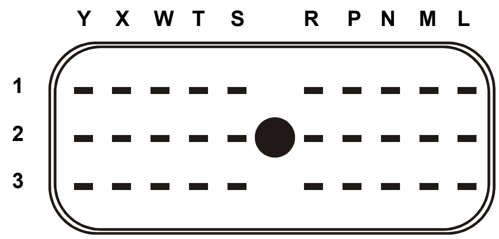


Pin	Circuit	Circuit Function
1	-	Not Used
2	-	Not Used
3	-	Not Used
4	-	Not Used
5	-	Not Used
6	307 BK/YL	Idle Validation Switch Input
7	361 RD/57 BK	Ground
8	151 LB/BK	Drive By Wire Signal Input
9	359 GY/RD	Drive By Wire Signal Return
10	351 BR/WH	VREF 5 Volts

ICM Body Side Harness 14324

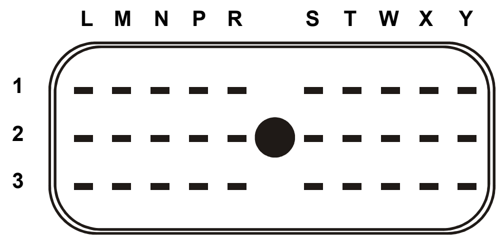
Pin	Circuit	Circuit Function
A	YL/BK	Fuel Select 2 Input
B	PK/LB	Fault Shutdown Line
C	LB/RD	Engine Run Indicator
D	OG/LG	Tachometer Output
E	RD/LB	Starter Lockout Relay Input
F	XXX RD/LB	Starter Lockout Relay Output
G	-	Not used
H	XXX OG	Aux. IN
J	XXX RD/LG	12 Volt Switched Ignition Input
K	XXX BR/WH	Fuel Select 1 Input

ECM to EPM Engine Harness Connector C2F



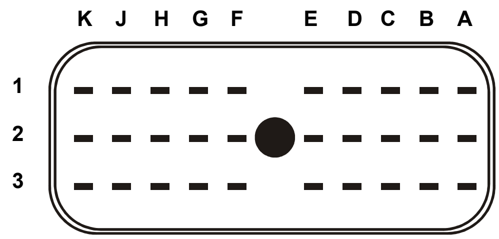
Pin	Circuit	Circuit Function
L1	198 DG/OG	Auxillary input
L2	-	Not used
L3	342 LG/PK	Starter lockout
M1	107 PK	Data link
M2	914 TN/OG	RS 485 +
M3	-	Not used
N1	-	Not used
N2	915 PK/LB	RS 485 -
N3	-	Not used
P1	-	Not used
P2	242 DG	Fuel Lockoff
P3	926A LB/OG	Fuel pump relay control
R1	-	Not used
R2	77 DB/YE	Gaseous Trim
R3	658 PK/LG	Malfunction Indicator Lamp (MIL)
S1	557 BN/YE	Fuel injector #3
S2	556 WH	Fuel injector #2
S3	555 TN	Fuel injector #1
T1	558 BN/LB	Fuel injector #4
T2	-	Not used
T3	57 BK	Ground
W1	570B BK/WH	Power ground
W2	570H BK/WH	Power ground
W3	-	Not used
X1	95 TN/WH	Ignition Coil #1
X2	570 BK/WH	Power ground
X3	570A BK/WH	Power ground
Y1	96 TN/OG	Ignition coil #2
Y2	-	Not used
Y3	-	Not used

ECM to EPM Engine Harness Connector C2M



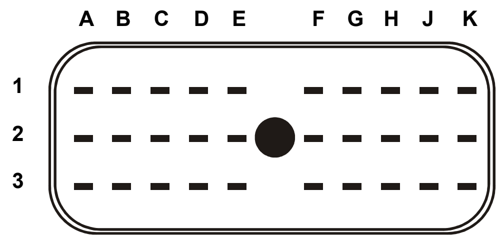
Pin	Circuit	Circuit Function
L1	198 DG/OG	Auxillary input
L2	-	Not used
L3	342 LG/PK	Starter lockout
M1	107 PK	Data link
M2	914 TN/OG	RS 485 +
M3	-	Not used
N1	-	Not used
N2	915 PK/LB	RS 485 -
N3	-	Not used
P1	-	Not used
P2	242 DG	Fuel Lockoff
P3	926A LB/OG	Fuel pump relay control
R1	-	Not used
R2	77 DB/YE	Gaseous Trim
R3	658 PK/LG	Malfunction Indicator Lamp (MIL)
S1	557 BN/YE	Fuel injector #3
S2	556 WH	Fuel injector #2
S3	555 TN	Fuel injector #1
T1	558 BN/LB	Fuel injector #4
T2	-	Not used
T3	57 BK	Ground
W1	570B BK/WH	Power ground
W2	570H BK/WH	Power ground
W3	-	Not used
X1	95 TN/WH	Ignition Coil #1
X2	570 BK/WH	Power ground
X3	570A BK/WH	Power ground
Y1	96 TN/OG	Ignition coil #2
Y2	-	Not used
Y3	-	Not used

ECM to EPM Engine Harness Connector C1F



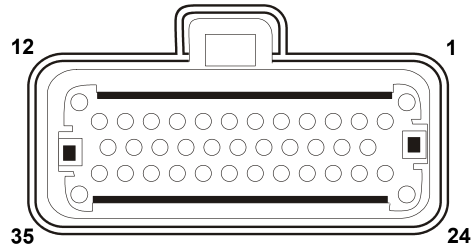
Pin	Circuit	Circuit Function
A1	151 LB/BK	FPP1
A2	351 BN/WH	5 Volt eference (VREF)
A3	-	Not used
B1	358 LG/BK	Manifold Absolute Pressure (MAP) sensor signal
B2	359F GY/RD	Signal return
B3	-	Not used
C1	-	Not used
C2	-	Not used
C3	-	Not used
D1	743 GY	Intake Air Temperature (IAT) sensor signal
D2	354 LG/RD	Engine Coolant Temperature (ECT) sensor signal
D3	148 YE/RD	Aux. PU2
E1	-	Not used
E2	74 GY/LB	Heated Oxygen Sensor (HO2S) signal
E3	-	Not used
F1	-	Not used
F2	37B YE	Keep alive Memory (KAM) (Battery voltage)
F3	238A DG/YE	Fuel pump monitor
G1	349 DB	Crankshaft Position (CKP) sensor signal
G2	-	Not used
G3	-	Not used
H1	-	Not used
H2	350 GY	Crankshaft Position (CKP) sensor return
H3	209 WH/PK	Self Test Input (STI)
J1	-	Not used
J2	306 TN/LB	Governor speed select #1
J3	253B DG/WH	Oil pressure switch
K1	361L RD	Vehicle power (VPWR)
K2	307 BK/YE	Governor speed select #2
K3	72 YE/BK	Fuel Select

ECM to EPM Engine Harness Connector C1M



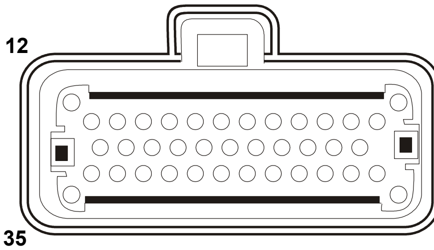
Pin	Circuit	Circuit Function
A1	151 LB/BK	FPP1
A2	351 BN/WH	5 Volt eference (VREF)
A3	-	Not used
B1	358 LG/BK	Manifold Absolute Pressure (MAP) sensor signal
B2	359F GY/RD	Signal return
B3	-	Not used
C1	-	Not used
C2	-	Not used
C3	-	Not used
D1	743 GY	Intake Air Temperature (IAT) sensor signal
D2	354 LG/RD	Engine Coolant Temperature (ECT) sensor signal
D3	148 YE/RD	Aux. PU2
E1	-	Not used
E2	74 GY/LB	Heated Oxygen Sensor (HO2S) signal
E3	-	Not used
F1	-	Not used
F2	37B YE	Keep alive Memory (KAM) (Battery voltage)
F3	238A DG/YE	Fuel pump monitor
G1	349 DB	Crankshaft Position (CKP) sensor signal
G2	-	Not used
G3	-	Not used
H1	-	Not used
H2	350 GY	Crankshaft Position (CKP) sensor return
H3	209 WH/PK	Self Test Input (STI)
J1	-	Not used
J2	306 TN/LB	Governor speed select #1
J3	253B DG/WH	Oil pressure switch
K1	361L RD	Vehicle power (VPWR)
K2	307 BK/YE	Governor speed select #2
K3	72 YE/BK	Fuel Select

ECM to EPM Jumper Harness Connector C2F (Gray)



Pin	Circuit	Circuit Function
1	850 YE/BK	Coil 1 ground output
2	851 YE/RD	Coil 2 ground output
3	852 YE/WH	Coil 3 ground output
4	-	Not used
5	-	Not used
6	-	Not used
7	253 DG/WH	Oil pressure input
8	-	Not used
9	926A LB/OR	Enable fuel pump relay
10	238 DG/YL	Fused fuel pump 12V monitor
11	-	Not used
12	-	Not used
13	-	Not used
14	72 YL/BK	Fuel select
15	148 YL/RD	Aux. analog pull-up circuit #2
16	306 TN/LB	Gov select 1
17	307 BK/YL	Gov select 2
18	-	Not used
19	-	Not used
20	642 DG/OR	RS 485 positive (+)
21	461 OR	RS 485 negative (-)
22	342 LG/PK	Starter lockout
23	242 DG	Fuel lockoff
24	-	Not used
25	-	Not used
26	77 DB/YL	Gaseous trim (vacuum control)
27	658 PK/LG	MIL light ground
28	151 LB/BK	Drive by wire positive (+)
29	317 GY/OR	Drive by wire ground (-)
30	355 GY/WH	Throttle Position Sensor (TPS) 1
31	357 YL/WH	Throttle Position Sensor (TPS) 2
32	-	Not used
33	-	Not used
34	669 DG/WH	RS 232 positive (+) TX
35	458 OR/BK	RS 232 negative (-) RX

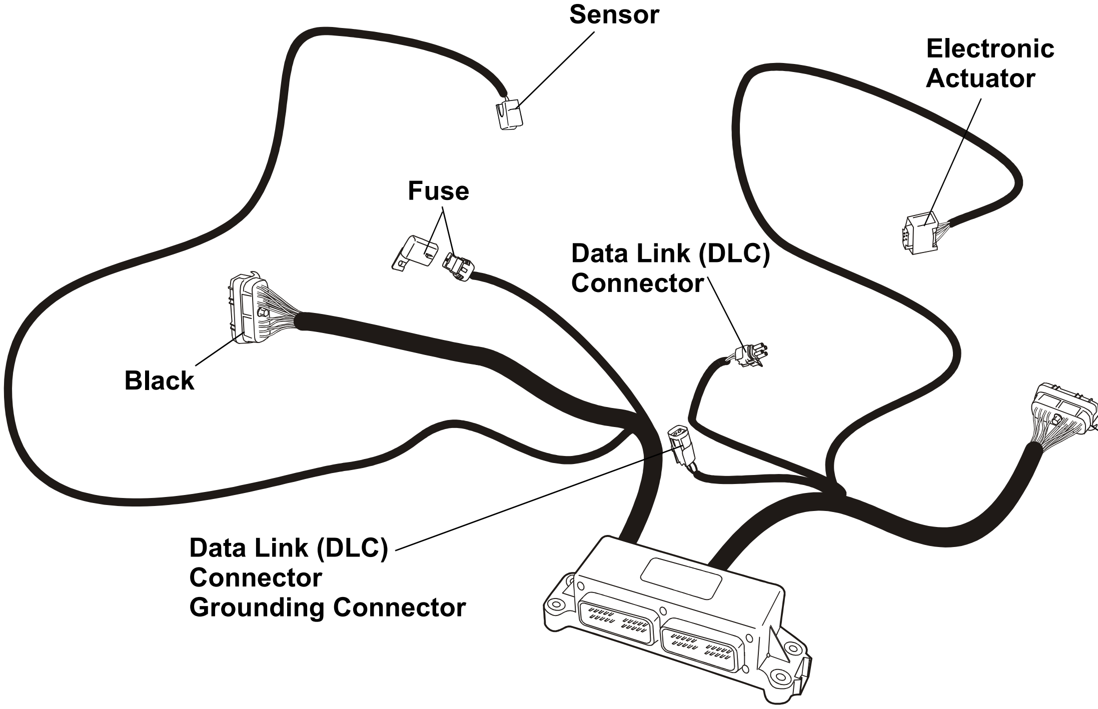
ECM to EPM Jumper Harness Connector C3F (Black)



Pin	Circuit	Circuit Function
1	570 BK/WH	Power ground
2	570 BK/WH	Power ground
3	16 RD/LG	Fused ignition voltage
4	361 RD	Fused VBAT (12 volts)
5	-	Not used
6	-	Not used
7	555 TN	Fuel injector #1 ground
8	557 BR/YL	Fuel injector #3 ground
9	558 BR/LB	Fuel injector #4 ground
10	556 WH	Fuel injector #2 ground
11	-	Not used
12	-	Not used
13	359 GY/RD	Signal return TMAP, ECT, foot pedal, HEGO, throttle communication
14	351 BR/WH	VREF (5 volt output)
15	151 LB/BK	Foot Pedal Position (FPP) 0-5 volt input #1
16	-	Not used
17	-	Not used
18	150 DG/WH	Aux. analog pull up circuit
19	-	Not used
20	358 LG/BK	Manifold Absolute Pressure (MAP) sensor input
21	-	Not used
22	-	Not used
23	-	Not used
24	74 GY/LB	HEGO 1 (0-1 volt input)
25	-	Not used
26	-	Not used
27	743 GY	Intake Air Temperature (IAT) sensor input
28	354 LG/RD	Engine Coolant Temperature (ECT) sensor input
29	-	Not used
30	-	Not used
31	-	Not used
32	349 DB	Crankshaft Position (CKP) sensor (+)
33	350 GY	Crankshaft Position (CKP) sensor (-)
34	282 DB/OR	Camshaft Position (CMP) sensor (+)
35	452 GY/RD	Camshaft Position (CMP) sensor (-)

ECM to EPM Jumper Harness Conversion

A Jumper Harness Adapter is available to convert an ECM system to an EPM module.



Ciruit Description	Black C3	Grey C2	581-01-60-001 (CINCH)
INJ 1	7		S3
INJ 3	8		S1
INJ 4	9		T1
INJ 2	10		S2
INJ 5	11		Y3
INJ 6	12		W2
MAP	20		B1
FPP1	15		A1
IAT	27		D1
ECT	28		D2
AUX ANA PU1	18		L1
POWER GROUND	1		X2,X3,T3
ANA RTN	13		B2
5 VOLT REF	14		A2
VSW	3		K1
HEGO 1	24		E2
CRANK +	32		G1
CRANK -	33		H2
CAM +	34		
CAM -	35		
VBAT	4,5		F2
COIL 1		1	X1

Ciruit Description	Black C3	Grey C2	581-01-60-001 (CINCH)
COIL 2		2	Y1
COIL 3		3	Y2
STARTER LOCKOUT		22	L3
FUEL LOCKOFF		23	P2
FUEL PUMP		9	P3
TPS1		30	
TPS2		31	
DBW +		28	
DBW -		29	
OIL PRESSURE		7	J3
MIL		27	R3
FUEL PUMP MON		10	F3
FUEL SELECT		14	K3
AUX ANA PU2		15	D3
GOV SELECT 1		16	J2
GOV SELECT 2		17	K2
GASEOUS TRIM		26	R2
RS 485 +		20	M2
RS 485 -		21	N2
RS 232 TX		34	
RS 232 RX		35	
SELF TEST			H3

DIAGNOSIS

EPM Diagnostic Overview

FORD Diagnostic Trouble Codes are set when the FORD system EPM runs a diagnostic self-test and the test fails. When a DTC is set, the FORD system EPM will illuminate the Malfunction Indicator Lamp (MIL) on the instrument panel and save the code in memory. The FORD system EPM will continue to run the self-test unless the DTC is an oxygen sensor lean, oxygen sensor rich, or an EPM related DTC. If the system continues to fail the test, the lamp will stay illuminated and the DTC is current (ACTIVE). All DTC's are stored as historical faults until they are cleared. All DTC's except the EPM related DTC's will automatically clear from memory if the DTC does not reset within 50 consecutive engine run cycles.

While a Diagnostic Trouble Code is current for a sensor, the FORD system EPM may assign a default limp home value and use that value in its control algorithms. All of the FORD system diagnostic self-tests run continuously during normal engine operation.

The Diagnostic Trouble Codes can be read by using either the Malfunction Indicator Lamp (MIL) or a Laptop computer. Refer to Using a Laptop Computer to Diagnose the FORD System and Using a Diagnostic Jumper to Diagnose the FORD System, located in this section. Diagnostic Trouble Codes can be cleared from memory with a laptop computer or by turning the ignition key to the OFF position and removing the FORD system main power fuse (F3) for 15 seconds.

If more than one DTC is detected, begin with the lowest number DTC and diagnose each problem to correction unless directed to do otherwise by the fault tree. The DTC's are numbered in order of importance. Having DTC 112 and DTC 122, both concerning the oxygen sensor, is possible. By repairing DTC 112 first, the problem causing the DTC 122 may also be corrected.

On-Board Diagnostics - EPM

The diagnostic tests and circuit charts are designed to assist the technician to locate a faulty circuit or component through a process of logical decisions. The tests and charts are prepared with the requirement that the engine functioned correctly at the time of assembly and that there were not multiple faults present.

There is a continuous self-diagnosis on certain control functions. This diagnostic capability is complimented by the diagnostic procedures contained in this section. The language for communicating the source of the malfunction is a system of diagnostic trouble codes. When a malfunction is detected by the Engine Performance Module (EPM), a Diagnostic Trouble Code (DTC) is set and the Malfunction Indicator (MIL) lamp will be illuminated (refer to MIL DTC Retrieval Procedure for process description) -- Refer to"Diagnosis Using a Personal Computer" on page 53 or Palm Pilot Diagnosis, for information regarding performing EPM and engine control system diagnosis.

Engine Performance Module (EPM) Limp Home Mode Strategy

The EPM has four settings for limp home mode. Depending on what Diagnostic Trouble Code (DTC) is set, one or more of the limp home modes will be in effect.

The four limp home modes are as follows:

Power Derate 1

The actuator is limited to a maximum opening of 50%. If "Power Derate 1" is active, it will remain active until the active DTC goes away.

The following DTC's will cause Power Derate 1 to take affect:

- DTC 223: CHT/ECT higher than expected 1. (CHT/ ECT is greater than 240 °F).
- DTC 213: IAT higher than expected 1. (IAT is greater than 200°F).
- DTC 253: Knock sensor open. (1.6L and 4.2L only)
- DTC 254: Excessive knock signal. (1.6L and 4.2L only)
- DTC 511: FPP1 high voltage.
- DTC 512 FPP1 low voltage.
- DTC 521: FPP2 high voltage.
- DTC 522: FPP2 low voltage.
- DTC 545: IVS/Brake interlock failure.

Power Derate 2

The actuator is limited to a maximum opening of 20%. If "Power Derate 2" is active, it will remain active until the active DTC goes away and the ignition input to the EPM (usually the ignition switch) is cycled.

- DTC 513: FPP1 higher than IVS limit.
- DTC 514: FPP1 lower than IVS limit.
- DTC 523: FPP2 higher than IVS limit.
- DTC 524: FPP2 lower than IVS limit.
- DTC 515: FPP1 higher than FPP2.
- DTC 516: FPP1 lower than FPP2.
- DTC 353: MegaJector delivery pressure higher than expected.
- DTC 354: MegaJector delivery pressure lower than expected.
- DTC 355: MegaJector communication lost.
- DTC 363: MegaJector internal actuator fault detection.
- DTC 364: MegaJector internal circuitry fault detection.
- DTC 365: MegaJector internal communication fault detection.
- DTC 611: COP failure (Internal EPM failure).

- DTC 614: RTI 1 loss (internal EPM failure).
- DTC 655: RTI 2 loss (internal EPM failure).
- DTC 656: RTI 3 loss (internal EPM failure).
- DTC 613: A/D loss (internal EPM failure).
- DTC 612: Invalid interrupt (internal EPM failure).
- DTC 615: Flash checksum invalid (internal EPM failure).
- DTC 616: RAM failure (internal EPM failure).

Fault Low Rev Limit

The engine RPM will be limited to a maximum of 1600 RPM. If the “Fault Low Rev Limit” is active, it will remain active until the active DTC goes away and the ignition input to the EPM (usually the ignition switch) is cycled.

- DTC 511: FPP1 high voltage.
- DTC 512: FPP1 low voltage.
- DTC 513: FPP1 higher than IVS limit.
- DTC 514: FPP1 lower than IVS limit.
- DTC 523: FPP2 higher than IVS limit.
- DTC 524: FPP2 lower than IVS limit.
- DTC 515: FPP1 higher than FPP2.
- DTC 516: FPP1 lower than FPP2.
- DTC 545: IVS/Brake interlock failure.

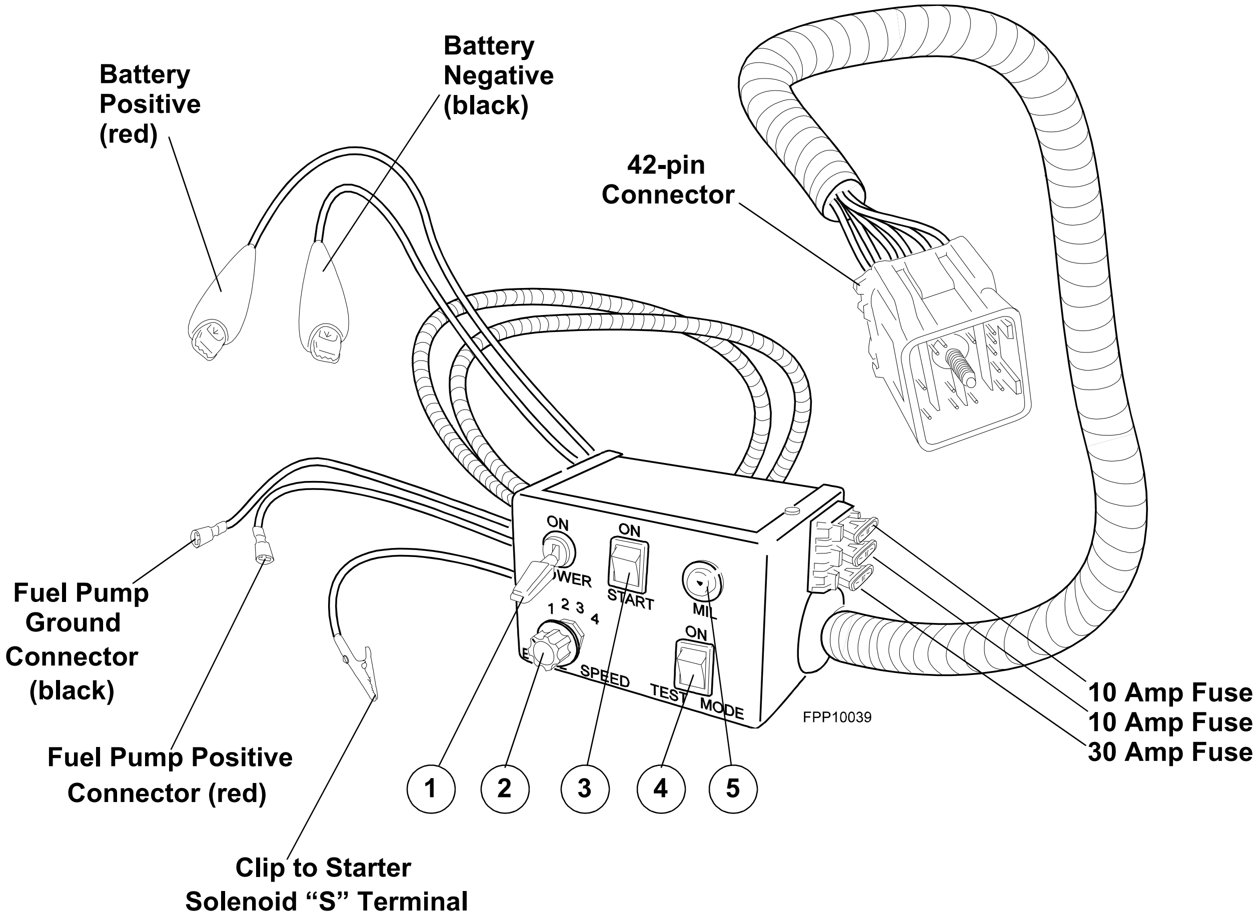
Force to Idle

The engine RPM will be limited to a maximum of 800 RPM. If the “Force to Idle” is active, it will remain active until the active DTC goes away.

- DTC 511: FPP1 high voltage.
- DTC 512: FPP1 low voltage.
- DTC 521: FPP2 high voltage.
- DTC 522: FPP2 low voltage.
- DTC 513: FPP1 higher than IVS limit.
- DTC 514: FPP1 lower than IVS limit.
- DTC 523: FPP2 higher than IVS limit.
- DTC 524: FPP2 lower than IVS limit.
- DTC 515: FPP1 higher than FPP2.
- DTC 516: FPP1 lower than FPP2.

Breakout Box

The breakout box #XU1L-12T650-AA can be used to diagnose the EPM system. However modification must be made to the wires coming out of the 42 pin connector.



1. Power Switch: Flip to ON to energize system.
2. Speed Select Switch: Turn to desired speed for testing.
3. Crank Engine Toggle: Toggle to ON to crank and start engine.
4. Test Mode Toggle: Toggle to ON to test system for any diagnostic trouble codes (DTC) which will cause MIL to blink if any codes.
5. Malfunction Indicator Light (MIL): will blink when test mode toggle switch is in the ON position and there are any DTC's.

Breakout Box Conversion

In order to use the breakout box with the Engine Performance Module (EPM) System, the following changes must be made to the wires coming out of the 42 pin connector. The breakout box will then work with both Engine Performance Module (EPM) and ECM sysems.

- The wire in pin 3 must be spliced to the wire in pin 18. Solder the splice and cover with sealable heatshrink tubing.
- The wire from pin 11 must be moved to pin 23. To move the pin, first remove the red plastic retaining clips in the 42 pin connector. Lightly pry back the black plastic retainer that presses against the terminal of pin 11 and slide the wire out the back of the connector. Insert this wire into pin 23 or the 42 pin connector. Insert the red plastic retaining clips back into the 42 pin connector.
- The new wire in pin 23 must be spliced to the wire in pin 25. Solder the splice and cover with sealable heatshrink tubing.

The conversion is now complete. The Breakout box will now work for an EPM system as well as an ECM system.

Intermittent MIL

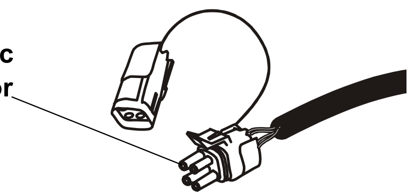
Conditions that are only present from time to time are called intermittents. To resolve intermittents, perform the following steps:

1. Evaluate the history of DTC's observed with this particular engine.
2. Evaluate the symptoms and conditions described by the customer.
3. Use strategy-based diagnosis, especially where it relates to the elimination of bad connectors and wiring.
4. When using a personal computer with Ford Power Products software, data-capturing capabilities are available that can assist in detecting intermittents. Contact the Ford Power Products Customer Service Center Technical Support Hotline (1-800-521-0370) for more information.

When a malfunction occurs for DTC's with the "limp-home" mode feature, a DTC will be set, the MIL will illuminate, and the corrective action (limp-home mode or default values) will be initiated. This will continue as long as the engine runs without being shut off. If the malfunction occurs and then corrects itself while the engine is continuously running, the DTC will be stored, the MIL will remain illuminated, and the engine will continue to run in the limp-home mode until it is shut off and restarted. Once restarted, if the malfunction does not recur, the MIL stays on and engine will resume running in a normal operating mode.

Using the ECM to EPM Jumper Harness to Diagnose the FORD System

If you do not have access to a laptop computer, it is still possible to access the Diagnostic Trouble Codes stored in the memory of the FORD system EPM using a diagnostic jumper and the Malfunction Indicator Lamp. With the key off, connect the diagnostic jumper to the FORD system diagnostic connector located near the EPM. Turn the ignition on but do not start the vehicle. Switch the self test input to ground (pin 18 of the body side harness). The Malfunction Indicator Lamp (MIL) will begin to flash.



The MIL displays three digit codes by flashing the first digit, pausing, then flashing the second digit, pausing, and then flashing the third digit. There will be a long pause between codes. For example, a code 143 would be one flash followed by four flashes followed by three flashes.

The MIL will first display a 123 three times. Code 123 indicates that the EPM based diagnostic MIL routine is now active. Then, any Diagnostic Trouble Codes (DTC's) stored in memory will flash three times each. The MIL will then start over with the code 123. If the vehicle is started while the diagnostic jumper is in place, the MIL will flash rapidly. Diagnostic Trouble Codes may be cleared from the FORD system EPM's memory by moving the ignition key to the OFF position and removing the FORD system battery fuse for at least 15 seconds.

NOTE: This will erase all of the memory in the computer including the adaptive learn.

Malfunction Indicator Lamp (MIL) DTC Retrieval Procedure

NOTE: DTC's can be retrived from the engine control module (ECM) by using either the MIL or an IBM compatible personal computer or hand held Palm Pilot® using the optional serial interface available. Refer to Equipment Setup for information about using a personal computer to assist with unit diagnosis.

DTC's can be retrieved by shorting the Self Test Input (STI) connector to ground. The STI circuit is a white/purple wire exiting pin 3 of the 42 pin connector. The STI white/purple wire branches off to terminal "A" of the 4 pin diagnostic connector. If no DTC is stored with key on/engine off (KOEO), a DTC 123 is flashed, indicating that all systems are OK.

During key on/engine running (KOER) operation, with no DTCs stored, the MIL is not illuminated. If during KOER operation a DTC is stored, the MIL will illuminate and remain on steady if the code is active.

MIL Bulb Test

The MIL bulb test occurs KOEO with the STI connector not grounded. The ML bulb will stay on and remain on if no DTCs are present. If DTCs are present (except DTC 123), the MIL bulb will blink. If the MIL bulb does not illuminate when bulb test is performed, access diagnostic software and view the fault indicator on screen. If the screen fault indicator is lilluminated and the MIL light is not, inspect the bulb and replace it if damaged. If bulb is OK or does not illuminate after replacement, refer to MIL circuit test procedure. Once MIL bulb illumination has been verified or established, DTCs can be extracted from the MIL as follows:

- KOEO, short the STI circuit to a known good ground. There will be a 5 second delay before DTCs begin flashing.

When extracting DTCs via the MIL the following apply:

- The flashing MIL is on for 0.4 second and off for 0.4 second.
- The MIL is off for 1.2 seconds between digits of three digit DTCs.
- The MIL is off for 2.4 seconds between DTCs.
- Each DTC repeats 3 times before the next stored DTC begins flashing.
- Up to 6 DTCs can be stored.
- Once all stored DTCs are flashed, the process repeats with the first stored DTC.
- DTCs are flashed in the order in which they were set.

Once the DTC(s) is retrieved, refer to the appropriate DTC chart for explanation of what caused the DTC to set. Perform component and circuit test as required to conduct repair.

Diagnosis Using a Personal Computer

Equipment Requirements

You will need a laptop computer (with a serial port) or personal digital assistant (PDA) and a communications cable/interface cable kit:

- Kit for laptop part #: PN 2U1L-6K947-AA
- Kit for PDA or laptop part #: PN 2U1E-6K947-AA

The required software is available from your local Ford Power Products distributor or you can download it from: web.fpp.ford.com

Laptop Requirements:

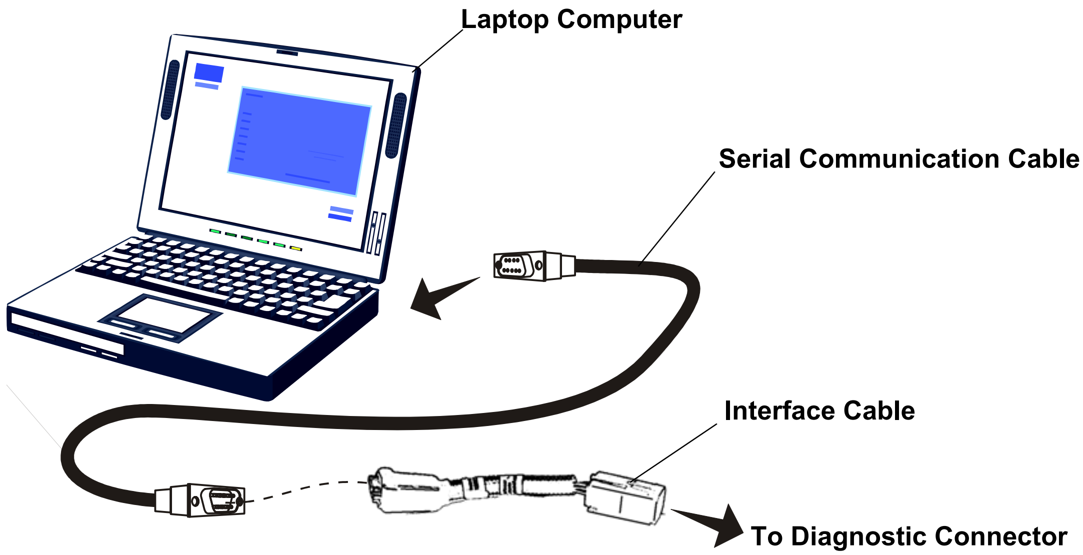
- Serial port
- 800 x 600 dpi screen
- Windows 95 or newer operating system
- No speed minimum
- 32 MB of RAM

PDA Requirements:

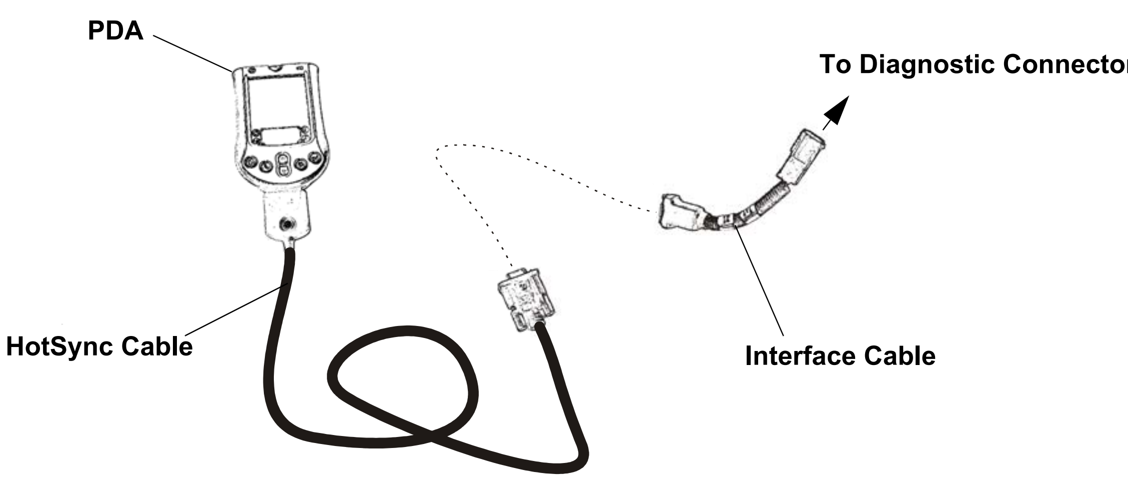
- Palm OS 3.0 software
- 64 K RAM

Interface Hook-up

For connection to a laptop, use kit PN 2U1L 6K947-AA. Connect serial cable to RS232 port on the back of the laptop computer. Connect interface cable to serial cable. Connect interface cable to the 4 pin diagnostic connector on the engine harness.



For connection to a PDA, use kit PN 2U1E-6K947-AA. Connect as shown below:



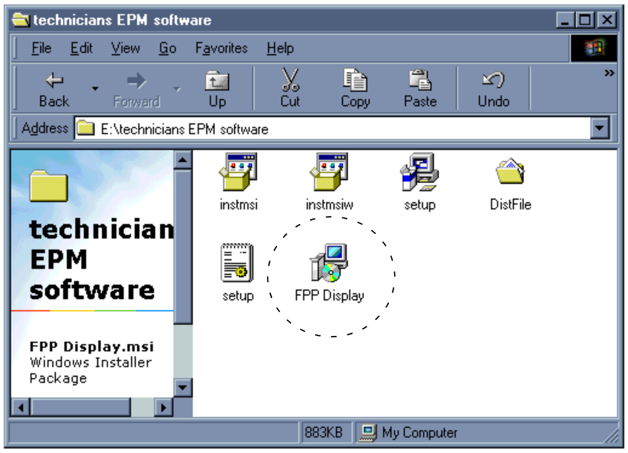
EPM Software Installation

Insert CD into CD-ROM drive.

Double click “My Computer” Icon.

Double Click CD-ROM drive letter

This will display the contents of the CD as shown.

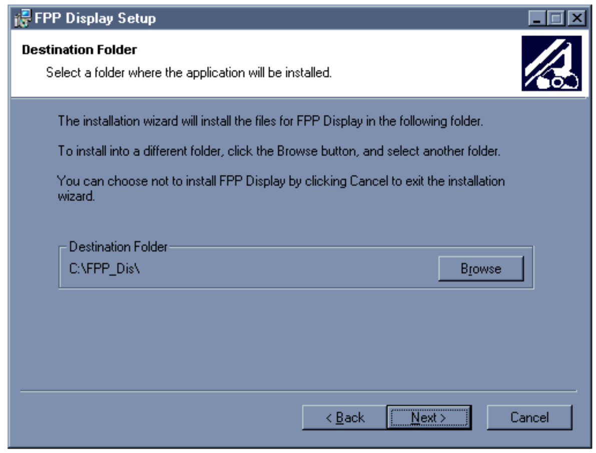


Double click FPP Display icon.

You will now see a welcome screen.

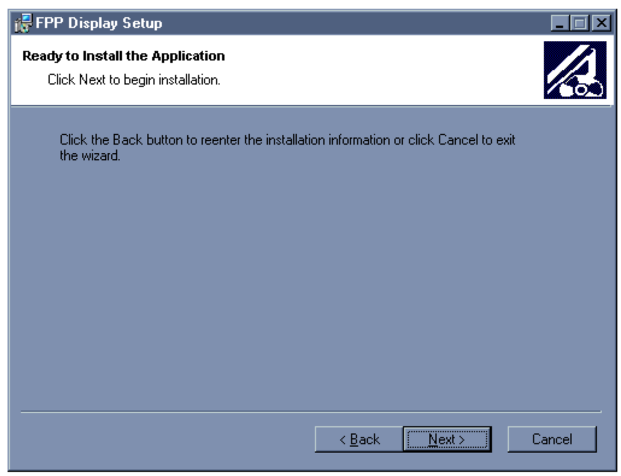
Click next.

A screen will pop up telling you the name of the destination folder.



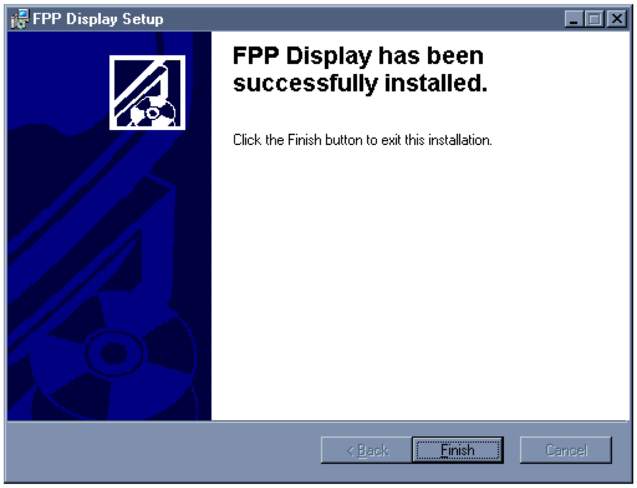
Click next.

You will now see a screen telling you it is ready to install the software.



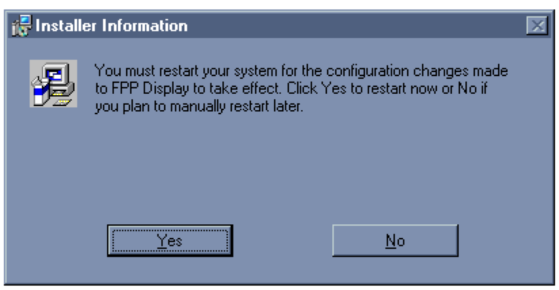
Click next.

You will see an Installation Success" screen when the software is finished installing.



Click Finish.

A screen will pop up asking if it is ok to reboot your system.



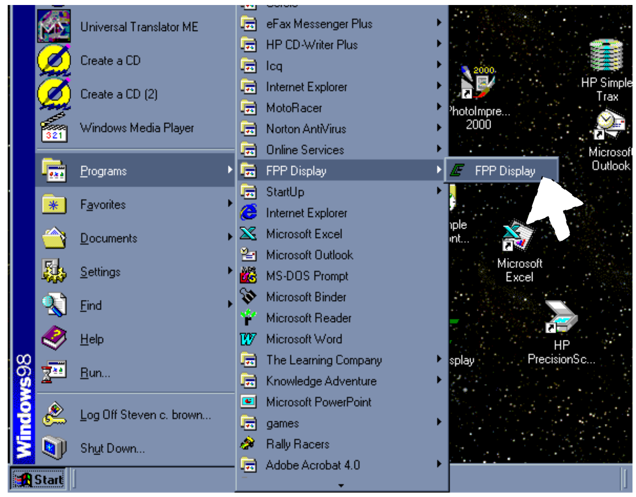
Click yes.

Your system will shut down and reboot.

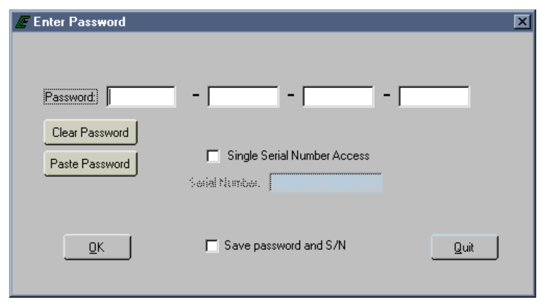
The software is now installed on your system in a folder called “FPP Display”. Refer now to “Using Technicians EPM Software” in this Section.

Using EPM Software - Menu Functions

You can begin using the technicians EPM software after installation, by clicking Start - Programs - FPP Display - FPP Display as shown.



Type in the Password which can be found on the label of the CD-ROM.

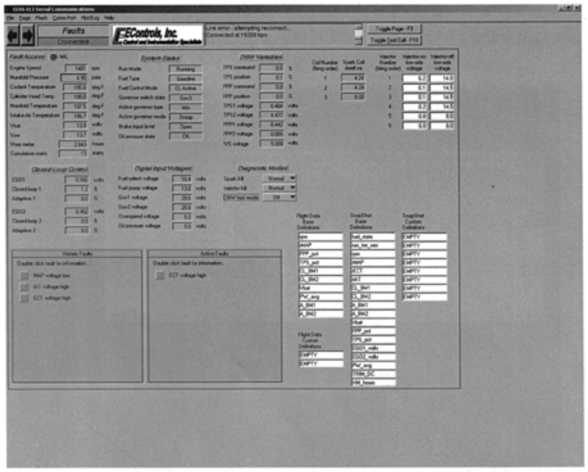


Place the ignition key in the ON position.

The FORD system Gauge screen should now appear and a green banner in the upper left hand corner will read “Connected”.

Diagnostic Trouble Codes

The System Fault screen is used to view and clear DTC's, which have been set.



Checking Diagnostic Trouble Codes

The System Fault screen contains a listing of all of the Historic and Active DTC's set within the FORD system. If a DTC is stored in memory, the screen will display that fault in the Historic Faults column. If the fault condition currently exists, the DTC will also show up in the Active Faults column.

Opening Diagnostic Trouble Codes

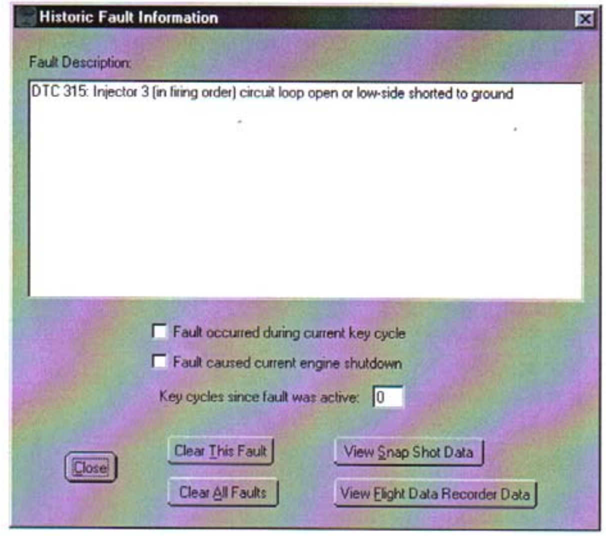
To open a DTC, click on the DTC in the Historic Faults column. A DTC Dialog Box will pop up on the screen. The DTC Dialog Box contains the following useful information:

- If the fault occurred during the current key cycle.
- If the fault caused current engine shutdown.
- How many key cycles since the fault was active.
- Snapshot Data (explained later).
- Flight Data Recorder (explained later).

The DTC Dialogue Box also allows you to clear a single fault by clicking on the "Clear This Fault" button and it allows you to clear all faults by clicking on the "Click All Faults" button.

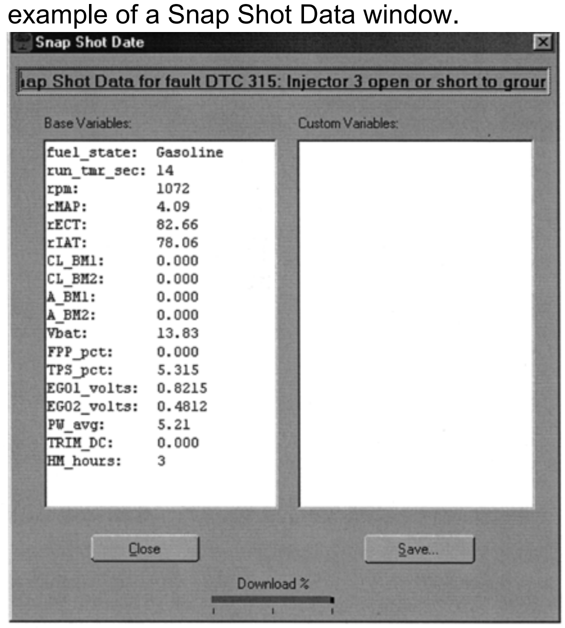
NOTE: Record faults before clearing them. This will aid in diagnosis.

Hear is an example of a DTC Dialogue Box.



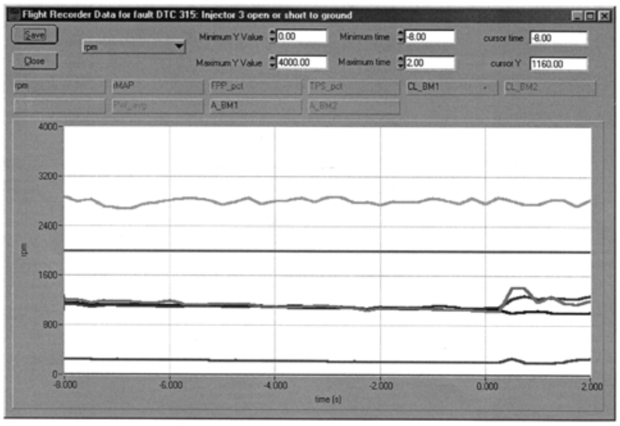
Snap Shot Data

The Snap Shot Data is a listing of specific engine system variables. These variables are recorded by the EPM at the instant the DTC sets. By clicking on the "View Snap Shot Data" button, a new window will pop up and you will be able to view these variables. Here is an example of a Snap Shot Data window.



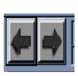
Flight Data Recorder

The Flight Data Recorder is also a listing of specific engine system variables. These variables are recorded by the EPM for an interval of 10 seconds. The 10 second interval includes 8 seconds before the DTC sets and 2 seconds after the DTC sets. By clicking on the “View Flight Data Recorder Data” button, a new window will pop up and you will be able to view these variables. Here is an example of a flight Data Recorder Data window.



The FAULTS screen shows the following:

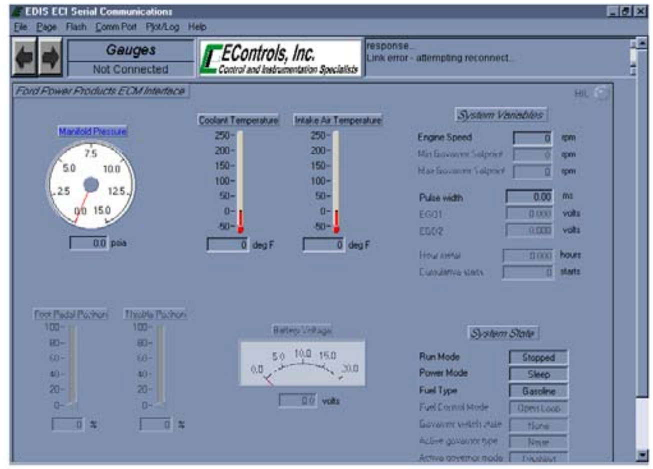
- Fault Access
- System States
- DBW Variables
- Closed Loop Control
- Digital Input Voltages
- Diagnostic Modes
- Historic Faults
- Active Faults

Use the  keys at the upper left corner

or the “page” command to toggle the three main screens (GAUGES, FAULTS AND RAW VOLTS).

NOTE: F9 key will toggle to the last screen you were on.

Data Stream - Reading Sensor & Actuator Values



Most applicable sensor and actuator values are displayed on the Gauges Screen. The display shows the voltage the FORD system EPM is reading and, for sensors, the sensor value in engineering units.

This is one of three main screens (GAUGES, FAULTS AND RAW VOLTS).

The GAUGES screen shows the following:

- Manifold Absolute Pressure (MAP)
- Engine Coolant Temperature (ECT)
- Intake Air Temperature (IAT)
- Throttle Position (TP)
- Foot Pedal Position (FPP)
- Battery Voltage
- Engine speed (RPM)
- Exhaust Gas Oxygen (HO2S)
- Hour meter
- Number of continuous starts
- Run mode, power mode and fuel type

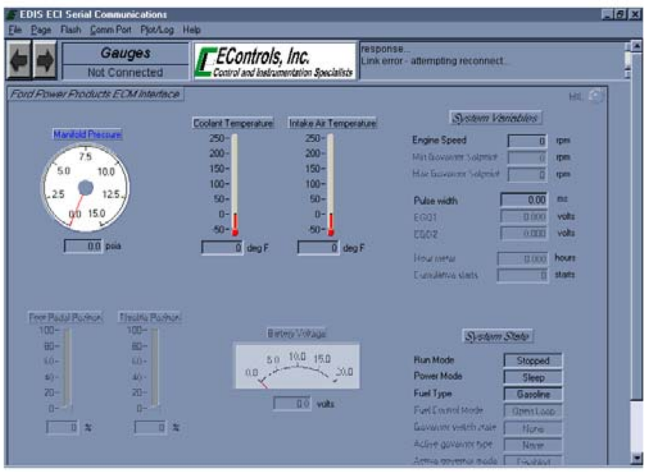
Use the  keys at the upper left corner

or the “page” command to toggle the three main screens (GAUGES, FAULTS AND RAW VOLTS).

NOTE: F9 key will toggle to the last screen you were on.

NOTE: If a DTC for a sensor is current, the engineering value for that sensor may be a default, limp home value and the voltage value will be the actual sensor voltage. Use the voltage value when performing diagnostics unless directed to do otherwise by the diagnostic trouble tree.

Plotting and Data Logging



Recording the values and voltages can be a very useful tool while diagnosing engine problems. The FORD diagnostic software includes real time **plotting** and real time **logging** capabilities. These features enhance the ability to diagnose and repair possible problems with the FORD system. Both plotting and logging allows the user to record, in real time, any variable that can be seen in the FPP_Dis software. In order to record variables, the FPP_Dis software must be "Connected" to the EPM.

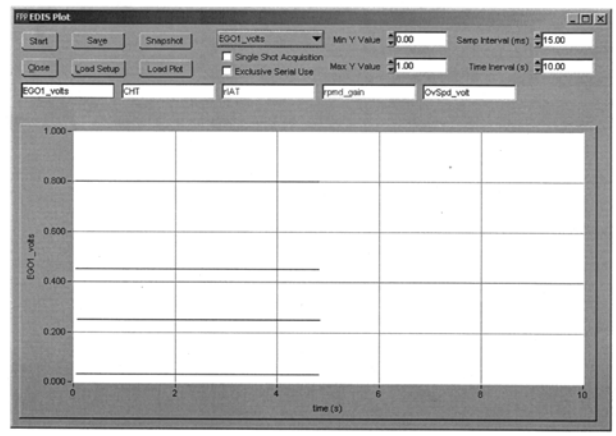
Plotting

To plot a variable, you must first "TAG" the variable. To do this, use the mouse to right click on the variable. The variable will highlight in green to let you know it is "TAGGED".

Next, press the "P" key or click the Plot/Log button and then click the Plot Tags button to invoke the plotting feature. This begins the plot function and you can observe the plotted variables. The plot sweeps from right to left. To stop the plotting feature, simply click the "STOP" button. To restart the plotter, click on the "START" button. The maximum number of variables that can be plotted at one time is 10. The range of the selected variables will be shown on the Y-axis and the time will be shown on the x-axis. You may change the desired time interval and sample interval for the plot by stopping the plot and typing in a new intervals.

The plot can be saved to the PC by stopping the plot and clicking the "SAVE" button. When saving a plot, you will have to type in a filename. Plot files can later be viewed with the edis_saplot software located in the Windows Start Programs FPP_Dis folder, or the data can be viewed in Notepad or Excel.

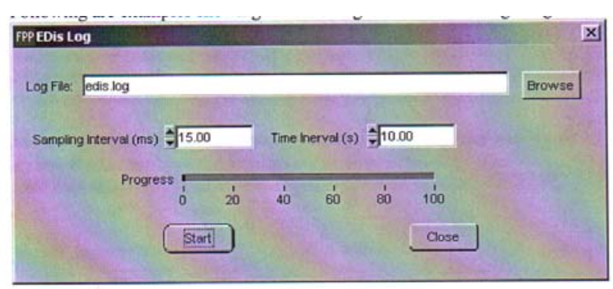
Here is a sample of a plot.

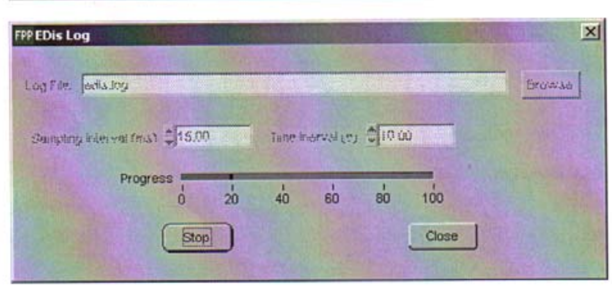


Logging

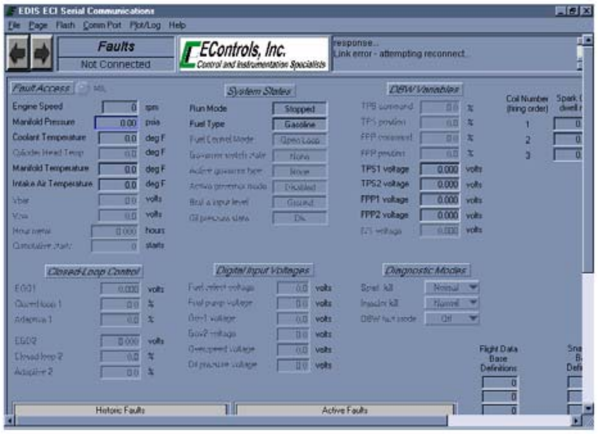
Logging variables means the variables are stored to the PC. During logging, there is no plot shown on the screen. To log variables you must first "TAG" the variables by right clicking them (same as plotting). Next, click on Plot / Log and then Log Tags. An "Edis Log" window will pop up. You can type in a custom log File name or select a custom folder to save the log file to. The default filename is "edis.log" and the default folder is FPP_Dis. The sample interval and time interval can also be changed from the default. To start logging, click on the "START" button. You will see the progress bar moving from 0 to 100%. When the logging is complete, you can close the Edis Log box or start another log file. If you start another log file, you must change the Log File name or the first log file will be overwritten. To view the contents of a saved log file, you can use Notepad or Excel.

The following are examples showing the Edis Log box before starting a log file and during a log file.





Ignition System Test



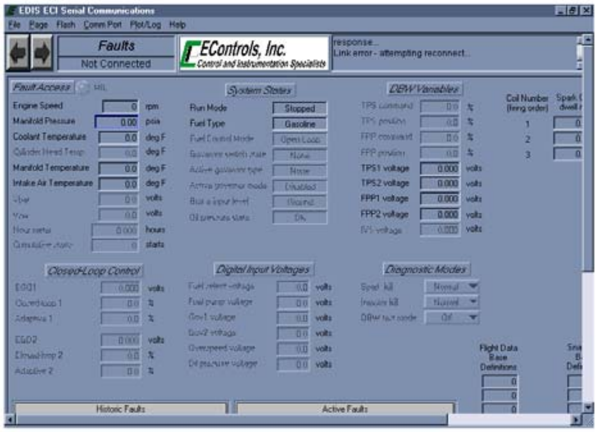
The Spark Kill diagnostic mode allows the technician to disable the ignition on individual cylinders. If the Spark Kill diagnostic mode is selected with the engine running below 1000 RPM, the minimum throttle command will lock into the position it was in when the test mode was entered. If the Spark System Test mode is selected with the engine running above 1000 RPM, the throttle will continue to operate mormally.

Disabling Ignition Ouputs

To disable the ignition system for an individual cylinder, use the mouse to highlight the “Spark Kill” button and select the desired coil. The spark output can be re-enabled by using the mouse to highlight the “Spark Kill” button and selecting “Normal”. If the engine is running below 1000 RPM, the spark output will stay disabled for 15 seconds and then re-set. If the engine is running above 1000 RPM, the spark output will stay disabled for 5 seconds and then re-set. This test mode has a timeout of 10 minutes. Record the rpm drop related to each spark output disabled.

The Spark outputs are arranged in the order which the engine fires, not by cylinder number.

Injector Test

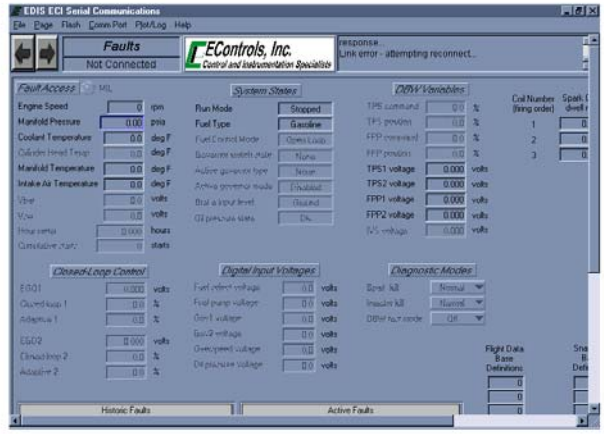


The Injector Kill mode is used to disable individual fuel injectors. If the Injector Kill mode is selected with the engine running below 1000 RPM, the minimum throttle command will lock into the position it was in when the test mode was entered. If the Injector Kill mode is selected with the engine running above 1000 RPM, the throttle will continue to operate normally.

Disabling Injectors

To disable an injector, use the mouse to select the desired injector. The word “Normal” will change to the Injector you have selected. The injector driver can be re-enabled by selecting again. If the engine is running below 1000 RPM, the injector driver will stay disabled for 15 seconds and then re-set. If the engine is running above 1000 RPM, the injector driver will stay disabled for 5 seconds and then re-set. Record the change in rpm or closed loop multiplier while each driver is disabled.

Throttle Test



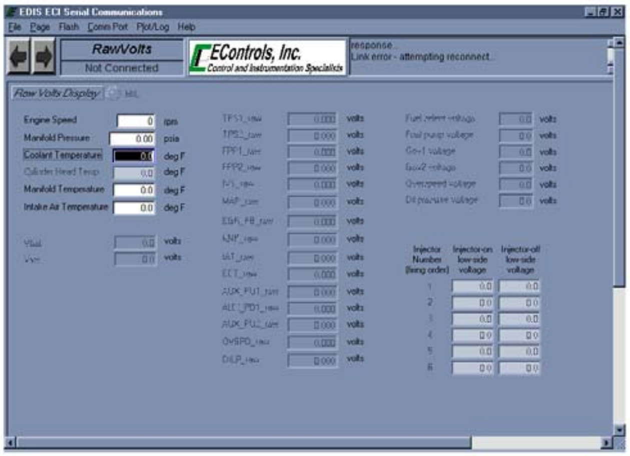
To select this test mode the engine must be off, but the key must be in the ON position.

The DBW Test mode allows the technician to control the throttle directly (without the engine running) with the foot pedal or entering a number into the “TPS Command” box. It is used during the diagnostic routines specified for FPP and TPS related faults.

FPP position displays the current position of the foot pedal as a percentage. FPP volts display the voltage that the EPM is reading from the FPP sensor.

TPS Command displays the commanded throttle position expressed as a percentage, which is being sent to the throttle. TPS Position is the actual percent of throttle opening being sent to the EPM from the throttle. TPS volts display the actual TPS signal voltage the EPM is receiving from the throttle.

RAW VOLTS Screen



The RAW VOLTS screen shows actual voltage readings from various circuits.

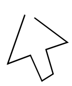
Use the  keys at the upper left corner

or the “page” command to toggle the three main screens (GAUGES, FAULTS AND RAW VOLTS).

NOTE: F9 key will toggle to the last screen you were on.

Using ICM Software

You can begin using the technicians ICM software after installation, by clicking Start - Programs - FPP 6 Cylinder ICM EDis - FPP 6 Cylinder ICM EDis.



Main Screen

The first screen shown is the “MAIN” screen.

This is one of six screens (MAIN, PLOTS, BASE SPARK, FUEL1 SPARK, FUEL2 SPARK, FAULT CONFIGURATION).

The MAIN screen shows the following:

- Engine Speed (RPM)
- Manifold Pressure (PSIA)
- Coolant Temperature (°F)
- Spark Timing (CADBTDC)

Use the  keys at the upper left corner

or the “page” command to toggle the six main screens (MAIN, PLOTS, BASE SPARK, FUEL1 SPARK, FUEL 2 SPARK, & FAULT CONFIGURATION).

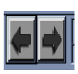
NOTE: F9 key will toggle to the last screen you were on.

Plots Screen

If you toggled to the right, the next screen will be the “PLOTS” screen.

The PLOTS screen shows the following values over time:

- Engine Speed (RPM)
- Manifold Pressure (PSIA)
- Coolant Temperature (°F)
- Spark Timing (CADBTDC)

Use the  keys at the upper left corner

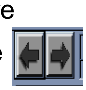
or the “page” command to toggle the six main screens (MAIN, PLOTS, BASE SPARK, FUEL1 SPARK, FUEL 2 SPARK, & FAULT CONFIGURATION).

NOTE: F9 key will toggle to the last screen you were on.

Base Spark Screen

If you toggled to the right, the next screen will be the “BASE SPARK” screen.

The BASE SPARK screen will show Base Spark Advance (CADBTDC) at a given RPM and manifold pressure

Use the  keys at the upper left corner

or the “page” command to toggle the six main screens (MAIN, PLOTS, BASE SPARK, FUEL1 SPARK, FUEL 2 SPARK, & FAULT CONFIGURATION).

NOTE: F9 key will toggle to the last screen you were on.

FUEL1 Spark Screen

If you toggled to the right, the next screen will be the “FUEL1 SPRK” screen.

The FUEL1 SPRK screen will show Fuel Option 1 Spark Advance (CADBTDC) at a given RPM and manifold pressure.

Use the  keys at the upper left corner

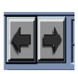
or the “page” command to toggle the six main screens (MAIN, PLOTS, BASE SPARK, FUEL1 SPARK, FUEL 2 SPARK, & FAULT CONFIGURATION).

NOTE: F9 key will toggle to the last screen you were on.

FUEL2 SPRK Screen

If you toggled to the right, the next screen will be the “FUEL2 SPRK” screen.

The Fuel2 Sprk screen will show Fuel Option 2 Spark Advance (CADBTDC) at a given RPM and manifold pressure.

Use the  keys at the upper left corner

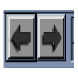
or the “page” command to toggle the six main screens (MAIN, PLOTS, BASE SPARK, FUEL1 SPARK, FUEL 2 SPARK, & FAULT CONFIGURATION).

NOTE: F9 key will toggle to the last screen you were on.

FAULT CONFIGURATION Screen

If you toggled to the right, the next screen will be the “Fault_Cfg” screen.

The Fault configuration screen will show Fault/ Shutdown Configuration.

Use the  keys at the upper left corner

or the “page” command to toggle the six main screens (MAIN, PLOTS, BASE SPARK, FUEL1 SPARK, FUEL 2 SPARK, & FAULT CONFIGURATION).

NOTE: F9 key will toggle to the last screen you were on.

Visual Inspection

Perform a careful visual and physical engine inspection before performing any diagnostic procedure. Perform all necessary repairs before proceeding with additional diagnosis, this can often lead to repairing a problem without performing unnecessary steps. Use the following guidelines when performing a visual/physical inspection check:

- Inspect engine for modifications or aftermarket equipment that can contribute to the symptom; verify that all electrical and mechanical loads or accessory equipment is “OFF” or disconnected before performing diagnosis.
- Inspect engine fluids for correct levels and evidence of leaks.
- Inspect vacuum hoses for damage, leaks, cracks, kinks and improper routing, inspect intake manifold sealing surface for a possible vacuum leak.
- Inspect PCV valve for proper installation and operation.
- Inspect all wires and harnesses for proper connections and routing; bent or broken connector pins; burned, chafed, or pinched wires; and corrosion. Verify that harness grounds are clean and tight.
- Inspect EPM, sensors and actuators for physical damage.
- Inspect EPM grounds for cleanliness, tightness, and proper location.
- Inspect fuel system for adequate fuel level, and fuel quality (concerns such as proper octane, contamination, winter/summer blend).
- Inspect intake air system and air filter for restrictions.
- Inspect battery condition and starter current draw.

If no evidence of a problem is found after visual inspection has been performed, proceed to “Diagnostic System Check”

Intermittent Problems

NOTE: An intermittent problem may or may not turn on the MIL or store a DTC. Do not use the DTC charts for intermittent problems. The fault must be present to locate the problem.

NOTE: Most intermittent problems are caused by faulty electrical connections or wiring. Perform a careful visual inspection for the following conditions:

- Poor mating of the connector halves or a terminal not fully seated in the connector (backed out).
- Improperly formed or damaged terminals
- Improper contact tension. All connector terminals in the problem circuit should be carefully checked.
- Poor terminal-to-wire connections. This requires removing the terminal from the connector body to check.
- Improperly installed aftermarket equipment or accessories.

Operate the engine with accessories “OFF” and a suitable multimeter connected to the suspected circuit. An abnormal voltage when the malfunction occurs is a good indication that there is a fault in the circuit being monitored.

To check EPM for loss of diagnostic code memory, disconnect the MAP sensor connector and idle the engine until the MIL illuminates. Perform MIL DTC retrieval procedure. DTC should be stored and kept in memory when the ignition is turned “OFF”. If not, the EPM is faulty. When this test is completed, make sure that you clear the DTC from memory. An intermittent MIL with no stored DTC may be caused by the following:

- DIS ignition coil shorted to ground and arcing at ignition wires or plugs.
- MIL circuit to EPM shorted to ground.
- Poor EPM grounds.

Symptom Charts

NOTE: If you have a symptom of the pedal not working, and no DTC is set, go to the voltage screen and check pedal voltage. If pedal voltage is.75-1.25 volts, and idle validation switch says you're at idle - replace the pedal.

Table of Charts

Symptom	Go to Page #
Malfunction Indicator Lamp (MIL) “ON” Steady	
No Malfunction Indicator Lamp (MIL)	
Engine Cranks but Does Not Start	
Hard Start	
Engine Surges	
Lack of Power or Sluggish	
Detonation / Spark Knock	
Rough, Unstable, or Incorrect Idle, Stalling	
Excessive Fuel Consumption	
Dieseling, Run-on	
Backfire	
Hesitation, Sag Stumble	
Cuts Out, Misses	

Engine Performance Module (EPM) - Diagnostic Trouble Codes

CAUTION: When checking codes with the diagnostic software, the DTC terminal can NOT be grounded.

CAUTION: Removing battery power before accessing diagnostic program will errase all codes recorded.

This section contains circuit description information and troubleshooting charts on all the DTC's obtained by diagnostic software or a Malfunction Indicator Lamp (MIL). When diagnostic trouble codes are obtained by a Malfunction Indicator Lamp (MIL), the following secquence will be flashed:

- 123 will flash 3 times to indicate the beginning of the flash code display sequence.
- Any active DTC's will flash 3 times each.
- 123 will flash 3 times indicating the end of the code display sequence.

If code 123 is the only code present, the system does not have any active codes - all systems are working fine.

If an active DTC is present, refer to the corresponding DTC chart. Begin with the lowest number code first.

NOTE: If you have a symptom of the pedal not working, and no DTC is set, go to the voltage screen and check pedal voltage. If pedal voltage is .75 - 1.25 volts, and idle validation switch says you're at idle - replace the pedal.

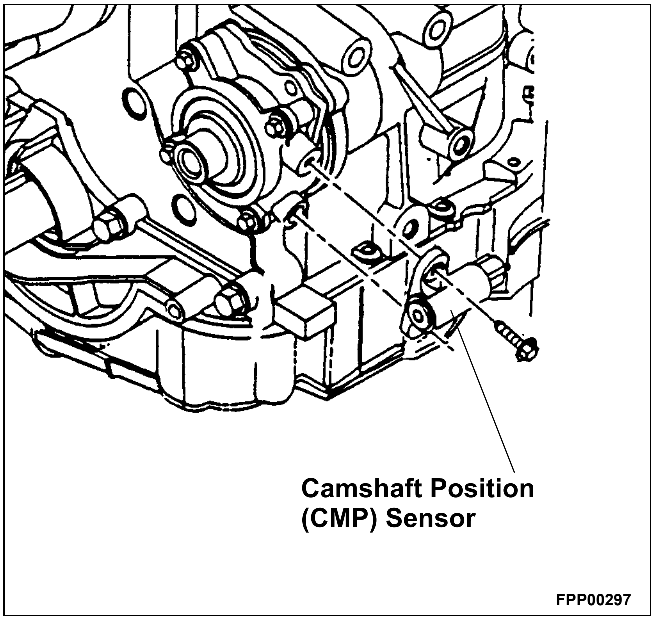
Diagnostic Trouble Code (DTC)	
DTC 111	Closed Loop Multiplier High (LPG)
DTC 112	HO2S Open/Inactive (Bank 1)
DTC 113	HO2S Open/Inactive (Bank 2)
DTC 121	Closed Loop Multiplier High Bank 1 (Gasoline)
DTC 122	Closed Loop Multiplier Low Gank 1 (Gasoline)
DTC 124	Closed Loop Multiplier Low (LPG)
DTC 125	Closed Loop Multiplier High (Natural Gas)
DTC 126	Closed Loop Multiplier Low (Natural Gas)
DTC 131	Closed Loop Multiplier High Bank 2 (Gasoline)
DTC 132	Closed Loop Multiplier Low Bank 2 (Gasoline)
DTC 141	Adaptive Lean Fault (High Limit - Gasoline)
DTC 142	Adaptive Rich Fault (Low Limit Gasoline)
DTC 143	Adaptive Learn High (LPG)
DTC 144	Adaptive Learn Low (LPG)
DTC 145	Adaptive Learn High (Natural Gas)
DTC 146	Adaptive Learn Low (Natural Gas)
DTC 161	System Voltage Low
DTC 162	System Voltage High
DTC 211	IAT High Voltage
DTC 212	IAT Low Voltage
DTC 213	IAT Higher Than Expected 1
DTC 214	IAT Higher Than Expected 2
DTC 215	Oil Pressure Low
DTC 221	CHT/ECT High Voltage
DTC 222	CHT/ECT Low Voltage
DTC 223	CHT Higher Than Expected 1
DTC 224	CHT Higher Than Expected 2
DTC 231	MAP High Pressure
DTC 232	MAP Low Voltage
DTC 234	BP High Pressure
DTC 235	BP Low Pressure
DTC 242	Crank Sync Noise
DTC 243	Never Crank Synced At Start
DTC 244	Camshaft Sensor Loss
DTC 245	Camshaft Sensor Noise
DTC 253	Knock Sensor Open
DTC 254	Excessive Knock Signal
DTC 311	Injector Driver #1 Open
DTC 312	Injector Driver #1 Shorted
DTC 313	Injector Driver #2 Open
DTC 314	Injector Driver #2 Shorted
DTC 315	Injector Driver #3 Open
DTC 316	Injector Driver #3 Shorted
DTC 321	Injector Driver #4 Open
DTC 322	Injector Driver #4 Shorted
DTC 351	Fuel Pump Loop Open or High Side Short to Ground
DTC 352	Fuel Pump High Side Shorted to Power

Diagnostic Trouble Code (DTC)	
DTC 353	MegaJector Delivery Pressure Higher than Expected
DTC 354	MegaJector Delivery Pressure Lower than Expected
DTC 355	MegaJector Communication Lost
DTC 361	MegaJector Voltage Supply High
DTC 362	MegaJector Voltage Supply Low
DTC 363	MegaJector Internal Actuator Fault Detection
DTC 364	MegaJector Internal Circuitry Fault Detection
DTC 365	MegaJector Internal Communication Fault Detection
DTC 411	Coil Driver #1 Open
DTC 412	Coil Driver #1 Shorted
DTC 413	Coil Driver #2 Open
DTC 414	Coil Driver #2 Shorted
DTC 511	FPP1 High Voltage
DTC 512	FPP1 Low Voltage
DTC 513	FPP1 Higher Than IVS Limit
DTC 514	FPP1 Lower Than IVS Limit
DTC 521	FPP2 High Voltage
DTC 522	FPP2 Low Voltage
DTC 531	TPS1 (Signal Voltage) High
DTC 532	TPS1 (Signal Voltage) Low
DTC 533	TPS2 (Signal Voltage) High
DTC 534	TPS2 (Signal Voltage) Low
DTC 535	TPS1 Higher Than TPS2
DTC 536	TPS1 Lower Than TPS2
DTC 537	Throttle Unable to Open
DTC 538	Throttle Unable to Close
DTC 545	Governor Interlock Failure
DTC 551	Max Govern Speed Override
DTC 552	Fuel Rev Limit
DTC 553	Spark Rev Limit
DTC 611	COP Failure
DTC 612	Invalid Interrupt
DTC 613	A/D Loss
DTC 614	RTI 1 Loss
DTC 615	Flash Checksum Invalid
DTC 616	RAM Failure
DTC 631	External 5V Ref Lower Than Expected
DTC 632	External 5V Ref Higher Than Expected
DTC 655	RTI 2 Loss
DTC 656	RTI 3 Loss

REMOVAL AND INSTALLATION

Camshaft Position Sensor (CMP)

Removal



1. Disconnect the negative battery cable.
2. Disconnect electrical connector.
3. Remove screws.
4. Remove the sensor.

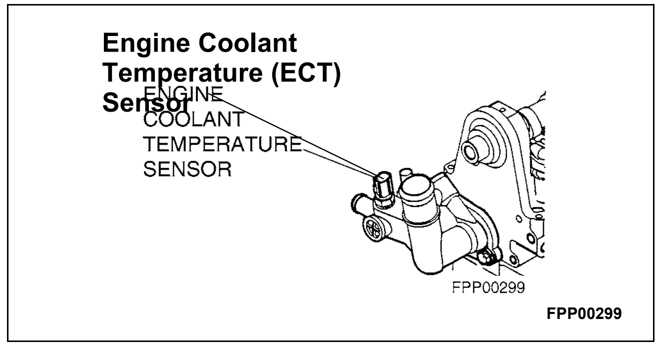
Installation

1. Install the sensor.
2. Install screws. Tighten to 5-7 Nm (45-61 lb-in).
3. Connect electrical connector.
4. Connect the negative battery cable.

Engine Coolant Temperature (ECT) Sensor

Removal

1. Disconnect the negative battery cable.
2. Partially drain the cooling system.
3. Disconnect the electrical connector.
4. Remove the sensor.

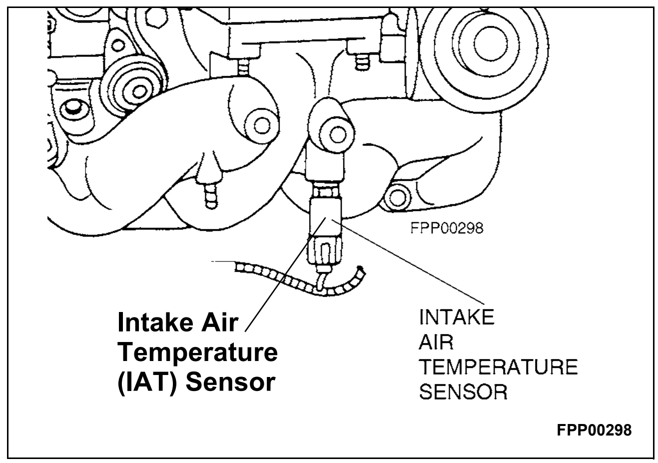


Installation

1. Install the sensor. Tighten to 16-24 Nm (12-17 lb-ft).
2. Connect the electrical connector.
3. Connect the negative battery cable.
4. Fill the cooling system with the proper coolant.

Intake Air Temperature (IAT) Sensor

Removal



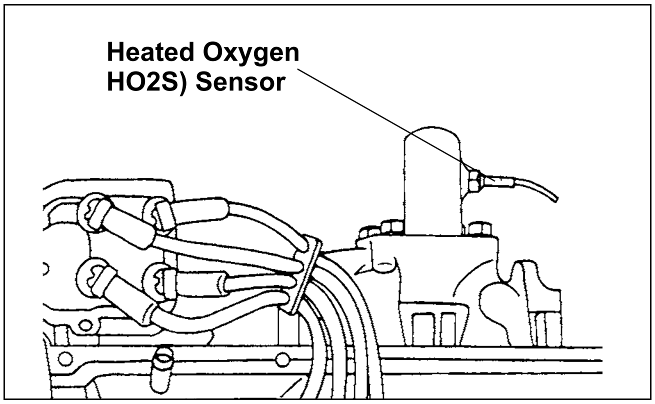
1. Disconnect the negative battery cable.
2. Disconnect the electrical connector.
3. Remove the sensor.

Installation

1. Install the sensor. Tighten to 13-16 Nm (7-12 lb-ft).
2. Connect electrical connector.
3. Connect the negative battery cable.

Heated Oxygen (HO2S) Sensor

Removal



1. Disconnect the negative battery cable.
2. Disconnect electrical connector.
3. Remove the sensor using an oxygen sensor wrench.

NOTE: If necessary, lubricate sensor using penetrating lubricant such as E8AZ-19A501-B or equivalent.

Installation

1. Apply a light coat of Anti-seize compound such as F6AZ-9L494-AA or equivalent meeting Ford specification ESE-M12A4A to the threads of the sensor.
2. Install the sensor using an oxygen sensor wrench. Tighten to 36-46 Nm (27-33 lb-ft).
3. Connect electrical connector.
4. Connect the negative battery cable.