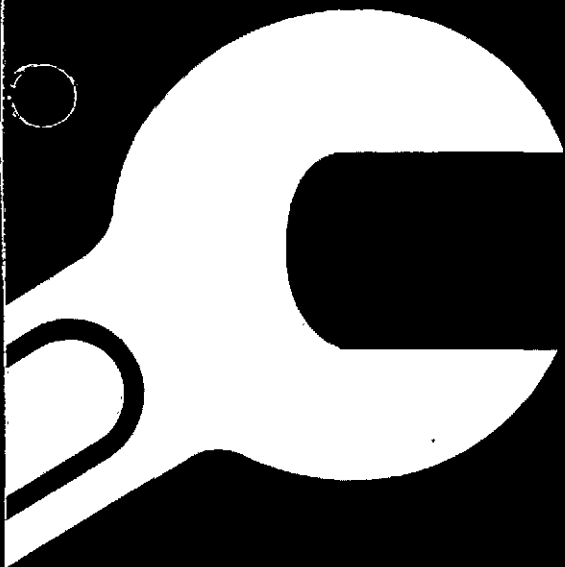


WORKSHOP MANUAL

EFI Diagnostic
8.1Gi-A, 8.1GSi-A



**VOLVO
PENTA**

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Introduction

Circuit Protection



Do not attempt to connect or disconnect any part of the electrical circuit while the engine is running.

When installing additional electrical accessories always use individual fused circuits. Power takeoff should be made at a terminal strip powered by auxiliary accessory wire and protected by a 20 amp (maximum) fuse.

Circuit Protectors and Locations

10 Amp Fuse

Protects trim switch. Located on trim/tilt pump.

SFE 20 Amp Fuse

Protects ignition switch. Located under dash.

15 Amp Fuse F3

Protects ignition/injector relay and ECM. Located inside fuse box.

20 Amp Fuse F7

Protects fuel pumps. Located inside fuse box.

50 Amp Circuit Breaker

Protects trim/tilt motor. Located rear starboard adjacent to warning alarm and engine 10 pin connector.

20 Amp Fuses F1 & F2

Protects main harness. Located inside fuse box.

15 Amp Fuse F4

Protects ECM. Located inside fuse box.

Battery and Cables

Special Tools Required: Battery Hydrometer

The primary function of the battery is to provide power to operate the starter motor. The battery also supplies power to operate the lights and other electrical equipment which may be used when the engine is not running. On battery ignition systems, the battery must supply the ignition current during the starting period and during the time that the alternator is not producing a sufficient charge to meet operating requirements.

Battery Requirements

- Use a 12 volt battery having a minimum rating of 650 Cold Cranking Amps at 0° F (-18° C), and a 165 minute reserve capacity rating at 80° F (27° C).

Battery Maintenance

There are two things which must be done periodically in order to obtain long life from a battery.

1. The electrolyte must be kept above the plates and separators at all times. The liquid level should be brought up to the level specified by the battery manufacturer. Acid should never be added except when it is definitely known that some has been lost by spilling, and then only by an experienced battery man.



Battery electrolyte is a corrosive acid and should be handled with care. If electrolyte is spilled or splashed on any part of the body, immediately flush the exposed area with liberal amounts of water and obtain medical aid as soon as possible.

2. Be sure that the battery is kept nearly at full charge at all times. The state of charge should be checked at frequent intervals by making specific gravity readings with a battery hydrometer. It is suggested that gravity readings and replacement of evaporated water be made every two weeks. Should the gravity fall more than 0.040 specific gravity below a fully charged gravity reading, remove the battery and have it charged.

Note

Full charge specific gravity is 1.260 at 80° F (27° C).



Do not use a jumper cable and a booster battery to start engine. Remove battery from boat and recharge. Fumes vented during charging battery can lead to an explosion.

Good Battery Servicing Includes the Following Nine Points:

- a. Protect boat against acid damage.
- b. Clean battery.
- c. Inspect cables.
- d. Clean terminals.
- e. Inspect hold-downs.
- f. Inspect casing for leaks.
- g. Make hydrometer test.
- h. Remove battery from boat for tests. Recharge battery if less than 3/4 charged. Make load test.
- i. Add water.

If battery is not in a good state of charge or if it uses an excessive amount of water, check the charging system.

Clean the battery and terminals with a solution of baking soda and water. This will neutralize the acid on the battery. After washing with this solution, flush top of battery with clear water. Care must be taken when washing the battery so that the baking soda and water solution does not enter the battery cells.


Cable Requirements

The battery should be mounted as close to the engine as practical to cut down on battery cable lengths. Follow the recommendations below.

- 0-10 Feet 0 Gauge
- 10-15 Feet 2/0 Gauge
- 15-20 Feet 4/0 Gauge

Note

These specifications do not apply to aluminum battery cables. *Volvo Penta* does not recommend the use of aluminum battery cables.

 To prevent possible explosion or fire, do not substitute automotive parts for the following marine components: starter, alternator, distributor and related ignition parts, spark plug leads, solenoids, fuel pump or fuel filter canister. These components have been specifically designed not to emit fuel vapors or to cause ignition of fuel vapors in the bilge.

Tuning The Engine

The purpose of an engine tune-up is to restore power and performance that has been lost through wear, corrosion or deterioration of one or more parts or components. In the normal operation of an engine, these changes can take place gradually at a number of points, so that it is seldom advisable to attempt an improvement in performance by correction of one or two items only. Time will be saved and more lasting results will be obtained by following a definite and thorough procedure of analysis and correction of all items affecting power and performance. Refer to the Engine Service Manual for all tune-up specifications.

Gasoline Requirements

The 8.1Gi and 8.1GSI covered in this manual are designed for maximum performance with the use of gasoline with the following minimum or higher octane specification:


- Anti-Knock Index Number (AKI) - 89
- Research Octane Number (RON) - 93

Some marinas sell fuel with lead additives. Do not use such fuel as it may plug the fuel injectors. Premium grade fuels contain injector cleaners and other additives that protect the fuel system and provide optimum performance. The use of premium grade fuels is strongly recommended.

If fuels with 89 AKI (93 RON) octane or higher are not available, lower octane fuels, with a minimum of 87 AKI (90 RON) octane, can be used. When lower octane fuels are used, a slight decrease in power can be expected.

Note Engine damage resulting from the use of gasoline with octane 86 AKI (89 RON) and lower is considered misuse of the engine and will void the engine warranty. *Volvo Penta* suggests the use of 89 AKI or higher fuels. These fuels have additives that are beneficial to maximum engine performance and long life of service components.

To prevent gum formation and corrosion in the fuel system, use *Volvo Penta* Marine Fuel Stabilizer in the gasoline. *Volvo Penta* Marine Fuel Stabilizer is available from your authorized dealer.

 Gasoline is extremely flammable and highly explosive under certain conditions. Always stop engine and do not smoke or allow open flames or sparks near the boat when refueling gas tanks. When filling the gas tank, ground the tank to the source of gasoline by holding the hose nozzle firmly against the side of the deck filler plate, or ground it in some other manner. This action prevents static electricity build-up which could cause sparks and ignite fuel vapors.

Gasolines Containing Alcohol

Many gasolines being sold today contain alcohol. Two commonly used alcohol additives are Ethanol (ethyl alcohol) and Methanol (methyl alcohol).

See the Owner's Manual for your boat to determine if the boat's fuel system is compatible with alcohol blended fuels. If it is compatible, your engine may be operated using gasolines blended with no more than 10% Ethanol (ethyl alcohol) meeting the minimum octane specification. Do not use any gasoline which contains METHANOL (methyl alcohol).


Note Serious damage to the boat or engine fuel systems will result from the continued use of fuel containing METHANOL (methyl alcohol).

If you use gasoline containing alcohol, be aware of the following:





- The engine will operate leaner with alcohol blended fuel. This may cause engine problems such as vapor lock, low speed stall, or hard starting.
- Alcohol blended fuels attract and hold moisture. Moisture inside fuel tanks can cause corrosion of the tank material. Inspect fuel tanks at least annually. Replace fuel tanks if inspection indicates leakage or corrosion.
- Inspect non-metallic parts of fuel system frequently and replace if excessive stiffness, deterioration or fuel leakage is found.

 Fuel leakage can contribute to a fire and/or explosion.






Periodic Maintenance Chart

Items marked  Safety Warning are safety related service points to prevent mechanical failures, fire and explosion. Make sure the safety related service is performed at these points and at the intervals specified.

Electrical

Service Point	Every 25 Hours or as Specified	Every 50 Hours or as Specified	Recommendations
Battery	Check electrolyte level monthly	Tighten connections	Recharge battery if specific gravity is below 1.220 temperature corrected.
 Electrical System		Check connections and insulation.	Tighten loose connections and replace deteriorating wiring
 High Tension Leads		Check for corrosion, deterioration or arching. Boots must fit snugly on coils and spark plugs.	If damaged, replace with specified Volvo Penta parts. Maintain original routing and support.
 Ignition Coils		Check for arching or cracks in plastic portion of coil.	Replace with specified Volvo Penta parts.
 Spark Plugs		Annually check ceramic for cracks. Replace, or clean and gap.	If damaged, replace with specified Volvo Penta parts. Maintain original routing and support.

Fuel

Service Point	Every 25 Hours or as Specified	Every 50 Hours or as Specified	Recommendations
 Flame Arrestor - Mounting		Clean and check annually.	Tighten clamp. Replace if damaged.
 Fuel Filter		Replace annually	Replace fuel filter.
 Fuel System	Check for leaks daily		Tighten connections. Replace with Volvo Penta components.
 Fuel Tank		Check for water in fuel tank.	Keep tank filled with recommended fuel to prevent condensation.
 Non-Metallic fuel hoses		Check for excessive stiffness, deteriorated and/or leakage every 50 hours or monthly, whichever occurs first.	Replace as necessary with A.B.Y.C.* approved components.

*American Boat and Yacht Council

Drill Size Conversion Chart

SHOWING MILLIMETER SIZES, FRACTIONAL AND DECIMAL INCH SIZES AND NUMBER DRILL SIZES

Milli-Meter	Dec. Equiv.	Fract-ional	Num-ber	Milli-Meter	Dec. Equiv.	Fract-ional	Num-ber	Milli-Meter	Dec. Equiv.	Fract-ional	Num-ber	Milli-Meter	Dec. Equiv.	Fract-ional	Num-ber	Milli-Meter	Dec. Equiv.	Fract-ional
.1	.0039			1.75	.0689			...	.1570		22	6.8	.2677			10.72	.4219	27/64
.15	.0059			...	.0700		50	4.0	.1575			6.9	.2716			11.0	.4330	
.2	.0079			1.8	.0709			...	.1590		21	...	.2720	I		11.11	.4375	7/16
.25	.0098			1.85	.0728			...	.1610		20	7.0	.2756			11.5	.4528	
.3	.0118			...	.0730		49	4.1	.1614			...	.2770	J		11.51	.4531	29/64
...	.0135		80	1.9	.0748			4.2	.1654			7.1	.2795			11.91	.4687	15/32
.35	.0138			...	.0760		48	...	.1660		19	...	.2811		K	12.0	.4724	
...	.0415		79	1.95	.0767			4.25	.1673			7.14	.2812	9/32	...	12.30	.4843	31/64
.39	.0156	1/64	...	1.98	.0781	5/64	...	4.3	.1693			7.2	.2835			12.5	.4921	
.4	.0157			...	.0785		47	...	.1695		18	7.25	.2854			12.7	.5000	1/2
...	.0160		78	2.0	.0787			4.37	.1719	11/64	...	7.3	.2874			13.0	.5118	
.45	.0177			2.05	.0807			...	.1730		17	...	.2900	L		13.10	.5156	33/64
...	.0180		77	...	.0810		46	4.4	.1732			7.4	.2913			13.49	.5312	17/32
.5	.0197			...	.0820		45	...	.1770		16	...	.2950	M		13.5	.5315	
...	.0200		76	2.1	.0827			4.5	.1771			7.5	.2953			13.89	.5469	35/64
...	.0210		75	2.15	.0846			...	.1800		15	7.54	.2968	19/64	...	14.0	.5512	
.55	.0217			...	.0860		44	4.6	.1811			7.6	.2992			14.29	.5624	9/16
...	.0225		74	2.2	.0866			...	.1820		14	...	.3020	N		14.5	.5709	
.6	.0236			2.25	.0855			4.7	.1850		13	7.7	.3031			14.68	.5781	37/64
...	.0240		73	...	.0890		43	4.75	.1870			7.75	.3051			15.0	.5906	
...	.0250		72	2.3	.0905			4.76	.1875	3/16	...	7.8	.3071			15.08	.5937	19/32
.65	.0256			2.35	.0925			4.8	.1890		12	7.9	.3110			15.48	.6094	39/64
...	.0260		71	...	.0935		42	...	.1910		11	7.94	.3125	5/16	...	15.5	.6102	
...	.0280		70	2.38	.0937	3/32	...	4.9	.1929			8.0	.3150			15.88	.6250	5/8
.7	.0276			2.4	.0945			...	.1935		10	...	.3160		O	16.0	.6299	
...	.0292		69	...	.0960		41	...	.1960		9	8.1	.3189			16.27	.6406	41/64
.75	.0295			2.45	.0964			5.0	.1968			8.2	.3228			16.5	.6496	
...	.0310		68	...	.0980		40	...	.1990		8	...	.3230	P		16.67	.6562	21/32
.79	.0312	1/32	...	2.5	.0984			5.1	.2008			8.25	.3248			17.0	.6693	
.8	.0315			...	.0995		39	...	.2010		7	8.3	.3268			17.06	.6719	43/64
...	.0320		67	...	.1015		38	5.16	.2031	13/64	...	8.33	.3281	21/64	...	17.46	.6875	11/16
...	.0330		66	2.6	.1024			...	.2040		6	8.4	.3307			17.5	.6890	
.85	.0335			...	.1040		37	5.2	.2047			...	.3320	Q		17.86	.7031	45/64
...	.0350		65	2.7	.1063			...	.2055		5	8.5	.3346			18.0	.7087	
.9	.0354			...	.1065		36	5.25	.2067			8.6	.3386			18.26	.7187	23/32
...	.0360		64	2.75	.1082			5.3	.2086			...	.3390	R		18.5	.7283	
...	.0370		63	2.78	.1094	7/64	...	...	.2090		4	8.7	.3425			18.65	.7344	47/64
.95	.0374			...	.1100		35	5.4	.2126			8.73	.3437	11/32	...	19.0	.7480	
...	.0380		62	2.8	.1102			...	.2130		3	8.75	.3445			19.05	.7500	3/4
...	.0390		61	...	.1110		34	5.5	.2165			8.8	.3465			19.45	.7656	49/64
1.0	.0394			...	.1130		33	5.56	.2187	7/32	...	...	.3480	S		19.5	.7677	
...	.0400		60	2.9	.1141			5.6	.2205			8.9	.3504			19.84	.7812	25/32
...	.0410		59	...	.1160		32	...	.2210		2	...	.3543			20.0	.7874	
1.05	.0413			3.0	.1181			5.7	.2244			...	.3580	T		20.24	.7969	51/64
...	.0420		58	...	.1200		31	5.75	.2263			9.1	.3583			20.5	.8071	
...	.0430		57	3.1	.1220			...	.2280		1	9.13	.3594	23/64	...	20.64	.8125	13/16
1.1	.0433			3.18	.1250	1/8	...	...	.2283			9.2	.3622			21.0	.8268	
1.15	.0452			3.2	.1260			5.9	.2323			9.25	.3641			21.04	.8218	53/64
...	.0465		56	3.25	.1279			...	.2340		A	9.3	.3661			21.43	.8437	27/32
1.19	.0469	3/64	...	...	.1285		30	5.95	.2344	15/64	...	...	.3680	U		21.5	.8465	
1.2	.0472			3.3	.1299			6.0	.2362			9.4	.3701			21.83	.8594	55/64
1.25	.0492			3.4	.1338			...	.2380		B	9.5	.3740			22.0	.8661	
1.3	.0512			...	.1360		29	6.1	.2401			9.53	.3750	3/8	...	22.23	.8750	7/8
...	.0520		55	3.5	.1378			...	.2420		C	...	.3770	V		22.5	.8858	
1.35	.0513			...	.1405		28	6.2	.2441			9.6	.3780			22.62	.8906	57/64
...	.0550		54	3.57	.1406	9/64	...	6.25	.2460			9.7	.3819			23.0	.9055	
1.4	.0551			3.6	.1417			6.3	.2480			9.75	.3838			23.02	.9062	29/32
1.45	.0570			...	.1440		27	6.35	.2500	1/4	E	9.8	.3858			23.42	.9219	59/64
1.5	.0591			3.7	.1457			6.4	.2520			...	.3860	W		23.5	.9252	
...	.0595		53	...	.1470		26	6.5	.2559			9.9	.3839			23.81	.9375	15/16
1.55	.0610			3.75	.1476			...	.2570		F	9.92	.3906	25/64	...	24.0	.9449	
1.59	.0625	1/16	...	...	.1495		25	6.6	.2598			10.0	.3937			24.21	.9531	61/64
1.6	.0629			3.8	.1496			...	.2610		G	...	.3970		X	24.5	.9646	
...	.0635		52	...	.1520		24	6.7	.2638			...	.4040	Y		24.61	.9687	31/32
1.65	.0649			3.9	.1535			6.75	.2657	17/64	...	10.32	.4062	13/32	...	25.0	.9843	
1.7	.0669			...	.1540		23	6.75	.2657			...	.4130	Z		25.03	.9844	63/64
...	.0670		51	3.97	.1562	5/32	...	...	.2660		H	10.5	.4134			25.4	1.0000	1

SYMBOLS

Certain symbols or combinations of symbols may appear on your stern drive or on their accessories. It is very important that you understand their meaning or purpose. If any symbol is not clearly understood, see your authorized dealer.

"Safety Warning" Symbols

	<ul style="list-style-type: none"> • Risk of serious injury • Be Careful • Follow instructions 	<p>Poisonous</p>	<p>Fire Hazard</p>
		<p>Contents Under Pressure</p>	

"Position Indicator" Symbols

	<p>Raise</p>		<p>Lower</p>	<p>Shift Positions NEUTRAL</p>
--	--------------	--	--------------	------------------------------------

"Condition" Symbols

	<p>Hour Meter</p>		<ul style="list-style-type: none"> • Voltmeter • Ammeter 		<p>Tachometer</p>
	<p>Battery</p>		<p>Oil Filter</p>		<p>Fuel Filter</p>
	<p>Water Temperature</p>		<p>Emergency Stop</p>		<p>Oil Pressure</p>

"Instructional" Symbols

	<ul style="list-style-type: none"> • Use unleaded gasoline • Gasoline is present 		<p>Read Operator's Manual before operating product</p>		<p>Oil Fill</p>
--	--	--	--	--	-----------------

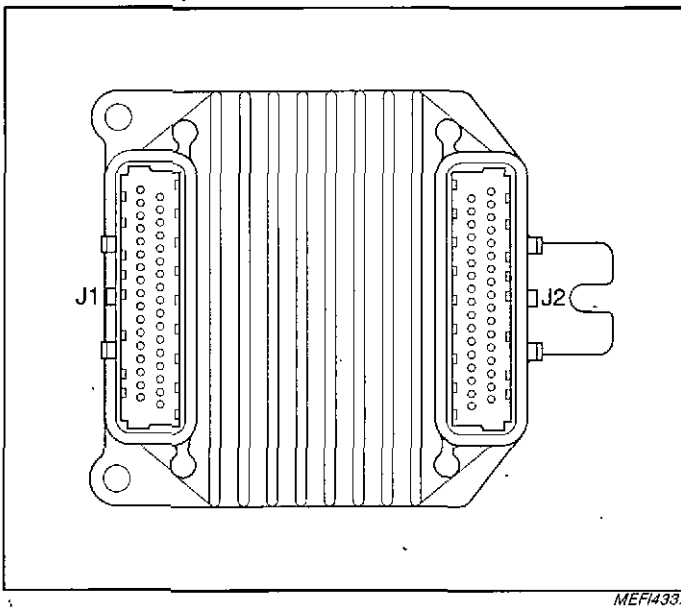
Description and Operation

Engine Control Module (ECM) Description

The engine control module (ECM) is designed to maintain exhaust emission levels while maintaining excellent drivability and fuel efficiency. The ECM controls the following conditions:

- The fuel control
- The ignition control (IC)
- The knock-sensor (KS) system
- The idle air control (IAC)
- Various other discrete outputs

Engine Control Module (ECM)



The engine control module (ECM) is the control center of the engine and controls the following systems:

- The fuel metering system
- The ignition timing
- The on-board diagnostics

The ECM constantly monitors the information from various sensors and controls the systems that affect vehicle performance and emissions. The ECM also performs the diagnostic functions for those systems. The ECM can recognize operational problems and alert the operator through the malfunction indicator lamp (MIL) when a malfunction has occurred. When a malfunction is detected, the ECM stores a diagnostic trouble code (DTC) or a logged warning which helps to identify problem areas. This is done to aid the technician in making repairs.

The ECM supplies either 5.0 or 12.0 volts to power various sensors and switches. This is done through resistance in the ECM. The resistance is so high in value that a test lamp does not illuminate when connected to the circuit. In some

cases, even an ordinary shop voltmeter does not give an accurate reading because the voltmeters resistance is too low. Therefore, a DMM with a minimum of 10 megaohms input impedance is required to ensure accurate voltage readings.

The ECM controls output circuits such as the fuel injectors, ignition coils, the idle air control (IAC) and various relays by controlling the ground or power feed circuit through transistors or a device called an output driver module (ODM).

RPM Reduction Mode

RPM reduction mode is a function of the ECM that reduces engine power under certain conditions. RPM reduction will disable one fuel injector driver when the engine speed goes above a certain RPM and enable the fuel injector driver when the engine speed drops below a certain RPM. RPM reduction may be active for the following conditions:

- Engine coolant temperature too high
- Low oil pressure

ECM Function

The ECM supplies a buffered voltage to various sensors and switches. The ECM controls most components with electronic switches which complete a ground circuit when turned ON.

Use of Circuit Testing Tools

Do not use a test lamp in order to diagnose the engine electrical systems unless specifically instructed by the diagnostic procedures. Use the J 35616-A connector test adapter kit whenever diagnostic procedures call for probing any connectors.

Basic Knowledge Required

Without basic knowledge of electricity, it will be difficult to use the diagnostic procedures contained in this section. You should understand the basic theory of electricity and know the meaning of voltage (volts), current (amps) and resistance (ohms). You should understand what happens in a circuit with an open or shorted wire. You should be able to read and understand a wiring diagram.

ECM Service Precautions

The ECM is designed to withstand normal current draws associated with engine operation. Avoid overloading any circuit. When testing for opens or shorts, do not ground any of the ECM circuits unless instructed. When testing for opens or shorts, do not apply voltage to any of the ECM circuits unless instructed. Only test these circuits with a DMM while the ECM connectors remain connected.

Aftermarket (Add-On) Electrical And Vacuum Equipment

Aftermarket, add-on electrical and vacuum equipment is defined as any equipment installed on an engine after leaving the factory that connects to the engine's electrical or vacuum systems.

Notice: Do not attach add-on vacuum operated equipment to this engine. The use of add-on vacuum equipment may result in damage to engine components or systems.

Notice: Connect any add-on electrically operated equipment to the engine's electrical system at the accessory battery (power and ground) in order to prevent damage to the vehicle.

Add-on electrical equipment, even when installed to these strict guidelines, may still cause the engine system to malfunction. This may also include equipment not connected to the vessel's electrical system such as portable telephones and radios. Therefore, the first step in diagnosing any engine problem, is to eliminate all aftermarket electrical equipment from the vessel. After this is done, if the problem still exists, diagnose the problem in the normal manner.

Electrostatic Discharge Damage

Notice: In order to prevent possible Electrostatic Discharge damage to the ECM, Do Not touch the connector pins.

Electronic components used in the control systems are often designed in order 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. There are several ways for a person to become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a car seat. Charging 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.

EFI Diagnostic Information

The drivability and emissions information describes the function and operation of the engine control module (ECM).

The engine controls information contains the following:

- Wiring diagrams
- ECM terminal end views and terminal definitions
- On-Board Diagnostic (OBD) System Check
- Diagnostic Trouble Code (DTC) tables

The Component System includes the following items:

- Component and circuit description
- Service for each sub-system
- Functional checks and diagnostic tables

The DTCs also contain diagnostic support information containing circuit diagrams, circuit or system information and helpful diagnostic information.

Visual and Physical Inspection

Important: This visual and physical inspection is very important. Perform this inspection carefully and thoroughly. Perform a careful visual and physical inspection when performing any diagnostic procedure. This can often lead to repairing a problem without further steps. Use the following guidelines when performing a visual and physical inspection:

- Inspect all vacuum hoses for the following conditions:
 - Correct routing
 - Pinches
 - Cuts
 - Disconnects
- Inspect all wires in the engine compartment for the following conditions:
 - Proper connections
 - Burned or chafed spots
 - Pinched wires
 - Contact with sharp edges
 - Contact with hot exhaust manifolds

Basic Knowledge Of Tools Required

Important: Lack of basic knowledge of this engine when performing diagnostic procedures could result in incorrect diagnosis or damage to engine components. Do not attempt to diagnose a engine problem without this basic knowledge.

A basic understanding of hand tools is necessary in order to effectively use this information.

Input Components

The ECM monitors the input components for circuit continuity and out-of-range values. This includes performance checking. Performance checking refers to indicating a fault when the signal from a sensor does not seem reasonable, such as a throttle position (TP) sensor that indicates high throttle position at low engine loads or MAP voltage. The input components may include, but are not limited to, the following sensors:

- Intake air temperature (IAT) sensor
- Crankshaft position (CKP) sensor
- Camshaft position (CMP) sensor
- Knock sensor (KS)
- Throttle position (TP) sensor
- Engine coolant temperature (ECT) sensor
- Manifold absolute pressure (MAP) sensor

Output Components

Diagnose the output components for the proper response to ECM commands. Components where functional monitoring is not feasible, will be monitored for circuit continuity and out-of-range values, if applicable.

Output components to be monitored include, but are not limited to, the following circuits:

- The malfunction indicator lamp (MIL) control
- The buzzer control

Wiring Harness Service

Replace the wire harnesses with the proper part number replacement. When splicing signal wires into a harness, use the wiring that has high temperature insulation.

Consider the low amperage and voltage levels utilized in the engine control systems. Make the best possible bond at all splices. Use rosin-core solder in these areas.

Molded-on connectors require complete replacement of the connector. Splice a new connector into the harness.

Connector and Terminals

In order to prevent shorting between opposite terminals, use care when probing a connector and when replacing terminals. Damage to the components could result.

Always use jumper wires between connectors for circuit checking.

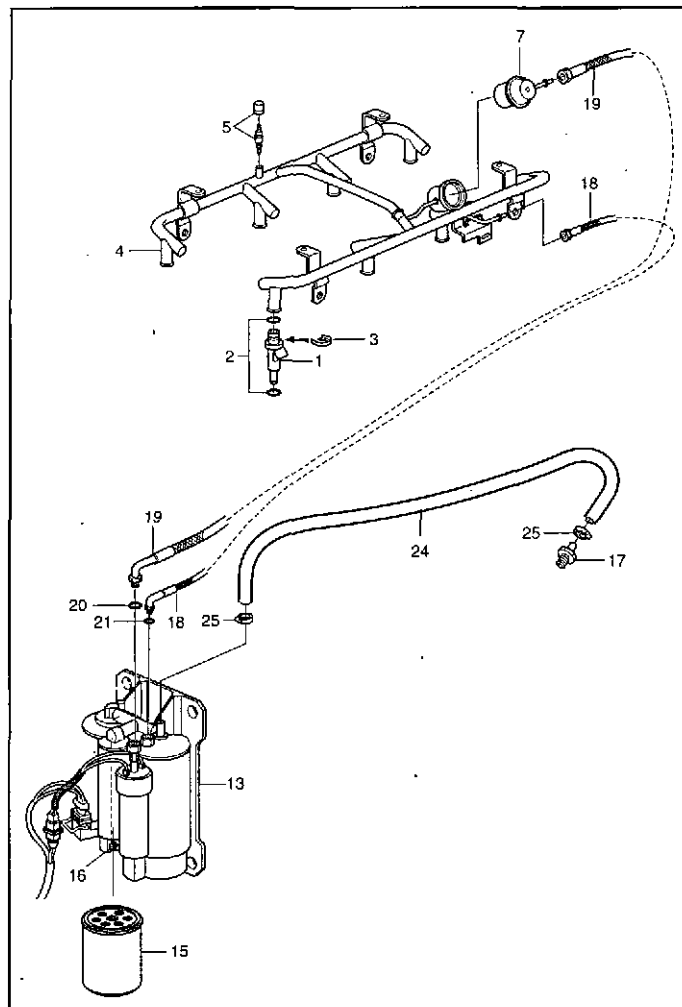
Never probe through Weather-Pack seals.

The J 35616-A connector test adapter kit, or the equivalent, contains an assortment of flexible connectors used to probe terminals during diagnosis.

Open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the

connectors. Merely wiggling a connector on a sensor, or in the wiring harness, may temporarily correct the open circuit. *Oxidized or loose connections may cause intermittent problems.*

Be certain of the type of connector and terminal before making any connector or terminal repair.



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Fuel System Description

Fuel System Overview

The fuel tank stores the fuel supply. The low pressure fuel pump contained in the Fuel Cell draws fuel through a replaceable fuel filter mounted on the fuel cell. It then sends the filtered fuel into a cooling venting/chamber where the fuel is cooled and any vapor is vented to the intake manifold for burning in the combustion process. Any fuel that is not demanded by the high pressure pump is re-circulated through the cooling/venting chamber. The high pressure pump, which is integral to the fuel cell, then draws fuel from the cooling/venting chamber and supplies fuel at a pressure more than is needed by the injectors. The fuel pressure regulator, part of the fuel rail assembly, keeps fuel available to the fuel injectors at a regulated pressure. A separate pipe returns unused fuel to the fuel cell cooling/venting chamber. The engine control module (ECM) con-

controls the electric fuel pumps operation through a fuel pump relay.

Important! The fuel cell is NOT serviceable. In the unlikely event that a fuel pump fails, the entire fuel cell must be replaced.

Fuel Feed and Return Pipes

The fuel feed pipe carries fuel from the fuel tank to the fuel rail assembly. The fuel return pipe carries unused fuel from the fuel rail assembly back to the fuel tank.

Quick-Connect Fittings

Quick-Connect fittings provide a simplified means of installing and connecting fuel system components. The fittings consist of a unique female connector and a compatible male pipe end. O-rings, located inside the female connector, provide the fuel seal. Integral locking tabs inside the female connector hold the fittings together.

Fuel Pipe O-Rings

O-rings seal the threaded connections in the fuel system. Fuel system O-ring seals are made of special material. Service the O-ring seals with the correct service part.

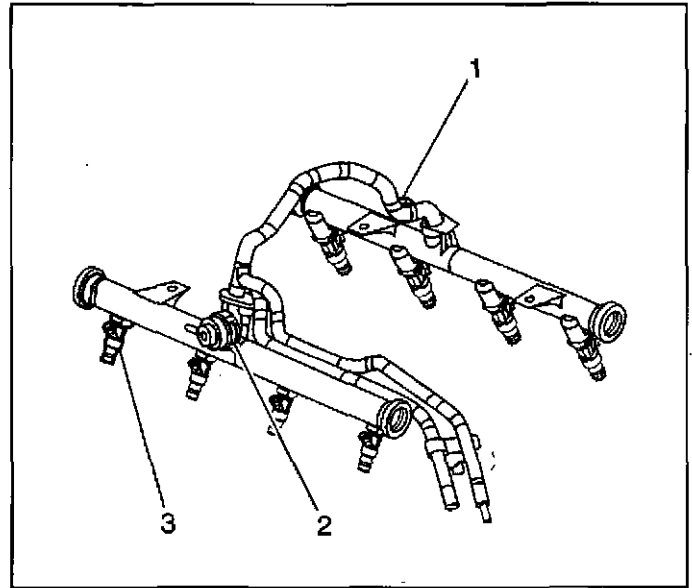
Fuel Rail Assembly

The fuel rail assembly attaches to the engine intake manifold. The fuel rail assembly performs the following functions:

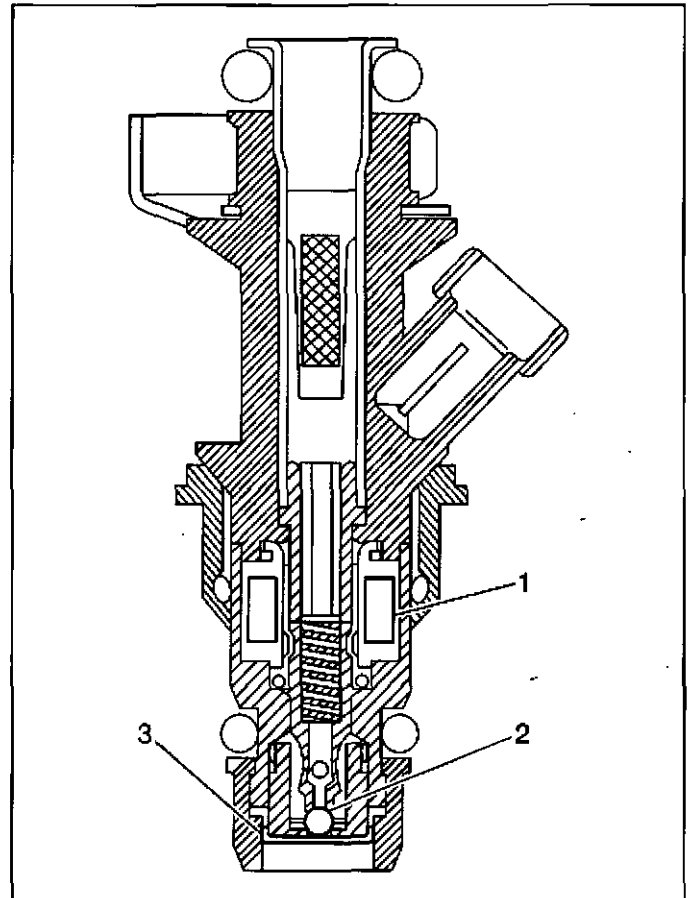
- Positions the injectors (3) in the intake manifold
- Distributes fuel evenly to the injectors
- Integrates the fuel pressure regulator (2) with the fuel metering system

Fuel Injectors

The Multec 2 fuel injector assembly is a solenoid operated device, controlled by the ECM, that meters pressurized fuel to a single engine cylinder. The ECM energizes the high-impedance (12.2 ohms) injector solenoid (1) to open a normally closed ball valve (2). This allows fuel to flow into the top of the injector, past the ball valve and through a director plate (3) at the injector outlet. The director plate has four machined holes that control the fuel flow, generating a spray of finely atomized fuel at the injector tip. Fuel from the injector tip is directed at the intake valve, causing it to become further atomized and vaporized before entering the combustion chamber. An injector stuck partly open can cause a loss of pressure after engine shutdown. Consequently, long engine cranking times would be noticed on some engines.



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Fuel Pressure Regulator Assembly

The fuel pressure regulator is a vacuum operated diaphragm relief valve with fuel pump pressure on one side and regulator spring pressure and intake manifold vacuum on the other side. The fuel pressure regulator maintains a constant pressure differential across the injectors at all times. The pressure regulator compensates for engine load by increasing fuel pressure as the engine vacuum drops.

Fuel Metering Modes of Operation

The engine control module (ECM) reads voltages from several sensors in order to determine how much fuel to give the engine. The fuel is delivered under one of several conditions called modes. The ECM controls all modes.

Starting Mode

With the ignition switch in the ON position, before engaging the starter, the ECM energizes the fuel pump relay for 2 seconds allowing the fuel pumps to build up pressure. The ECM uses the engine coolant temperature (ECT), the throttle position (TP) and the manifold absolute pressure (MAP) sensors to determine the proper air/fuel ratio for starting. The ECM controls the amount of fuel delivered in the starting mode by changing the pulse width of the injectors. This is done by pulsing the injectors for very short times.

Clear Flood Mode

If the engine floods, clear the engine by opening the throttle plates to 100 percent. When the throttle position (TP) sensor is at wide open throttle, the ECM reduces the injector pulse width in order to increase the air to fuel ratio. The ECM holds this injector rate as long as the throttle stays wide open and the engine speed is below a predetermined RPM. If the throttle is not held wide open, the ECM returns to the starting mode.

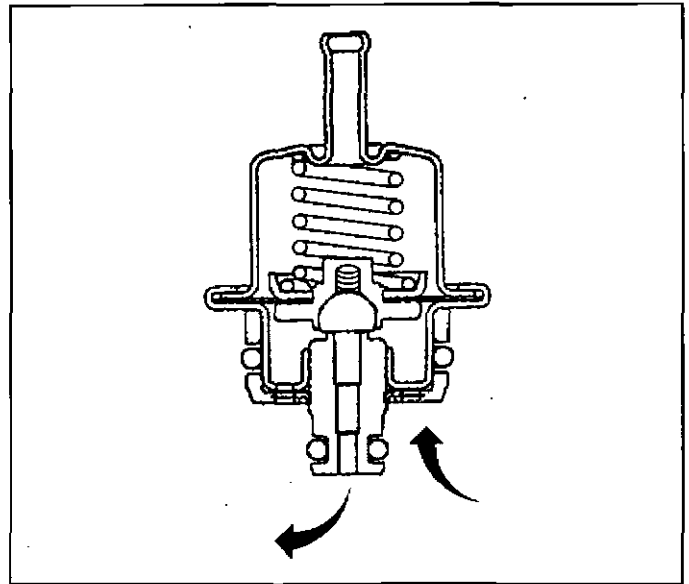
Run Mode

When the engine is first started and the engine speed is above a predetermined RPM, the system begins Open Loop operation. The ECM calculates the air/fuel ratio based on inputs from the ECT, MAP and TP sensors.

Specified values for the above conditions exist for each different engine, and are stored in the electrically erasable programmable read-only memory (EEPROM).

Acceleration Mode

When the operator moves the throttle, air flow into the cylinders increases rapidly, while fuel flow tends to lag behind. To prevent possible hesitation, the ECM increases the pulse width to the injectors to provide extra fuel during acceleration. The ECM determines the amount of fuel required based upon the throttle position, the coolant temperature, the manifold pressure and the engine speed.



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Deceleration Mode

When the operator retards the throttle, air flow into the engine is reduced. The ECM reads the corresponding changes in throttle position and manifold pressure. The ECM shuts OFF fuel completely if the deceleration is very rapid, or for long periods.

Battery Correction Mode

When the battery voltage is low, the ECM compensates for the weak spark delivered by the ignition system in the following ways:

- Increasing the amount of fuel delivered
- Increasing the idle RPM
- Increasing the ignition dwell time

Fuel Cutoff Mode

The ECM cuts off fuel from the fuel injectors when the following conditions are met in order to protect the engine from damage and improve drivability:

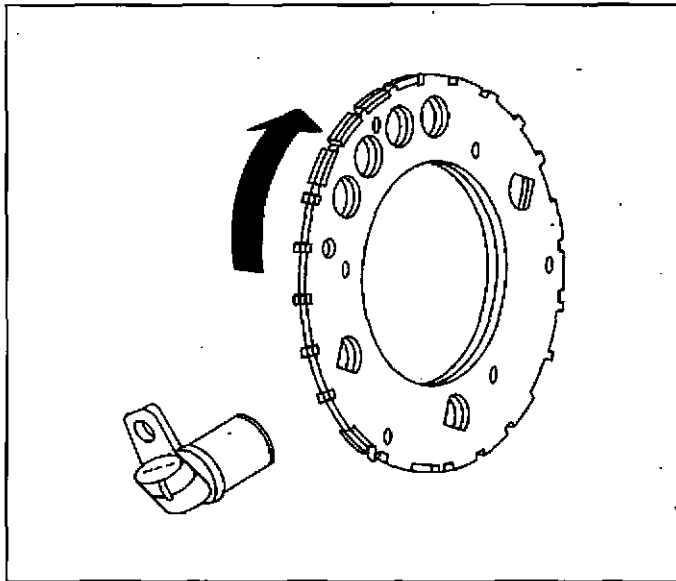
- The ignition is OFF. This prevents engine run-on.
- The ignition is ON but there is no ignition reference signal. This prevents flooding or backfiring.
- Engine speed is too high, above rev limit.

Electronic Ignition (EI) System Description

Ignition System Overview

The ignition system consists of the following components or circuits:

- The 8 ignition secondary wires
- The 8 ignition coils
- The 8 ignition control (IC) circuits
- The camshaft position (CMP) sensor
- The camshaft reluctor wheel
- The crankshaft position (CKP) sensor
- The crankshaft reluctor wheel
- The related connecting wires
- The engine control module (ECM)



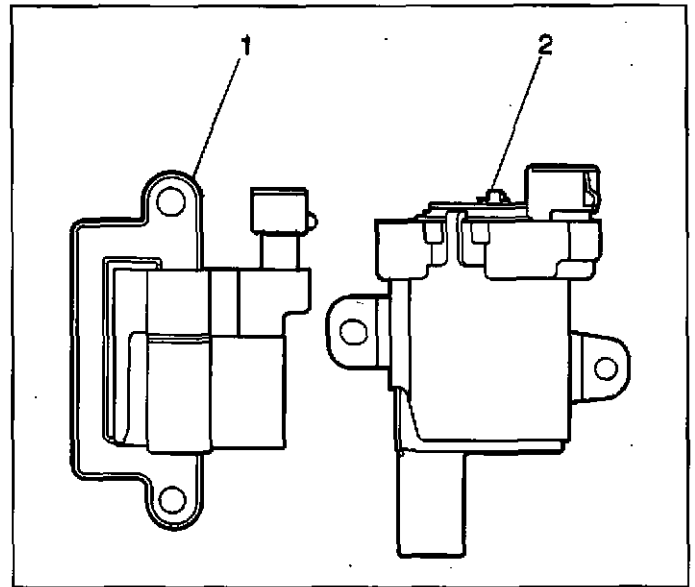
Crankshaft Position (CKP) Sensor and Reluctor Wheel

The crankshaft position (CKP) sensor is a magneto resistive type sensor. The CKP sensor works in conjunction with a 24X reluctor wheel. The reluctor wheel is mounted on the rear of the crankshaft. The 24X reluctor wheel uses 2 different width notches that are 15 degrees apart. This pulse width encoded pattern allows cylinder position identification within 90 degrees of crankshaft rotation. In some cases, this can be achieved within 45 degrees of crankshaft rotation. The reluctor wheel also has dual track notches that are 180 degrees out of phase. This design allows for quicker starts and accuracy. The CKP sensor also outputs a 4X signal for spark control, tachometer output and fuel control. All CKP signals are output as a digital waveform.

Camshaft Position (CMP) Sensor and Reluctor Wheel

The camshaft position (CMP) sensor works in conjunction with a 1X reluctor wheel mounted at the front of the camshaft. The CMP is used to determine the top dead center position of cylinder #1, and will synchronize with the 24X CKP sensor signal for quicker starting. The CMP signals are output as a digital waveform.

Ignition Coils



The ignition system on this engine features a multiple coil configuration and is known as coil near plug. There are two styles of ignition coil assemblies (1,2). The engine could have either style. The ignition coil mounting bracket is attached to the rocker cover.

The 8 ignition coils are individually mounted above each cylinder on the rocker covers, the coils are fired sequentially. There is an ignition control (IC) circuit for each ignition coil. The 8 ignition control circuits are connected to the ECM. The ECM triggers each ignition coil individually and makes all timing decisions. The ignition coils are supplied with the following circuits:

- The ignition voltage circuit
- The ignition control circuit
- The ground circuit
- The reference low circuit

The ignition voltage circuits also supply the power for the fuel injectors. Each coil is serviced separately.

This system puts out very high ignition energy for plug firing. Less energy is lost to ignition wire resistance because the ignition wires are much shorter than in a conventional ignition system.

A diagnostic trouble code (DTC) may set for the following conditions or faults:

The ECM malfunctions in a manner which will not allow the ECM to run a diagnostic of the KS circuit.

The KS signal is within the assigned voltage range.

The KS signal is not present.

The ECM is unable to eliminate the knocking condition using maximum spark retard.

Circuits Affecting Ignition Control

To properly control ignition timing, the ECM relies on the following information:

- The engine load, manifold pressure or vacuum
- The atmospheric, barometric, pressure
- The engine temperature
- The intake air temperature, if applicable
- The crankshaft position
- The engine speed (RPM)

The ignition control (IC) system consists of the following components:

- The ignition coils
- The 24X crankshaft position sensor
- The engine control module (ECM)
- All connecting wires

The ignition control utilizes the following to control spark timing functions:

- *The 24X signal* - The 24X crankshaft position sensor sends a signal to the ECM. The ECM uses this signal to determine crankshaft position.
- The ignition control (IC) circuits - The ECM uses these circuits to trigger the ignition coils.

Noteworthy Ignition Information

There are important considerations to point out when servicing the ignition system. The following noteworthy information will list some of these to help the technician in servicing the ignition system.

- The ignition coils secondary voltage output capabilities are very high - more than 40,000 volts. Avoid body contact with ignition high voltage secondary components when the engine is running or personal injury may result.
- The 24X crankshaft position (CKP) sensor is the *most critical part of the ignition system*. If the sensor is damaged so that the pulses are not generated, the engine does not start.
- The CKP sensor clearance is very important. If the interrupter ring is bent or damaged in any way, the CKP sensor may be destroyed. Extreme care must be exercised during removal and installation procedures.
- **The ignition timing is not adjustable. There are no timing marks on the crankshaft balancer or the timing chain cover.**
- Be careful not to damage the secondary ignition wires or boots when servicing the ignition system. Rotate each boot in order to dislodge the boot from the plug or coil tower before pulling the boot from the spark plug or the ignition coil tower.

Engine Control Module (ECM)

The ECM is responsible for maintaining proper spark and fuel injection timing for all operating conditions. To provide optimum operation and emissions, the ECM monitors input signals from the additional following components in calculating ignition control (IC) spark timing:

- The engine coolant temperature (ECT) sensor
- The intake air temperature (IAT) sensor
- The throttle position (TP) sensor

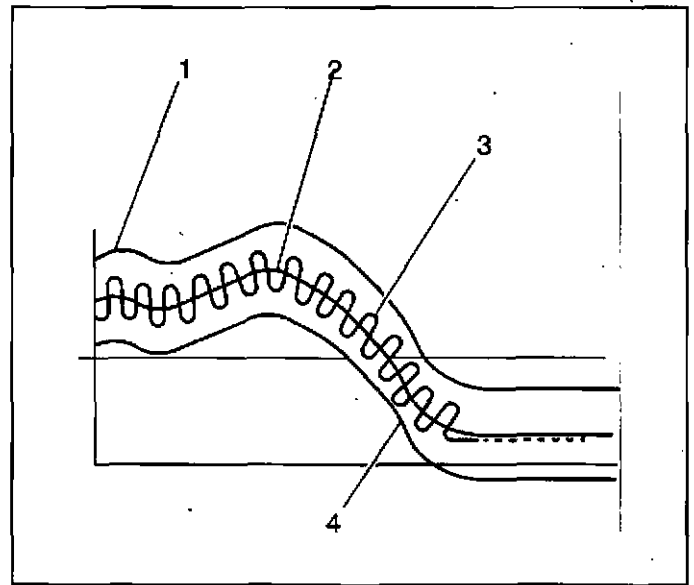
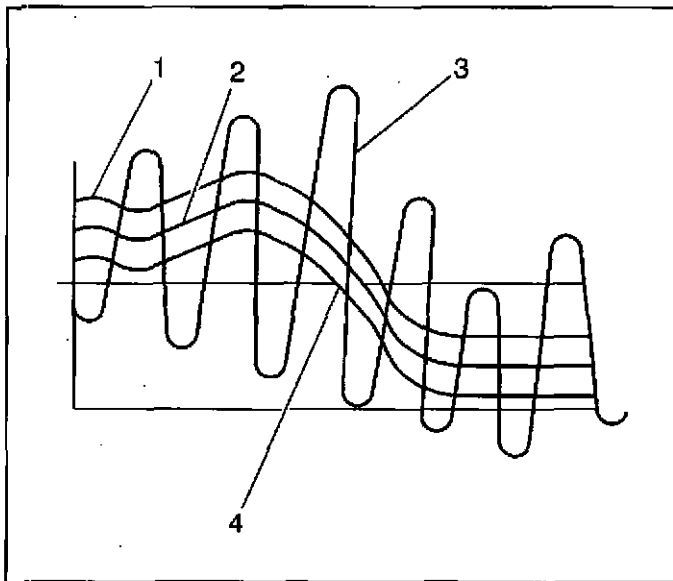
Knock Sensor (KS) System Description

Purpose:

To control spark knock (detonation), a knock sensor (KS) system is used. This system is designed to retard spark timing when excessive spark knock is detected in the engine. The KS system allows the engine to use maximum spark advance for optimal drivability and fuel economy under all operating conditions.

Operation:

The ECM uses a knock sensor(s) to detect abnormal vibration in the engine (detonation/spark knock). Mounted on the engine block, the knock sensor(s) produces an AC voltage signal at all engine speeds and loads. The ECM then adjusts the spark timing based on the amplitude and frequency of the KS signal. The ECM uses the KS signal to calculate an average voltage. Then, the ECM assigns a voltage range above and below the average voltage value. The ECM checks the KS and related wiring by comparing the actual knock signal to the assigned voltage range. A normal KS signal should vary outside the assigned voltage range as shown in the NORMAL KS figure. If the ECM detects a KS signal within the assigned voltage range as shown in the ABNORMAL KS figure, the applicable DTC will set.



Normal Knock Sensor Signal

Abnormal Knock Sensor Signal

Legend

1. Upper fail region
2. Knock sensor calculated average
3. Knock sensor signal
4. Lower fail region

General Description

Visual / Physical Inspection

A careful visual and physical inspection must be performed as part of any diagnostic procedure. This can often lead to fixing a problem without further diagnostics. Inspect all vacuum hoses for correct routing, pinches, cracks or disconnects. Be sure to inspect hoses that are difficult to see. Inspect all the wires in the engine compartment for proper connections, burned or chafed spots, pinched wires or contact with sharp edges or hot manifolds. This visual/physical inspection is very important. It must be done carefully and thoroughly.

Basic Knowledge and Tools Required

To use this manual most effectively, a general understanding of basic electrical circuits and circuit testing tools is required. You should be familiar with wiring diagrams, the meaning of voltage, ohms, amps and the basic theories of electricity. You should also understand what happens if a circuit becomes open, shorted to ground or shorted to voltage.

To perform system diagnostics, several special tools and equipment are required. Please become acquainted with the tools and their use before attempting to diagnose the system. Special tools that are required for system service are illustrated in this section.

Electrostatic Discharge Damage

Electronic components used in control systems are often designed to carry very low voltage, and are very susceptible to damage caused by electrostatic discharge. It is possible for less than 100 volts of static electricity to cause damage to some electronic components. By comparison, it takes as much as 4,000 volts for a person to feel the zap of a static discharge.

There are several ways a person can become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a seat, in which a charge of as much as 25,000 volts can build up. Charging 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 of either type can cause damage. Therefore, it is important to use care when handling and testing electronic components.

Engine Wiring

When it is necessary to move any of the wiring, whether to lift wires away from their harnesses or move harnesses to reach some component, take care that all wiring is replaced in its original position and all harnesses are routed correctly. If clips or retainers break, replace them. Electrical problems can result from wiring or harnesses becoming loose and moving from their original positions, or from being rerouted.

Engine Control Module (ECM) Self-Diagnostics

The Engine Control Module (ECM) performs a continuous self-diagnosis on certain control functions. This diagnostic capability is complemented by the diagnostic procedures contained in this manual. The ECM's language for communicating the source of a malfunction is a system of Diagnostic Trouble Codes (DTC's). The DTC's are two digit numbers that can range from 12 to 81. When a malfunction is detected by the ECM, a DTC is set and the Malfunction Indicator Lamp (MIL) is illuminated.

Malfunction Indicator Lamp (MIL)

The Malfunction Indicator Lamp (MIL) is part of the Diagnostic Trouble Code (DTC) tool, or it can be a dash mounted warning light on some applications.

- If present, it informs the operator that a problem has occurred and that the boat should be taken for service as soon as reasonably possible.
- It displays DTC's stored by the ECM which help the technician diagnose system problems.

As a bulb and system check, the light will come "ON" with the key "ON," engine "OFF." When the engine is started, the light will turn "OFF." If the light remains "ON," the self-diagnostic system has detected a problem. If the problem goes away, the light will go out in most cases after 10 seconds, but a DTC will remain stored in the ECM.

When the light remains "ON" while the engine is running, or when a malfunction is suspected due to a drivability problem, the "On-Board Diagnostic (OBD) System Check" must be performed as the first step. These checks will expose malfunctions which may not be detected if other diagnostics are performed prematurely.

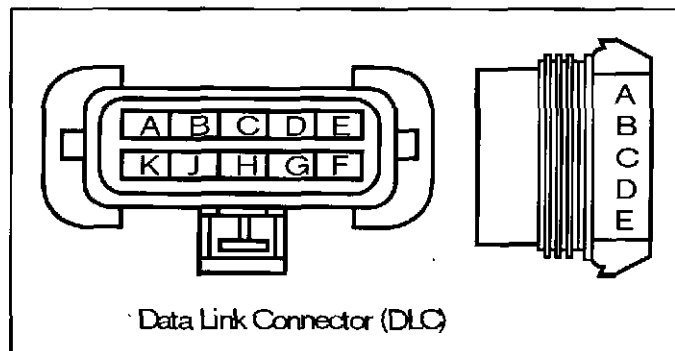
Intermittent Malfunction Indicator Lamp (MIL)

In the case of an "intermittent" problem, the Malfunction Indicator Lamp (MIL) may light for 10 seconds, and then go out. However, the corresponding DTC will be stored in the memory of the ECM. When DTC's are set by an intermittent malfunction, they could be helpful in diagnosing the system.

If an intermittent DTC is cleared, it may or may not reset. If it is an intermittent failure, consult the "Diagnostic Aids" on the facing page of the corresponding DTC table. *Symptoms* section also covers the topic of "Intermittents." A physical inspection of the applicable subsystem most often will resolve the problem.

Reading Diagnostic Trouble Codes (DTC's)

The provision for communicating with the ECM is the Data Link Connector (DLC) (Figure 1-1). It is part of the engine wiring harness, and is a 10-pin connector, which is electrically connected to the ECM. It is used in the assembly plant to receive information in checking that the engine is operating properly before it leaves the plant. The DTC(s) stored in the ECM's memory can be retrieved two different ways. One way is with a Diagnostic Trouble Code (DTC)



tool. The preferred way is through a scan tool, a hand-held diagnostic scanner plugged into the DLC.

Once the DTC tool has been connected, and "service mode" or "ON" selected, the ignition switch must be moved to the ignition "ON," engine "OFF" position. At this point, the MIL should flash DTC 12 two times consecutively. This would be the following flash sequence: "flash, pause, flash-flash, long pause, flash, pause, flash-flash." DTC 12 indicates that the ECM's diagnostic system is operating. If DTC 12 is not indicated, a problem is present within the diagnostic system itself, and should be addressed by consulting the "On-Board Diagnostic (OBD) System Check."

Following the output of DTC 12, the MIL will indicate a DTC two times if a DTC is present, or it will continue to flash DTC 12. If more than one DTC has been stored in the ECM's memory, the DTC's will be flashed out from the lowest to the highest, with each DTC being flashed two times. At the end of the DTC's, the ECM will simply go back and start over with flashing DTC 12.

Service Mode

When the DTC tool is installed at the DLC and "service mode" or "ON" is selected, the system will enter what is called the "Service Mode." In this mode, the ECM will:

- Display a DTC 12 by flashing the MIL, indicating that the diagnostic system is working.
- Display any stored DTC's by flashing the MIL. Each DTC will be flashed two times, then DTC 12 will be flashed again.
- The ignition timing is controlled to a fixed timing programmed in the ECM.
- Control the Idle Air Control (IAC) valve to maintain approximately 1000 RPM.

Normal Mode

When the DTC tool is in the "normal mode" or "OFF," it has no affect on the engine operation.

On-Board Diagnostic (OBD) System Check

After the visual/physical inspection, the "On-Board Diagnostic (OBD) System Check" is the starting point for all diagnostic procedures.

The correct procedure to diagnose a problem is to follow two basic steps:

1. Are the on-board diagnostics working? This is determined by performing the "On-Board Diagnostic (OBD) System Check." Since this is the starting point for the diagnostic procedures, always begin here. If the on-board diagnostics are not working, the OBD system check will lead to a diagnostic table to correct the problem. If the on-board diagnostics are working properly, the next step is:
2. Is there a DTC stored? If a DTC is stored, go directly to the number DTC table. This will determine if the fault is still present.

DLC Scan Tools

The ECM can communicate a variety of information through the DLC. This data is transmitted at a high frequency which requires a scan tool for interpretation.

With an understanding of the data which the scan tool displays, and knowledge of the circuits involved, the scan tool can be very useful in obtaining information which would be more difficult or impossible to obtain with other equipment.

A scan tool does not make the use of diagnostic tables unnecessary, nor do they indicate exactly where the problem is in a particular circuit. Tables are provided for the use of a scan tool (scan diagnostics), or with the DTC tool (non-scan diagnostics). The non-scan diagnostics are limited to basic circuits. For complete diagnostics, a scan tool must be used.

Scan Tool Use With Intermittents

The scan tool provides the ability to perform a "wiggle test" on wiring harnesses or components with the engine not running, while observing the scan tool display.

The scan tool can be plugged in and observed while driving the vehicle under the condition when the MIL turns "ON" or the engine drivability is poor. If the problem seems to be related to certain parameters that can be checked on the scan tool, they should be checked while driving the vehicle. If there does not seem to be any correlation between the problem and any specific circuit, the scan tool can be checked on each position, watching for a period of time to see if there is any change in the readings that indicates an intermittent operation.

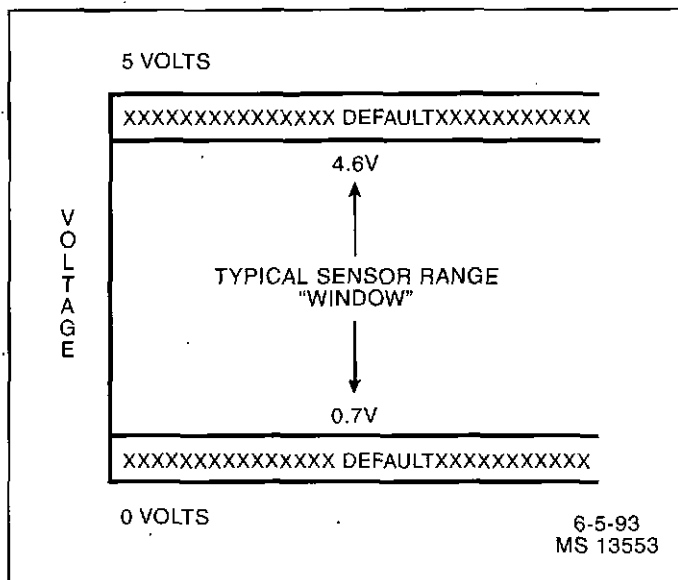
The scan tool is also an easy way to compare the operating parameters of a poorly operating engine with those of a known good one. For example, a sensor may shift in value but not set a DTC. Comparing the sensor's readings with those of a known good identical vehicle may uncover the problem.

The scan tool has the ability to save time in diagnosis and prevent the replacement of good parts. The key to using the scan tool successfully for diagnosis lies in the technician's ability to understand the system they are trying to diagnose, as well as an understanding of the scan tool operation and limitations. The technician should read the tool manufacturer's operating manual to become familiar with the tool's operation.

How Diagnostic Trouble Codes (DTC) Are Set

The ECM is programmed to receive calibrated voltage signals from the sensors. The voltage signal from the sensor may range from as low as 0.1 volt to as high as 4.9 volts. The sensor voltage signal is calibrated for engine application. This would be the sensor's operating parameter or "window." The ECM and sensors will be discussed further in the *ECM and Sensor* section.

If a sensor is within its operating or acceptable parameters (Figure 1-2), the ECM does not detect a problem. When a sensor voltage signal falls out of this "window," the ECM no longer receives a signal voltage within the operating "window." When the ECM does not receive the "window" voltage for a calibrated length of time, a DTC will be stored. The MIL will be illuminated and a known default value will replace the sensor value to restore limited engine performance.



Clearing Diagnostic Trouble Codes (Non-Scan)

1. Install Diagnostic Trouble Code (DTC) tool.
2. Ignition "ON," engine "OFF"
3. Switch DTC tool to "service mode" or "ON."
4. Move the throttle from 0% (idle) to 100% (WOT) and back to 0%.
5. Switch DTC tool to "normal mode" or "OFF" (If this step is not performed, the engine may not start and run).
6. Turn ignition "OFF" for at least 20 seconds.
7. Ignition "ON," engine "OFF"
8. Switch DTC tool to "service mode" or "ON" and verify DTC 12 only. Remove DTC tool.
9. If original DTC(s) are still present, check "Notice" below and repeat the DTC clearing procedure.
10. If new DTC(s) are displayed, perform the OBD system check.

NOTICE: When clearing DTC's with or without the use of a scan tool, the ignition must be cycled to the "OFF" position after codes are cleared or the DTC's will not clear.

Clearing Diagnostic Trouble Codes (Scan)

1. Install scan tool.
2. Start engine.
3. Select "clear DTC's" function.
4. Clear DTC's.
5. Turn ignition "OFF" for at least 20 seconds.
6. Turn ignition "ON" and read DTC's. If DTC's are still present, check "Notice" below and repeat procedure following from step 2.

NOTICE: When clearing DTC's with or without the use of a scan tool, the ignition must be cycled to the "OFF" position after codes are cleared or the DTC's will not clear.

Non-Scan Diagnosis Of Drivability Concerns (No DTC's Set)

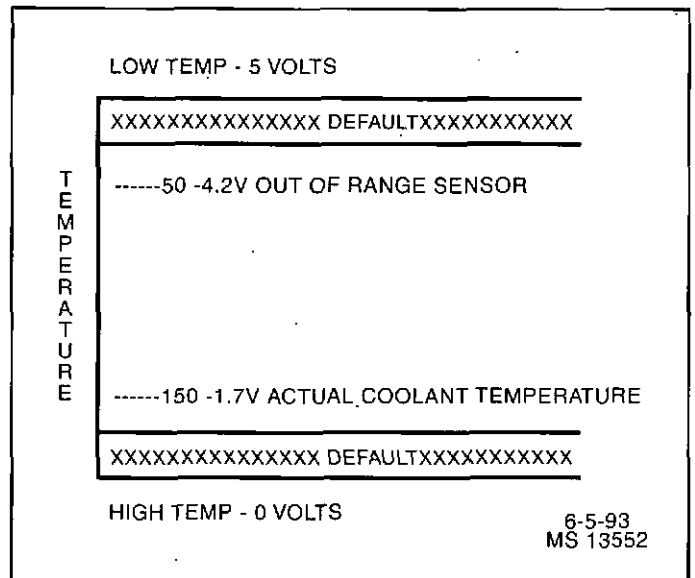
If a drivability concern still exists after following the OBD system check and reviewing the *Symptoms* tables, an out of range sensor may be suspected. Because of the unique design of the MEFI system, the ECM will replace sensed values with calibrated default values in the case of a sensor or circuit malfunction. By allowing this to occur, limited engine performance is restored until the vehicle is repaired. A basic understanding of sensor operation is necessary to be able to diagnose an out of range sensor.

If the sensor is out of range, but still within the operating "window" of the ECM, the problem will go undetected by the ECM and may result in a drivability concern.

A good example of this would be if the coolant sensor was reading incorrectly and indicating to the ECM that coolant temperature was at 50°F, but actual coolant temperature was at 150°F (Figure 1-3). This would cause the ECM to deliver more fuel than what was actually needed by the engine. This resulted in an overly rich condition, causing rough running. This condition would not have caused a DTC to set, as the ECM interprets this as within the operating "window."

To identify a sensor that is out of range, you may unplug the sensor electrical connector while the engine is running. After about 2 minutes, the DTC for that sensor will set, illuminate the MIL, and replace the sensed value with a calibrated default value. If at that point, a noticeable performance increase is observed, the non-scan DTC table for that particular sensor should be followed to correct the problem.

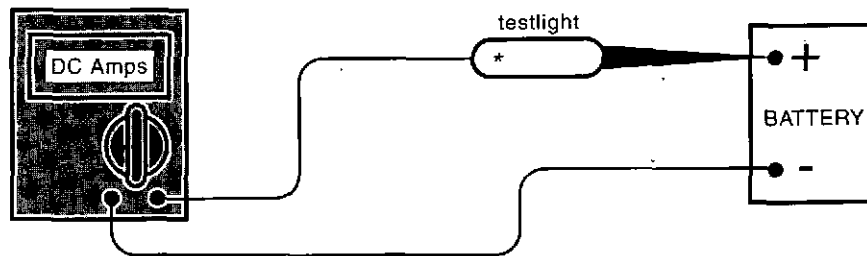
NOTICE: Be sure to clear each DTC after disconnecting and reconnecting each sensor. Failure to do so may result in a mis-diagnosis of the drivability concern.



Service Precautions

The following requirements must be observed when working on MEFI equipped engines.

1. Before removing any ECM system component, disconnect the negative battery cable.
2. Never start the engine without the battery being solidly connected.
3. Never separate the battery from the on-board electrical system while the engine is running.
4. Never separate the battery feed wire from the charging system while the engine is running.
5. When charging the battery, disconnect it from the vehicle's electrical system.
6. Ensure that all cable harnesses are connected solidly and the battery connections are thoroughly clean.
7. Never connect or disconnect the wiring harness at the ECM when the ignition is switched "ON."
8. Before attempting any electric arc welding on the vehicle, disconnect the battery leads and the ECM connector(s).
9. When steam cleaning engines, do not direct the nozzle at any ECM system components. If this happens, corrosion of the terminals or damage of components can take place.
10. Use only the test equipment specified in the diagnostic tables, since other test equipment may either give incorrect test results or damage good components.
11. All measurements using a multimeter must use a digital meter with a rating of 10 megaohm input impedance.
12. When a test light is specified, a "low-power" test light must be used. Do not use a high-wattage test light. While a particular brand of test light is not suggested, a simple test on any test light will ensure it to be safe for system circuit testing. Connect an accurate ammeter (such as the high-impedance digital multimeter) in series with the test light being tested, and power the test light ammeter circuit with the vehicle battery.



If the ammeter indicates less than 3/10 amp(.3A) current flow, the testlight is safe to use.
If the ammeter indicates more than 3/10 amp(.3A) current flow, the testlight is not safe to use.

I 22307

Tools Needed To Service The System

Refer to *Special Tools* for servicing the system.

Repair Instructions

Wiring Harness Service

Wiring harnesses should be replaced with proper part number harnesses. When wires are spliced into a harness, use the same gauge wire with high temperature insulation only.

With the low current and voltage levels found in the system, it is important that the best possible bond be made at all wire splices by soldering the splices as shown in Figure 1-4.

Use care when probing a connector or replacing a connector terminal. It is possible to short between opposite terminals. If this happens, certain components can be damaged. Always use jumper wires with the corresponding mating terminals between connectors for circuit checking. NEVER probe through connector seals, wire insulation, secondary ignition wires, boots, nipples or covers. Microscopic damage or holes may result in water intrusion, corrosion and/or component failure.

1 REMOVE OUTER JACKET.
2 UNWRAP ALUMINUM/MYLAR TAPE. DO NOT REMOVE MYLAR.

3 UNTWIST CONDUCTORS. STRIP INSULATION AS NECESSARY.

4 SPLICE WIRES USING SPLICE CLIPS AND ROSIN CORE SOLDER. WRAP EACH SPLICE TO INSULATE.
5 WRAP WITH MYLAR AND DRAIN (UNINSULATED) WIRE.

6 TAPE OVER WHOLE BUNDLE TO SECURE AS BEFORE.

1 LOCATE DAMAGED WIRE.
2 REMOVE INSULATION AS REQUIRED.

3 SPLICE TWO WIRES TOGETHER USING SPLICE CLIPS AND ROSIN CORE SOLDER.

4 COVER SPLICE WITH TAPE TO INSULATE FROM OTHER WIRES.
5 RETWIST AS BEFORE AND TAPE WITH ELECTRICAL TAPE AND HOLD IN PLACE.

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RS 22186

Wiring Connector Service

Most connectors in the engine compartment are protected against moisture and dirt which could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system. The connectors have a lock which secures the male and female terminals together. A secondary lock holds the seal and terminal into the connector.

When diagnosing, open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor, or in the wiring harness, may locate the open circuit condition. This should always be considered when an open circuit or failed sensors is indicated. Intermittent problems may also be caused by oxidized or loose connections.

Before making a connector repair, be certain of the type of connector. Some connectors look similar but are serviced differently. Replacement connectors and terminals are listed in the parts catalogue.

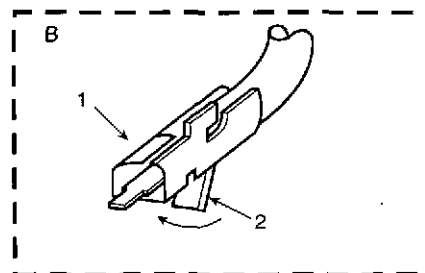
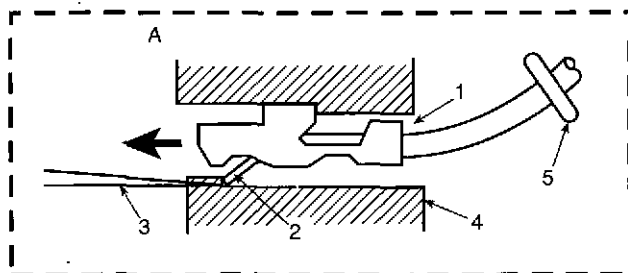
Metri-Pack Series 150 Terminals

Some ECM harness connectors contain terminals called Metri-Pack. These are used at some of the sensors and the distributor connector.

Metri-Pack terminals are also called "Pull-To-Seat" terminals because, to install a terminal on a wire, the wire is first inserted through the seal and connector. The terminal is then crimped on the wire, and the terminal is pulled back into the connector to seat it in place.

To remove a terminal:

1. Slide the seal back on the wire.
2. Insert tool J 35689 or equivalent to release the terminal locking tang.
3. Push the wire and terminal out through the connector. If the terminal is being reused, reshape the locking tang.



1. METRI-PACK SERIES 150 FEMALE TERMINAL.
2. LOCKING TANG.

3. TOOL J35689 OR BT-8446.
4. CONNECTOR BODY.
5. SEAL.

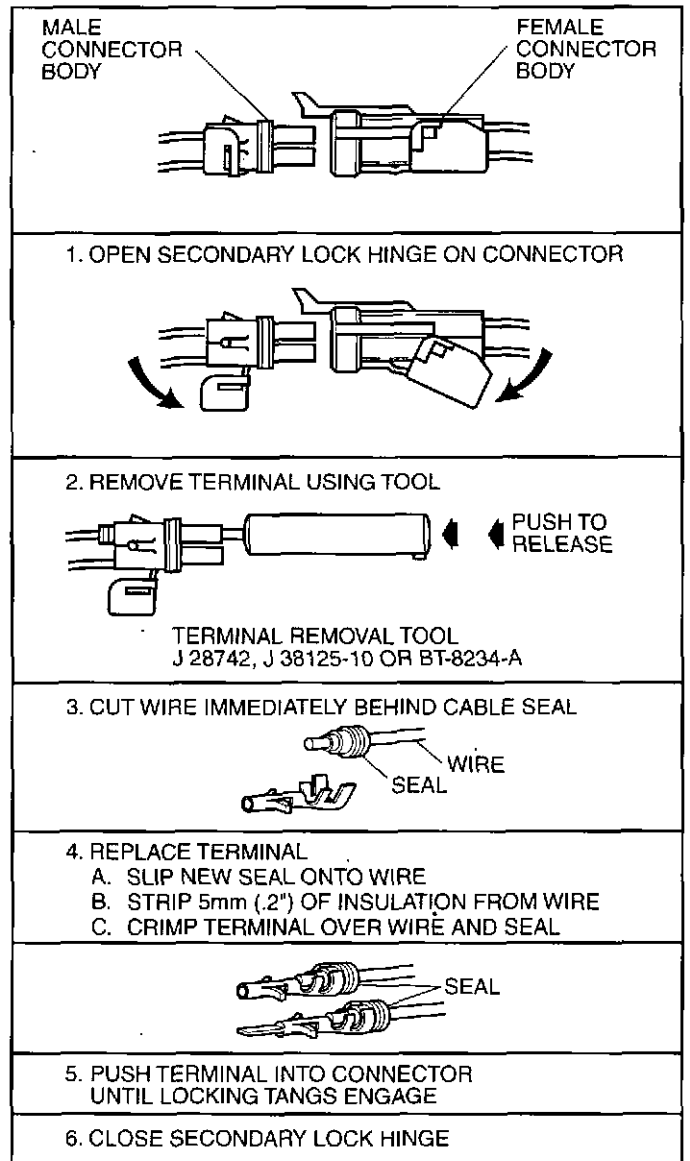
RS22187

Weather-Pack Connectors

This figure shows a Weather-Pack connector and the tool (J 28742 or equivalent) required to service it. This tool is used to remove the pin and sleeve terminals. If terminal removal is attempted without using the special tool required, there is a good chance that the terminal will be bent or deformed, and unlike standard blade type terminals, these terminals cannot be straightened once they are bent.

Make certain that the connectors are properly seated and all of the sealing rings in place when connecting leads. The hinge-type flap provides a secondary locking feature for the connector. It improves the connector reliability by retaining the terminals if the small terminal lock tangs are not positioned properly.

Weather-Pack connections cannot be replaced with standard connections. Instructions are provided with Weather-Pack connector and terminal packages.



RS22188

Micro-Pack 100/W Series Connectors

The harness connectors used with the ECM "J1" and "J2" connectors are Micro-Pack 100/W Series. It is used for its ruggedized construction, capable of carrying more current and provides good sealing ability. The connector is made up of five different parts : Strain Relief (1), Seal (2), Connector (3), Index Cover (4) and Terminals (not shown).

Remove or Disconnect

1. Negative battery cable.
2. Connector from ECM by lifting up locking tab with thumb and pulling on connector body.

Inspect

- Check strain relief for being cracked or locking tab damaged.
- Check index cover for being cracked.
- Check seal for being torn, twisted or out of shape from improper installation.
- Check terminals for being corroded, out of position, bent or stretched out.
 - Use a wire gauge .038 for checking terminal internal fit. Wire gauge should slide with smooth feel and not be loose.

Notice: If you are only going to clean terminals, complete disassembly is not necessary. Remove index cover from the connector by pushing on Tab C on both sides and sliding off cover. Care must be taken not to move terminals out of their position. The index cover locks the terminals in position. If repair or replacement of parts is needed, DO NOT remove index cover at this time.

3. With a small screwdriver, move Tabs A on strain relief (1) to unlock position.
4. Open strain relief as shown in View B.
5. Release Tabs B (View C) on connector (3) by pushing inward with both thumbs or small screwdriver.
6. Push Tabs B through strain relief (1) with thumbs or small screwdriver while in released position.

Important

- Where there are not wires in strain relief, small plugs are installed. DO NOT lose the plugs, they are important to help keep connector assembly sealed.
7. Remove plugs where there are not any wires.
 8. Slide strain relief off of seal and back on wires.
 9. Slide seal off of connector and back on wires.

Important

- To insure proper engine operation after repair of connector assembly, wires must be in proper connector location. Before removing index cover, note if there are any wires of the same color. Mark these wires from the location that they were removed. The strain relief is numbered for identifying wire location.

10. Index cover (4) by pushing in on Tabs C with a small screwdriver.
11. Terminals by pulling out of connector.
12. Seal (2) from wires.
13. Strain relief (1) from wires.

Clean and Inspect

- Terminals for corrosion.
 - Use spray electrical contact cleaner.
- Loose crimps on terminals.
- Broken wires at terminals.

Notice: For terminal replacement, refer to instructions found with terminal repair kit and crimper tool.

Install or Connect

1. Align index cover (4) on connector (3) and lock into position. Make sure Tabs C are locked.
2. Align seal (2) on connector (3) and slide all the way on.
 - DO NOT install strain relief (1) onto connector (3) yet.
3. One wire with terminal installed, through strain relief (1) in location that it was removed.
 - Start with the lowest numbered wire position for that connector.
4. Terminal through seal (2), connector (3) and into index cover (4) until it locks in place.
5. Remaining wires one at a time per same method.
 - Keep wires straight.
 - DO NOT kink wires.
6. Strain relief (1) onto seal (2) and connector (3).
7. Lock Tabs B into strain relief (1).
8. Plugs into strain relief (1) where there are not any wires.
9. Fold strain relief (1) together and lock Tabs A.
10. Connector assembly to ECM.
11. Negative battery cable.

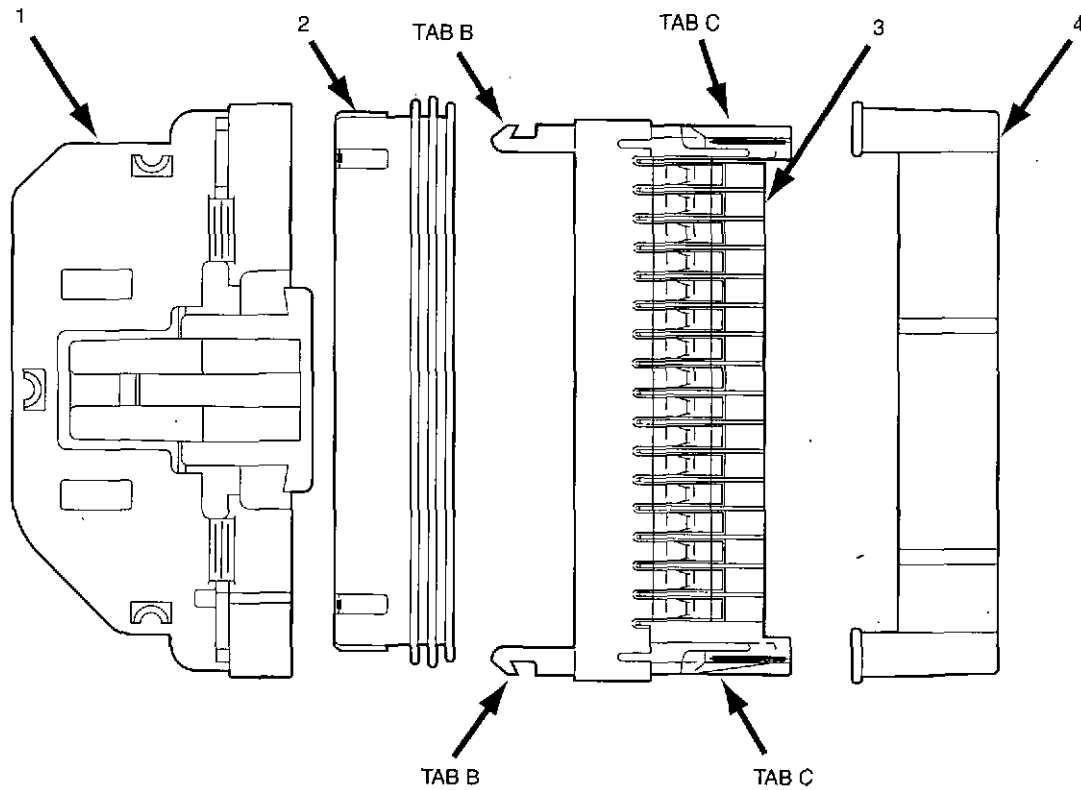


FIGURE A - EXPLODED VIEW OF CONNECTOR ASSEMBLY

1 STRAIN RELIEF
2 SEAL

3 CONNECTOR
4 INDEX COVER

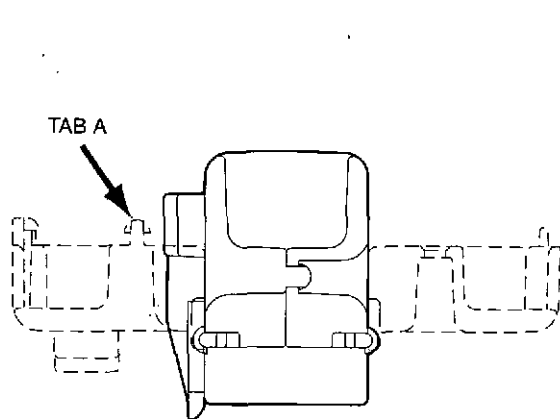


FIGURE B - STRAIN RELIEF CLOSED

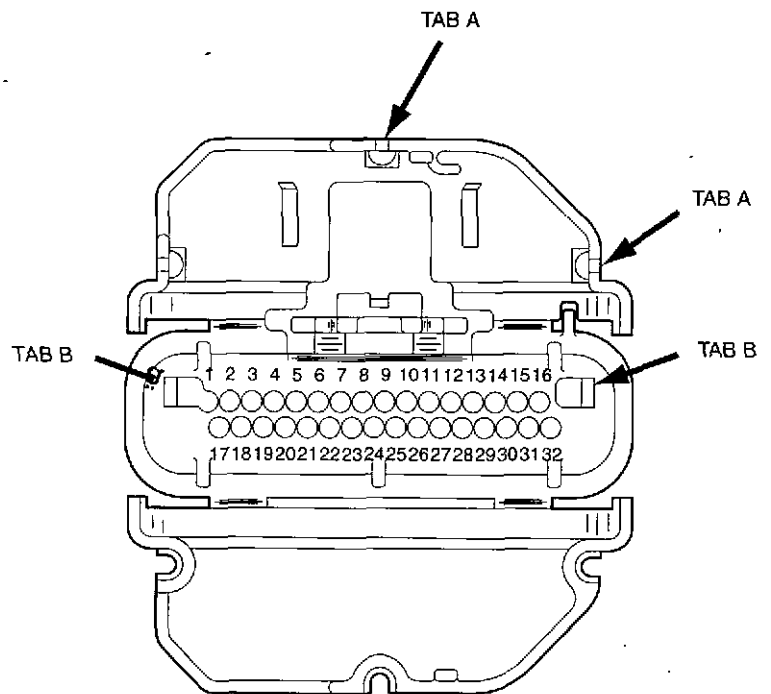


FIGURE C - STRAIN RELIEF OPENED

Engine Control Module (ECM) Replacement

Notice: When replacing the ECM, the ignition must be "OFF" and disconnect the battery before disconnecting or reconnecting the ECM "J1" and "J2" connectors to prevent internal damage to the ECM.

Notice: To prevent possible electrostatic discharge damage to the ECM, do not touch the connector pins. The ECM is an electrical component. Do Not soak in any liquid cleaner or solvent, as damage may result.

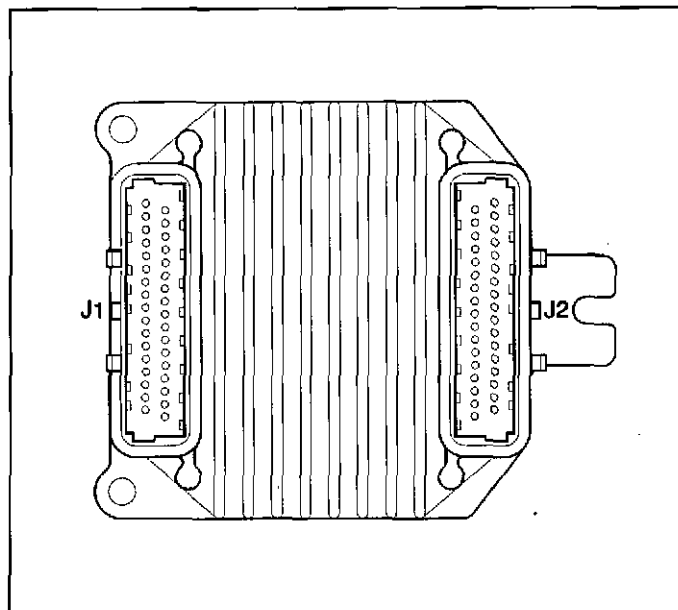
Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the "J1" and "J2" connectors from ECM.
3. Remove the three ECM mounting screws.
4. Remove the ECM from mounting bracket.

Installation Procedure

Important: Make sure the new ECM has the same part number and service number as the old ECM, to ensure proper engine performance.

1. Install the new ECM to the mounting bracket.
2. Install the three ECM mounting screws.
Tighten
Tighten the ECM to 10-14 N•m (88-124 lb in).
3. Reconnect the "J1" and "J2" connectors to the ECM.
4. Reconnect the negative battery cable.



MEF4332

System/Ignition Relay Replacement

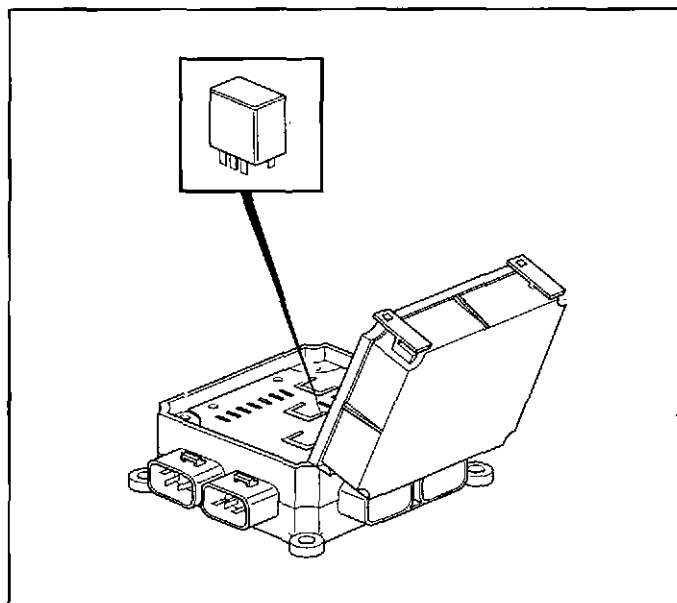
Removal Procedure

1. Turn the ignition OFF.
2. Open the cover.
3. Remove the system/ignition relay from the socket.

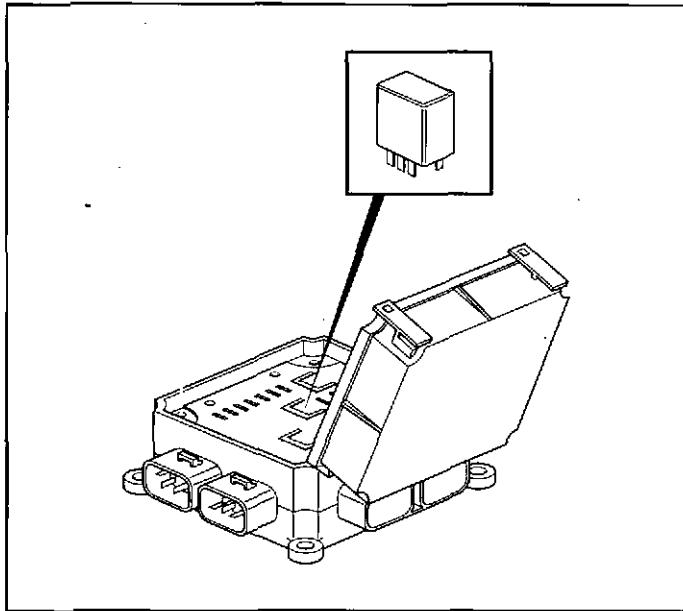
Important: The system relay is an electrical component. Do Not soak in any liquid or solvent as damage may result.

Installation Procedure

1. Install the system relay in the socket.
2. Close the cover.



MEF4337A



Fuel Pump Relay Replacement

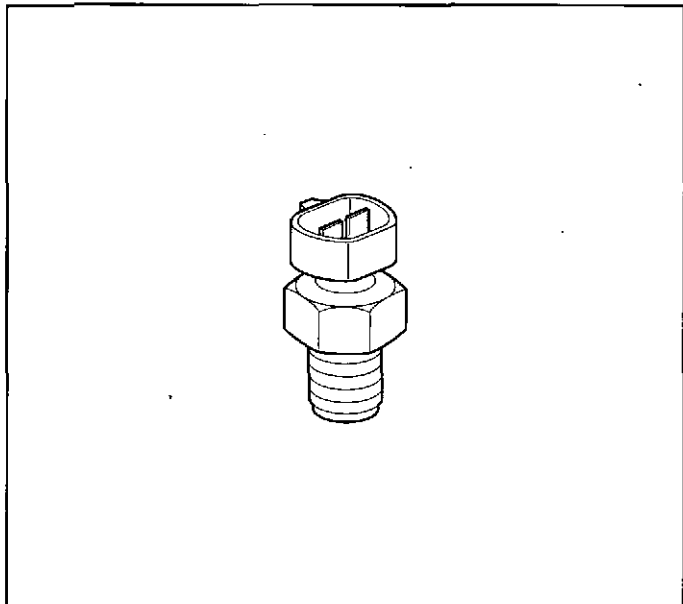
Removal Procedure

1. Turn the ignition OFF.
2. Open the cover.
3. Remove the fuel pump relay from the socket.

Important: The fuel pump relay is an electrical component. Do Not soak in any liquid or solvent as damage may result.

Installation Procedure

1. Install the fuel pump relay.
2. Close the cover.



Engine Coolant Temperature (ECT) Sensor Replacement

Notice: Care must be taken when handling the ECT sensor. Damage to the sensor will affect proper operation of the MEFI system.

Remove or Disconnect

1. Turn OFF the ignition.
2. Drain the cooling system below the level of the ECT sensor.
3. Disconnect the ECT electrical connector.
4. Remove the ECT sensor.

Installation Procedure

Important: Coat ECT sensor threads with Teflon® tape sealant prior to installation.

1. Install the ECT sensor.
Tighten
Tighten the ECT sensor to 20 N•m (15 lb ft).
2. Reconnect the ECT electrical connector.
3. Refill the cooling system.

Manifold Absolute Pressure (MAP) Sensor Replacement

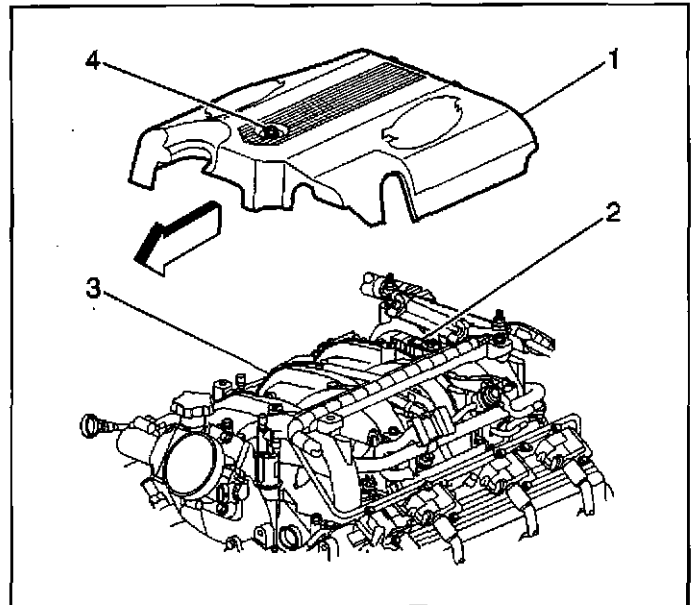
Removal Procedure

1. Loosen the fastener (4) from the intake manifold sight shield.
2. Remove the sight shield (1) from the intake manifold (3).
3. Disconnect the manifold absolute pressure (MAP) sensor electrical connector.
4. Remove the MAP sensor retaining bolt and washer (1).
5. Remove the MAP sensor (3) from the intake manifold (2).
6. Inspect the MAP sensor seal for wear or damage and replace as necessary.

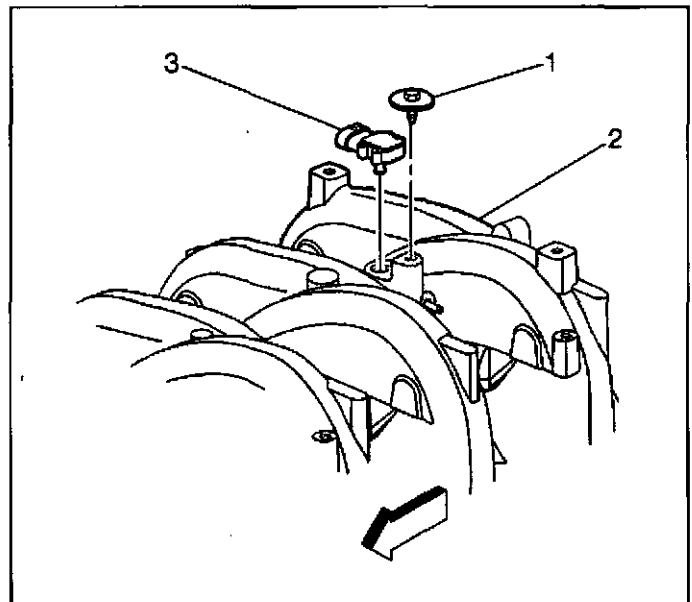
Installation Procedure

Important: Lightly coat the MAP sensor seal with rubber lubricant part number 9985770 before installing the sensor. The lubricant should be applied with a sponge or brush. To prevent blockage, avoid dipping the sensor port directly into the lubricant.

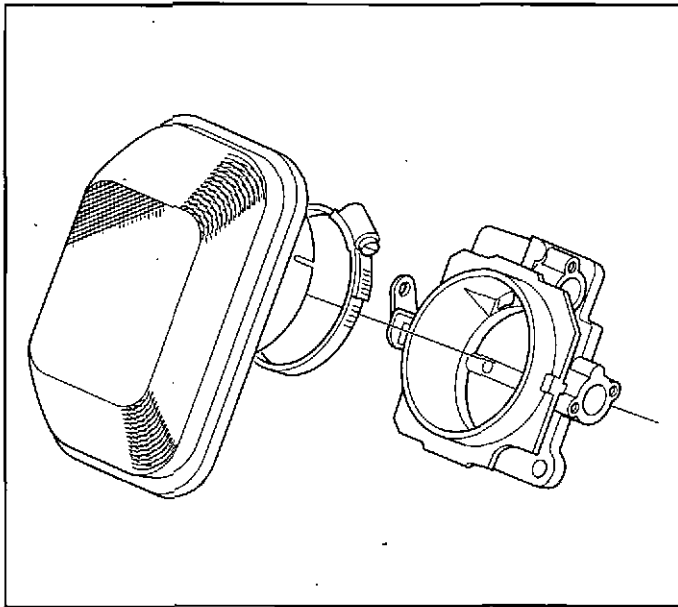
1. Install the MAP sensor (3).
2. Install the MAP sensor retaining bolt and washer (1).
Tighten
Tighten the MAP sensor retaining bolt to 12 N.m (106 lb in).
3. Connect the MAP sensor electrical connector (2).
4. Install the intake manifold sight shield (1).
Tighten
Tighten the sight shield fastener to 10 N.m (89 lb in).



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17971A

Flame Arrestor Replacement

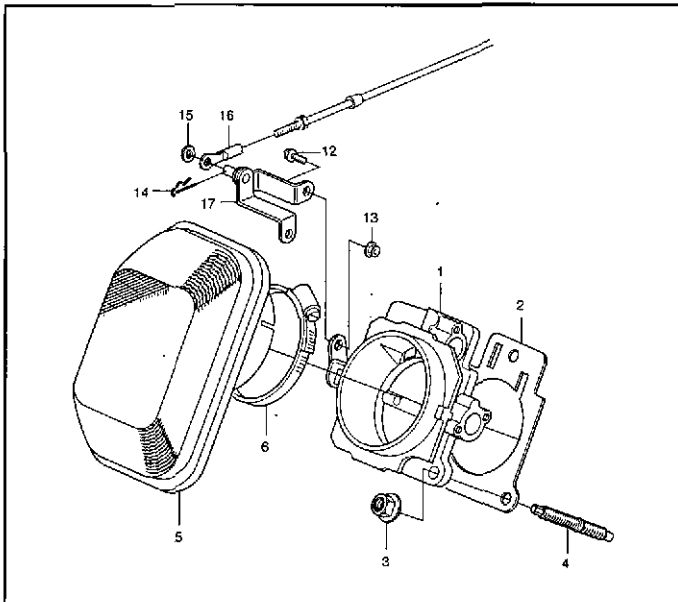
Removal Procedure

1. Turn ignition OFF.
2. Disconnect MAT sensor harness connector.
3. Loosen the flame arrestor element retaining clamp.
4. Remove the flame arrestor element.

Important: Inspect the flame arrestor for dust, dirt or damage. Replace if required.

Installation Procedure

1. Install the flame arrestor element to the throttle body.
2. Tighten the flame arrestor retaining clamp to flame arrestor element.
3. Reconnect the MAT sensor harness connector.



17971

Throttle Body Assembly Replacement

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the MAT sensor harness connector
3. Remove the flame arrestor and gasket (if applicable).
4. Disconnect the electrical connectors from the IAC valve and the TP sensor.
4. Disconnect the throttle linkage.
6. Remove the throttle body assembly attaching nuts.
7. Remove the throttle body assembly and gasket.
8. Discard the gasket.

Important: To prevent damage to the throttle valve, it is essential that the unit be placed on a holding fixture before performing service.

Notice: Stuff a rag in the intake manifold opening to prevent foreign material from entering the engine.

Inspect

- Manifold bore for loose parts and foreign material.
- Manifold mating surface for cleanliness or burrs that could affect gasket sealing.

Important: Clean the throttle bore and valve deposits using carburetor cleaner and a parts cleaning brush. Do Not use a cleaner that contains methyl ethyl ketone, an extremely strong solvent, and not necessary for this type of deposit.

The throttle body metal parts may be cleaned in a cold, immersion type cleaner following the disassembly of the unit.

Notice: The TP sensor and IAC valve should not come in contact with solvent or cleaner, as they may be damaged. These components must be removed before immersion. Follow the procedures outlined in this section.

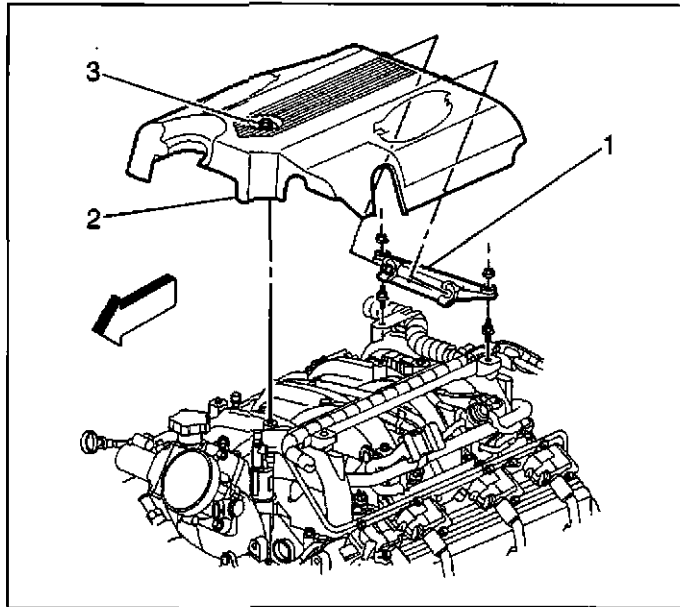
Caution: Safety glasses must be worn when using compressed air, as flying dirt particles may cause eye injury.

- Clean all metal parts thoroughly and blow dry with compressed air. Be sure that all fuel and air passages are free of dirt and burrs.
- Inspect the mating surfaces for damage that could affect gasket sealing.
- Inspect throttle body for cracks in casting.
- Use Loctite® 262 or equivalent when thread locking is required.

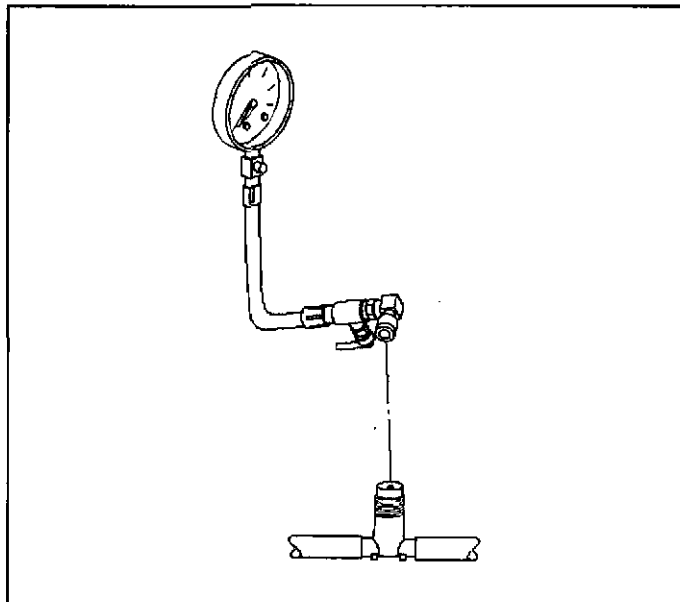
Notice: When pre-coating the mounting bolts, do not use a higher strength locking compound than recommended. This may cause the removal of the bolts to be very difficult.

Installation Procedure

1. Install a new throttle body gasket.
2. Install the throttle body assembly and the throttle body assembly attaching nuts.
Tighten
Tighten the throttle body assembly attaching nuts to 10 N.m (89 lb in).
3. Reconnect the throttle linkage.
4. Reconnect the electrical connectors to the IAC valve and the TP sensor.
5. Install the flame arrestor and reconnect the MAT sensor harness connector.
6. Reconnect the negative battery cable.



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Fuel Pressure Relief Procedure

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

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

The following is general information required when working on the fuel system:

- Always keep a dry chemical fire extinguisher near the work area.
- Do not replace fuel pipe with fuel hose.
- Always bleed off fuel pressure before servicing any fuel system components.
- Do not do any repairs on the fuel system until you have read the instructions and checked the figures relating the repair.
- Observe all notices and cautions.

Tools Required

J 34730-1A Fuel Pressure Gauge

1. Turn the ignition OFF.
2. Disconnect the negative battery cable in order to avoid possible fuel discharge if an accidental attempt is made to start the engine.
3. Remove the fuel injector sight shield.
4. Connect the J 34730-1A fuel pressure gauge to the fuel pressure valve. Wrap a shop towel around the fitting while connecting the gauge in order to avoid spillage.
5. Install the bleed hose of the gauge into an approved container.
6. Open the valve on the gauge to bleed the system pressure. The fuel connections are now safe for servicing.
7. Drain any fuel remaining in the gauge into an approved container.

Quick Connect Fitting(s) Service (Metal Collar)


Tools Required

J 37088-A Tool Set, Fuel Line Quick-Connect Separator

J 44581 Fuel Line Quick Connect Separator

Removal Procedure

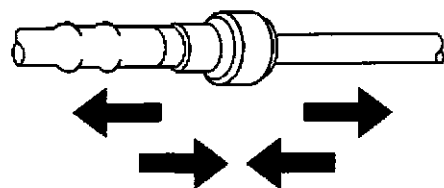
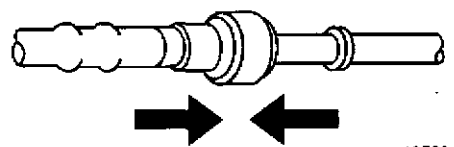
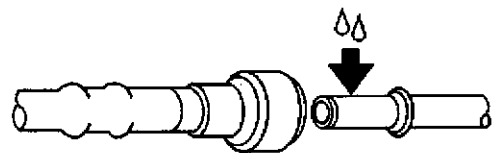
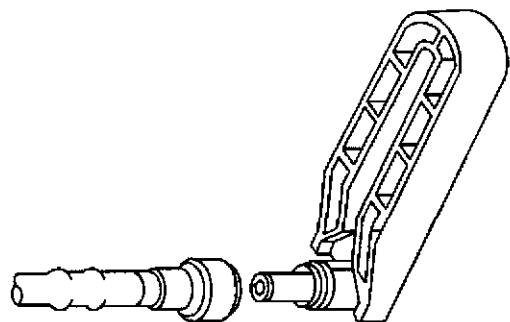
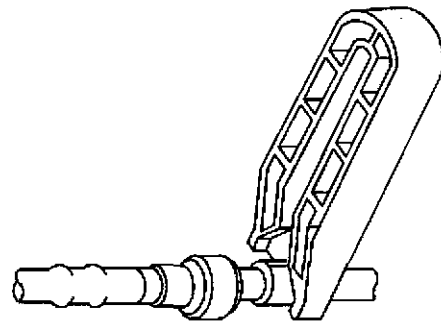
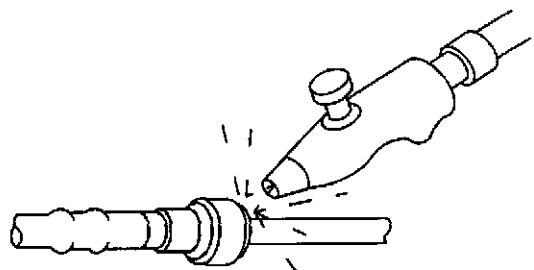
1. Relieve the fuel system pressure before servicing any fuel system connection. Refer to *Fuel Pressure Relief Procedure*.
2. Remove the retainer from the quick-connect fitting.

 **Caution:** Wear safety glasses to avoid eye damage.

3. Blow dirt out of the fitting using compressed air.
4. Choose the correct tool from the tool set for the size of the fitting. Insert the tool into the female connector, then push inward in order to release the locking tabs.
5. Pull the connection apart.
6. Use a clean shop towel in order to wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs. Clean or replace the components as required.

Installation Procedure

1. Apply a few drops of clean engine oil to the male pipe end.
2. Push both sides of the fitting together in order to snap the retaining tabs into place.
3. Once installed, pull on both sides of the fitting in order to make sure the connection is secure.
4. Install the retainer to the quick-connect fitting.



Fuel Pump Replacement

Notice! The fuel pumps on this Volvo Penta engine are not serviceable. The entire fuel cell must be replaced if either or both fuel pumps fail.

Removal Procedure

1. Disconnect negative battery cable.
2. Relieve the fuel system pressure before servicing any fuel system component. Refer to *Fuel Pressure Relief Procedure*.
3. Clean all the fuel fitting connections and the surrounding areas before disconnecting the fuel pipes in order to avoid possible contamination of the fuel system.
4. Disconnect the threaded fittings from the fuel cell.
5. Cap the fuel pipes in order to prevent possible fuel system contamination.
6. Disconnect the fuel pump electrical connectors.
7. Disconnect the cooling lines to the fuel cell.
8. Remove the fuel filter and dispose of it in an approved manner.
9. Remove the 4 retaining screws and retain for installation on the new fuel cell.
10. Remove the fuel cell.

Installation Procedure

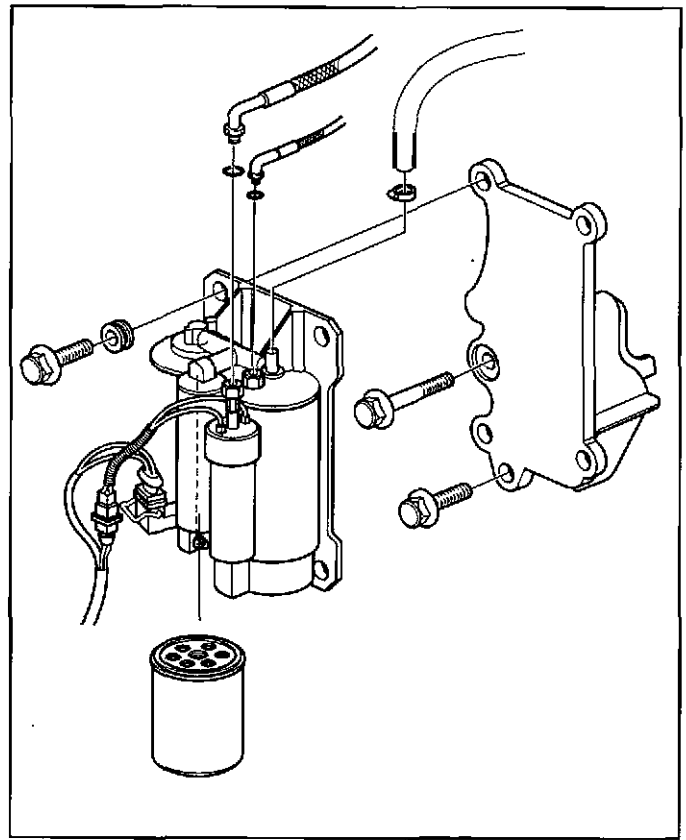
Important! Make sure to replace the fuel cell with the identical part number.

1. Install the fuel cell.
2. Reconnect the fuel pump electrical connectors.
3. Remove the caps from the fuel pipes.
4. Reconnect the threaded fittings into the fuel pump.

Tighten

Tighten the fittings to 25 N.m (18 lb ft).

5. Reconnect the cooling lines.
6. If a fuel filter does not come installed on the new fuel cell, install a new fuel filter.
5. Connect the negative battery cable.
6. Inspect for leaks.
 - 6.1. Turn the ignition ON for 2 seconds.
 - 6.2. Turn the ignition OFF for 10 seconds.
 - 6.3. Turn the ignition ON.
 - 6.4. Inspect for fuel leaks.

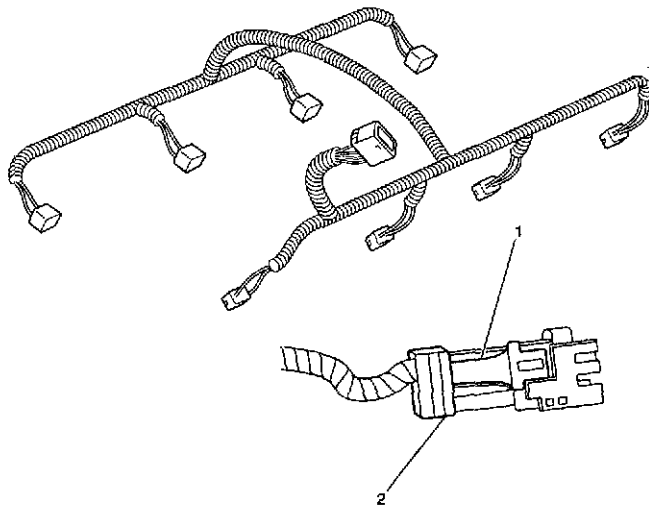
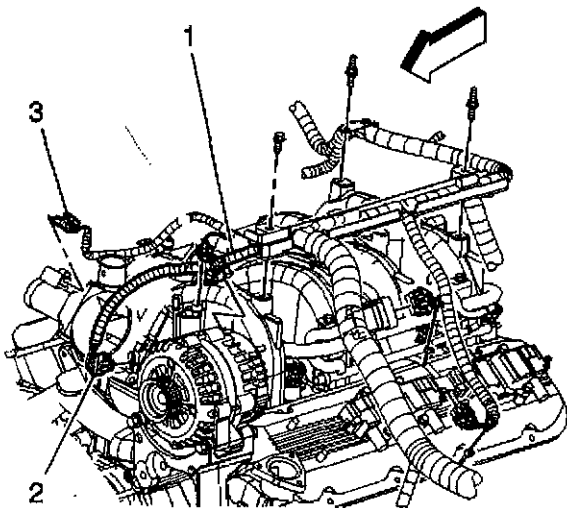
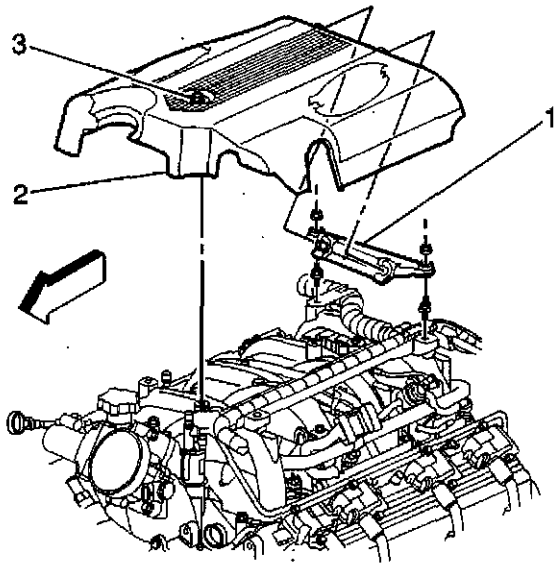


Fuel Rail Assembly Replacement

Removal Procedure

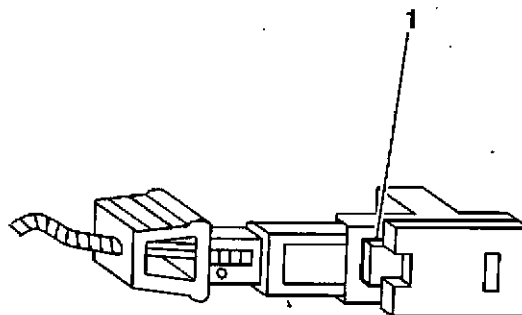
An eight digit identification number is located on the fuel rail assembly. Refer to this model identification number if servicing or part replacement is required.

1. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief Procedure*.
2. Before removal, clean the fuel rail assembly with a spray type engine cleaner, if necessary. Do not soak fuel rails in liquid cleaning solvent.
3. Remove the engine cover bracket (1) nuts and bracket.
4. Disconnect the alternator harness connector (1).
5. Disconnect the TP sensor harness connector (2).
6. Disconnect the IAC valve harness connector (3).
7. Remove the upper engine wiring harness bracket studs and position the upper engine wire harness aside.

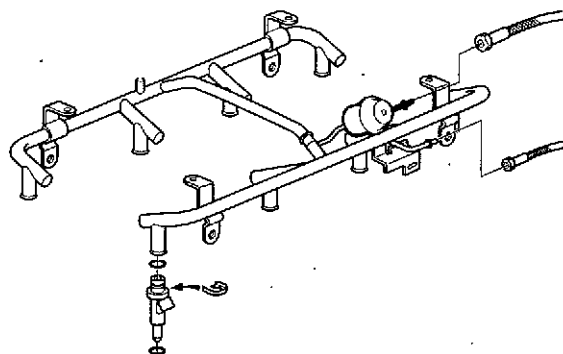


8. Identify the connectors to their corresponding injectors to ensure correct injector firing order after re-assembly.
9. Pull the top portion (2) of the injector connector up. Do not pull the top portion of the connector past the top of the white portion (1).

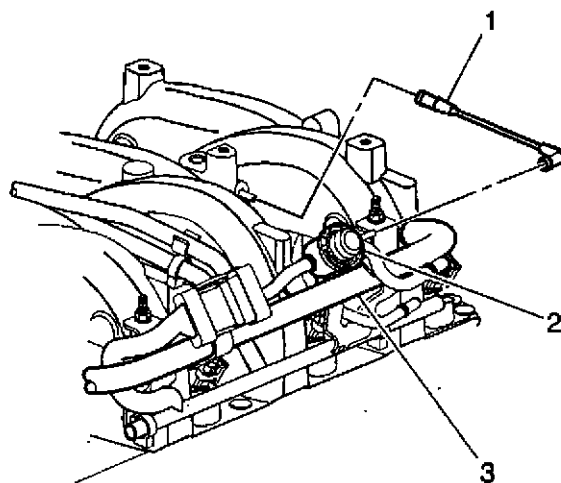
10. Push the tab (1) on the lower side of the injector connector in order to release the connector from the injector.
11. Repeat step 9 and step 10 for each injector connector.

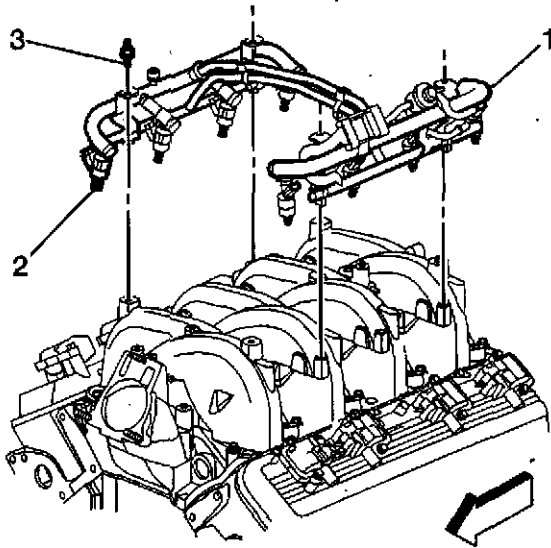


12. Disconnect the fuel feed and return pipes (1), (2) from the fuel rail.

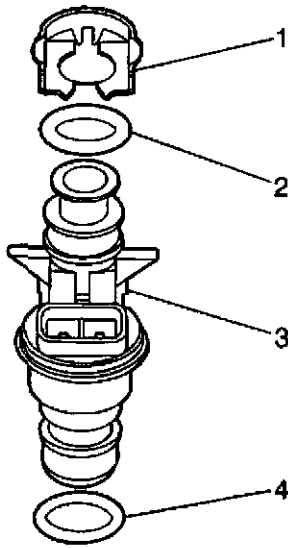


13. Disconnect the fuel pressure regulator vacuum line.





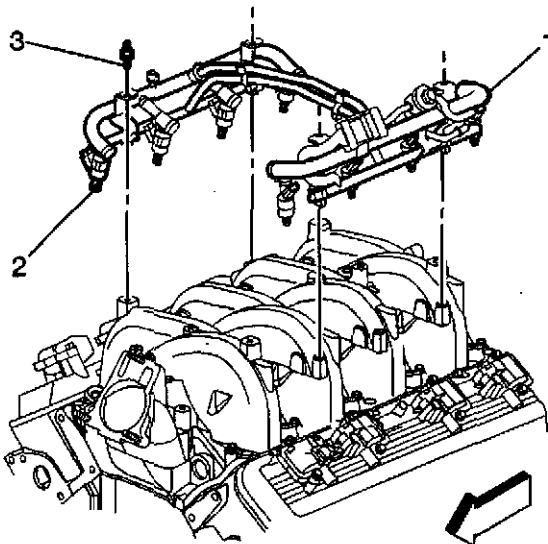
14. Remove the fuel rail attaching bolts.
15. Remove the fuel rail assembly.



16. Remove the injector lower O-ring seal (4) from the spray tip end of each injector (3).
17. Discard the O-ring seals.

Installation Procedure

1. Lubricate the new lower injector O-ring seals (4) with clean engine oil.
2. Install the new O-ring seals (4) on the spray tip end of each injector (3).

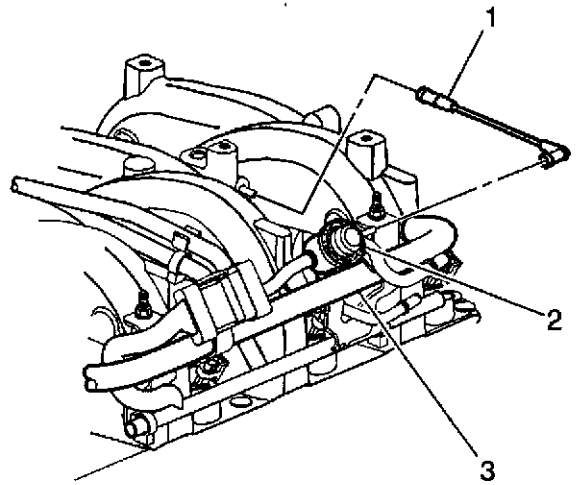


3. Install the fuel rail assembly to the intake manifold.
4. Apply a 5 mm (0.020 in) band of GM P/N 12345382 threadlock or equivalent to the threads of the fuel rail attaching bolts.
5. Install the fuel rail attaching bolts.

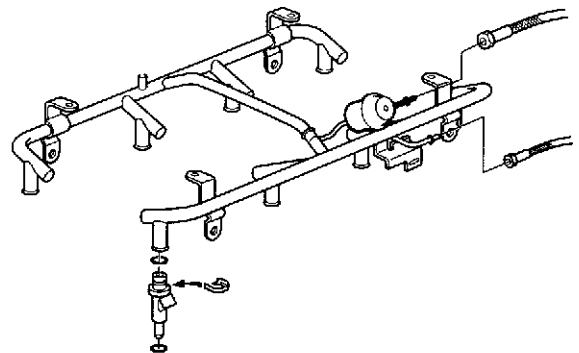
Tighten

Tighten the fuel rail attaching bolts to 12 N.m (106 lb in).

6. Connect the fuel pressure regulator vacuum line.



7. Connect the fuel feed and return pipes (1), (2) to the fuel rail.



8. Connect the injector electrical connectors

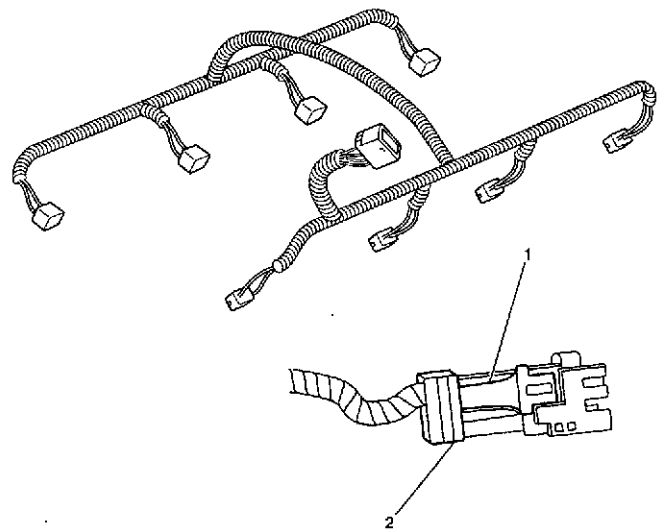
- Install each connector on the proper injector in order to ensure correct injector firing order.
- Rotate the injectors as required in order to avoid stretching the wire harness.

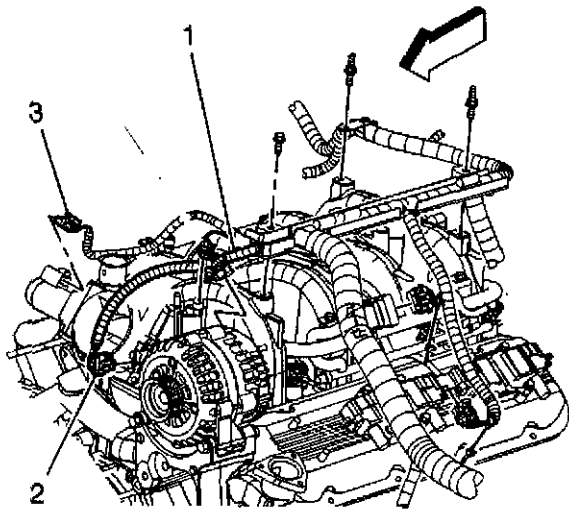
9. Install the upper engine wire harness bracket.

10. Install the retainer studs to the upper engine wire harness.

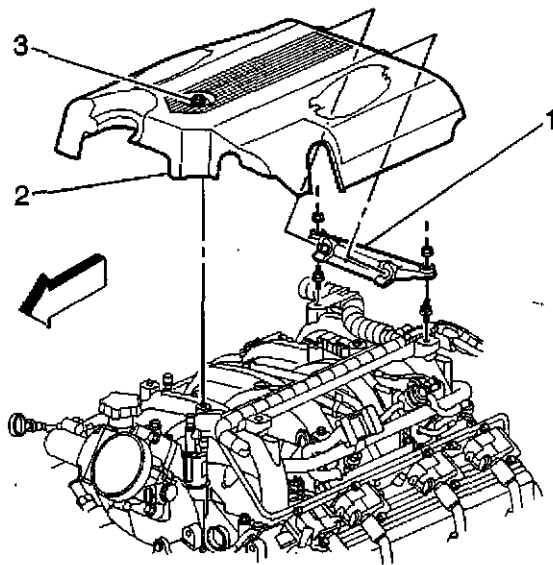
Tighten

Tighten the nut to 10 N.m (89 lb in).





- 11.Reconnect the alternator harness connector (1).
- 12.Reconnect the TP sensor harness connector (2).
- 13.Reconnect the IAC valve harness connector (3).



- 14.Install the engine sight shield mounting bracket and nuts.

Tighten

Tighten the bolts 10 N.m (89 lb in).

- 15.Connect the negative battery cable.

- 16.Inspect for leaks.

16.1. Turn the ignition ON for 2 seconds.

16.2. Turn the ignition OFF for 10 seconds.

16.3. Turn the ignition ON.

16.4. Inspect for fuel leaks.

- 17.Install the engine sight shield.

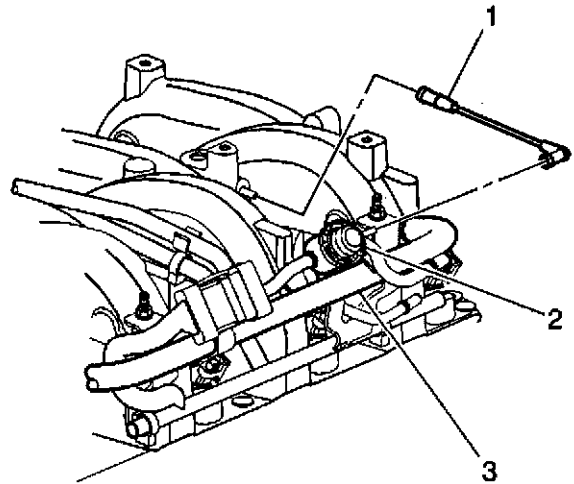
Tighten

Tighten the bolts 10 N.m (89 lb in).

Fuel Pressure Regulator Replacement

Removal Procedure

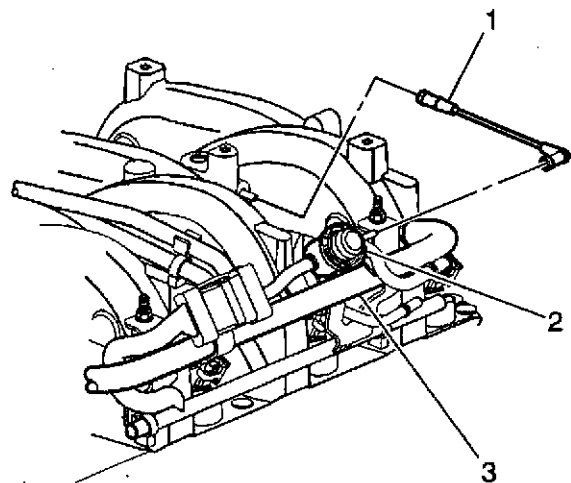
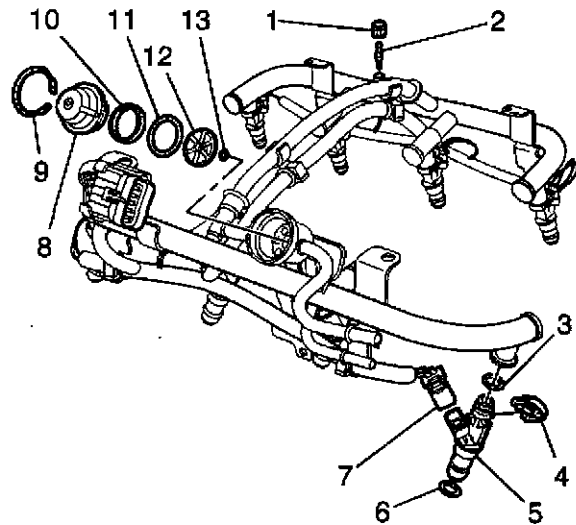
1. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief Procedure*.
2. Disconnect the fuel pressure regulator vacuum line (1).

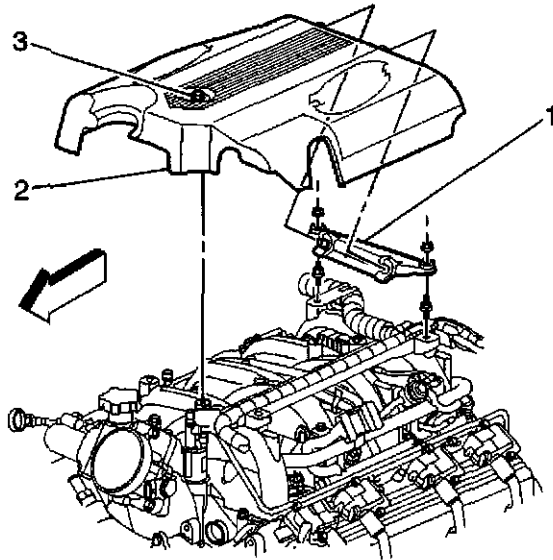


3. Clean any dirt from the fuel pressure regulator retainer and the surrounding area.
4. Remove the fuel pressure regulator retainer (9).
5. Remove the fuel pressure regulator (8) from the fuel pressure regulator housing.

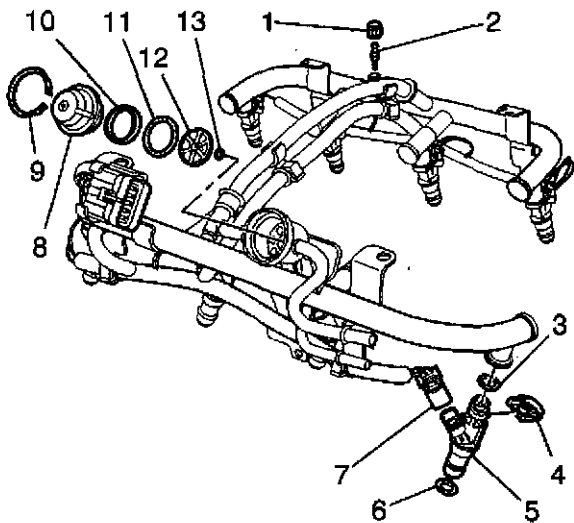
Installation Procedure

1. Install the backup ring (10) on the fuel pressure regulator (8).
2. Install the new large O-ring (11) on the fuel pressure regulator.
3. Install the regulator filter (12) on the fuel pressure regulator.
4. Install the new small O-ring (13) on the fuel pressure regulator.
5. Lubricate the fuel pressure regulator large O-ring and the small O-ring with clean engine oil.
6. Push the fuel pressure regulator into the regulator housing on the fuel rail.
7. Install a new fuel pressure regulator retainer (9).
8. Connect the fuel pressure regulator vacuum line.
9. Connect the negative battery cable.
10. Inspect for leaks.
 - 10.1. Turn the ignition ON for 2 seconds.
 - 10.2. Turn the ignition OFF for 10 seconds.
 - 10.3. Turn the ignition ON.
 - 10.4. Inspect for fuel leaks.





11. Install the engine cover.

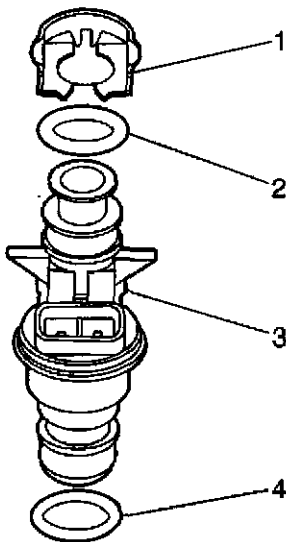


Fuel Injector Replacement

Removal Procedure

Important: The engine oil may be contaminated with fuel if the fuel injectors are leaking.

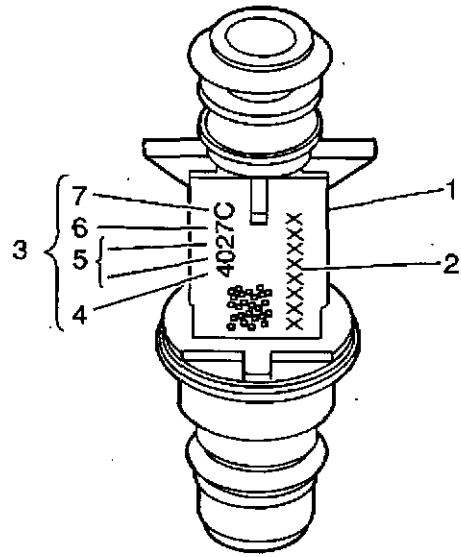
1. Remove the fuel rail assembly. Refer to *Fuel Rail Assembly Replacement*.
2. Remove the injector retainer clip (4).
3. Insert the fork of J 43013, the fuel injector assembly removal tool, between the fuel rail pod and the 3 protruding retaining clip ledges. Use a prying motion while inserting the tool in order to force the injector out of the fuel rail pod.
4. Discard the injector retainer clip (1).
5. Remove the injector O-ring seals (2), (4) from both ends of the injector. Discard the O-ring seals.



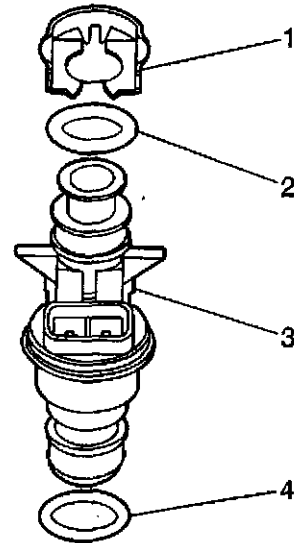
Installation Procedure

Important: When ordering new fuel injectors, be sure to order the correct injector for the application being serviced.

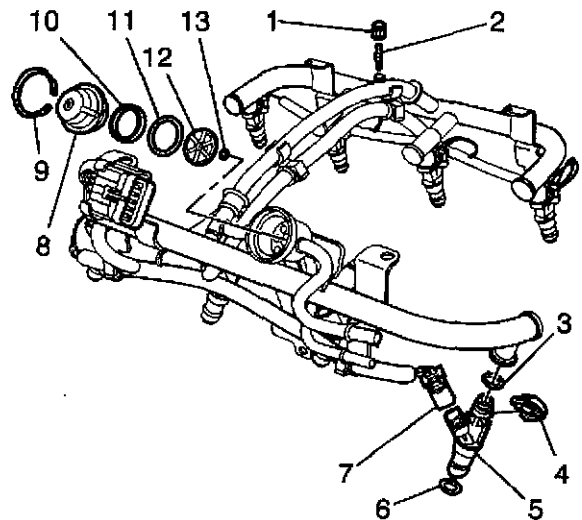
The fuel injector assembly (1) is stamped with a part number identification (2). A four digit build date code (3) indicates the month (4), day (5), year (6) and the shift (7) that built the injector.

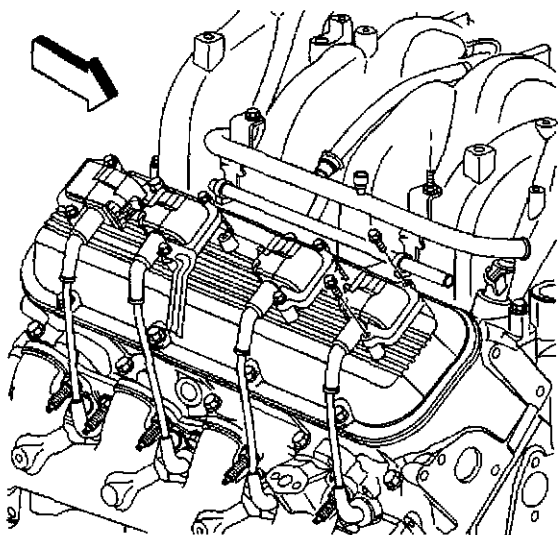


1. Lubricate the new O-ring seals (2), (4) with clean engine oil.
2. Install the new injector O-ring seals on the injector.
3. Install a new retainer clip (1) on the injector.



4. Push the fuel injector (5) into the fuel rail injector socket with the electrical connector facing outwards. The retainer clip (4) locks on to a flange on the fuel rail injector socket.
5. Install the fuel rail assembly. Refer to *Fuel Rail Assembly Replacement*.





Ignition Coil(s) Replacement

Removal Procedure

1. Disconnect the spark plug wires at the ignition coils. Refer to *Spark Plug Wire Replacement*.
2. Disconnect the ignition coil harness connector.
3. Remove the ignition coil mounting bolts.
4. Remove the ignition coil.

Installation Procedure

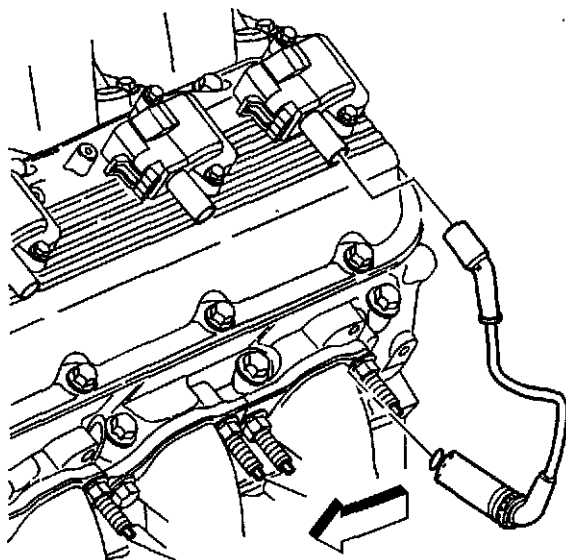
1. Install the ignition coil.
2. Install the ignition coil mounting bolts.
Tighten
Tighten the ignition coil mounting bolts to 12 N.m (106 lb in).
3. Connect the ignition coil harness connector.
4. Connect the spark plug wires at the ignition coils. Refer to *Spark Plug Wire Replacement*.

Spark Plug Wire Inspection

Spark plug wire integrity is vital for proper engine operation. A thorough inspection will be necessary to accurately identify conditions that may affect engine operation. Inspect for the following conditions:

1. Correct routing of the spark plug wires. Incorrect routing may cause cross-firing.
2. Any signs of cracks or splits in the wires.
3. Inspect each boot for the following conditions:
 - Tearing
 - Piercing
 - Arcing
 - Carbon tracking
 - Corroded terminal

If corrosion, carbon tracking or arcing are indicated on a spark plug wire boot or on a terminal, replace the wire and the component connected to the wire.



Spark Plug Wire Replacement

Removal Procedure

1. Disconnect the spark plug wire at each spark plug.
 - 1.1. Twist each spark plug wire 1/2 turn.
 - 1.2. Pull only on the boot in order to remove the wire from each spark plug.
2. Disconnect the spark plug wire from each ignition coil.
 - 2.1. Twist each spark plug wire 1/2 turn.
 - 2.1. Pull only on the boot in order to remove the wire from each ignition coil.

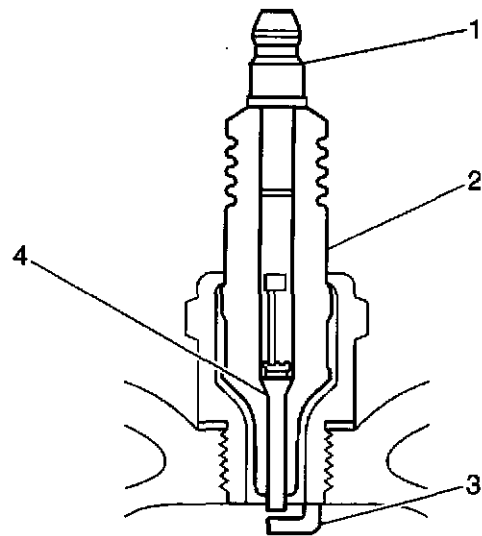
Installation Procedure

1. Install the spark plug wire at each ignition coil.
2. Install the spark plug wire at each spark plug.
3. Inspect the wires for proper installation:
 - A. Push sideways on each boot in order to inspect the seating.
 - B. Reinstall any loose boot.

Spark Plug Inspection

Spark Plug Usage

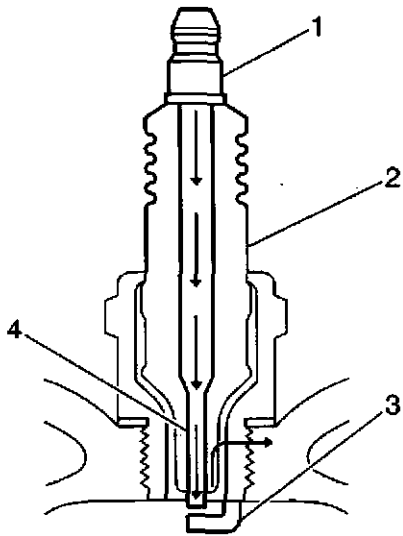
- Ensure that the correct spark plug is installed. An incorrect spark plug causes drivability conditions.
- Ensure that the spark plug has the correct heat range. An incorrect heat range causes the following conditions:
 - Spark plug fouling - colder plug
 - Pre-ignition causing spark plug and/or engine damage - hotter plug
- Inspect the terminal post (1) for damage.
 - Inspect for a bent or broken terminal post (1).
 - Inspect the spark plug boot for damage.
 - Inspect the spark plug recess area of the cylinder head for moisture, such as oil, coolant or water. A spark plug boot that is saturated causes arcing to ground.
- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3,4).
- Inspect for evidence of improper arcing.
 - Measure the gap between the center electrode (4) and the side electrode (3) terminals. An excessively wide electrode gap can prevent correct spark plug operation.
 - Inspect for the correct spark plug torque. Insufficient torque can prevent correct spark plug operation. An over torqued spark plug may cause the insulator (2) to crack.



- Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
- Inspect for a broken or worn side electrode (3).
- Inspect for a broken, worn or loose center electrode (4) by shaking the spark plug.
- A rattling sound indicates internal damage.
- A loose center electrode (4) reduces the spark intensity.
 - Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
 - Inspect for worn or missing platinum pads on the electrodes (3, 4), if equipped.
 - Inspect for excessive fouling.
- Inspect the spark plug recess area of the cylinder head for debris. Dirty or damaged threads can cause the spark plug not to seat correctly during installation.

Spark Plug Visual Inspection

- Normal Operation - Brown to greyish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives.
- Carbon Fouled - Dry, fluffy black carbon, or soot caused by the following condition:
 - Rich fuel mixtures
- Leaking fuel injectors
- Excessive fuel pressure
- Restricted flame arrestor/air filter element
- Incorrect combustion
 - Reduced ignition system voltage output
- Weak coil(s)
- Worn ignition wires
- Incorrect spark plug gap
 - Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that



normal combustion deposits may not burn off.

- Inspect for evidence of improper arcing.
 - Measure the gap between the center electrode (4) and the side electrode (3) terminals. An excessively wide electrode gap can prevent correct spark plug operation.
 - Inspect for the correct spark plug torque. Insufficient torque can prevent correct spark plug operation. An over torqued spark plug may cause the insulator (2) to crack.
 - Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
 - Inspect for a broken or worn side electrode (3).
 - Inspect for a broken, worn or loose center electrode (4) by shaking the spark plug.
- A rattling sound indicates internal damage.
- A loose center electrode (4) reduces the spark intensity.
 - Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
 - Inspect for worn or missing platinum pads on the electrodes (3, 4), if equipped.
 - Inspect for excessive fouling.
- Inspect the spark plug recess area of the cylinder head for debris. Dirty or damaged threads can cause the spark plug not to seat correctly during installation.

Spark Plug Visual Inspection

- Normal Operation - Brown to greyish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives.
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 - Excessive fuel pressure
 - Restricted flame arrestor/air filter element
 - Incorrect combustion
- Reduced ignition system voltage output
 - Weak coil(s)
 - Worn ignition wires
 - Incorrect spark plug gap
- Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.
- Deposit Fouling - Oil, coolant or additives that include substances such as silicone, very white coating, reduces the spark intensity. Most powdery deposits will not effect spark intensity unless they form into a glazing over the electrode.

Spark Plug Replacement

Removal Procedure

1. Remove the spark plug wires. Refer to *Spark Plug Wire Replacement*.
2. Loosen each spark plug one or two turns.
3. Brush or air blast away any dirt from around the spark plugs.
4. Remove the spark plugs one at a time and place each plug in a tray marked with the corresponding cylinder numbers.

Installation Procedure

1. Inspect each spark plug gap. Adjust each plug gap as needed.

Specification

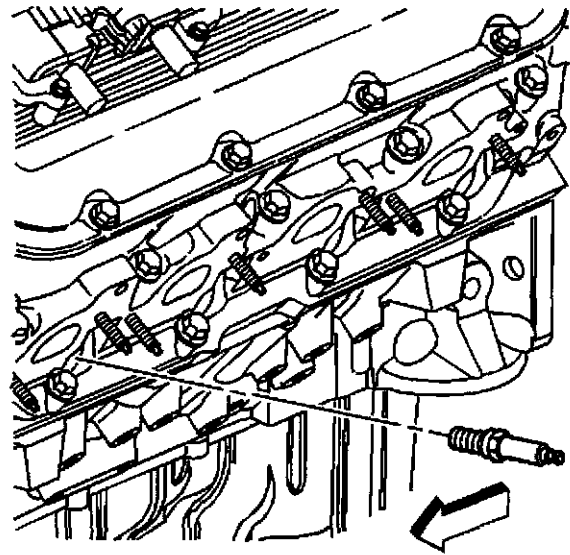
Spark plug gap: 1.524 mm (0.060 in)

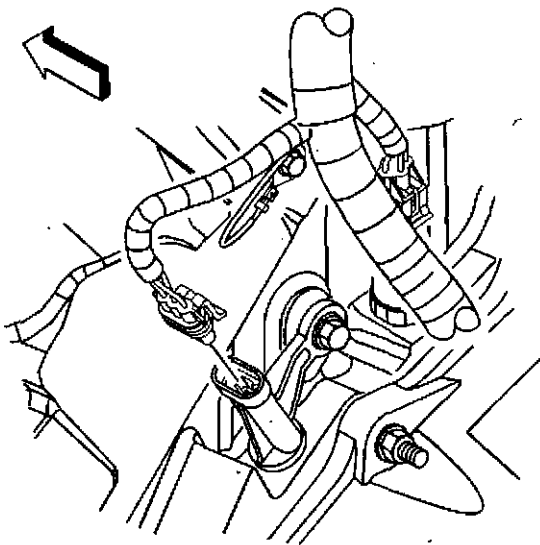
3. Install the spark plugs.

Tighten

- Tighten the spark plugs to 20 N.m (15 lb ft).

4. Install the spark plug wires. Refer to *Spark Plug Wire Replacement*.





Crankshaft Position (CKP) Sensor Replacement

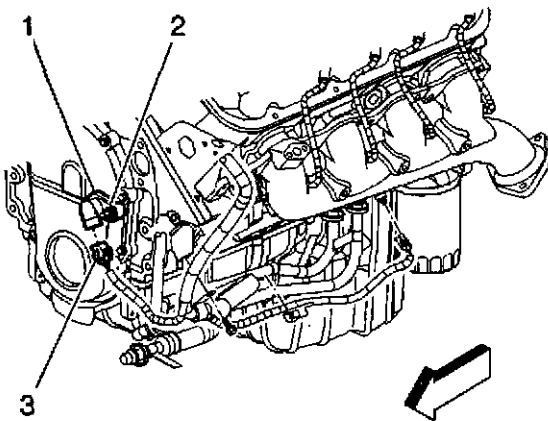
Removal Procedure

1. Disconnect the crankshaft position (CKP) sensor harness connector at the CKP sensor.
2. Remove the CKP sensor retaining bolt.
3. Remove the CKP sensor.

Installation Procedure

Important: Inspect the CKP sensor O-ring for wear or damage. If a problem is found, replace the O-ring. Lubricate the new O-ring with clean engine oil before installing.

1. Install the CKP sensor.
2. Install the CKP sensor retaining bolt.
Tighten
Tighten the bolt 10 N.m (88 lb in).
3. Connect the CKP sensor harness connector.



Camshaft Position (CMP) Sensor Replacement

Removal Procedure

1. Disconnect the camshaft position (CMP) sensor harness connector (3) from the CMP sensor (1).
2. Remove the CMP sensor retaining bolt (2).
3. Remove the CMP sensor (1).
4. Inspect the CMP sensor for wear, cracks or leakage if the sensor is not being replaced.

Installation Procedure

Important: Inspect the CMP sensor O-ring for wear or damage. If a problem is found, replace the O-ring. Lubricate the new O-ring with clean engine oil before installing.

1. Install the CMP sensor (1).
2. Install the CMP sensor retaining bolt (2).
Tighten
Tighten the bolt 10 N.m (88 lb in).
3. Connect the CMP sensor harness connector (3).

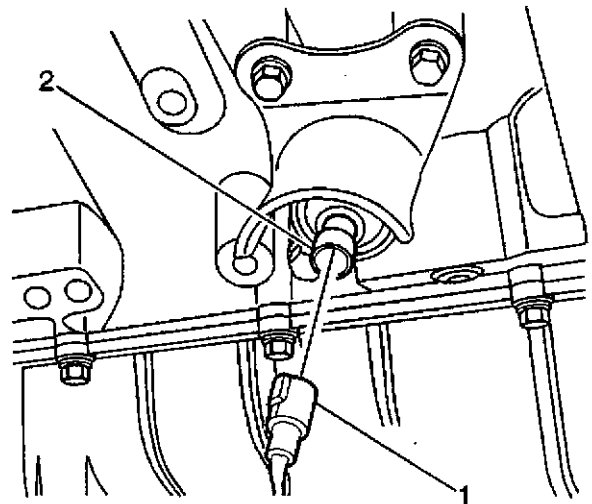
Knock Sensor (KS) Replacement

Removal Procedure

1. Remove the wiring harness connector (1) from the knock sensor (2).
2. Remove the knock sensor (2) from the engine block.

Installation Procedure

1. Install the knock sensor (2) into the engine block.
Tighten
Tighten the knock sensor to 19 N.m (14 lb ft).
2. Connect the knock sensor harness connector (1) to the knock sensor (2).



Abbreviations

BARO	- BAROMETRIC PRESSURE	I/O	- INPUT/OUTPUT
BAT	- BATTERY, BATTERY POSITIVE TERMINAL, BATTERY OR SYSTEM VOLTAGE	kPa	- KILOPASCAL
B+	- BATTERY POSITIVE	KS	- KNOCK SENSOR
CEFI	- COMMERCIAL ELECTRONIC FUEL INJECTION	KV	- KILOVOLTS
CKT	- CIRCUIT	MAP	- MANIFOLD ABSOLUTE PRESSURE
CONN	- CONNECTOR	MFI	- MULTIPOINT FUEL INJECTION
CYL	- CYLINDER	MIL	- MALFUNCTION INDICATOR LAMP
DEG	- DEGREES	MSEC	- MILLSECOND
DI	- DISTRIBUTOR IGNITION	N/C	- NORMALLY CLOSED
DIAG	- DIAGNOSTIC	N/O	- NORMALLY OPEN
DIST	- DISTRIBUTOR	OBD	- ON-BOARD DIAGNOSTIC
DLC	- DATA LINK CONNECTOR	OPT	- OPTIONAL
DTC	- DIAGNOSTIC TROUBLE CODE	PFI	- PORT FUEL INJECTION
DVOM	- DIGITAL VOLT OHMMETER	PWM	- PULSE WIDTH MODULATION
ECM	- ENGINE CONTROL MODULE	RAM	- RANDOM ACCESS MEMORY
ECT	- ENGINE COOLANT TEMPERATURE	REF HI	- REFERENCE HIGH
EEPROM	- ELECTRONIC ERASABLE PROGRAMMABLE READ ONLY MEMORY	REF LO	- REFERENCE LOW
EI	- ELECTRONIC IGNITION	ROM	- READ ONLY MEMORY
EMI	- ELECTROMAGNETIC INTERFERENCE	SLV	- SLAVE
ENG	- ENGINE	SW	- SWITCH
E-STOP	- EMERGENCY STOP	TACH	- TACHOMETER
GND	- GROUND	TBI	- THROTTLE BODY INJECTION
GOV	- GOVERNOR	TERM	- TERMINAL
GPH	- GALLONS PER HOUR	TP	- THROTTLE POSITION
IAC	- IDLE AIR CONTROL	V	- VOLTS
IAT	- INTAKE AIR TEMPERATURE	VAC	- VACUUM
IC	- IGNITION CONTROL	VSS	- VEHICLE SPEED SENSOR
IGN	- IGNITION	WOT	- WIDE OPEN THROTTLE
INJ	- INJECTOR	" HG	- INCHES OF MERCURY

Specifications

Temperature vs. Resistance IAT and ECT

°C	°F	Ohms
Temperature vs. resistance Values (Approximate)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	133	1188
40	104	1459
35	95	1802
30	86	2238

Temperature vs. Resistance (cont'd)

°C	°F	Ohms
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

Ignition System Specifications

Application	Specifications	
	Metric	English
Firing Order	1-8-7-2-6-5-4-3	
Spark Plug Wire Resistance	10,000 ohms per foot	
Spark Plug Torque	15N m	11 lb. ft.
Spark Plug Gap	1.52mm	.060 in.
Spark Plug Type	VP# 3861326 AC# TJ14R-P15	

Fastener Tightening Specifications

Application	Specifications	
	Metric	English
Camshaft Position (CMP) Sensor Bolt	25N•m	18 lb. ft.
Crankshaft Position (CKP) Sensor Bolt	25N•m	18 lb. ft.
Engine Control Module (ECM) Mounting Screws	10-14N•m	88-124 lb. in.
Engine Coolant Temperature (ECT) Sensor	17N•m	13 lb. ft.
Engine Cover Bolts	10N•m	89 lb. in.
Fuel Rail Attachment Bolts	10N•m	89 lb. in.
Idle Air Control (IAC) Valve Attaching Screws	2 N•m	18 lb. in.
Ignition Coil Attaching Bolts	12N•m	106 lb. in.
Knock Sensor (KS)	20N•m	15 lb. in.
Throttle Body Attaching Bolts	20N•m	88 lb. in.
Throttle Position (TP) sensor Attaching Screws	3 N•m	28 lb.in

General Torque Specifications

The following specifications are for nut and screw sizes not having specific torque recommendations.

U.S. Screw Sizes	Ft. Lbs.	N•m	Metric Thread Sizes	Ft. Lbs.	N•m
No. 6	...	1,1-1,6	M-6	6-9	8-12
No. 8	...	2,2-2,8	M-8	14-21	19-28
No. 10	2-3,5	2,7-4,7	M-10	28-40	38-54
No. 12	3-4	4,1-5,4	M-12	50-71	68-96
1/4-20	5-7	6,8-9,5	M-14	80-114	108-155
5/16-18	12-14	16-19			5
3/8-16	20-25	27-34			
7/16-14	32-40	43-54			

Pound-inches x 0.11298 = Newton-meters N•m

Pound-feet x 1.3558 = Newton-meters N•m

Engine Scan Tool List

The Engine Scan Tool Data List contains all engine related parameters that are available on the scan tool. Use the Engine Scan Tool Data List only after the following is determined:

- On-Board Diagnostic System Check is completed.
- No Diagnostic Trouble Codes (DTCs).
- On-board diagnostics are functioning properly.

Scan tool values from a properly running engine may be used for comparison with the engine you are diagnosing. The Engine Scan Tool Data List represents values that would be seen on a normal running engine.

Important: A scan tool that displays faulty data should not be used. The scan tool problem should be reported to the manufacturer. Use of a faulty scan tool can result in misdiagnosis and unnecessary parts replacement.

Only the parameters listed below are referenced in this service manual for use in diagnosis. If all values are within the typical range described below, refer to *Symptoms* for diagnosis.

Scan Tool Parameter	Units	Parameter Range
Calibration ID	Numeric	0-255 Identification number assigned specific calibration
Calibration Checksum	Numeric	0-65535
Engine Speed	RPM	0-6000
Desired Idle	RPM	0-1600
ECT	C, F	-40 C - 151 C, -40 F - 304 F
IAT	C, F	-40 C - 151 C, -40 F - 304 F
MAP	kPa / Volts	8-207 kPa, 0.00 - 4.98 volts
Baro	kPa / Volts	8-207 kPa, 0.00 - 4.98 volts
TP Sensor	Volts	0.00 - 4.98 volts
Throttle Angle	Percent	0 - 100%
Injector A Pulse Width	Milliseconds	0.0 - 500 ms
Injector B Pulse Width	Milliseconds	0.0 - 500 ms
Spark Advance	Degrees	-20 to 69.6484
Cam Retard	Degrees	0 to 90
Knock Retard	Degrees	0 to 89.6484
KS System Enabled	Yes/No	Yes/No
Knock Signal	Yes/No	Yes/No
IAC Position	Counts	0-255 counts
IAC Throttle Follower	Counts	0-255 counts
Closed Throttle	Yes/No	Yes/No
Vessel Speed	MPH	0-255
Battery Ignition Voltage	Volts	0.0 to 25.5
System Voltage Warning	Discrete	OK/Low Voltage
J1-20 Input	Discrete	On/Off
J2-20 Input	Discrete	On/Off
Emergency Stop Mode	Discrete	On/Off
Troll RPM Limit	Discrete	On/Off
Malfunction Indicator Lamp	Discrete	On/Off
Fuel Pump Relay	Discrete	On/Off
Cause Power Reduction	Discrete	On/Off
Power Reduction	Discrete	Yes/No
Overheat Detection	Discrete	Yes/No

Engine Scan Tool List (cont'd)

Scan Tool Parameter	Units	Parameter Range
Oil Pressure Input	Discrete	OK/Low Press
J1-9 Output	Discrete	On/Off
Oil Level Input	Discrete	OK/Low
Buzzer	Discrete	On/Off
J1-19 Input	Discrete	On/Off
J1-22 Output	Discrete	On/Off
J1-4 Input	Discrete	On/Off
J1-23 Output	Discrete	On/Off
Master/Slave	Discrete	Master/Slave
J1-7 RPM Output	Discrete	On/Off
Time From Start	Hour:Minutes:Seconds	00:00:00 - 18:12:15
Engine Hour Meter	Hours	0.0 - 1193046,47 hours
Fuel Consumption	Gallons per hour	0.0 - 255 gph
Fuel Pressure Volts	Volts	0.00 - 5.00 volts
Low Fuel Pressure Warning	Discrete	OK/Low Pressure
Fuel Temp	Volts	0-5 volts

Engine Scan Tool Data Definitions

The Engine Scan Tool Data Definitions contains a brief description of all engine related parameters available on the scan tool.

ECM Data Descriptions

CALIBRATION ID - Scan Tool Range 0-255 - This is an identification number given to each calibration by the OEM.

CALIBRATION CHECKSUM - Scan Tool Range 0-65535 - This number is automatically calculated by the ECM. This number may also be used as a calibration identifier.

ENGINE SPEED - Scan Tool Range 0-9999 RPM - Engine speed is computed by the ECM from the Ignition Control reference input. It should remain close to the desired idle under various engine loads with engine idling.

DESIRED IDLE - Scan Tool Range 0-3187 RPM - The idle speed that is commanded by the ECM. The ECM will compensate for various engine loads based on engine coolant temperature to keep the engine at the desired speed.

ECT - Scan Tool Range -40°C to 151°C, -40°F to 304°F - The Engine Coolant Temperature (ECT) sensor is mounted in the coolant stream and sends engine temperature information to the ECM. The ECM supplies 5 volts to the ECT sensor circuit. The sensor is a thermistor which changes internal resistance as temperature changes. When the sensor is cold (internal resistance high), the ECM monitors a high signal voltage and interprets it as a cold engine. As the sensor warms (internal resistance decreases), the voltage signal will decrease and the ECM will interpret the lower voltage as a warm engine.

IAT - Scan Tool Range -40°C to 151°C, -40°F to 304°F - The ECM converts the resistance of the intake air temperature sensor to degrees. Intake Air Temperature (IAT) is used by the ECM to adjust fuel delivery and spark timing according to incoming air density. (Big Block Multiport Fuel Injection Application Only).

MAP - Scan Tool Range 10-210 kPa/0.00-5.00 Volts - The Manifold Absolute Pressure (MAP) sensor measures the change in the intake manifold pressure from engine load and speed changes. As intake manifold pressure increases, intake vacuum decreases resulting in a higher MAP sensor voltage and kPa reading.

BARO - Scan Tool Range 10-105 kPa/0.00-5.00 Volts - The Barometric Pressure reading displayed is measured from the MAP sensor signal monitored at ignition "ON," engine "OFF" and WOT conditions. The Barometric Pressure is used to compensate for altitude differences.

TP SENSOR - Scan Tool Range 0.00-5.00 Volts - This

is the voltage being monitored by the ECM on the TP sensor signal circuit.

TP-ANGLE - Scan Tool Range 0% - 100% - TP Angle is computed by the ECM from the TP Sensor voltage. TP Angle should display 0% at idle and 100% at wide open throttle.

FUEL CONSUMPTION - Scan Tool Range 0-100 gph - This is the gallons per hour of fuel that the engine is consuming.

INJ. PULSE WIDTH - Scan Tool Range 0-1000 msec. - Indicates the amount of time the ECM is commanding the injectors "ON" during each engine cycle. A larger injector pulse width will cause more fuel to be delivered. Inj. Pulse Width should increase with increased engine load.

SPARK ADVANCE - Scan Tool Range -90° to 90° - This is a display of the spark advance (IC) calculations which the ECM calculates and then provides all spark advance to the ignition system. The ECM computes the desired spark advance using data such as engine temperature, RPM, engine load, vessel speed, and operating mode. There is no adjustment for spark advance. The ECM also uses spark advance to help maintain idle speed. Under normal operating condition, with the engine warmed up and 0% throttle angle, it is normal to see timing vary continuously.

KNOCK RETARD - Scan Tool Range 0.0°-45.5° - Indicates the amount of spark the ECM is removing from IC spark advance in response to the signal from the knock sensor (KS).

KS ENABLED - Scan Tool Displays "YES" or "NO" - This is informing you whether or not the Knock System is enabled.

KNOCK SIGNAL - Scan Tool Displays "YES" or "NO" - Indicates whether or not a knock signal is being detected by the ECM. Should display "NO" at idle.

KNOCK SENSOR 1 - Scan Tool Displays "OK" or "Fault" - Indicates whether or not a fault is being detected on the knock sensor 1 circuit.

KNOCK SENSOR 2 - Scan Tool Displays "OK" or "Fault" - Indicates whether or not a fault is being detected on the knock sensor 2 circuit.

IAC POSITION - Scan Tool Range 0-255 - Displays the commanded position of the idle air control pintle in counts. A larger number of counts means that more air is being commanded through the idle air passage. Idle air control should respond fairly quickly to changes in engine load to maintain desired idle RPM.

IAC THROTTLE FOLLOWER - Scan Tool Range 0-255 - When the throttle is moved from the closed throttle position, some idle air control counts are added to prevent stalling when returned to the closed throttle position.

CLOSED THROTTLE - Scan Tool Displays "YES" or "NO" - Indicates whether the throttle is in the closed position.

VESSEL SPEED - Scan Tool Range 0-255 MPH - Indicates the speed of the vessel in MPH.

BATTERY / IGNITION VOLTAGE - Scan Tool Range 0.0 - 25.5 volts - This represents the system voltage

SYSTEM VOLTAGE WARNING - Scan Tool Displays "OK" or "LOW VOLTAGE" - Indicates if there may be a fault in the charging system.

J2-9 INPUT - Scan Tool Displays "ON" or "OFF" - This is a discrete input to the ECM that is determined and calibratable per OEM.

J2-20 INPUT - Scan Tool Displays "ON" or "OFF" - This is a discrete input to the ECM that is determined and calibratable per OEM.

EMERGENCY STOP MODE - Scan Tool Displays "YES" or "NO" - Indicates whether you are in emergency stop mode or not.

TROLL RPM LIMIT - Scan Tool Displays "ON" or "OFF" - This is a discrete input to the ECM which limits the RPM for such things as trolling. This RPM limit is calibratable by the OEM.

MIL - Scan Tool Displays "ON" or "OFF" - Indicates the ECM commanded state of the Malfunction Indicator Lamp.

FUEL PUMP RELAY - Scan Tool Displays "ON" or "OFF" - Indicates the ECM commanded state of the fuel pump relay driver circuit.

CAUSE POWER REDUCTION - Scan Tool Displays "YES" or "NO" - Indicates whether or not the ECM has recognized a fault which would put the engine into Power Reduction when the appropriate RPM is achieved.

POWER REDUCTION - Scan Tool Displays "YES" or "NO" - Indicates whether or not the ECM is functioning in Power Reduction mode. During this mode, the ECM only triggers one injector driver resulting in fuel to only half of the cylinders.

OVERHEAT DETECTED - Scan Tool Displays "YES" or "NO" - Indicates if the ECM has recognized an overheat condition with the engine.

OIL PRESSURE WARNING - Scan Tool Displays "OK" or "LOW PRESSURE" - Indicates if the ECM has recognized a fault in the oil pressure circuit.

CHECK GAUGES LAMP - Scan Tool Displays "ON" or "OFF" - Indicates the ECM commanded state of the Check Gauges lamp.

BUZZER - Scan Tool Displays "ON" or "OFF" - Indicates the ECM commanded state of the Buzzer.

GENERAL WARNING 1 - Scan Tool Displays "OK" or "Fault Detected" - This is a discrete input to the ECM that is determined and calibratable per OEM.

J1-21 OUTPUT - Scan Tool Displays "ON" or "OFF" - Indicates the ECM commanded state of this output circuit.

GENERAL WARNING 2 - Scan Tool Displays "OK" or "Fault Detected" - This is a discrete input to the ECM that is determined and calibratable per OEM.

J1-22 OUTPUT - Scan Tool Displays "ON" or "OFF" - ECM driven output that is determined and calibratable per OEM.

ECM MASTER / SLAVE - Scan Tool Displays "MASTER" or "SLAVE" - Indicates whether you are receiving data from a master or a slave engine.

J1-8 RPM OUTPUT - Scan Tool Displays "ON" or "OFF" - ECM driven output that is determined and calibratable per OEM.

TIME FROM START - Scan Tool Range 00:00:00-99:99:99 Hrs:Min:Sec - Indicates the amount of time the ignition key was in the "ON" or "RUN" position. Once the key has been cycled to the "OFF" position, this counter will reset to 00:00.

ENGINE HOUR METER - Scan Tool Range 00:00:00-99:99:99 Hrs:Min:Sec - Indicates the engine run time.

ECM Diagnostic Trouble Codes

The Malfunction Indicator Lamp (MIL) will be "ON" if the malfunction exists under the conditions listed below. If the malfunction clears, the lamp will go out and the Diagnostic Trouble Code (DTC) will be stored in the ECM. Any DTC's stored will be erased if no problem re-occurs within 50 engine starts. The amount of time after the malfunction occurs before the MIL illuminates is calibratable. (Instantly or up to one minute).

Many of the DTC tables include a functional check of the system that may pinpoint a problem. However, it is important to remember that the DTC tables are specifically designed for use only when a DTC is set. Therefore, a thorough understanding of the normal operation of the system being diagnosed is necessary, and use of the tables for this purpose is at the discretion of the technician.

NOTICE: Some DTC's are referred as "Latching Codes." A latching code will cause the MIL lamp to stay "ON" during an ignition cycle whether the malfunction is corrected or not. This also means you can not clear the DTC during the same ignition cycle.

Diagnostic Trouble Code (DTC) Table

DTC	Description
13	Oxygen Sensor Circuit 1 (inactive)
13	Oxygen Sensor Circuit 2 (inactive)
14	Engine Coolant Temperature (ECT) Sensor Circuit. Low Temperature Indicated
15	Engine Coolant Temperature (ECT) Sensor Circuit High Temperature Indicated
21	Throttle Position (TP) Sensor Circuit High Signal Voltage Indicated
22	Throttle Position (TP) Sensor Circuit Low Signal Voltage Indicated
23	Intake Air Temperature (IAT) Sensor Circuit Low Temperature Indicated
24	Not Used
25	Intake Air Temperature (IAT) Sensor Circuit High Temperature Indicated
31	Not Used
33	Manifold Absolute Pressure (MAP) Sensor Circuit High Signal Voltage Indicated
34	Manifold Absolute Pressure (MAP) Sensor Circuit Low Signal Voltage Indicated
41	Ignition Control (IC) H Fault
41	Ignition Control (IC) G Fault
41	Ignition Control (IC) F Fault
41	Ignition Control (IC) E Fault
41	Ignition Control (IC) D Fault
41	Ignition Control (IC) C Fault
41	Ignition Control (IC) B Fault
41	Ignition Control (IC) A Fault
44	Knock Sensor (KS) 1 Circuit
44	Knock Sensor (KS) 2 Circuit
51	Calibration Checksum Failure
54	Not Used

Diagnostic Trouble Code (DTC) Table (cont'd)

DTC	Description
55	Not Used
61	Not Used
62	Not Used
63	Not Used
64	Not Used
81	Crankshaft Position (CKP) Sensor Circuit Fault
81	Camshaft Position (CMP) Sensor Circuit Fault
81	Injector Driver A Circuit High, Low, Open
81	Injector Driver B Circuit High, Low, Open
81	Recirc J1-32 Fault
81	5 Volt Reference Circuit Out of Range
81	DEPSPWR Circuit out of Range
81	CAN Bus Fault

Logged Warnings

These warnings will be displayed following the Diagnostic Trouble Codes. They can be cleared the same as the trouble codes. Unlike trouble codes, these warnings can not be flashed out through the MIL using the DTC tool.

Clearing Diagnostic Trouble Codes - Non Scan

1. Install Diagnostic Trouble Code (DTC) tool.
2. Ignition "ON," engine "OFF."
3. Switch DTC tool to "service mode" or "ON."
4. Move the throttle from 0% (idle) to 100% (WOT) and back to 0%.
5. Switch DTC tool to "normal mode" or "OFF." (If this step is not performed, the engine may not start and run).
6. Turn ignition "OFF" for at least 20 seconds.
7. Ignition "ON," engine "OFF."
8. Switch DTC tool to "service mode" or "ON" and verify DTC 12 only. Remove MDTC tool.
9. If original DTC's are still present, check "Notice" below and repeat the DTC clearing procedure.
10. If new DTC's are displayed, perform the "On-Board Diagnostic" (OBD) system check.

Clearing Diagnostic Trouble Codes - Scan

1. Install scan tool.
2. Start engine.
3. Select "Clear DTC's" function.
4. Clear DTC's.
5. Turn ignition "OFF" for at least 20 seconds.
6. Turn ignition "ON" and read DTC's. If DTC's are still present, check "Notice" below and repeat procedure following from step 2.

NOTICE: When clearing DTC's with or without the use of a scan tool, the ignition must be cycled to the "OFF" position or the DTC's will not clear.

System Configuration Options

Scan Tool Parameter	Units	Parameter Range
Cam Sensor	Discrete	Yes/No
58x Crank Sensor	Discrete	Yes/No
7x Crank Sensor	Discrete	Yes/No
24x Encoded Crank Sensor	Discrete	Yes/No
TAC Module Present	Discrete	Yes/No
Knock Sensor	Discrete	Yes/No
Intake Air Temperature	Discrete	Yes/No
GPH Calculation Enabled	Discrete	Yes/No
Alternate Fuel Spark Curve	Discrete	Yes/No
2-Atmosphere Map	Discrete	Yes/No
MPH Sensor	Discrete	Yes/No
Load Anticipate1	Discrete	Yes/No
Load Anticipate 2	Discrete	Yes/No
RPM Change State	Discrete	Yes/No
Troll Mode	Discrete	Yes/No
Shift Interrupt	Discrete	Yes/No
Twin Engine Shift Sync.	Discrete	Yes/No
Emergency Stop	Discrete	Yes/No
Power Balance	Discrete	Yes/No
Fuel Temperature Sensor	Discrete	Yes/No
Fuel Pressure Sensor	Discrete	Yes/No
Bosch IAT/MAP Sensor	Discrete	Yes/No

Diagnosis

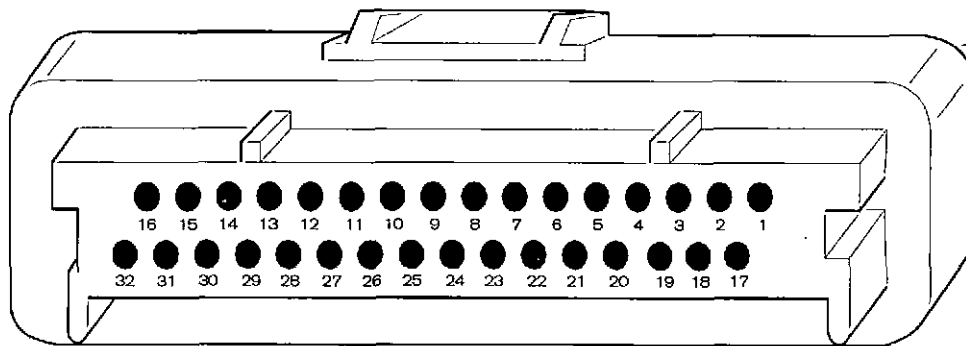
The diagnostic tables and functional checks in this manual are designed to locate a faulty circuit or component through logic based on the process of elimination. The tables are prepared with the requirement that the system functioned correctly at the time of assembly and that there are no multiple failures.

Engine control circuits contain many special design features not found in standard vehicle wiring. Environmental protection is used extensively to protect electrical contacts. Proper splicing methods must be used when necessary.

The proper operation of low amperage input/output circuits depend upon good continuity between circuit connectors. It is important before component replacement and/or during normal troubleshooting procedures that a visual inspection of any questionable mating connector is performed. Mating surfaces should be properly formed, clean and likely to make proper contact. Some typical causes of connector problems are listed below:

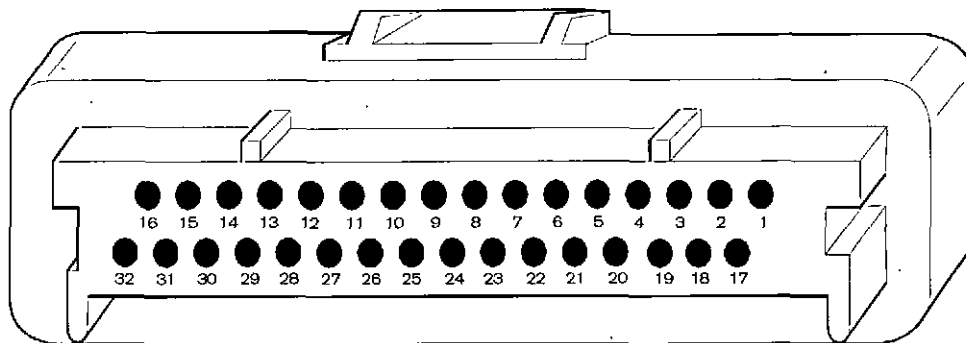
- Improperly formed contacts and/or connector housing.
- Damaged contacts or housing due to improper engagement.
- Corrosion, sealer or other contaminants on the contact mating surfaces.
- Incomplete mating of the connector halves during initial assembly or during subsequent troubleshooting procedures.
- Tendency for connectors to come apart due to vibration and/or temperature cycling.
- Terminals not fully seated in the connector body.
- Inadequate terminal crimps to the wire.

J-1 ECM 32 Pin Connector



J1-1	SB/GN	KNOCK SENSOR 2 SIGNAL (OPTIONAL)
J1-2	W/SB	DIAGNOSTIC TEST TERMINAL
J1-3	Y/GR	MASTER/SLAVE
J1-4		
J1-5		
J1-6	SB/Y	FUEL PUMP RELAY CONTROL
J1-7		RPM CHANGE STATE
J1-8	T/SB	ALARM
J1-9		
J1-10		
J1-11	T/OR	FUEL INJECTOR B DRIVER
J1-12		
J1-13	SB	ECM GROUND
J1-14	GR	TACHOMETER OUTPUT
J1-15	GN/SB	IDLE AIR CONTROL (IAC) COIL B LOW
J1-16	BL/Y	IDLE AIR CONTROL (IAC) COIL A HIGH
J1-17	SB/GN	KNOCK SENSOR 1 SIGNAL
J1-18		
J1-19		
J1-20		SHIFT INTERRUPT
J1-21		
J1-22		
J1-23		
J1-24		
J1-25		
J1-26	T/BL	FUEL INJECTOR A DRIVER
J1-27	GN/Y	IDLE AIR CONTROL (IAC) COIL B LOW
J1-28	SB	ECM GROUND
J1-29	BLK	ECM GROUND
J1-30	P/BL	IDLE AIR CONTROL (IAC) COIL B HIGH
J1-31	BN/Y	IDLE AIR CONTROL (IAC) COIL A LOW
J1-32		

J-2 ECM 32 Pin Connector



J2-1	R/PU	BATTERY FEED
J2-2	GR/OR	5 VOLT REFERENCE
J2-3	SB/OR	SENSOR GROUND
J2-4		FUEL PRESSURE SENSOR SIGNAL
J2-5		
J2-6		
J2-7	Y/BL	ECT SENSOR SIGNAL
J2-8	LT GN	MAP SENSOR SIGNAL
J2-9		
J2-10	OR/SB	SERIAL DATA
J2-11		
J2-12	BL/W	IGNITION CONTROL H
J2-13	GN/W	IGNITION CONTROL F
J2-14	R	IGNITION CONTROL D
J2-15	PU	IGNITION CONTROL B / BYPASS (DISTRIBUTOR APP.)
J2-16	GR/BL	CRANK SENSOR SIGNAL
J2-17	SB/W	DEPSPOWER
J2-18	GR/SB	DEPSLO
J2-19	P/W	IGNITION FEED
J2-20	T/SB	OIL PRESSURE INPUT
J2-21	T/Y	IAT SENSOR SIGNAL
J2-22		
J2-23	OR/BL	TP SENSOR SIGNAL
J2-24		
J2-25		
J2-26		
J2-27		
J2-28	GN	IGNITION CONTROL G
J2-29	LT BL	IGNITION CONTROL E
J2-30	R/W	IGNITION CONTROL C
J2-31	PU/W	IGNITION CONTROL A
J2-32	SB/T	CAM SENSOR SIGNAL

Diagnostic Information and Procedures

A Diagnostic Starting Point - Engine Controls

Begin the system diagnosis with *A Diagnostic System Check-Engine Controls*. The Diagnostic System Check will provide the following information:

- The ability of the control module to communicate through the serial data circuit.
- The identification of any stored Diagnostic Trouble Codes (DTCs) and Logged Warnings.

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system.

A Diagnostic System Check - Engine Controls

Description

The Diagnostic System Check is an organized approach to

identifying a condition that is created by a malfunction in the electronic engine control system. The Diagnostic System Check must be the starting point for any drivability concern. The Diagnostic System Check directs the service technician to the next logical step in order to diagnose the concern. Understanding, and correctly using the diagnostic table reduces diagnostic time, and prevents the replacement of good parts.

Test Description

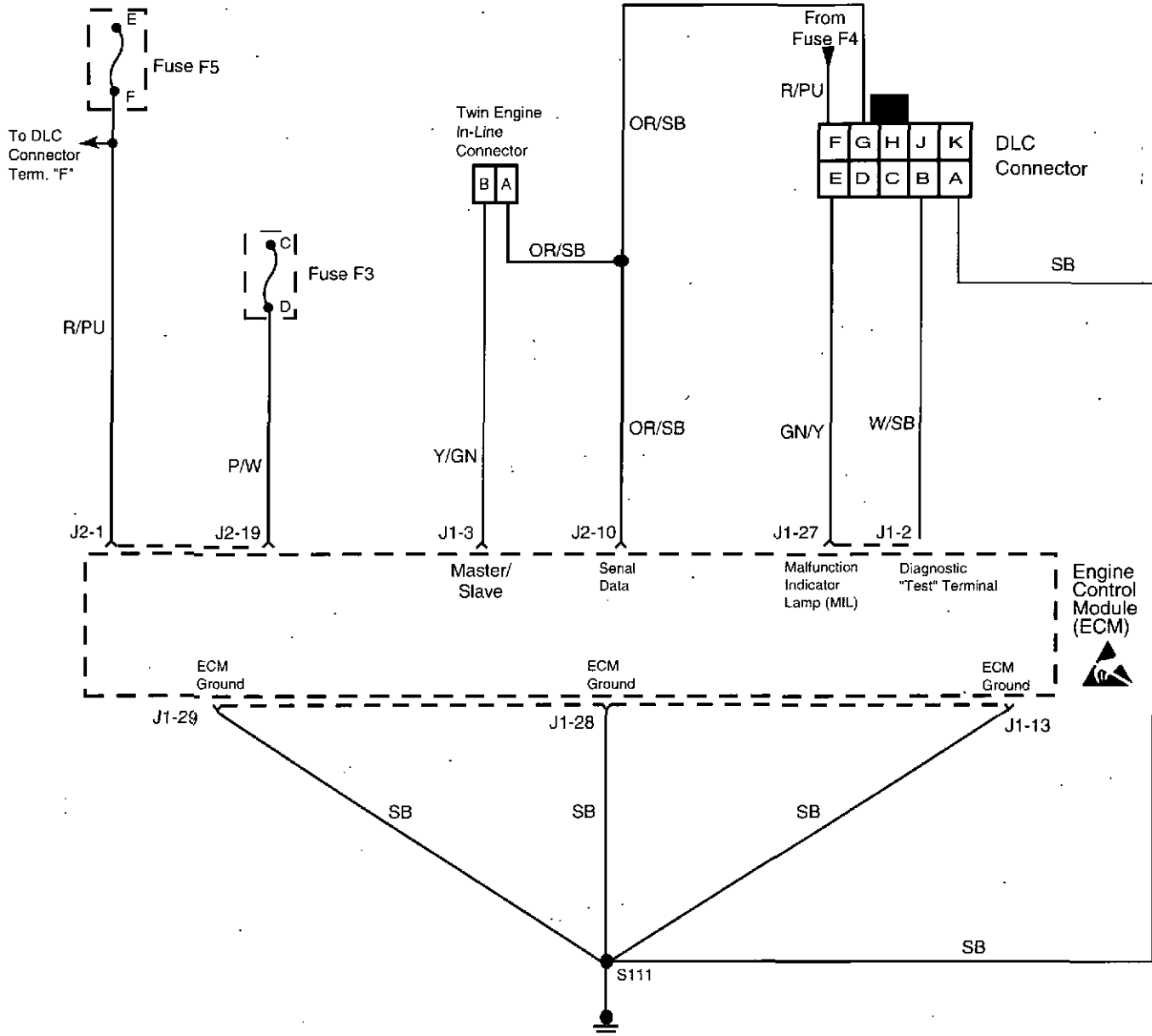
Number(s) below refer to the Step number(s) on the Diagnostic Table:

1. The MIL should be "ON" steady with the ignition "ON," engine "OFF." If not, Table A-1 should be used to isolate the malfunction.
3. Checks the serial data circuit and ensures that the ECM is able to transmit serial data.
5. If the engine will not start, Table A-3 should be used to diagnose the condition.
8. A scan tool parameter which is not within the typical range may help to isolate the area which is causing the problem.

On-Board Diagnostic (OBD) System Check - Scan

Step	Action	Value	Yes	No
1	<p>Important:</p> <ul style="list-style-type: none"> • Do not perform this diagnostic if there is not a drivability concern, unless another procedure directs you to this diagnostic. • Before you proceed with diagnosis, search for applicable service Bulletins. • Unless a diagnostic procedure instructs you, DO NOT clear DTC's. • If there is a condition with the starting system, repair that first. • Insure the battery has a full charge. • Ensure the battery cables are clean, tight, and the correct size. • Ensure the ECM grounds are clean, tight, and in the correct location. <p>Install a Scan Tool. Does the scan tool turn ON?</p>	-	Go to Step 2	Go to Data Link Connector Diagnosis
2	<p>Attempt to start the engine. Does the engine start and idle</p>	-	Go to Step 3	Go to Engine Cranks But Does Not Run
3	<p>Select the DTC display function on the Scan tool. Does the scan tool display DTCs?</p>	-	Go to Applicable DTC Table	Go to Step 4
4	<p>1. Review the following symptoms. 2. refer to the applicable symptom diagnostic table</p> <p>Hard Start Surges Lack of Power Detonation/Spark Knock Hesitation Cuts out, Misses Poor Fuel Economy Rough, Unstable or Incorrect Idle and Stalling Dieseling, Run-On Backfire</p> <p>Did you find and correct the condition?</p>	-	System OK	Go to Intermittent Conditions

Data Link Connector Diagnosis



4302

Circuit Description

Use a properly functioning scan tool with the diagnostic tables in this section. **DO NOT** clear the DTC's unless directed by a diagnostic procedure. Clearing the DTC's may also clear valuable diagnostic information.

Test Description

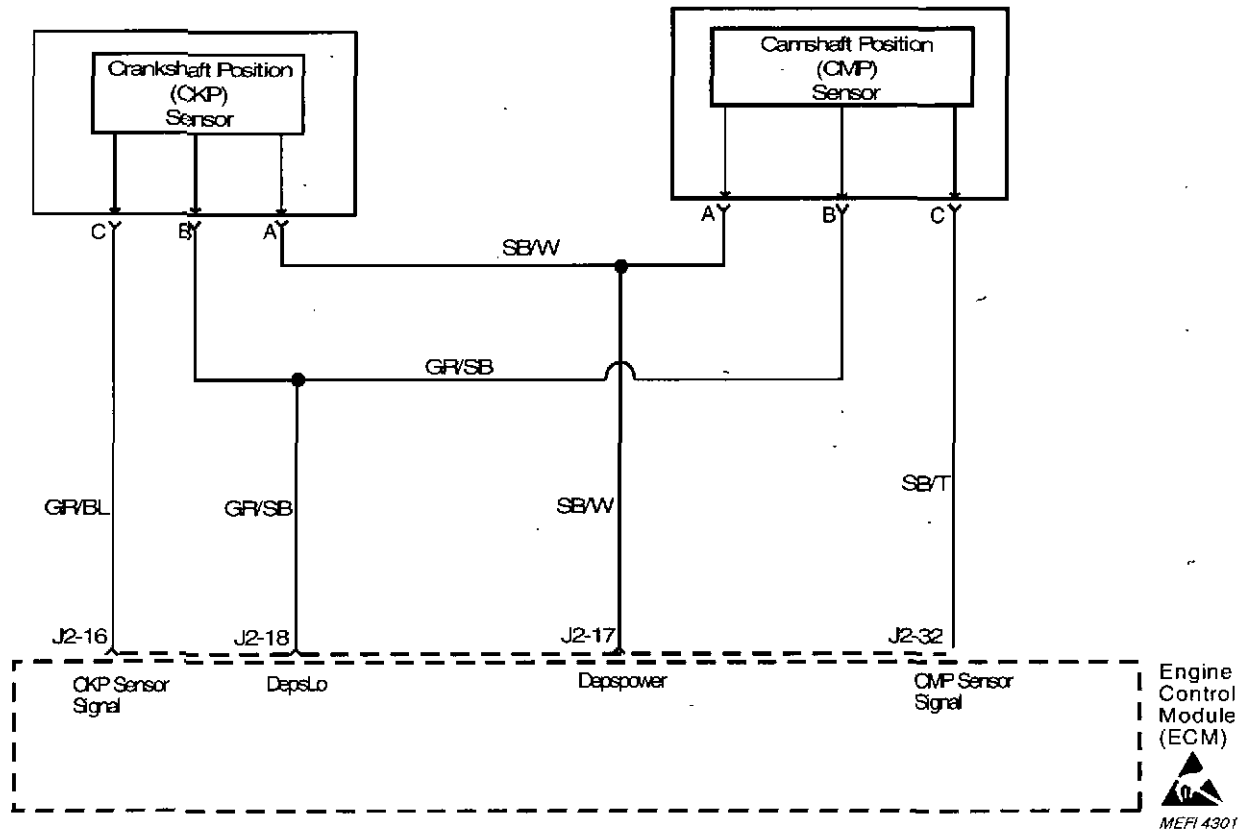
Number(s) below refer to the step number(s) on the diagnostic table:

3. An engine that just cranks and does not attempt to start indicates that the ECM is not powered-up.
5. This step is checking for a B+ supply to the Data Link Connector (DLC).
6. A ground must be available for the scan tool to function properly.
9. A no start condition occurs when the fuse(s) for the battery or ignition feed circuits is open. The MIL is inoperative when the battery and ignition feed circuit fuses open. Inspect the circuits for being grounded when either of these fuses open.
12. The scan tool does not communicate when the serial data circuit from the ECM to the DLC is open.
14. If the test lamp not illuminate for a circuit, inspect the fuse for being open. If the fuse is open, inspect the circuit for a short to ground.
15. Inspect for an open ground circuit.
16. Inspect for an open fuse that supplies the DLC. If the fuse is open, repair the grounded circuit.

Data Link Connector Diagnosis

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Important: This test assumes that the Scan tool you are using is functional. 1. Turn ON the ignition leaving the engine OFF. 2. Connect the Scan tool to the DLC. Does the scan tool power-up?	-	Go to Step 3	Go the Step 5
3	Does the engine start and continue to run?	-	Go to Step 6	Go to Step 4
4	Does the engine start and stall?	-	Go to Step 12	Go to Step 9
5	1. Disconnect the Scan tool for the DLC. 2. Turn ON the ignition leaving the engine OFF. 3. Probe the DLC terminal F using a test lamp connected to the battery ground. Is the test lamp illuminated?	-	Go to Step 6	Go to Step 16
6	Probe the DLC terminal A using a test lamp connected to B+ Is the test lamp illuminated?	-	Go to Step 7	Go to Step 8
7	Inspect the scan tool connections at the DLC. Also inspect the terminals for proper terminal tension at the DLC. Did you find and repair the condition?	-	Go to OBD System Check	Go to Step 12
8	Repair the open ground circuit to the DLC terminal A. Is the action complete?	-	Go to OBD System Check	-
9	1. Turn OFF the ignition. 2. Disconnect the ECM J-2 connector. 3. Turn the ignition ON leaving the engine OFF. 4. Probe the ECM battery and ECM ignition feed circuits (J2-1 and J2-19) in the ECM harness connector using a test lamp connected to ground. Does the test lamp illuminate for each circuit?	-	Go to Step 10	Go to Step 14
10	1. Turn OFF the ignition. 2. Disconnect the ECM connector J1 3. Measure the resistance between the battery ground and the ECM ground circuits J1-12, J1-28 and J1-29 in the ECM harness connectors using a digital multimeter (DMM). Does the DMM display between the specified range on each circuit?	0-2 Ohms	Go to OBD System Check	Go to Step 15
11	Inspect the ECM for proper connections. Did you find and correct the condition	-	Go to OBD System Check	Go to Step 13
12	Inspect the serial data circuit for open, shorted or a poor connection at the ECM. Did you find and repair the condition?	-	Go to OBD System Check	Go to Step 13
13	Replace the ECM. Is the action complete?	-	Go to OBD System Check	-
14	Repair the circuit that did not illuminate the test lamp. Is the action complete?	-	Go to OBD System Check	-
15	Repair the faulty ECM ground circuits. Is the action complete?	-	Go to OBD System Check	-
16	Repair the faulty B+ supply circuit. Is the action complete	-	Go to OBD	-

Engine Cranks but Does Not Run



Circuit Description

The Engine Cranks but Does Not Run diagnostic table assumes that battery condition and engine cranking speed are OK. If the battery condition and the cranking speed are not OK, refer to those conditions first. Make sure that there is adequate fuel in the fuel tank(s).

Test Description

Number(s) below refer to the step number(s) on the diagnostic table:

4. It may be necessary to connect a battery charger to the battery for this step. If the battery state of charge is low, the scan tool may reset during the cranking test.
5. This step tests the system relay for proper operation. The system relay supplies voltage to the injectors and the ignition coils. When the system relay is not operating properly, a no start condition occurs. If the test lamp does not illuminate, this indicates the system relay is not supplying a voltage to the fuses.
6. The Crankshaft Position sensor is located at the left rear of the engine.
7. The Camshaft Position sensor is located in the front engine cover.
8. The ignition feed circuit for the Camshaft and Crankshaft Position sensors is internally connected within the ECM. A short to ground on either circuit will cause a no start condition.
10. You may need to get close to the fuel pump in order to hear if the fuel pump is operating.
12. At this point, the engine should start. Refer to *Hard Start Symptom* for further diagnosis.

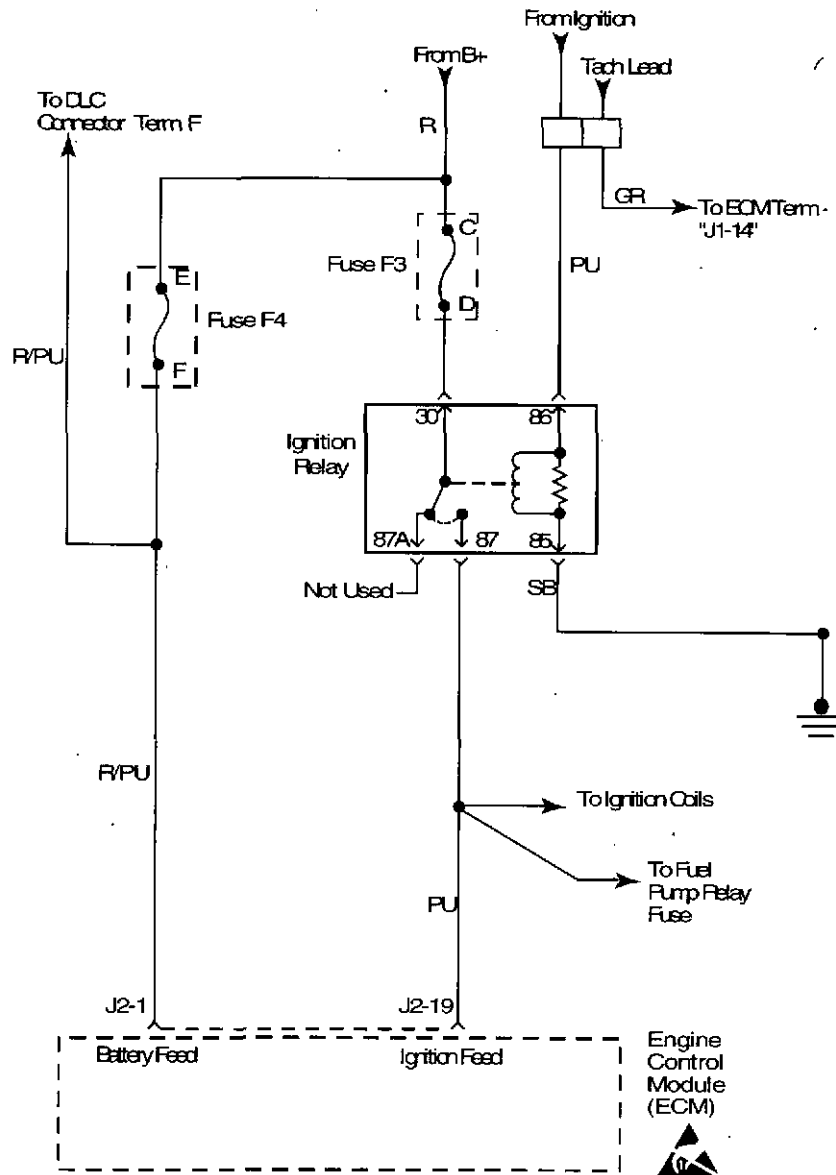
Engine Cranks but Does Not Run

Step	Action	Value	Yes	No
1.	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Important: Refer to the applicable DTC table if DTC 41 or 81 are set. Monitor the engine speed while cranking the engine. Is the engine RPM indicated on the scan tool?		Go to Step 3	Go to Step 4
3	1. Turn ON the ignition leaving the engine OFF. 2. Probe both sides of the fuses listed below using a test lamp connected to ground. <ul style="list-style-type: none">• Fuse F3• Fuse F4		Go to Step 7	Go to System Relay Diagnosis
4	1. Disconnect the Crankshaft Position Sensor (CKP) electrical connector 2. Measure the voltage at the ignition feed circuit at the CKP electrical connector using a Digital Multi-meter. Does the DMM display near the specified voltage?	B+	Go to Step 1.1	Go to Step 5
5	1. Disconnect the Camshaft Position Sensor (CMP) electrical connector. 2. Measure the voltage at the ignition feed circuit at the CMP electrical connector using a Digital Multi-meter. Does the DMM display the specified voltage?	B+	Go to Step 12	Go to Step 6
6	Inspect the Camshaft and Crankshaft Position sensor ignition feed circuits for a short to ground. Did you find and correct the condition?		Go to Step 14	Go to Step 13
7	Monitor the engine coolant temperature using the scan tool. Is the engine coolant temperature on the scan tool close to the actual engine temperature?		Go to Step 8	Go to DTC 15 ECT Sensor Circuit High Volt
8	Enable the fuel pumps using the scan tool. Do the pumps operate?		Go to Step 9	Go to Fuel System Relay Diagnosis
9	1. Turn OFF the ignition. 2. Install a fuel pressure gauge. Important: The fuel pumps operate for about 2 seconds when the ignition is turned ON. The fuel pressure must be observed when the fuel pumps are operating. 3. Turn ON the ignition leaving the engine OFF. 4. Observe the fuel pressure with the fuel pumps operating. Is the fuel pressure within the specified range?	379-427 kPa (55-62) psi	Go to Step 10	Go to Fuel System Diagnosis

Engine Cranks but Does Not Run (cont'd)

Step	Action	Value	Yes	No
10	<p>Perform the following additional inspections:</p> <ul style="list-style-type: none"> Inspect the throttle angle is at 0% at closed throttle. If the throttle angle is not 0%, refer to DTC 21 Throttle Position (TP) sensor circuit Low Voltage. Inspect the spark plugs for gas fouling. If the spark plugs are fouled, determine what caused the rich condition. Inspect for an engine mechanical failure that causes an engine not to start (i.e. slipped timing chain, low compression, etc.) Refer to Engine Compression test in the Engine Components Workshop Manual. Compare the MAP/BARO parameters to another engine. The parameter values should be close to each other. 	–	Go to Step 14	Go to Hard Start for Diagnosis
11	<p>Replace the CKP sensor. Refer to Crankshaft Position Sensor Replacement.</p> <p>Is the action complete?</p>	–	Go to Step 14	–
12	<p>Replace the CMP sensor. Refer to Camshaft Position Sensor Replacement.</p> <p>Is the action complete?</p>	–	Go to Step 14	–
13	<p>Replace the ECM</p> <p>Is the action complete?</p>	–	Go to Step 14	–
14	<ol style="list-style-type: none"> Select the Diagnostic Trouble codes (DTC) option and clear the DTC option using the scan tool. Attempt to start the engine. <p>Does the engine start and continue to run?</p>	–	Go to Step 15	Go to Step 2
15	<ol style="list-style-type: none"> Idle the engine at normal operating temperature. Select the Diagnostic Trouble Codes (DTC) option using the scan tool. <p>Are there any DTCs displayed</p>	–	Go to the applicable DTC table	System OK

Ignition Relay Diagnosis



MEFI 4303

Circuit Description

The system relay powers the following components:

- Injectors
- Ignition Coils

Diagnostic Aids

The following may cause an intermittent:

- Poor connections. Check for adequate terminal tension.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

Test Description

Number(s) below refer to the step number(s) on the

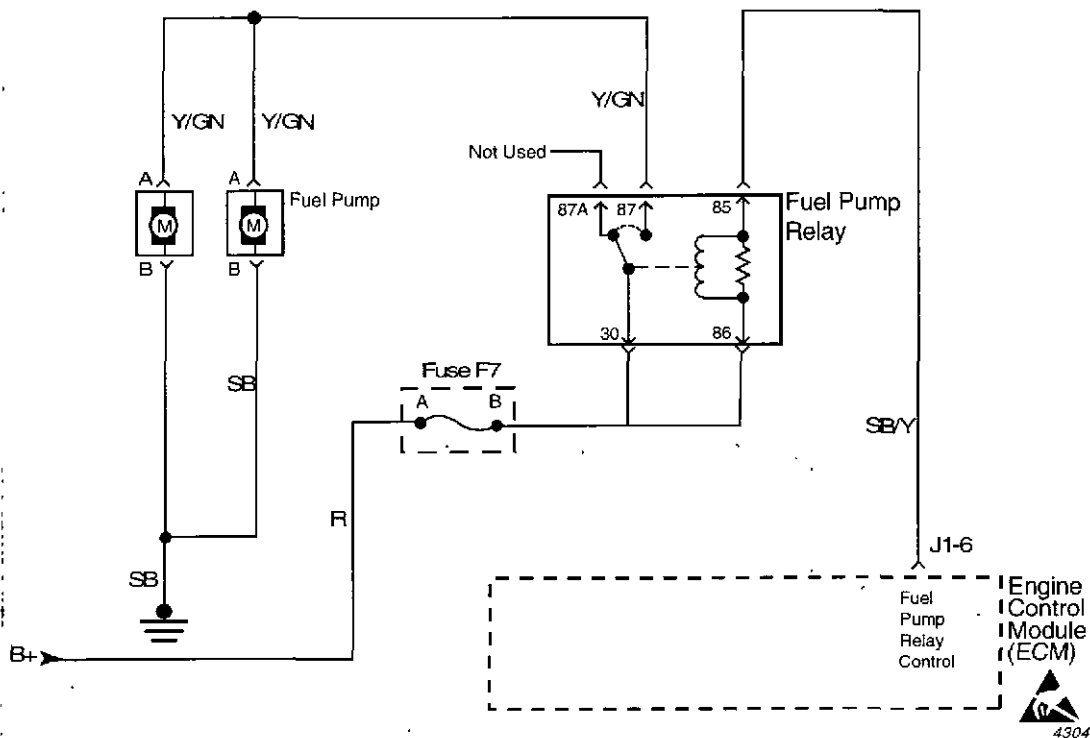
diagnostic table:

2. Refer to Thumbnail Schematic for proper relay terminal identification.
4. This step is testing the relay ground circuit.
5. This step isolates the circuit from the system relay. All of the circuits are good if the test lamp illuminates.
9. The open circuit will be between the splice and the system relay.

Ignition Relay Diagnosis

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board Diagnostic (OBD) System check?	–	Go to Step 2	Go to OBD System Check
2	1. Turn OFF the ignition. 2. Remove the ignition relay from the socket in the fuse box. 3. Probe the ignition relay B+ feed circuit (switch side of the relay) using a test lamp connected to a ground. Does the test lamp illuminate?	–	Go to Step 3	Go to Step 8
3	1. Turn ON the ignition leaving the engine OFF. 2. Probe the ignition relay ignition feed circuit using a test lamp connected to a ground. Does the lamp illuminate?	–	Go to Step 4	Go to Step 9
4	1. Turn OFF the ignition. 2. Measure the resistance of the ignition relay ground circuit using a Digital Multi-meter connected to battery ground. Is the resistance less than the specified value?	0-5 Ohms	Go to Step 5	Go to Step 10
5	1. Turn OFF the ignition. 2. Jumper the ignition relay B+ feed circuit and the ignition relay load circuit together using a fused jumper wire. 3. Probe the fuses for the following components with a test lamp connected to a ground. • Injectors • Ignition Coils Does the lamp illuminate?	–	Go to Step 6	Go to Step 11
6	Inspect for poor terminal contact at the ignition relay connector Did you find and correct the condition?	–	System OK	Go to Step 7
7	Replace the ignition relay. Is the action complete?	–	System OK	–
8	Repair the open B+ supply to the ignition relay. Is the action complete?	–	System OK	–
9	Repair the ignition feed circuit to the ignition relay. Is the action complete?	–	System OK	–
10	Repair the ignition relay ground circuit. Is the action complete?	–	System OK	–
11	Repair the ignition relay load circuit. Is the action complete?	–	System OK	–

Fuel Pump Relay Circuit Diagnosis



Circuit Description

When the ignition switch is ON, the ECM activates the electric fuel pump. The fuel pump remains ON as long as the ECM receives reference pulses from the ignition system. If there are no reference pulses, the ECM turns the fuel pump OFF after about 2 seconds. The pump delivers fuel to the fuel rail and injectors, then to the pressure regulator, where the system pressure remains at 379-427 kPa (55-62 psi) while the fuel pump is running. Excess fuel returns to the fuel tank. When the engine is stopped, a scan tool in the output controls function can turn ON the fuel pump.

Improper fuel system pressure results in one or many of the following symptoms:

- Cranks but will not run
- Cuts out, may feel like an ignition problem
- Poor fuel economy
- Loss of power
- Hesitation
- DTCs

Diagnostic Aids

The following conditions may have caused the fuel pump fuse to open:

- The fuse is faulty
- There is an intermittent short in the fuel pump power feed circuit.
- The fuel pump has an intermittent internal problem.

For an intermittent condition, refer to *Symptoms*.

Test Description

Number(s) below refer to the step number(s) on the diagnostic table:

3. Refer to Thumbnail Schematic for proper terminal identification.
5. The test lamp only illuminates for two seconds even through the scan tool commanded position is ON. You will have to command the fuel pump OFF then ON to re-enable the ECM fuel pump control.
12. Inspect the fuel pump fuse for an open. If the fuse is open, inspect the circuit for a short to ground.
20. Inspect the fuel pump fuse for an open. If the fuse is open, inspect the circuit for a short to ground.

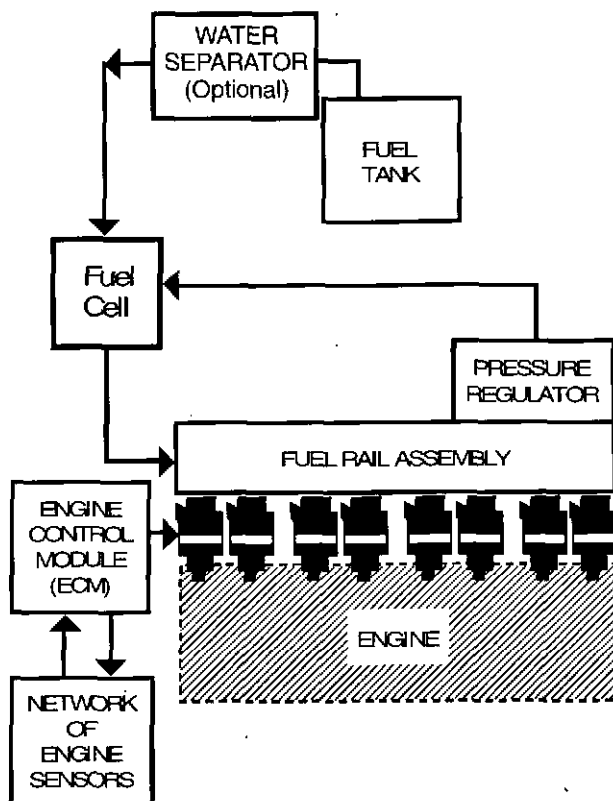
Fuel Pump Relay Circuit Diagnosis

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board Diagnostic (OBD) System Check?	-	Go to Step 2	Go to OBD System Check
2	Check the fuel pump fuse (F7). Is the fuse open?	-	Go to Step 9	Go to Step 3
3	1. Install a scan tool. 2. Remove the fuel pump relay. 3. Turn the ignition ON, leave the engine OFF. 4. Probe the fuel pump relay battery feed circuit at the socket with a test lamp connected to a ground. Does the test lamp illuminate?	-	Go to Step 4	Go to Step 12
4	Probe the fuel pump relay ground circuit at the socket with a test lamp connected to B+. Does the test lamp illuminate?	-	Go to Step 5	Go to Step 13
5	1. Probe the fuel pump control circuit at the harness connector with a test lamp connected to a ground. 2. Enable the fuel pumps using the scan tool. Does the test lamp illuminate?	-	Go to Step 6	Go to Step 11
6	Important: Ignition must be ON performing this step. Jumper the fuel pump relay battery feed circuit to the fuel pump load circuit at the fuse box socket with a fused jumper wire. Does the fuel pump operate?	-	Go to Step 18	Go to Step 7
7	1. Leave the fused jumper wire connected. 2. Disconnect the fuel pump harness connectors at the fuel pumps. 3. Probe the power feed circuit in the fuel pump harness connector with a test lamp connected to a ground. Does the lamp illuminate?	-	Go to Step 8	Go to Step 14
8	1. Leave the fused jumper wire connected. 2. Connect the test lamp between the battery feed circuit and the ground circuit in the fuel pump harness connector. Does the lamp illuminate?	-	Go to Step 25	Go to Step 15
9	1. Turn the ignition OFF. 2. Remove the fuel pump fuse. 3. Disconnect the fuel pump harness connector at the fuel pumps. 4. Probe the load circuit for the fuel pump relay at the fuse box socket with a test lamp connected to B+. Does the test lamp illuminate?	-	Go to Step 16	Go to Step 10
10	Probe the battery feed circuit to the fuel pump relay at the harness connector with a test lamp connected to B+. Does the test lamp illuminate?	-	Go to Step 20	Go to Step 21
11	1. Turn the ignition OFF. 2. Disconnect the ECM connector J1. 3. Measure the continuity of the fuel pump relay control circuit for the fuel pump relay harness connector to the ECM connector using a Digital Multi-meter. Does the DMM display the specified value or lower?	5 Ohms	Go to Step 22	Go to Step 17
12	Repair the open or grounded battery feed circuit to the relay. Replace the fuel pump fuse (F7) if the fuse is open. Is the action complete?	-	Go to Step 26	-

Fuel Pump Relay Circuit Diagnosis (cont'd)

Step	Action	Value(s)	Yes	No
13	Repair the open fuel pump relay ground circuit. Is the action complete?	-	Go to Step 26	-
14	Repair the open circuit between the fuel pump relay and the fuel pump. Is the action complete?	-	Go to Step 26	-
15	Repair the open fuel pump ground circuit. Is the action complete?	-	Go to Step 26	-
16	Repair the short to ground in the fuel pump relay load circuit between the relay and the fuel pump. Is the action complete?	-	Go to Step 26	-
17	Repair the fuel pump relay control circuit. Is the action complete?	-	Go to Step 26	-
18	Inspect for poor connections at the relay socket in the fuse box. Did you find and correct the condition?	-	Go to Step 26	Go to Step 19
19	Replace the fuel pump relay. Is the action complete?	-	Go to Step 26	-
20	Repair the short to ground in the battery feed circuit to the fuel pump relay. Is the action complete?	-	Go to Step 26	-
21	1. Turn OFF the ignition. 2. Re-install the fuel pump relay. 3. Install a new fuse. 4. Connect the fuel pump harness to the fuel pumps. 5. Turn ON the ignition leaving the engine OFF. 6. Command the fuel pump relay ON using the scan tool. Is the fuel pump fuse open?	-	Go to Step 24	Go to Diagnostic Aids
22	Inspect for a poor connection at the ECM. Did you find and correct the condition?	-	Go to Step 26	Go to Step 23
23	Replace the ECM. Is the action complete?	-	Go to Step 26	-
24	1. Inspect the fuel pump harness for a short to ground. 2. If you find a short, repair the circuit as necessary. Did you find and correct the condition?	-	Go to Step 26	Go to Step 25
25	Important: Inspect for poor electrical connections at the fuel pump harness before replacing the fuel cell. Replace the fuel cell. Is the action complete?	-	Go to Step 26	-
26	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Attempt to start the engine. Does the engine start and continue to operate?	-	Go to Step 27	Go to Step 2
27	1. Idle the engine until the normal operation temperature is reached. 2. Select the Diagnostic Trouble Code (DTC) option. Are there any DTCs displayed?	-	Go to the applicable DTC Table	System OK

Fuel System Diagnosis



MEFI 4305
4-20-00

Circuit Description

When the ignition switch is ON, the ECM activates the electric fuel pumps. The fuel pumps remain ON as long as the ECM receives reference pulses from the ignition system. If there are no reference pulses, the ECM turns the fuel pumps OFF after about 2 seconds.

The electric fuel pumps deliver filtered fuel to the fuel rail assembly. The fuel pumps provide fuel at a pressure above the pressure needed by the fuel injectors. A fuel pressure regulator, attached to the fuel rail, keeps the fuel available to the fuel injectors at a regulated pressure. Unused fuel returns to the fuel cell by a separate fuel return pipe.

Test Description

Number(s) below refer to the step number(s) on the diagnostic table:

2. When the ignition switch is ON and the fuel pumps are running, the fuel pressure indicated by the fuel pressure gauge should read 379-427 kPa (55-62 psi). The spring pressure inside the fuel pressure regulator controls the fuel pressure.
3. A fuel system that drops more than 14 kPa (2 psi) in 10 minutes has a leak in one or more of the following areas:

- The fuel pump check valve.
 - The fuel pump flex pipe.
 - The valve or valve seat within the fuel pressure regulator.
 - The fuel injector(s).
4. A fuel system that drops more than 14 kPa (2 psi) in 10 minutes after being relieved to 69 kPa (10 psi) indicates a leaking fuel pump check valve.
 5. Fuel pressure that drops off during acceleration, cruise or hard cornering may cause a lean condition. A lean condition can cause a loss of power, surging or misfire.
 8. When the engine is at idle, the manifold pressure is low (high vacuum). This low pressure (high vacuum) is applied to the fuel pressure regulator diaphragm. The low pressure (high vacuum) will offset the pressure being applied to the fuel pressure regulator diaphragm by the spring inside the fuel pressure regulator. When this happens, the result is lower fuel pressure. The fuel pressure at idle will vary slightly as the barometric pressure changes, but the fuel pressure at idle should always be less than the fuel pressure noted in step 2 with the engine OFF.

12. A rich condition may result from the fuel pressure being above 427 kPa (62 psi). Drivability conditions associated with rich conditions can include hard starting followed by black smoke, transom sooting and a strong fuel smell in the exhaust.

13. This test determines if the high fuel pressure is due to a restricted fuel return pipe or if the high fuel pressure is due to a faulty fuel pressure regulator.

15. A lean condition may result from the fuel pressure being below 379 kPa (55 psi). Drivability conditions associated with lean conditions can include hard starting (when the engine is cold), hesitation, poor drivability, lack of power, surging and misfiring.


Notice: Do not allow the fuel pressure to exceed 517 kPa (75 psi). Excessive pressure may damage the fuel pressure regulator.

16. Restricting the fuel return pipe with the J 37287 fuel pipe shut-off adapter causes the fuel pressure to rise above the regulated pressure. Using a scan tool to pressurize the fuel system, the fuel pressure should rise above 427 kPa (62 psi) as the valve on the fuel pipe shut-off adapter connected to the fuel return pipe becomes partially closed.

22. Check the spark plug associated with a particular fuel


injector for fouling or saturation in order to determine if that particular fuel injector is leaking. If checking the spark plug associated with a particular fuel injector for fouling or saturation does not determine that a particular fuel injector is leaking, use the following procedure.

1. Remove the fuel rail. Refer to *Fuel Rail Assembly Replacement*.
2. Reinstall the crossover pipe to the right fuel rail. Refer to *Fuel Rail Assembly Replacement*.
3. Connect the fuel feed pipe and the fuel return pipe to the fuel rail. Refer to *Fuel Rail Assembly Replacement*.
4. Lift the fuel rail just enough to leave the fuel injector nozzles in the fuel injector ports.

 *Caution:* To reduce the risk of fire and personal injury that may result from fuel spraying on the engine, verify that the fuel rail is positioned over the fuel injector ports. Also verify that the fuel injector retaining clips are intact.

5. Pressurize the fuel system by using the scan tool fuel pump enable.
6. Visually and physically inspect the fuel injector nozzles for leaks.

Fuel System Diagnosis

 *Caution:* Wrap a shop towel around the fuel pressure connection to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.

Step	Action	Value(s)	Yes	No
1	Did you perform the On-Board Diagnostic (OBD) System Check?	—	Go to Step 2	Go to OBD System Check
2	1. Turn OFF the ignition. 2. Install the J34730-1A fuel pressure gauge. 3. Place the bleed hose from the fuel pressure gauge into an approved gasoline container. 4. Turn ON the ignition leaving the engine OFF. 5. Bleed the air out of the fuel pressure gauge. 6. Turn the ignition OFF for 10 seconds. 7. Turn the ignition ON leaving the engine OFF. Important: The fuel pumps will run for approximately 2 seconds. Cycle the ignition as necessary in order to achieve the highest possible fuel pressure. 8. Observe the fuel pressure with the fuel pumps running. Is the fuel pressure within specified limits?	379-427 kPa (55-62 psi)	Go to Step 3	Go to Step 12

Fuel System Diagnosis (cont'd)

Step	Action	Value(s)	Yes	No
3	<i>Important: The fuel pressure may vary slightly when the fuel pumps stop running. After the pumps stop, the fuel pressure should stabilize and remain constant.</i> Does the fuel pressure drop more than the specified value in 10 minutes?	> 14 kPa (2 psi)	Go to Step 10	Go to Step 4
4	Relieve the fuel pressure to the first specified value. Does the fuel pressure drop more than the second specified value in 10 minutes.	69kPa (10 psi) 14kPa (2 psi)	Go to Step 19	Go to Step 5
5	Do you suspect the fuel pressure is dropping-off during acceleration, cruise or hard turning?	-	Go to Step 6	Go to Step 8
6	Visually and physically inspect the following items for a restriction: • Fuel Filter • Fuel feed pipe Did you find a restriction?	-	Go to Step 24	Go to Step 7
7	1. Start the engine. 2. Allow the engine to idle at normal operating temperature. Does the fuel pressure drop by the specified amount?	21-69kPa (3-10 psi)	Go to Symptoms	Go to Step 8
8	1. Disconnect the vacuum hose from the fuel pressure regulator. 2. With the engine idling, apply 30-35 cm. Hg. (12-14 in. Hg.) to the fuel pressure regulator. Does the fuel pressure drop by the specified amount?	21-69kPa (3-10 psi)	Go to Step 19	Go to Step 20
9	1. Relieve the fuel pressure. 2. Disconnect the fuel feed pipe and the fuel return pipe from the fuel rail. 3. Install the J 37287 fuel pipe shut-off adapters between the fuel feed pipe and the fuel return pipe and the fuel rail. 4. Open the valves on the fuel pipe shut-off adapters. 5. Turn the ignition ON. 6. Pressurize the fuel system using the scan tool. 7. Place the bleed hose of the fuel pressure gauge into an approved gasoline container. 8. Bleed the air out of the fuel pressure gauge. 9. Wait for the fuel pressure to build. 10. Close the valve in the fuel pipe shut-off adapter that is connected to the fuel return pipe. Does the fuel pressure remain constant?	-	Go to Step 18	Go to Step 10
10	1. Open the valve in the fuel pipe shut-off adapter that is connected to the fuel feed pipe. 2. Pressurize the fuel system using a scan tool. 3. Wait for the fuel pressure to build. 4. Close the valve in the fuel pipe shut-off adapter that is connected to the fuel return pipe. Does the fuel pressure remain constant?	-	Go to Step 20	Go to Step 21
11	Is the fuel pressure above the specified limit?	427kPa (62 psi)	Go to Step 12	Go to Step 14

Fuel System Diagnosis (cont'd)

Step	Action	Value(s)	Yes	No
12	<ol style="list-style-type: none"> 1. relieve the fuel pressure. 2. Disconnect the fuel return pipe form the fuel rail. 3. Attach a length of flexible fuel hose to the fuel rail outlet passage. 4. Place the open end of the hose into an approved gasoline container. 5. Turn the ignition OFF for 10 seconds. 6. Turn the ignition ON. 7. Observe the fuel pressure with the fuel pumps running. Is the fuel pressure within the specified limits?	379-427kPa (55-62 psi)	Go to Step 22	Go to Step 13
13	Visually and physically inspect the fuel rail outlet passages for a restriction. Was a restriction found?	-	Go to Step 23	Go to Step 20
14	Is the fuel pressure above the specified value?	0kPa (0 psi)	Go to Step 15	Go to Step 16
15	<ol style="list-style-type: none"> 1. Relive the fuel pressure. 2. Disconnect the fuel return pipe from the fuel rail. 3. Install the J 37287 fuel pipe shut-off adapter between the fuel return pipe and the fuel rail. 4. Open the valve on the fuel pipe shut-off adapter. 5. Turn the ignition ON. 6. Pressurize the fuel system using the scan tool. 7. Place the bleed hose of the pressue gauge into an approved gasoline container. 8. Bleed the air out of the fuel pressure gauge. Caution! Do not allow the fuel pressure to exceed 517kPa (75 psi). Excessive pressure may damage the fuel pressure regulator. 9. Slowly close the valve in the fuel pipe shut-off adapter that is connected to the fuel return pipe. does the fuel pressure rise above the specified value?	427kPa (62 psi)	Go to Step 20	Go to Step 6
16	Turn ON the fuel pump using the scan tool. Does the fuel pumps run?	-	Go to Step 17	Go to Fuel Pump Relay Diagnosis
17	Visually and physically inspect the following items: <ul style="list-style-type: none"> • Fuel filter for obstructions • Fuel feed pipe for a restriction. • Antisiphon vavle if equipped. • Fuel Cell for leaks Did you find a problem in any of these areas?	-	Go to Step 23	Go to Step 18
18	Replace the fuel cell Is the action complete?	-	System OK	-
19	Locate and repair the loss of vacuum to the fuel pressure regulator. Is the action complete?	-	System OK	-
20	Replace the fuel pressure regulator. Is the action complete?	-	System OK	-
21	Locate and replace any leaking fuel injector(s). Is the action complete?	-	System OK	-
22	Locate and repair the restriction in the fuel return pipe. Is the action complete?	-	System OK	-
23	Repair the problem as necessary. Is the action complete?	-	System OK	-

Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10°-35°C

Test Description

- The engine coolant temperature affects the ability of the fuel injector tester to detect a faulty fuel injector. If the engine coolant temperature is NOT between 10°-35°C (50°-95°F), use *Fuel Injector Test - Engine Coolant Temperature (ECT) Outside 10°-35°C (50°-95°F)* table.
- The first second of the voltage displayed by the DMM may be inaccurate due to the initial current surge. Therefore, record the lowest voltage displayed by the DMM after the first second of the test. The voltage displayed by the DMM should be within the specified range. Refer to the Example. The voltage displayed by the DMM may increase throughout the test as the fuel injector windings warm and the resistance of the fuel injector windings changes. An erratic voltage reading with large fluctuations in voltage that do not stabilize, indicates an intermittent connection with the fuel injector.

Resistance Ohms	Voltage Specification at 10°-35°C (50°-90°F)	
11.8 - 12.6	5.7 - 6.6 V	
Fuel Injector	Voltage Reading	Pass/Fail
1	6.3	P
2	5.9	P
3	6.2	P
4	6.1	P
5	4.8	F
6	6.0	P
7	5.0	P
8	5.3	P

Step	Action	Value(s)	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check.
2	1. Connect the scan tool. 2. Check the engine coolant temperature. Is the engine coolant temperature within the specified limits?	10°-35°C (50°-95°F)	Go to Step 3	Go to Fuel Injector Coil Test - ECT Outside 10°-35°C (50°-95°F)
3	1. Turn the ignition OFF. Caution! Do not flood a single cylinder. 2. Relieve the fuel pressure. 3. Access the fuel injector electrical connectors. 4. Connect the J 39021 fuel injector tester to B+ and an engine ground. 5. Set the amperage supply selector switch on the fuel injector tester to the Coil Test 0.5 amp position. 6. Connect the leads from the Digital Multi-Meter to the fuel injector tester. 7. Set the DMM to the tenths scale (0.0). 8. Connect the fuel injector tester to a fuel injector using the J 39021-380 injector test adapter. Important! Check the engine coolant temperature again in order to ensure that the correct chart is being used. 9. Press the "Push to StartTest" button on the fuel injector tester. Important! The voltage reading may rise during the test. 10. Observe the voltage reading on the DMM. 11. Record the lowest voltage observed after the first second of the test. 12. Repeat steps 8 through 11 for each fuel injector. Did any fuel injector have an erratic voltage reading with large fluctuations in voltage that do not stabilize, or a voltage reading outside the specified limits?	5.7 - 6.6 V	Go to Step 4	Go to Fuel Injector Balance Test with Special Tool
4	Replace the faulty fuel injectors. Refer to Fuel Injector Replacement.	-	Go to Fuel Injector Balance Test with Special Tool	-

Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Not Between 10°-35°C

Test Description

2. The engine coolant temperature affects the ability of the fuel injector tester to detect a faulty fuel injector. If the engine coolant temperature is between 10°-35°C (50°-95°F), use *Fuel Injector Test - Engine Coolant Temperature (ECT) Between 10°-35°C (50°-95°F)* table.
3. The first second of the voltage displayed by the DMM may be inaccurate due to the initial current surge. Therefore, record the lowest voltage displayed by the DMM after the first second of the test. The voltage displayed by the DMM may increase throughout the test as the fuel injector windings warm and the resistance of the fuel injector windings changes. An erratic voltage reading with large fluctuations in voltage that do not stabilize, indicates an intermittent connection with the fuel injector. From the voltages recorded, identify the highest voltage, excluding any voltages above 9.5 volts. Subtract each voltage that is not above 9.5 volts from the highest voltage. Record each subtracted value. Refer to the Example. The subtracted value that is more than 0.6 volt is faulty. Replace the fuel injector. A fuel injector with a recorded voltage above 9.5 volts is also faulty. Replace the fuel injector.

Highest Voltage Reading		Acceptable Subtracted Value Above/Below 10°-35°C (50°-90°F)	
7.1V		0.6V	
Fuel Injector	Voltage	Subtracted Value	Pass/Fail
1	9.8	-	F
2	6.6	0.5	P
3	6.9	0.2	P
4	5.8	1.3	F
5	7.0	0.1	P
6	7.1	0.0	P
7	9.6	-	F
8	6.0	1.1	F

				Go to OBD System Check.
2	1. Connect the scan tool. 2. Check the engine coolant temperature. Is the engine coolant temperature within the specified limits?	10°-35°C (50°-95°F)	Go to Step 3	Go to Fuel Injector Coil Test - ECT Outside 10°-35°C (50°-95°F)

Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Not Between 10°-35°C (cont.)

Step	Action	Value(s)	Yes	No
3	<p>1. Turn the ignition OFF. Caution! Do not flood a single cylinder.</p> <p>2. Relieve the fuel pressure.</p> <p>3. Access the fuel injector electrical connectors.</p> <p>4. Connect the J 39021 fuel injector tester to B+ and an engine ground.</p> <p>5. Set the amperage supply selector switch on the fuel injector tester to the Coil Test 0.5 amp position.</p> <p>6. Connect the leads from the Digital Multi-Meter to the fuel injector tester.</p> <p>7. Set the DMM to the tenths scale (0.0).</p> <p>8. Connect the fuel injector tester to a fuel injector using the J 39021-380 injector test adapter.</p> <p>Important! Check the engine coolant temperature again in order to ensure that the correct chart is being used.</p> <p>9. Press the "Push to StartTest" button on the fuel injector tester. Important! The voltage reading may rise during the test.</p> <p>10. Observe the voltage reading on the DMM.</p> <p>11. Record the lowest voltage observed after the first second of the test.</p> <p>12. Repeat steps 8 through 11 for each fuel injector.</p> <p>13. Identify the highest voltage reading recorded below 9.5 volts.</p> <p>14. Subtract any other voltage readings recorded from the highest voltage reading recorded.</p> <p><i>Are there any values result from subtraction more than the specified value.</i></p>	0.6V	Go to Step 4	Go to Fuel Injector Balance Test with Special Tool
4	Replace the faulty fuel injectors. Refer to Fuel Injector Replacement.	-	Go to Fuel Injector Balance Test with Special Tool	-

Fuel Injector Balance Test with Special Tool

Test Description

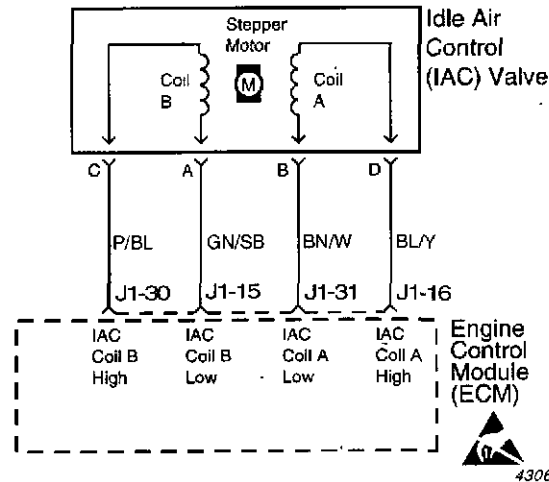
4. The engine coolant temperature must be below the operating temperature in order to avoid irregular fuel pressure readings due to Hot Soak fuel boiling.
5. The fuel pressure should be within the specified range.
6. The fuel pressure should reach a steady value.
7. If the fuel pressure drop value for each injector is within 10 kPa (1.5 psi) of the average pressure drop value, the fuel injectors are flowing properly. Calculate the pressure drop value for each fuel injector by subtracting the second pressure reading from the first pressure reading.

Step	Action	Value(s)	Yes	No
1	Was the On-Board Diagnostic system check performed?	-	Go to Step 2	Go to OBD System Check
2	Did you perform the Fuel Injector Coil Test Procedure?	-	Go to Step 3	Go to Fuel Injector Coil Test - ECT between 10°-35°C
3	Is the engine coolant temperature above the specified value?	62°C(145°F)	Go to Step 4	Go to Step 5
4	Allow the engine to cool below the specified value. Is the engine coolant temperature below the specified value?	62°C(145°F)	Go to Step 5	-
5	1. Turn the ignition OFF. 2. Connect the J34730-1A fuel pressure gauge to the fuel pressure test port. 3. Turn ON the ignition leaving the engine OFF. 4. Install the scan tool. 5. Energize the fuel pumps using the scan tool. 6. Place the bleed hose of the fuel pressure gauge into an approved gasoline container. 7. Bleed the air out of the fuel pressure gauge. 8. Again, energize the fuel pumps using the scan tool. Important! The fuel pumps will run for approximately 2 seconds. Repeat step 8 as necessary to achieve the highest possible fuel pressure. 9. Wait for the fuel pressure to build. 10. Observe the reading on the fuel pressure gauge while the fuel pumps are running. Is the fuel pressure within the specified limits?	379-427kPa (55-62 psi)	Go to Step 6	Go to Fuel System Diagnosis
6	After the fuel pumps stop, the fuel pressure may vary slightly, then should hold steady. Does the fuel pressure remain constant within the specified value?	379-427kPa (55-62 psi)	Go to Step 7	Go to Fuel System Diagnosis

Fuel Injector Balance Test with Special Tool (cont'd)

Step	Action	Value(s)	Yes	No
7	<p>1. Connect the J 39021 fuel injector tester to a fuel injector tester to a using the J 39021-380 injector test adapter.</p> <p>2. Set the amperage supply selector switch to the fuel injector tester to the balance test 0.5-2.5 amp position.</p> <p>3. Energize the fuel pump using the scan tool to pressurize the fuel system.</p> <p>4. Record the fuel pressure indicated by the fuel pressure gauge after the fuel pressure stabilizes. This is the 1st pressure reading.</p> <p>5. Energize the fuel injector by pressing the "Push to Start Test" button on the fuel injector tester.</p> <p>6. Record the fuel pressure indicated by fuel pressure gauge after the pressure has stabilized. This is the 2nd pressure reading.</p> <p>7. Repeat steps 1 through 6 for each of the fuel injectors.</p> <p>8. Subtract the 2nd pressure reading from the 1st pressure reading for each of the injectors. The result is the pressure drop value.</p> <p>9. Add all of the individual pressure drop values. The sum is the total pressure drop.</p> <p>10. Divide the total pressure drop by the number of fuel injectors. This is the average pressure drop.</p> <p>Does any fuel injector have a value that is either higher or lower than the specified value?</p>	10kPa (1.5 psi)	Go to Step 8	Go to Symptoms
8	<p>Caution! To prevent flooding the engine, do not repeat any portion of the test before running the engine.</p> <p>Retest any fuel injector that falls outside the pressure drop limits from step 7.</p> <p>Does any fuel injector have a value that is either higher or lower than the specified value?</p>	10kPa (1.5 psi)	Go to Step 9	Go to Symptoms
9	<p>Replace the faulty fuel injector(s). Refer to Fuel Injector Replacement.</p> <p>Is the action complete?</p>	—	SystemOK	—

Idle Air Control Function Test



Circuit Description

The ECM controls idle speed to a calibrated "desired" RPM based on sensor inputs and actual engine RPM. The ECM uses four (4) circuits to move the Idle Air Control (IAC) valve. The movement of the IAC valve varies the amount of air flow bypassing the throttle plates. The ECM controls idle speed by determining the position of the IAC valve.

Diagnostic Aids

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.

- Check for vacuum leaks, disconnected or brittle vacuum hoses, cuts, etc. Examine manifold and throttle body gaskets for proper seal. Check for cracked intake manifold.
- Check for poor connections, opens or short to grounds in circuits J1-16, J1-31, J1-15, and J1-30. This may result in improper idle control.
- An IAC valve which is "frozen" and will not respond to the ECM, a throttle stop screw which has been tampered with, or a damaged throttle body or linkage may cause improper idle.

Test Description

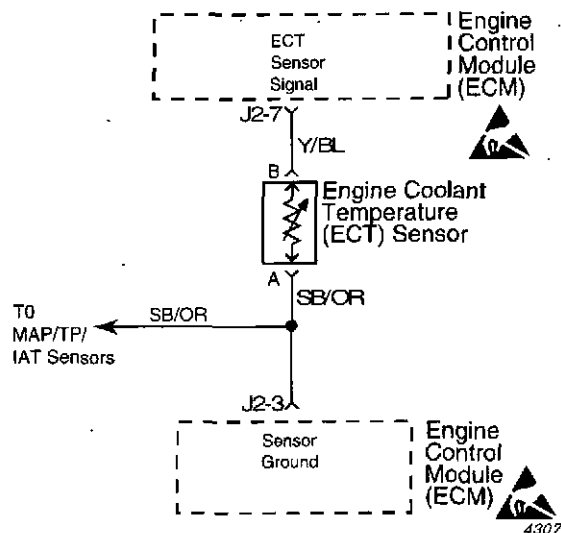
2. This step determines if the IAC valve is functioning properly.
4. This step determines if the circuitry or the IAC valve is faulty.

Idle Air Control Function Test

Step	Action	Value(s)	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	1. Engine should be at normal operating temperature. 2. Start the engine and allow the idle to stabilize. 3. Record the RPM. 4. Ignition OFF for 10 seconds. 5. Disconnect the IAC harness connector. 6. Restart the engine and record the r/m. Is the r/m higher than the first recorded RPM by more than the specified value	200 r/m	Go to Step 3	Go to Step 4
3	1. Reinstall the IAC harness connector 2. Idle speed should gradually return within 75 r/m of the original recorded r/m within 30 seconds.	-	Go to Step 5	Go to Step 4
4	1. Ignition OFF for 10 seconds. 2. Disconnect IAC harness connector. 3. Restart the engine. 4. Using a test lamp connected to ground, probe each of the four IAC harness terminals. Does the test lamp blink on all four terminals.	-	Go to Step 7	Go to Step 6
5	IAC circuit is functioning properly.	-	-	-
6	Locate and repair poor connection, open, or shorted IAC circuits that did not blink. Was a condition found and corrected?	-	Go to OBD System Check	Go to Step 8
7	Check for poor IAC connections or replace the IAC valve. Is the action complete?	-	Go to OBD System Check	-
8	Repair the faulty ECM connections or replace the faulty ECM. Is the action complete?	-	Go to OBD System Check	-

Non-Scan Diagnostics

DTC 14 – Engine Coolant Temperature (ECT) Sensor Circuit – Low Temperature Indicated



Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts from J2-7 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high. As the engine coolant warms up, the sensor resistance becomes less. See engine coolant temperature sensor table under "Diagnostic Aids." At normal operating temperature (85°C - 95°C or 185°F - 203°F), the voltage will measure about 1.5-2.0 volts.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- If DTC 33 is also set, check for open ground between J2-3 and pin A on the ECT sensor harness.

After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This step checks if there is a problem with the ECM and wiring or if the problem is the ECT sensor.
3. This step will isolate the problem on J2-7 to pin B ECT connector (5 volt reference) or J2-3 to pin A ECT connector (sensor ground).

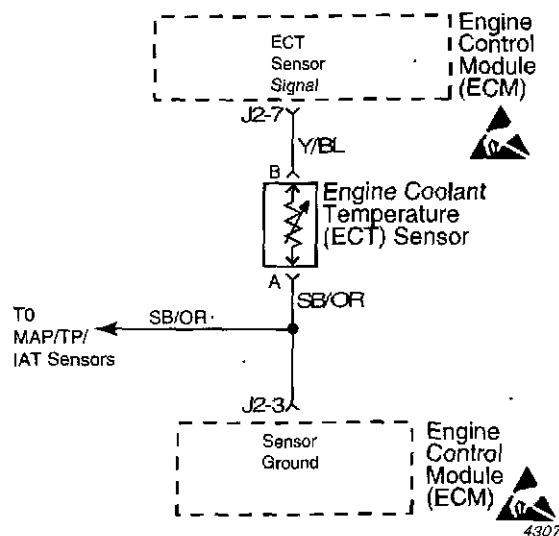
4. Check the harness terminals thoroughly for loose connections. If the resistance of the ECT sensor is monitored, the resistance should steadily decrease as the engine coolant warms up. The resistance reading should stabilize when the thermostat opens.

°C	°F	Ohms
Temperature vs. resistance Values (Approximate)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	133	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

DTC 14 – Engine Coolant Temperature (ECT) Sensor Circuit – Low Temperature Indicated (Non-Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	–	Go to Step 2	Go to OBD System Check
2	1. Ignition OFF. 2. Disconnect ECT sensor harness connector. 3. Ignition ON, engine OFF. Connect Digital Volt-Ohm Meter (DVOM) across the coolant sensor harness terminals. Is the voltage above the specified value?	4 volts	Go to Step 4	Go to Step 3
3	1. Connect positive DVOM lead to harness terminal B (5 volt ref.) 2. Connect negative DVOM lead to a known good engine ground. Is voltage above the specified value?	4 volts	Go to Step 6	Go to Step 5
4	Locate and repair intermittent faulty connections. If OK, replace faulty ECT sensor. Is the action complete?	–	Verify Repair	–
5	Locate and repair open circuit from ECM pin J2-7 to pin B ECT harness connector. Was the condition found and corrected?	–	Verify Repair	Go to Step 7
6	Locate and repair open ground reference circuit from ECM pin J2-3 to pin A ECT harness connector.		Verify Repair	Go to Step[7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	–	Verify Repair	–

DTC 15 - Engine Coolant Temperature (ECT) Sensor Circuit - High Temp Indicated



Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts from J2-7 to pin B on the ECT sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high. As the engine coolant warms up, the sensor resistance becomes less. See engine coolant temperature sensor table. At normal operating temperature (70°C - 73°C or 157°F - 163°F), the voltage will measure about 1.36 volts.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- **Check harness routing for a potential short to ground** between J2-7 and pin B ECT sensor harness.

After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

Test Description

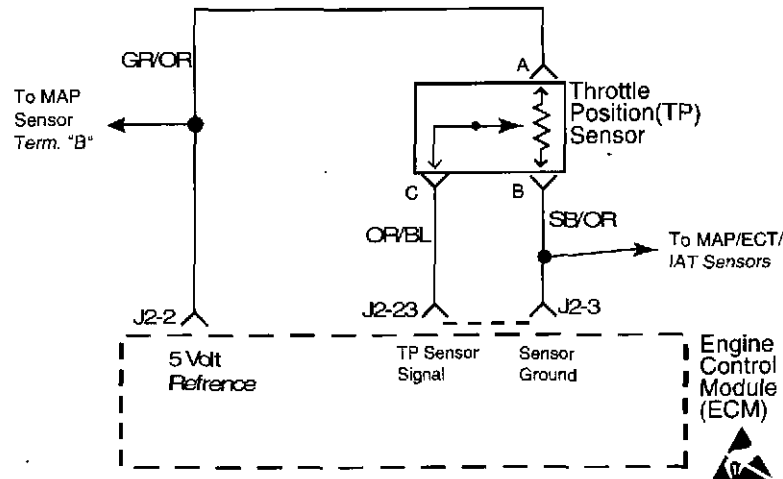
2. This step checks if there is a problem with the ECM, and wiring or if the problem is the ECT sensor.
3. Check the harness terminals thoroughly for loose connections. If the resistance of the ECT sensor is monitored, the resistance should steadily decrease as the engine coolant warms up. The resistance reading should stabilize when the thermostat opens.

°C	°F	Ohms
Temperature vs. resistance Values (Approximate)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	133	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450

DTC 15 - Engine Coolant Temperature (ECT) Sensor Circuit - High Temp Indicated (Non-Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition OFF. 2. Disconnect ECT sensor harness connector. 3. Ignition ON, engine OFF. 4. Connect Digital Volt-Ohm Meter (DVOM) across the coolant sensor harness terminals. Is the voltage above the specified value?	4 volts	Go to Step 3	Go to Step 4
3	Locate and repair intermittent faulty connections. If OK, replace faulty ECT sensor. Is action complete?	-	Verify Repair	-
4	Locate and repair Short to ground in the 5 volt ref. circuit ECM pin J2-7 to pin B ECT connector harness. Was a condition found and corrected?	-	Verify Repair	Go to Step 5
5	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

DTC 21 - Throttle Position (TP) Sensor Circuit - Signal Voltage High (Non-Scan)



Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides a voltage signal that changes relative to the throttle blade. Signal voltage should vary from about .7 volt at idle to about 4.8 volts at Wide Open Throttle (WOT).

The TP sensor signal is one of the most important inputs used by the ECM for fuel control and for IAC control.

The ECM supplies a 5 volt signal to the sensor from pin J2-2 to TP sensor connector terminal A. Terminal B to pin J2-3 is the TP sensor ground circuit. The TP sensor will send a voltage signal back to the ECM, to pin J2-23, according to where the throttle blades are positioned.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to the TP sensor. A change in the TP sensor display will indicate the location of the fault.
- **If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.**

After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

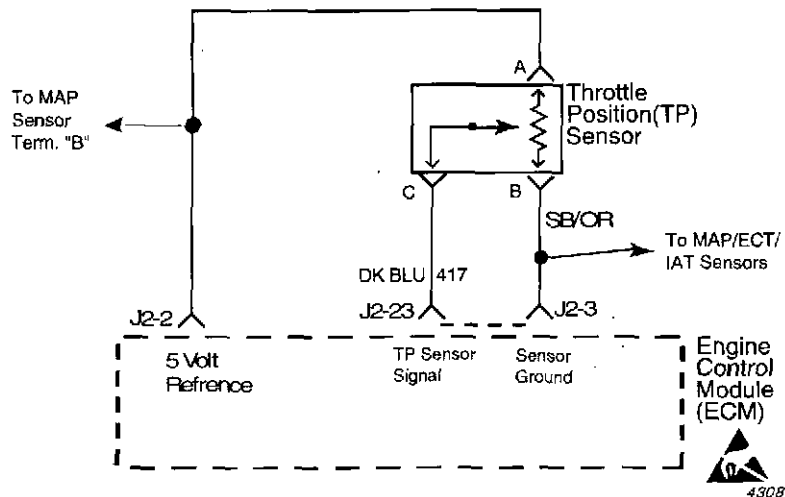
Test Description

2. This step simulates a DTC 22. If the ECM recognizes the low signal voltage and sets DTC 22, the ECM and wiring are OK.
3. This step checks to see if the ground circuit is open.

DTC 21 - Throttle Position (TP) Sensor Circuit - Signal Voltage High (Non-Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> 1. Diagnostic Trouble Code (DTC) tool switched to OFF. 2. Ignition OFF. 3. Disconnect TP sensor harness connector. 4. Start engine and idle for 2 minutes or until DTC tool indicates a stored DTC. 5. Ignition ON, engine OFF. 6. Switch DTC tool ON and note DTC. Is DTC 22 present?	-	Go to Step 4	Go to Step 3
3	<ol style="list-style-type: none"> 1. Disconnect TP sensor harness connector. 2. Ignition ON, engine OFF. 3. Connect Digital Volt-Ohm Meter from TP sensor harness connector terminal "B" and "A". Is voltage reading above the specified value?	4 volts	Go to Step 6	Go to Step 5
4	Locate and repair intermittent faulty connections. If OK, replace faulty TP sensor. Is action complete?	-	Verify Repair	-
5	Locate and repair open in TP sensor ground circuit (J2-3 to terminal "B" sensor harness connector.) Was a problem found and corrected?	-	Verify Repair	-
6	Locate and repair short to voltage in TP sensor signal circuit (J2-23 to terminal "C" sensor harness connector.) Was a problem found and corrected?	-	Verify Repair	-
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

DTC 22 - Throttle Position (TP) Sensor Circuit - Signal Voltage Low (Non-Scan)



Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides a voltage signal that changes relative to the throttle blade. Signal voltage should vary from about .7 volt at idle to about 4.8 volts at Wide Open Throttle (WOT).

The TP sensor signal is one of the most important inputs used by the ECM for fuel control and for IAC control.

The ECM supplies a 5 volt signal to the sensor from pin J2-2 to TP sensor connector terminal A. Terminal B to pin J2-3 is the TP sensor ground circuit. The TP sensor will send a voltage signal back to the ECM, to pin J2-23, according to where the throttle blades are positioned.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to the TP sensor. A change in the TP sensor display will indicate the location of the fault.
- If DTC 34 is also set, check for a short to ground in 5 volt reference circuit J2-2 to TP sensor harness connector terminal "A" or to MAP sensor harness connector terminal "B."
- If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

After repairs, clear DTC's following "Clear DTC's Proce-

dure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

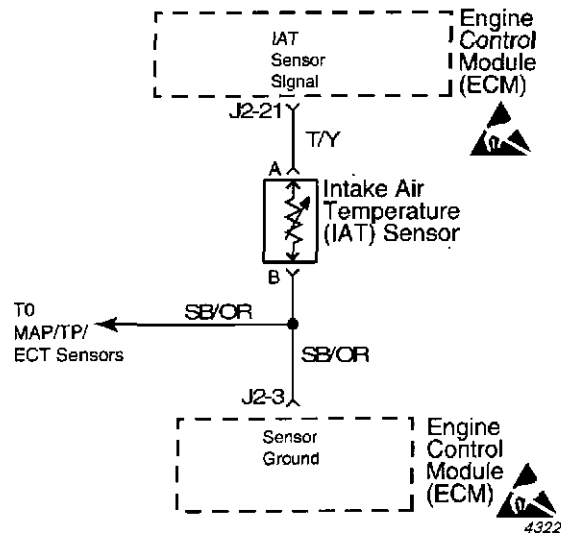
Test Description

2. This step simulates a DTC 21. If the ECM recognizes the high signal voltage and sets a DTC 21, the ECM and wiring are OK.
3. This step checks for the 5 volt reference.

DTC 22 - Throttle Position (TP) Sensor Circuit - Signal Voltage Low (Non-Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> 1. Diagnostic Trouble Code (DTC) tool switched to OFF 2. Ignition OFF. 3. Disconnect the TP sensor harness connector. 4. Connect a jumper wire from harness terminal A to harness terminal C. 5. Start engine and idle for 2 minutes or until DTC tool indicates a stored DTC. 6. Ignition ON, engine OFF. 7. Switch DTC tool to ON and note any DTC. Are DTC 21 present?	-	Go to Step 4	Go to Step 3
3	<ol style="list-style-type: none"> 1. Remove jumper wire from TP sensor harness connector. 2. Connect DVOM from TP sensor harness terminal A to harness terminal B. Is voltage reading above the specified value?	4 volts	Go to Step 5	Go to Step 6
4	Locate and repair intermittent faulty connections. If OK replace faulty sensor. Is action complete?	-	Verify Repair	-
5	Locate and repair open or short to ground in circuit between J2-23 and terminal C of the TP sensor harness. Was a condition found and repaired?	-	Verify Repair	Go to Step 7
6				

DTC 23 - Intake Air Temperature (IAT) Sensor Circuit - Low Temp Indicated (Non-Scan)



Circuit Description

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts to the sensor. When the intake air temperature is cold, the sensor (thermistor) resistance is high. As the intake air temperature warms up, the sensor resistance becomes less. See intake air temperature sensor table under "Diagnostic Aids."

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.
- If DTC 33 is also set, check for open ground on the MAP and TP circuits.

After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

Test Description

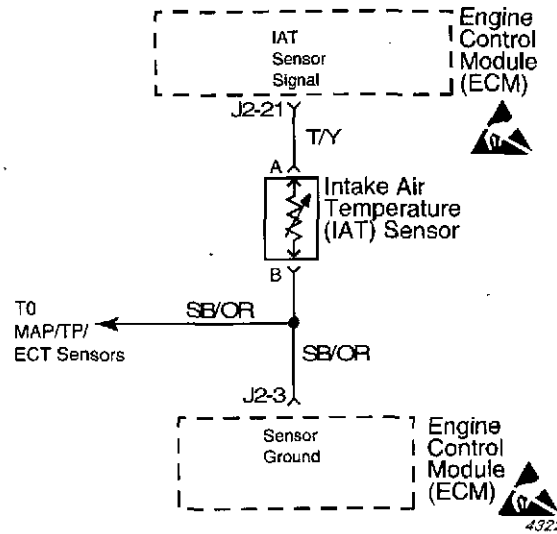
2. This step checks if there is a problem with the ECM and wiring or if the problem is the IAT sensor.
3. This step will isolate the problem to CKT 472 (5 volt reference) or to CKT 814 (sensor ground).
4. Check the harness terminals thoroughly for loose connections. If the resistance of the IAT sensor is monitored, the resistance should steadily decrease as the intake air temperature warms up.

°C	°F	Ohms
Temperature vs. resistance Values (Approximate)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	133	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

DTC 23 - Intake Air Temperature (IAT) Sensor Circuit - Low Temp Indicated (Non-Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> 1. Ignition OFF. 2. Disconnect IAT sensor harness connector. 3. Ignition ON, engine OFF. 4. Connect DVOM across the intake air temperature sensor harness terminals. 5. Is voltage above the specified value? 	4 volts	Go to Step 4	Go to Step 3
3	<ol style="list-style-type: none"> 1. Connect the positive DVOM lead to harness terminal A (5 volt reference). 2. Connect the negative DVOM lead to a known good engine ground. <p>Is the voltage above the specified value?</p>	4 volts	Go to Step 6	Go to Step 5
4	<p>Locate and repair intermittent faulty connections. If OK, replace faulty IAT sensor.</p> <p>Is action complete?</p>	-	Verify Repair	-
5	<p>Locate and repair the circuit between J2-21 and pin A of the IAT sensor connector.</p> <p>Was a problem found?</p>	-	Verify Repair	Go to Step 7
6	<p>Locate and repair open ground circuit between J2-3 and terminal B of the IAT harness connector.</p> <p>Was problem found and corrected?</p>	-	Verify Repair	Go to Step 7
7	<p>Repair faulty ECM connections or replace faulty ECM.</p> <p>Is action complete?</p>	-	Verify Repair	-

DTC 25 - Intake Air Temperature (IAT) Sensor Circuit - High Temp Indicated (Non-Scan)



Circuit Description

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM sends 5 volts out pin J2-21 to the IAT sensor through terminal "A" of the IAT harness connector. When the intake air temperature is cold, the sensor (thermistor) resistance is high. As the intake air temperature warms up, the sensor resistance becomes less. See intake air temperature sensor table.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.
- **Check harness routing for a potential short to ground in CKT 814.**

After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This step checks if there is a problem with the ECM and wiring or if the problem is the IAT sensor.
3. Check the harness terminals thoroughly for loose connections. If the resistance of the IAT sensor is

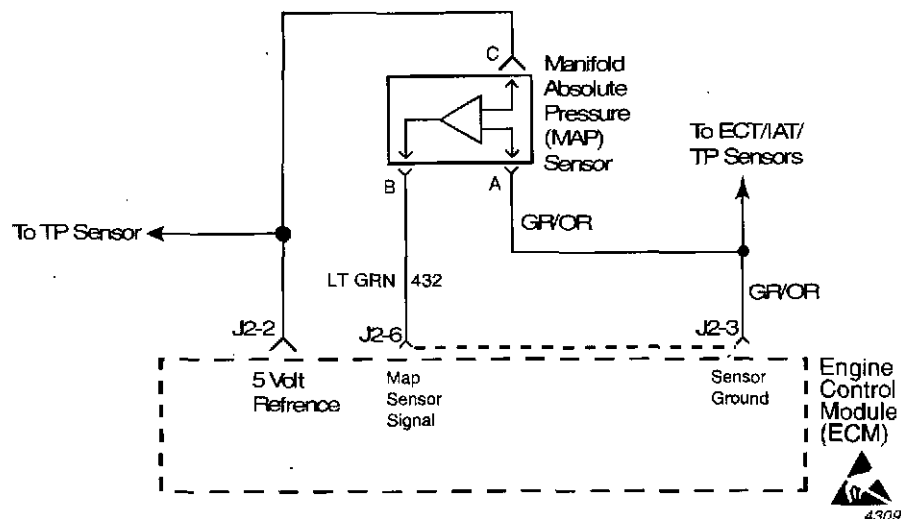
monitored, the resistance should steadily decrease as the intake air temperature warms up.

°C	°F	Ohms
Temperature vs. resistance Values (Approximate)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	133	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

DTC 25 - Intake Air Temperature (IAT) Sensor Circuit - High Temp Indicated (Non-Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition OFF 2. Disconnect IAT sensor harness connector 3. Ignition ON, engine OFF. 4. Connect DVOM across the IAT sensor harness terminals. Is the voltage above the specified value?	4 volts	Go to Step 3	Go to Step 4
3	Locate and repair intermittent faulty connections, If OK replace faulty IAT sensor. Is action complete?	-	Verify Repair	-
4	Locate and repair short to ground between J2-21 and terminal A of the IAT sensor harness connector. Is action complete?	-	Verify Repair	Go to Step 5
5	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

DTC 33 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage High (Non-Scan)



Circuit Description

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1.0-1.5 volts at idle to about 4.0-4.5 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with RPM.

The MAP sensor voltage of 5 volts is delivered to the MAP sensor through pin J2-2 and terminal "C" of the MAP sensor harness connector. Terminal "A" in the is the ground circuit for the MAP sensor and connects to pin J2-3 of the ECM. The MAP signal terminal "B" sends a voltage signal back to the ECM according to what the manifold pressure is.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAP sensor display on the scan tool while moving connectors and wiring harnesses related to the MAP sensor. A change in the MAP sensor display will indicate the location of the fault.
- If the idle is rough or unstable, refer to *Symptoms*

section for items which may cause an unstable idle.

- With the ignition "ON," engine "OFF," the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of altitude and is referred to as BARO.
- If DTC 14 is also set, check for open in ground between J2-3 and terminal a of the MAP sensor harness connector.
- If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

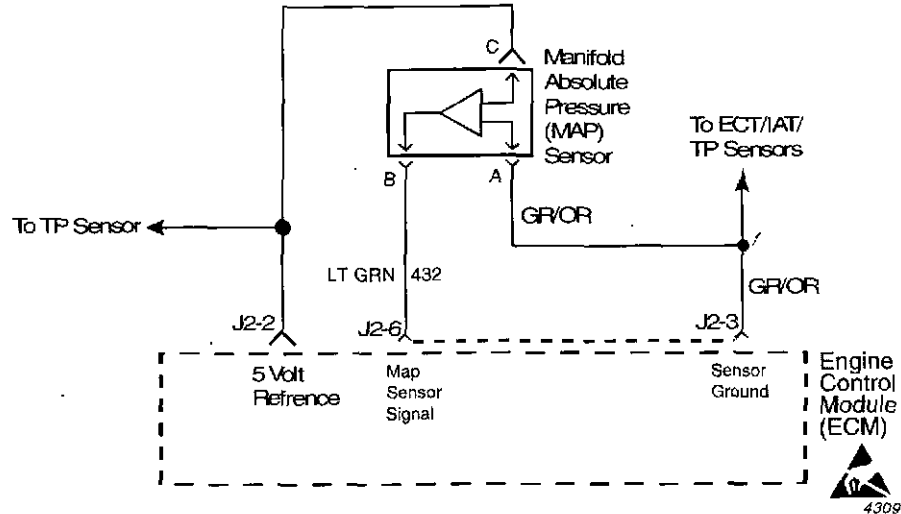
Test Description

2. This step will determine if there is an adequate vacuum supply to the MAP sensor. If the vacuum gauge reading is erratic, refer to the "Rough or Unstable Idle" symptom.
3. This step simulates a DTC 34. If the ECM recognizes the low signal voltage and sets a DTC 34, the ECM and wiring are OK.
4. This step checks to see if there is an open circuit between J2-3 and terminal "A" of the MAP sensor harness connector.
5. Low manifold vacuum may result from a restriction in the MAP sensor hose or from vacuum leaks in the engine induction system.

DTC 33 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage High (Non-Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> 1. Ignition OFF. 2. Install a vacuum gauge to a manifold vacuum source. 3. Start the engine and raise to about 1000r/m in neutral. 4. The vacuum reading should be steady. Is the vacuum gauge reading steady and above the specified value?	35.5 cm. Hg 45.5 kPa (14 in. Hg)	Go to Step 3	Go to Step 5
3	<ol style="list-style-type: none"> 1. Disconnect Trouble Code (DTC) tool switched to OFF. 2. Ignition OFF. 3. Disconnect MAP sensor harness connector. 4. Start engine and idle for 2 minutes or until DTC tool indicates a stored DTC. 5. Ignition ON, engine OFF. 6. Switch DTC tool to ON and note DTC. Is DTC 34 present?	-	Go to Step 6	Go to Step 4
4	<ol style="list-style-type: none"> 1. MAP sensor harness connector disconnected. 2. Ignition ON, engine OFF. 3. Connect Digital Volt-Ohm Meter from harness terminal "A" to harness terminal "C". Is voltage reading above the specified value?	4 volts	Go to Step 7	Go to Step 8
5	Repair low or unsteady vacuum problem. Is action complete?	-	Verify Repair	-
6	Check for plugged or leaking sensor vacuum fitting. Also locate and repair intermittent faulty connections. If OK, replace faulty MAP sensor. Is action complete?	-	Verify Repair	-
7	Locate and repair short to voltage from pin J2-8 to terminal B MAP sensor harness connector. Was a problem found?	-	Verify Repair	Go to Step 9
8	Locate and repair open in circuit between ECM pin J2-3 and terminal A MAP sensor harness connector. Was a problem found?	-	Verify Repair	Go to Step 9
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

DTC 34 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage Low (Non-Scan)



Circuit Description

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1.0-1.5 volts at idle to about 4.0-4.5 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with RPM.

The MAP sensor voltage of 5 volts is delivered to the MAP sensor through pin J2-2 and terminal "C" of the MAP sensor harness connector. Terminal "A" in the is the ground circuit for the MAP sensor and connects to pin J2-3 of the ECM. The MAP signal terminal "B" sends a voltage signal back to the ECM according to what the manifold pressure is.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the

MAP sensor display on the scan tool while moving connectors and wiring harnesses related to the MAP sensor. A change in the MAP sensor display will indicate the location of the fault.

- If the idle is rough or unstable, refer to *Symptoms* section for items which may cause an unstable idle.
- With the ignition "ON," engine "OFF," the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of altitude and is referred to as BARO.
- If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

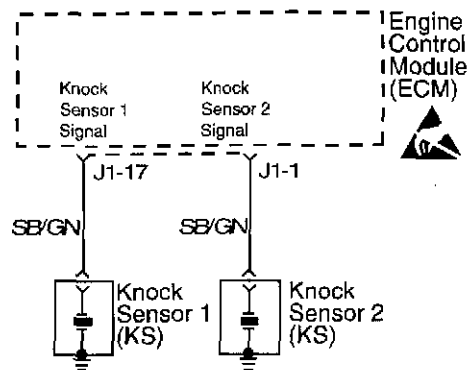
Test Description

2. This step simulates a DTC 33. If the ECM recognizes the high signal voltage and sets a DTC 33, the ECM and wiring are OK.
3. This step checks for open or shorted circuit for the 5 volt reference circuit.

DTC 34 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage Low (Non-Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Diagnostic Trouble Code (DTC) tool switched to OFF. Ignition OFF. Disconnect MAP sensor harness connector. Connect a jumper wire from harness terminal "B" to harness terminal "C." Start engine and idle for 2 minutes or until DTC tool indicates a stored DTC. Ignition ON, engine OFF. Switch DTC tool to ON and note DTC. Is DTC 33 present?	-	Go to Step 4	Go to Step 3
3	1. Remove jumper wire from between terminals ""B"" and ""C"" of the MAP sensor harness connector. 2. Connect Digital Volt-Ohm Meter from harness terminal "A" to harness terminal "C." Is the voltage reading above the specified value?	4 volts	Go to Step 5	Go to Step 6
4	Locate and repair intermittent faulty connections. If OK, replace faulty MAP sensor. Is action complete?	-	Verify Repair	-
5	Locate and repair open or short to ground between terminal "B" of the MAP sensor harness connector and pin J2-8 of the ECM. Was a problem found?	-	Verify Repair	Go to Step 7
6	Locate and repair open or short to ground in the 5 volt ref circuit, terminal "C" of the MAP sensor harness connector and pin J2-2 of the ECM. Also check the TP sensor circuit for a short to ground. Was a problem found and corrected?	-	Verify Repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

DTC 44 - Knock Sensor (KS) 1 System Inactive (Non-Scan)



Circuit Description

The ECM uses the Knock Sensors in order to detect engine detonation. This detection allows the ECM to retard spark timing based on the KS signal coming into the ECM.

DTC 44 will set only if the ECM does not see any activity on the KS signal circuits.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- Loose Knock Sensors in engine block.
- Poor connection at the Knock Sensors.

After repairs, clear DTC's following "Clear DTC's Procedure" in the *General Information* section. Failure to do so may result in DTC's not properly being cleared.

If either of the knock sensor wires are routed too close to spark plug ignition wires, the ECM may see the interference as a knock signal, resulting in false timing retard.

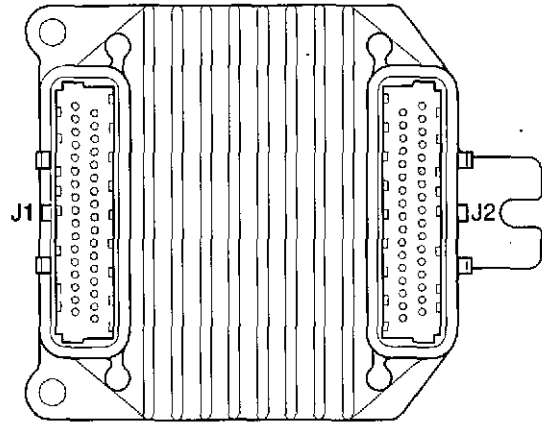
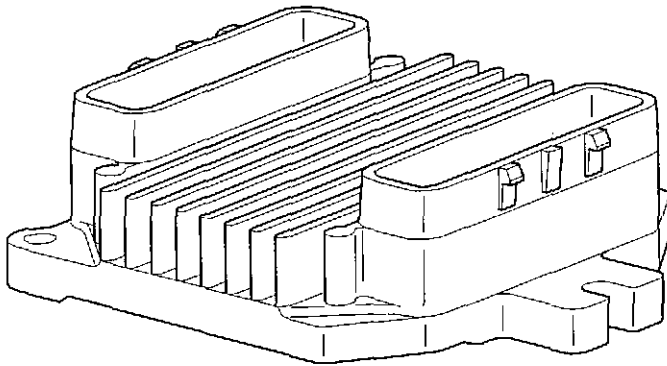
Test Description

4. This step ensures the knock sensors are secured properly in the engine block.
5. Checks to see that each knock sensor circuit is within specifications. Volvo Penta engines use two knock sensors, so both circuits need to be checked individually.

DTC 44 - Knock Sensor (KS) 1 System Inactive (Non-Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Important! If you can hear the engine knock, repair the engine mechanical problem before proceeding with this diagnostic table. Check the KS signal circuits for incorrect routing near the spark plug wires. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 3
3	Check the KS signal circuits for any terminals not being fully seated or for incorrect installation. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 4
4	Check knock sensors for being loose in the engine block. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 5
5	Ignition OFF Disconnect "J1" harness connector. Connect Digital Volt-Ohm Meter from "J1-17" (knock signal 1) to a known good engine ground near the knock sensor. Note the value. Connect Digital Volt-Ohm Meter from "J1-1" (knock signal 2) to a known good engine ground near the knock sensor. Note the value. Is the resistance value within the specified value for each circuit?	93-107K ohms	Go to Step 8	Go to Step 6
6	Locate and repair open or short to ground in the circuit(s) that were out of range. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 7
7	Inspect knock sensor terminal contacts. If OK, replace faulty knock sensor (s). Is the action complete?	-	Verify Repair	-
8	Replace faulty ECM connections or replace faulty ECM. Is the action complete?	-	Verify Repair	-

DTC 51 - Calibration Checksum Failure



MEFI3004

Circuit Description

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

This test is also used as a security measure to prevent improper use of calibration or changes to these calibrations that may alter the designed function of MEFI.

Diagnostic Aids

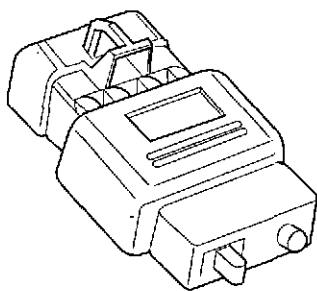
If DTC 51 failed more than once, but is intermittent, replace the ECM.

Test Description

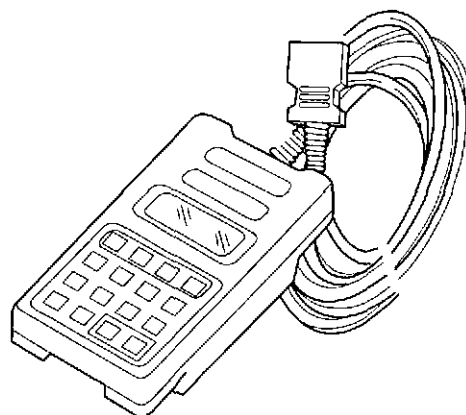
2. This step checks to see if the fault is present during diagnosis. If present, the ECM is not functioning properly and must be replaced or reprogrammed.

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> 1. Install Diagnostic Trouble Code (DTC) tool. 2. Using "Clear DTC Procedures," clear DTC 51. 3. Ignition ON. 4. Switch DTC tool to ON. Does DTC 51 reset?	-	Go to Step 3	Refer to Diagnostic Aids
3	Replace or reprogram faulty ECM and verify DTC does not reset. Is action complete?	-	Verify Repair	-

DTC 81 -Non-Scan Diagnostics



DTC Tool
DR5571



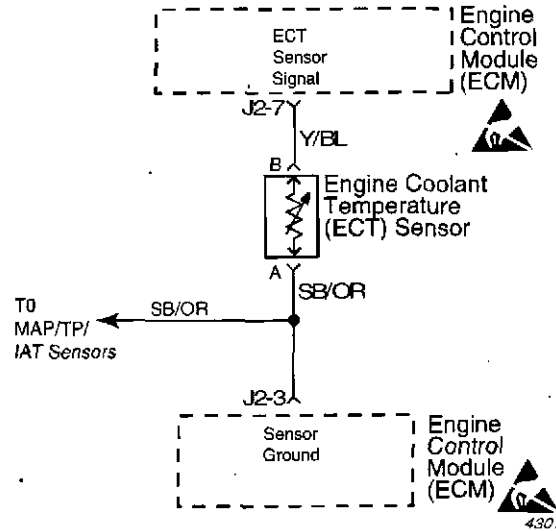
Scan Tool
DR5569

Diagnostic Aids

When a DTC 81 is flashed out using a Diagnostic Trouble Code (DTC) tool, a scan tool **MUST** be used for further diagnostics. DTC 81 has multiple failures, and are only distinguished using a scan tool.

Scan Diagnostics

DTC 14 – Engine Coolant Temperature (ECT) Sensor Circuit – Low Temperature Indicated (Scan)



Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts from J2-7 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high. As the engine coolant warms up, the sensor resistance becomes less. See engine coolant temperature sensor table under "Diagnostic Aids." At normal operating temperature (85°C - 95°C or 185°F - 203°F), the voltage will measure about 1.5-2.0 volts.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- The scan tool displays engine coolant temperature in degrees Celsius and Fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a ECT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a "shifted" coolant sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature when the thermostat opens.
- If DTC 33 is also set, check for open ground on J2-3.

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

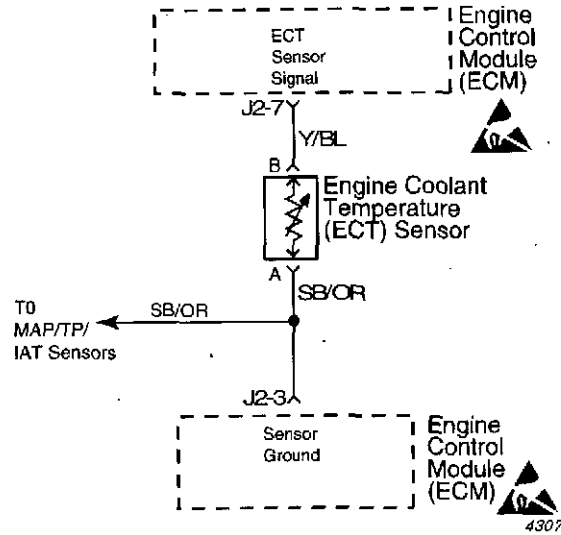
2. DTC 14 will set if signal voltage indicates a coolant temperature below -30°C (-22°F).
3. This test simulates a DTC 15. If the ECM recognizes the low voltage signal and displays a high temperature, the ECM and wiring are OK.

°C	°F	Ohms
Temperature vs. resistance Values (Approximate)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	133	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

DTC 14 – Engine Coolant Temperature (ECT) Sensor Circuit – Low Temperature Indicated (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	–	Go to Step 2	Go to OBD System Check
2	Turn ignition ON, leave engine OFF. Does the scan tool display a coolant temperature less than the specified value?	-30°C (-22°F)	Go to Step 3	Go to Step 4
3	Turn ignition OFF. Disconnect the ECT sensor harness connector. Connect a jumper wire from harness terminal "A" to harness terminal "B". Turn ignition ON, leaving engine OFF. Does scan tool display a coolant temperature above the specified value?	130°C (266°F)	Go to Step 6	Go to Step 5
4	DTC 14 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	–	Verify Repair	–
5	Locate and repair open in 5 volt reference circuit J2-7 to terminal "B" ECT harness connector or ground circuit J2-3 to terminal "A" ECT harness connector. Was a problem found?	–	Verify Repair	Go to Step 7
6	Repair faulty ECT sensor. Is action complete?	–	Verify Repair	–
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	–	Verify Repair	–

DTC 15 - Engine Coolant Temperature (ECT) Sensor Circuit - High Temp Indicated (Scan)



Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts from J2-7 to pin B on the ECT sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high. As the engine coolant warms up, the sensor resistance becomes less. See engine coolant temperature sensor table. At normal operating temperature (70°C - 73°C or 157°F - 163°F), the voltage will measure about 1.36 volts.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- The scan tool displays engine coolant temperature in degrees Celsius and Fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a ECT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a "shifted" coolant sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature when the thermostat opens.
- Check harness routing for a potential short to ground between J2-7 and ECT harness connector "B".

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

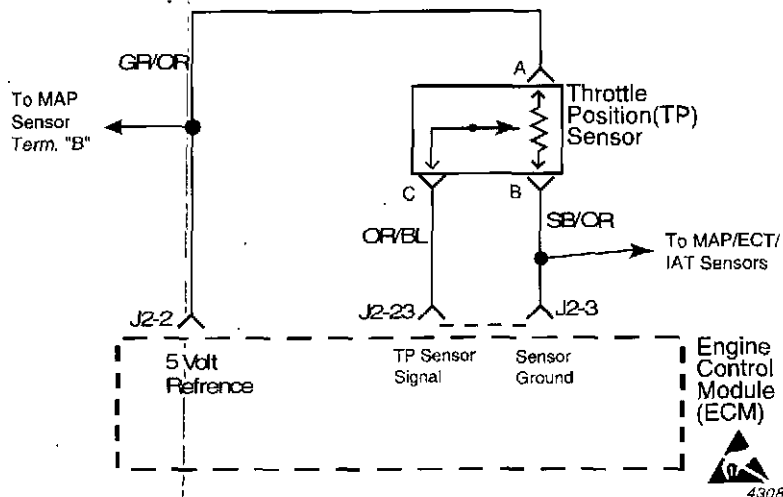
2. DTC 15 will set if signal voltage indicates a coolant temperature above 130°C or 266°F.
3. This test simulates a DTC 14. If the ECM recognizes the high voltage signal and displays a low temperature, the ECM and wiring are OK.

°C	°F	Ohms
Temperature vs. resistance Values (Approximate)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	133	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

DTC 15 - Engine Coolant Temperature (ECT) Sensor Circuit - High Temp Indicated (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Turn ignition ON, engine OFF. Does the scan tool display a coolant temperature greater than the specified value?	130°C (266°F)	Go to Step 3	Go to Step 4
3	Turn ignition OFF. Disconnect ECT sensor harness connector. Turn ignition ON, engine OFF. Does scan tool display a coolant temperature below the specified value?	-30°C (-22°F)	Go to Step 6	Go to Step 5
4	DTC 15 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	-	Verify Repair	-
5	Locate and repair short to ground between J2-7 and pin "B" ECT harness connector. Was a problem found?	-	Verify Repair	Go to Step 7
6	Repair faulty ECT sensor. Is action complete?	-	Verify Repair	-
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

DTC 21 - Throttle Position (TP) Sensor Circuit - Signal Voltage High (Scan)



Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides a voltage signal that changes relative to the throttle blade. Signal voltage should vary from about .7 volt at idle to about 4.8 volts at Wide Open Throttle (WOT).

The TP sensor signal is one of the most important inputs used by the ECM for fuel control and for IAC control.

The ECM supplies a 5 volt signal to the sensor from pin J2-2 to TP sensor connector terminal A. Terminal B to pin J2-3 is the TP sensor ground circuit. The TP sensor will send a voltage signal back to the ECM, to pin J2-23, according to where the throttle blades are positioned.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to the TP sensor. A change in the TP sensor display will indicate the location of the fault.
- The scan tool reads throttle position in voltage and percentage relative to the throttle blade opening. With ignition "ON," engine "OFF," throttle blades closed (idle), the voltage should be 0.3-0.9 volts. The voltage should steadily increase as the throttle is moved toward Wide Open Throttle (WOT).
- If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor

default value.

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

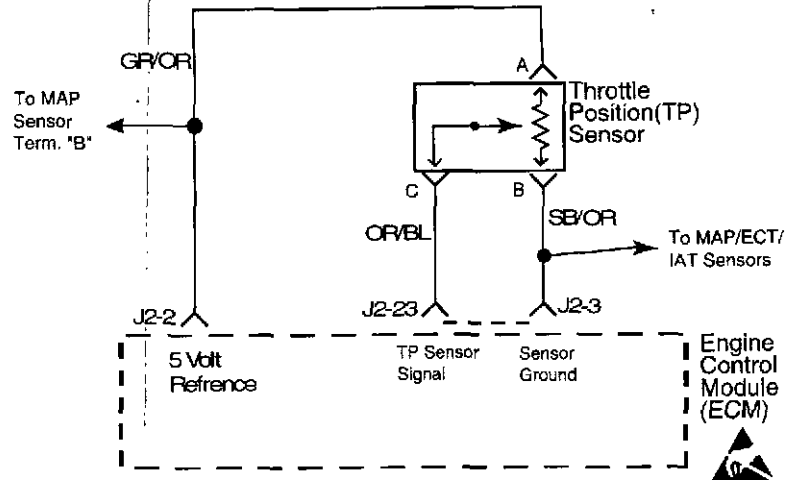
Test Description

2. With the throttle closed, the TP sensor voltage should read 0.3-0.9 volt. If it does not, check the throttle cable adjustment or for bent or binding linkage.
3. This test simulates a DTC 22. If the ECM recognizes the low voltage signal, the ECM and wiring are OK.
4. Using DVOM from harness terminal "A" harness terminal "B" checks the sensor ground circuit. A faulty sensor ground will cause a DTC 21.

DTC 21 - Throttle Position (TP) Sensor Circuit - Signal Voltage High (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	1. Throttle closed. 2. Turn ignition ON, engine OFF. Does scan tool indicate TP sensor voltage greater than specified value?	4 volts	Go to Step 3	Go to Step 5
3	Turn ignition OFF. Disconnect TP sensor harness connector. Turn ignition ON, engine OFF. Does the Digital Volt-Ohm Meter indicate a voltage less than the specified value?	.36 volt	Go to Step 4	Go to Step 6
4	Connect Digital Volt-Ohm Meter from harness terminal "A" to harness connector terminal "B". Does Digital Volt-Ohm Meter indicate a voltage greater than the specified value?	4 volts	Go to Step 8	Go to Step 7
5	DTC 21 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	-	Verify Repair	-
6	Locate and repair short to voltage in circuit between J2-23 and terminal "C" TP harness connector. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 9
7	Locate and repair open in ground circuit between J2-3 and terminal "B" TP harness connector. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 9
8	Replace faulty TP sensor. Is action complete?	-	Verify Repair	-
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

DTC 22 - Throttle Position (TP) Sensor Circuit - Signal Voltage Low (Scan)



Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides a voltage signal that changes relative to the throttle blade. Signal voltage should vary from about .7 volt at idle to about 4.8 volts at Wide Open Throttle (WOT).

The TP sensor signal is one of the most important inputs used by the ECM for fuel control and for IAC control.

The ECM supplies a 5 volt signal to the sensor through J2-2 to Pin A on the TP sensor. Pin B to J2-3 is the TP sensor ground circuit. The TP sensor will send a voltage signal back to the ECM, from Pin C to J2-23, according to where the throttle blades are positioned.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to the TP sensor.

A change in the TP sensor display will indicate the location of the fault.

- The scan tool reads throttle position in voltage and percentage relative to the throttle blade opening. With ignition "ON," engine "OFF," throttle blades closed (idle), the voltage should be 0.3-0.9 volts. The voltage should steadily increase as the throttle is moved toward Wide Open Throttle (WOT).
- If DTC 34 is also set, check for a short to ground in the 5 volt reference circuit.
- If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

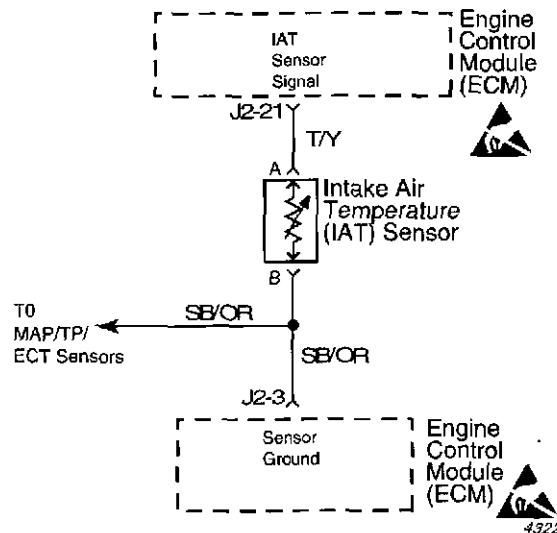
Test Description

2. With the throttle closed, the TP sensor voltage should read 0.3-0.9 volt. If it does not, check the throttle cable adjustment or for bent or binding linkage.
3. This test simulates a DTC 21. If the ECM recognizes the high signal voltage, the ECM and wiring are OK.
4. This test checks for the 5 volt reference.

DTC 22 - Throttle Position (TP) Sensor Circuit - Signal Voltage Low (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	1. Throttle closed. 2. Turn ignition ON, engine OFF. Does scan tool indicate TP sensor voltage less than the specified value?	.36 volts	Go to Step 3	Go to Step 5
3	1. Turn ignition OFF. 2. Disconnect TP sensor harness connector. 3. Connect a jumper wire between harness terminal "A" and harness terminal "C". 4. Turn ignition ON, engine OFF. Does the scan tool indicate TP sensor voltage greater than the specified value?	4 volts	Go to Step 8	Go to Step 4
4	1. Turn ignition OFF. 2. Connect Digital Volt-Ohm Meter from harness terminal "A" to a known good engine ground. 3. Turn ignition ON, engine OFF. Does DVOM indicate a voltage greater than the specified value?	4 volts	Go to Step 7	Go to Step 6
5	DTC 22 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	-	-	-
6	Locate and repair open or short to ground in circuit between J2-2 and harness connector "A." Also check the circuit to the MAP sensor for a short to ground. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 9
7	Locate and repair open or short to ground in TP sensor signal circuit between J2-23 and harness connector "C." If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 9
8	Replace faulty TP sensor. Is action complete?	-	Verify Repair	-
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

DTC 23 - Intake Air Temperature (IAT) Sensor Circuit - Low Temp Indicated (Scan)



Circuit Description

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts to the sensor. When the intake air temperature is cold, the sensor (thermistor) resistance is high. As the intake air temperature warms up, the sensor resistance becomes less. See intake air temperature sensor table under "Diagnostic Aids."

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.
- The scan tool displays intake air temperature in degrees Celsius and Fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a IAT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a "shifted" IAT sensor.
- If DTC 33 is also set, check for open ground circuit (J2-3 to harness connector terminal "B").

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

Test Description

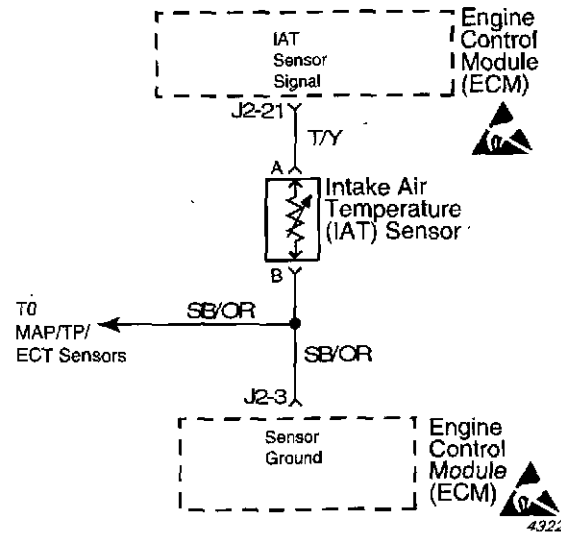
2. DTC 23 will set if signal voltage indicates a intake air temperature below -30°C (-22°F).
3. This test simulates a DTC 25. If the ECM recognizes the low voltage signal and displays a high temperature, the ECM and wiring are OK.

°C	°F	Ohms
Temperature vs. resistance Values (Approximate)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	133	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

DTC 23 - Intake Air Temperature (IAT) Sensor Circuit - Low Temp Indicated (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Turn ignition ON, engine OFF. Does the scan tool display an intake air temperature less than the specified value?	-30°C (-22°F)	Go to Step 3	Go to Step 4
3	1. Turn ignition OFF. 2. Disconnect IAT sensor harness connector. 3. Connect a jumper wire between the IAT harness connector terminals "A" and "B." 4. Turn ignition ON, engine OFF. Does the scan tool display a coolant temperature above the specified value?	130°C (266°F)	Go to Step 6	Go to Step 5
4	DTC 23 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	-	Verify Repair	-
5	Locate and repair open in the IAT sensor signal circuit (J2-21 to IAT harness terminal "A") or the IAT sensor ground circuit (J2-3 to IAT harness terminal "B"). Was a problem found and corrected?	-	Verify Repair	Go to Step 7
6	Repair faulty IAT sensor. Is action complete?	-	Verify Repair	-
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

DTC 25 - Intake Air Temperature (IAT) Sensor Circuit - High Temp Indicated (Scan)



Circuit Description

The Intake Air Temperature (IAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts to the sensor. When the intake air temperature is cold, the sensor (thermistor) resistance is high. As the intake air temperature warms up, the sensor resistance becomes less. See intake air temperature sensor table under "Diagnostic Aids."

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the IAT display on the scan tool while moving connectors and wiring harnesses related to the IAT sensor. A change in the IAT display will indicate the location of the fault.
- The scan tool displays intake air temperature in degrees Celsius and Fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display an IAT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a "shifted" IAT sensor.
- Check harness routing for a potential short to ground in the IAT sensor signal circuit (J2-21 to IAT harness connector terminal "A".)

After repairs, clear DTC's following "Clear DTC's Procedure. Failure to do so may result in DTC's not properly being cleared.

Test Description

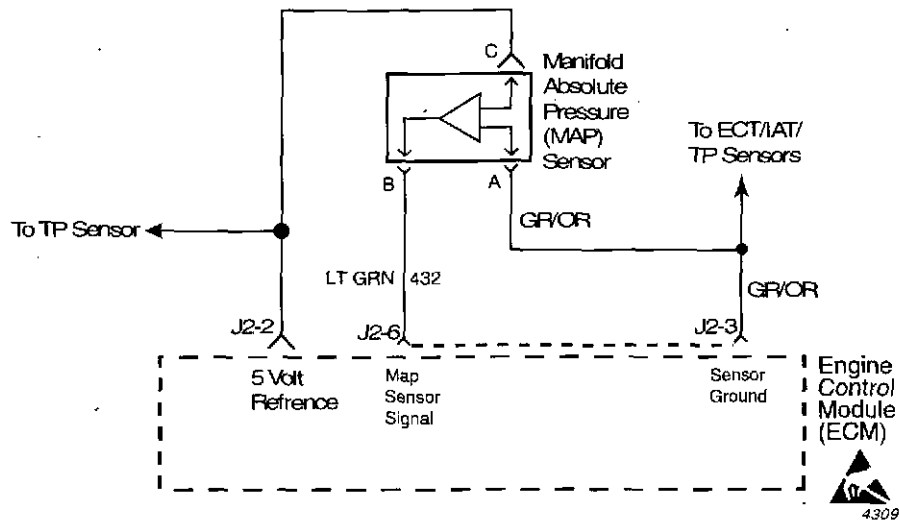
2. DTC 25 will set if signal voltage indicates an intake air temperature above 130°C or 266°F.
3. This test simulates a DTC 23. If the ECM recognizes the high voltage signal and displays a low temperature, the ECM and wiring are OK.

°C	°F	Ohms
Temperature vs. resistance Values (Approximate)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	133	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

DTC 25 - Intake Air Temperature (IAT) Sensor Circuit - High Temp Indicated (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Ignition ON, engine OFF. Does scan tool display intake air temperature greater than the specified value?	130°C (266°F)	Go to Step 3	Go to Step 4
3	1. Turn ignition OFF. 2. Disconnect IAT sensor harness connector. 3. Turn ignition ON, engine OFF. Does scan tool display an intake air temperature below the specified value?	-30°C (-22°F)	Go to Step 6	Go to Step 5
4	DTC 25 is intermittent. Locate and repair faulty connections. Refer to Diagnostic Aids.	-	Verify Repair	-
5	Locate and repair short to ground in the IAT sensor signal circuit (J2-21 to IAT harness connector terminal "A".) Was a problem found and corrected?	-	Verify Repair	-
6	Repair faulty IAT sensor. Is action complete?	-	Verify Repair	-
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

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



Circuit Description

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1.0-1.5 volts at idle to about 4.0-4.5 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with RPM.

The MAP sensor voltage of 5 volts is delivered to the MAP sensor through pin J2-2 and terminal "C" of the MAP sensor harness connector. Terminal "A" in the is the ground circuit for the MAP sensor and connects to pin J2-3 of the ECM. The MAP signal terminal "B" sends a voltage signal back to the ECM according to what the manifold pressure is.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAP sensor display on the scan tool while moving connectors and wiring harnesses related to the MAP sensor. A change in the MAP sensor display will indicate the location of the fault.

- If the idle is rough or unstable, refer to *Symptoms* for items which may cause an unstable idle.
- With the ignition "ON," engine "OFF," the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of altitude and is referred to as BARO. Comparison of this BARO reading, with a known good MAP sensor, is a good way to check the accuracy of a "suspect" sensor. Reading should be the same, plus or minus 0.4 volt.
- If DTC 14 is also set, check for open in ground in the sensor ground circuit (J2-3 to MAP harness connector terminal "B".)
- If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

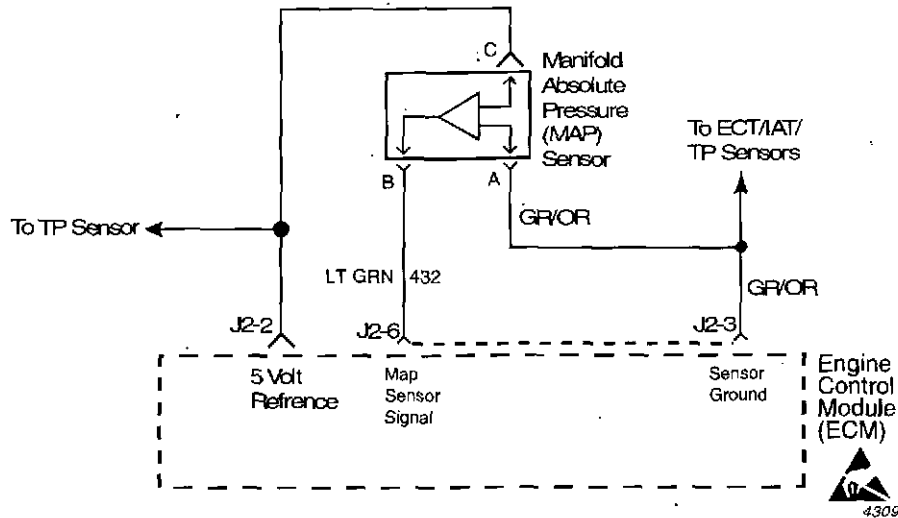
Test Description

2. This step will determine if there is an adequate vacuum supply to the MAP sensor. If the vacuum gauge reading is erratic, refer to the "Rough or Unstable Idle" symptom.
4. This step simulates a DTC 34. If the ECM recognizes the low signal voltage and sets a DTC 34, the ECM and wiring are OK.
5. This step checks for an open in ground in the sensor ground circuit.

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

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	1. Install a vacuum gauge to a manifold vacuum source. 2. Start engine and raise to 1000 r/m in neutral. 3. The vacuum reading should be steady. Is the vacuum gauge reading steady and above the specified	35.56 cm Hg 45.5 kPa (14 in. Hg)	Go to Step 3	Go to Step 6
3	1. Install a scan tool. 2. Start the engine and allow engine to idle. Does the scan tool indicate MAP sensor voltage greater than the specified value?	4 volts	Go to Step 4	Go to Step 7
4	1. Turn the ignition OFF. 2. Disconnect MAP sensor harness connector. Does scan tool indicate MAP sensor voltage greater than the specified value?	1 volt	Go to Step 5	Go to Step 8
5	Turn the ignition OFF. Connect Digital Multi-Meter (DMM) between MAP sensor harness terminal "A" and "C". Turn ignition ON, engine OFF. Does the DMM indicate a voltage greater than the specified value?	4 volts	Go to Step 10	Go to Step 9
6	Repair low or unsteady vacuum problem. Is action complete?	-	Verify Repair	-
7	DTC 33 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	-	-	-
8	Locate and repair short to voltage in MAP sensor signal circuit (J2-8 to MAP harness connector terminal "B".) Was a problem found and corrected?	-	Verify Repair	Go to Step 11
9	Locate and repair open in MAP sensor ground circuit (J2-3 to MAP harness connector terminal "A"). Was a problem found and corrected?	-	Verify Repair	Go to Step 11
10	Check for plugged or leaking sensor vacuum fitting. If OK, replace faulty MAP sensor. Is action complete?	-	Verify Repair	-
11	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

DTC 34 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage Low (Scan)



Circuit Description

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1.0-1.5 volts at idle to about 4.0-4.5 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with RPM.

The MAP sensor voltage of 5 volts is delivered to the MAP sensor through pin J2-2 and terminal "C" of the MAP sensor harness connector. Terminal "A" in the is the ground circuit for the MAP sensor and connects to pin J2-3 of the ECM. The MAP signal terminal "B" sends a voltage signal back to the ECM according to what the manifold pressure is.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAP sensor display on the scan tool while moving connectors and wiring harnesses related to the MAP sensor. A change in the MAP sensor display will indicate the location of the fault.

- If the idle is rough or unstable, refer to *Symptoms* for items which may cause an unstable idle.
- With the ignition "ON," engine "OFF," the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of altitude and is referred to as BARO. Comparison of this BARO reading, with a known good MAP sensor, is a good way to check the accuracy of a "suspect" sensor. Reading should be the same, plus or minus 0.4 volt.
- If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

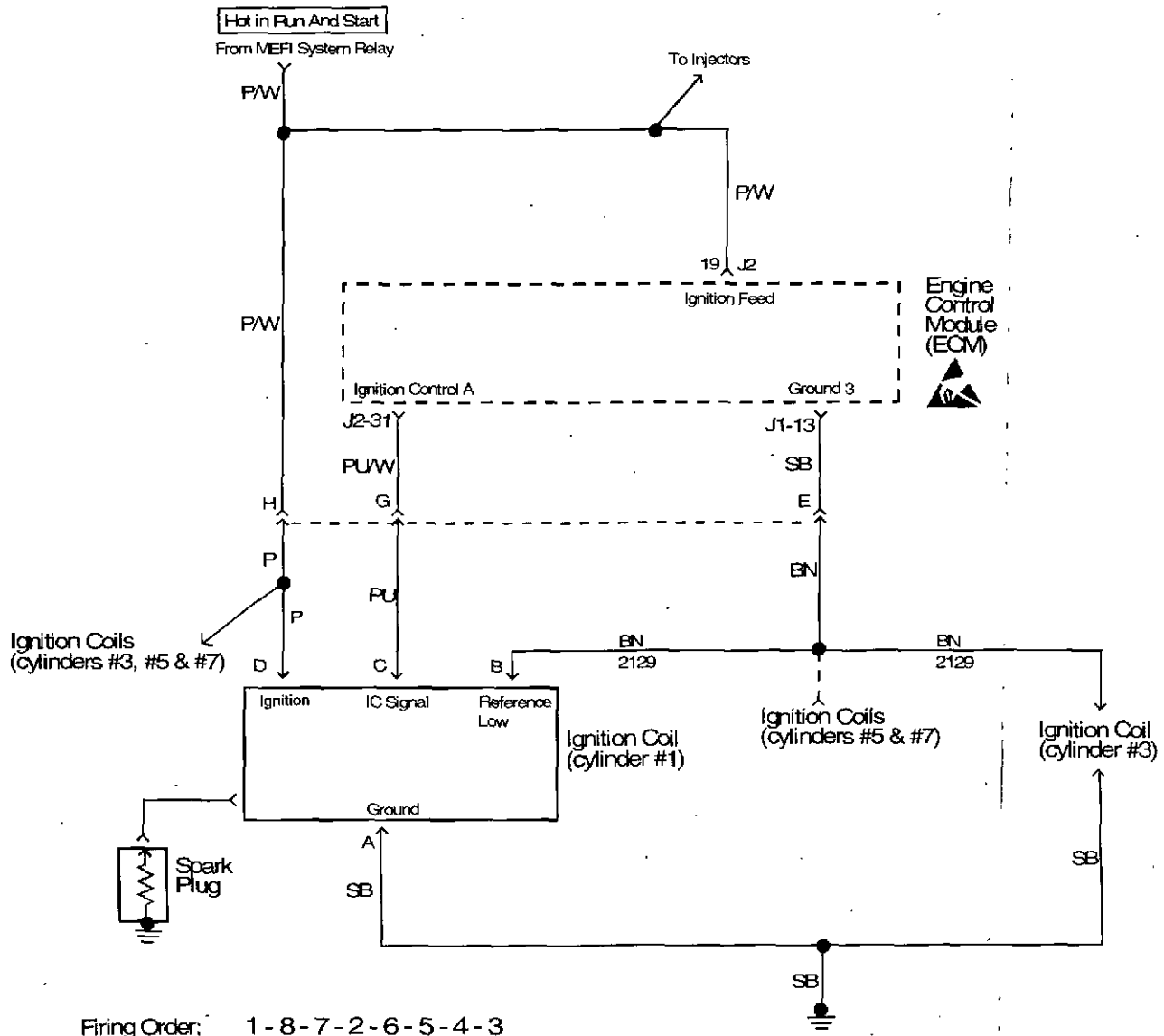
Test Description

2. This step will determine if there is an adequate vacuum supply to the MAP sensor. If the vacuum gauge reading is erratic, refer to the "Rough or Unstable Idle" symptom.
3. This step determines if DTC 34 is the result of a hard failure or an intermittent condition. A DTC will set when MAP signal voltage is too low with engine running.
4. This step simulates a DTC 33. If the ECM recognizes the high signal voltage, the ECM and wiring are OK.
5. This step checks for the 5 volt reference circuit.

DTC 34 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage Low (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> 1. Turn ignition OFF. 2. Install vacuum gauge to a manifold vacuum source. 3. Start engine and raise to 1000 r/m in neutral. 4. The vacuum reading should be steady. <p>Is the vacuum gauge reading steady and above the specified value?</p>	35.5 cm Hg 45.5 kPa (14 in. Hg)	Go to Step 3	Go to Step 6
3	<ol style="list-style-type: none"> 1. Install a scan tool. 2. Start the engine and allow to engine to idle. <p>Does scan tool indicate map sensor voltage less than the specified value?</p>	1 volt	Go to Step 4	Go to Step 7
4	<ol style="list-style-type: none"> 1. Turn the ignition OFF. 2. Disconnect MAP sensor harness connector. 3. Connect a jumper wire between MAP sensor harness connector terminals "B" and "C". 4. Turn ignition ON, engine OFF. <p>Does the scan tool indicate MAP sensor voltage greater than the specified value?</p>	4 volts	Go to Step 10	Go to Step 5
5	<p>Turn OFF ignition.</p> <p>Connect a Digital Multi-Meter between MAP sensor harness connector terminal "C" and a known good engine ground.</p> <p>Turn ignition ON, engine OFF.</p> <p>Does the Digital Multi-Meter indicate a voltage greater than the specified value?</p>	4 volts	Go to Step 9	Go to Step 8
6	<p>Repair low or unsteady vacuum problem.</p> <p>Is action complete?</p>	-	Verify Repair	-
7	DTC 34 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	-	-	-
8	<p>Locate and repair open or short to ground in 5 volt reference circuit J2-2 to MAP harness connector terminal "C."</p> <p>Was a problem found and corrected?</p>	-	Verify Repair	Go to Step 11
9	<p>Locate and repair open or short to ground in MAP sensor signal circuit J2-8 to MAP harness connector terminal "B."</p> <p>Was a problem found and corrected?</p>	-	Verify Repair	-
10	<p>Check for plugged or leaking sensor vacuum fitting. If OK, replace faulty MAP sensor.</p> <p>Is action complete?</p>	-	Verify Repair	-
11	<p>Repair faulty ECM connections or replace faulty ECM.</p> <p>Is action complete?</p>	-	Verify Repair	-

DTC 41 - Ignition Coil 1 Control Circuit (Scan)



Firing Order: 1-8-7-2-6-5-4-3

Ignition Control: A-B-C-D-E-F-G-H

Circuit Description

The ignition system on this engine uses an individual ignition coil/module for each cylinder. The ECM controls the ignition system operation. The ECM controls each coil using one of eight Ignition Control (IC) circuits. The ECM commands the IC circuit low when a spark event is requested. This causes the IC module to energize the ignition coil to create a spark at the spark plug. Each ignition coil/module has the following circuits:

- A power feed
- A ground circuit
- An Ignition Control (IC) circuit
- A reference low circuit

Sequence and timing are ECM controlled. This DTC sets when the IC circuit is out of range.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

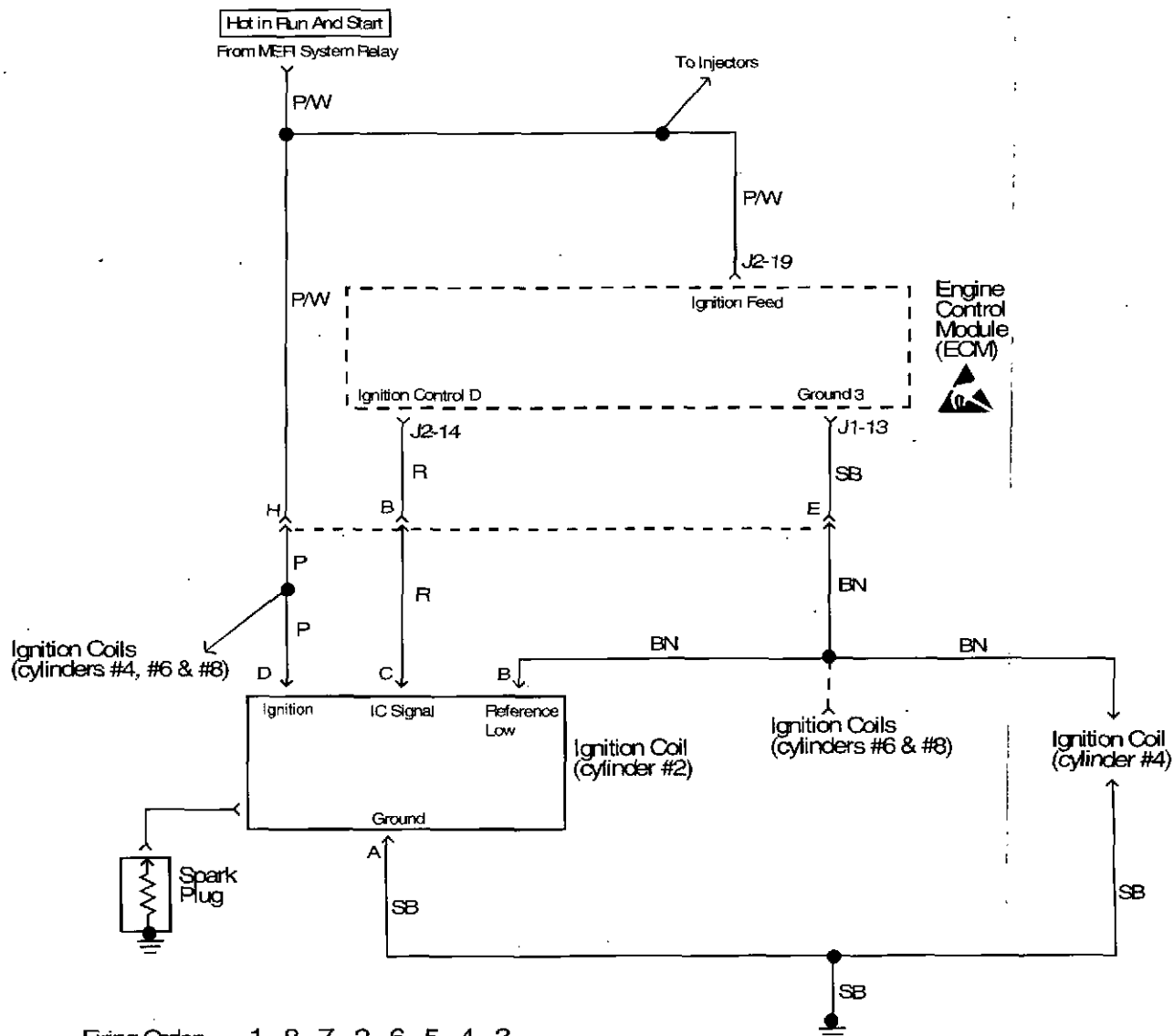
Test Description

2. This step verifies the fault is present.
4. This step tests the integrity of the IC circuit and the ECM output.
5. This step tests for a short to ground on the IC signal circuit.

DTC 41 - Ignition Coil 1 Control Circuit (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 1?	-	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter. Is the voltage greater than the specified value	1.0 volt	Go to Step 8	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate continuity?	-	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate OL?	-	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	-	Go to Step 12	-
8	Repair the ignition control circuit for a short to voltage. Is action complete?	-	Go to Step 12	-
9	Repair the Ignition control circuit for an open or grounded circuit. Is the action complete?	-	Go to Step 12	-
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	-	Go to Step 12	Go to Step 11
11	Replace the ECM. Is action complete?	-	Go to Step 12	-
12	Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	-	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	-	Go to the applicable DTC	System OK

DTC 41 - Ignition Coil 2 Control Circuit



Firing Order: 1-8-7-2-6-5-4-3

Ignition Control: A-B-C-D-E-F-G-H

Circuit Description

The ignition system on this engine uses an individual ignition coil/module for each cylinder. The ECM controls the ignition system operation. The ECM controls each coil using one of eight Ignition Control (IC) circuits. The ECM commands the IC circuit low when a spark event is requested. This causes the IC module to energize the ignition coil to create a spark at the spark plug. Each ignition coil/module has the following circuits:

- A power feed
- A ground circuit
- An Ignition Control (IC) circuit
- A reference low circuit

Sequence and timing are ECM controlled. This DTC sets when the IC circuit is out of range.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

Test Description

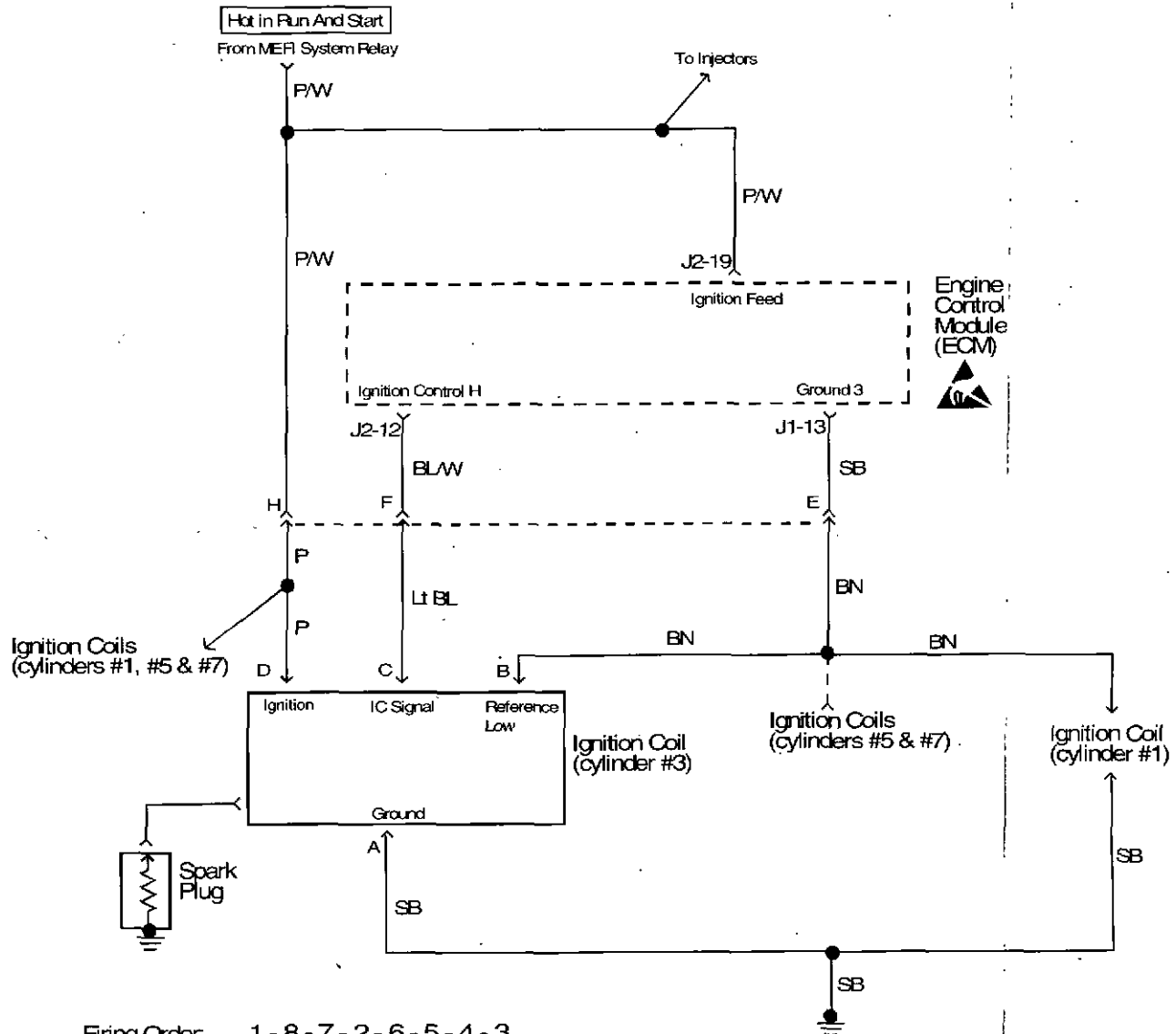
2. This step verifies the fault is present.
4. This step tests the integrity of the IC circuit and the ECM output.
5. This step tests for a short to ground on the IC signal circuit.

4312

DTC 41 - Ignition Coil 2 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 2?	-	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter. Is the voltage greater than the specified value	1.0 volt	Go to Step 8	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate continuity?	-	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate OL?	-	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	-	Go to Step 12	-
8	Repair the ignition control circuit for a short to voltage. Is action complete?	-	Go to Step 12	-
9	Repair the Ignition control circuit for an open or grounded circuit. Is the action complete?	-	Go to Step 12	-
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	-	Go to Step 12	Go to Step 11
11	Replace the ECM. Is action complete?	-	Go to Step 12	-
12	Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	-	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	-	Go to the applicable DTC	System OK

DTC 41 - Ignition Coil 3 Control Circuit (Scan)



Firing Order: 1-8-7-2-6-5-4-3

Ignition Control: A-B-C-D-E-F-G-H

Circuit Description

The ignition system on this engine uses an individual ignition coil/module for each cylinder. The ECM controls the ignition system operation. The ECM controls each coil using one of eight Ignition Control (IC) circuits. The ECM commands the IC circuit low when a spark event is requested. This causes the IC module to energize the ignition coil to create a spark at the spark plug. Each ignition coil/module has the following circuits:

- A power feed
- A ground circuit
- An Ignition Control (IC) circuit
- A reference low circuit

Sequence and timing are ECM controlled. This DTC sets when the IC circuit is out of range.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

Test Description

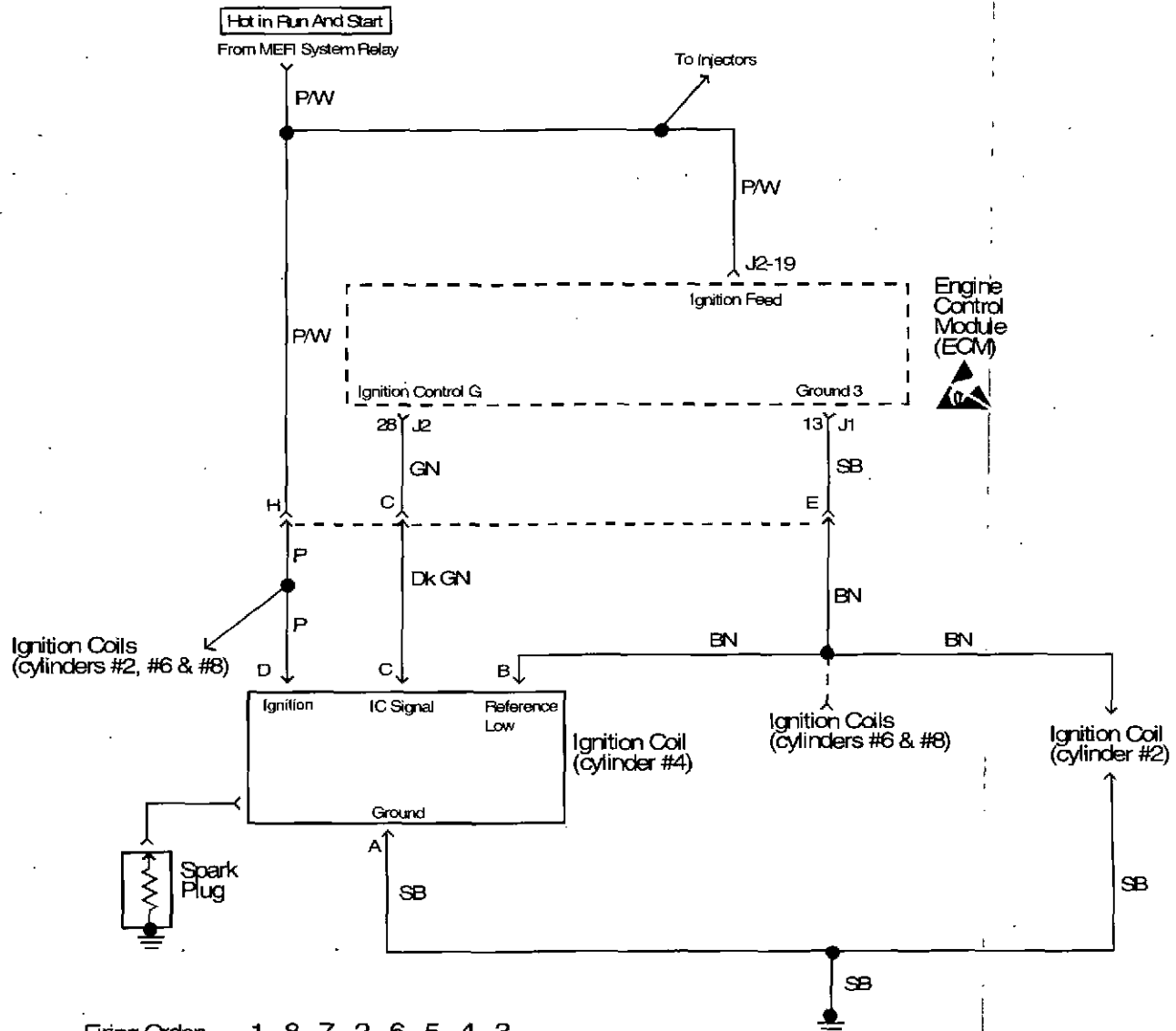
2. This step verifies the fault is present.
4. This step tests the integrity of the IC circuit and the ECM output.
5. This step tests for a short to ground on the IC signal circuit.

4315

DTC 41 - Ignition Coil 3 Control Circuit (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 3?	-	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter. Is the voltage greater than the specified value	1.0 volt	Go to Step 8	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate continuity?	-	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate OL?	-	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	-	Go to Step 12	-
8	Repair the ignition control circuit for a short to voltage. Is action complete?	-	Go to Step 12	-
9	Repair the Ignition control circuit for an open or grounded circuit. Is the action complete?	-	Go to Step 12	-
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	-	Go to Step 12	Go to Step 11
11	Replace the ECM. Is action complete?	-	Go to Step 12	-
12	Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	-	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	-	Go to the applicable DTC	System OK

DTC 41 - Ignition Coil 4 Control Circuit (Scan)



Firing Order: 1-8-7-2-6-5-4-3

Ignition Control: A-B-C-D-E-F-G-H

Circuit Description

The ignition system on this engine uses an individual ignition coil/module for each cylinder. The ECM controls the ignition system operation. The ECM controls each coil using one of eight Ignition Control (IC) circuits. The ECM commands the IC circuit low when a spark event is requested. This causes the IC module to energize the ignition coil to create a spark at the spark plug. Each ignition coil/module has the following circuits:

- A power feed
- A ground circuit
- An Ignition Control (IC) circuit
- A reference low circuit

Sequence and timing are ECM controlled. This DTC sets when the IC circuit is out of range.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

Test Description

2. This step verifies the fault is present.
4. This step tests the integrity of the IC circuit and the ECM output.
5. This step tests for a short to ground on the IC signal circuit.

4316

DTC 41 - Ignition Coil 4 Control Circuit (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 4?	-	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter. Is the voltage greater than the specified value	1.0 volt	Go to Step 8	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate continuity?	-	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate OL?	-	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	-	Go to Step 12	-
8	Repair the ignition control circuit for a short to voltage. Is action complete?	-	Go to Step 12	-
9	Repair the Ignition control circuit for an open or grounded circuit. Is the action complete?	-	Go to Step 12	-
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	-	Go to Step 12	Go to Step 11
11	Replace the ECM. Is action complete?	-	Go to Step 12	-
12	Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	-	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	-	Go to the applicable DTC	System OK

DTC 41 - Ignition Coil 5 Control Circuit (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	<p>Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open.</p> <ol style="list-style-type: none"> 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. <p>Does the scan tool indicate a DTC 41 for ignition coil 5?</p>	-	Go to Step 3	Go to Diagnostic Aids
3	<ol style="list-style-type: none"> 1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. <p>Is the frequency within the specified range?</p>	3.0-20 Hz	Go to Step 7	Go to Step 4
4	<p>Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter.</p> <p>Is the voltage greater than the specified value</p>	1.0 volt	Go to Step 8	Go to Step 9
5	<ol style="list-style-type: none"> 1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. <p>Does the Digital Volt-Ohm Meter indicate continuity?</p>	-	Go to Step 6	Go to Step 9
6	<p>Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter.</p> <p>Does the Digital Volt-Ohm Meter indicate OL?</p>	-	Go to Step 10	Go to Step 9
7	<p>Replace the ignition coil.</p> <p>Is the action complete?</p>	-	Go to Step 12	-
8	<p>Repair the ignition control circuit for a short to voltage.</p> <p>Is action complete?</p>	-	Go to Step 12	-
9	<p>Repair the Ignition control circuit for an open or grounded circuit.</p> <p>Is the action complete?</p>	-	Go to Step 12	-
10	<ol style="list-style-type: none"> 1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. <p>Did you find and correct the problem?</p>	-	Go to Step 12	Go to Step 11
11	<p>Replace the ECM.</p> <p>Is action complete?</p>	-	Go to Step 12	-
12	<p>Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool.</p> <p>Idle the engine at the normal operating temperature.</p> <p>Is DTC 41 indicated?</p>	-	Go to Step 2	Go to Step 13
13	<p>Select the Diagnostic Trouble Code (DTC) option.</p> <p>Does the scan tool display any DTCs that you have not diagnosed?</p>	-	Go to the applicable DTC	System OK

DTC 41 - Ignition Coil 6 Control Circuit (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	<p>Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open.</p> <ol style="list-style-type: none"> 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. <p>Does the scan tool indicate a DTC 41 for ignition coil 6?</p>	-	Go to Step 3	Go to Diagnostic Aids
3	<ol style="list-style-type: none"> 1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. <p>Is the frequency within the specified range?</p>	3.0-20 Hz	Go to Step 7	Go to Step 4
4	<p>Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter.</p> <p>Is the voltage greater than the specified value</p>	1.0 volt	Go to Step 8	Go to Step 9
5	<ol style="list-style-type: none"> 1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. <p>Does the Digital Volt-Ohm Meter indicate continuity?</p>	-	Go to Step 6	Go to Step 9
6	<p>Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter.</p> <p>Does the Digital Volt-Ohm Meter indicate OL?</p>	-	Go to Step 10	Go to Step 9
7	<p>Replace the ignition coil.</p> <p>Is the action complete?</p>	-	Go to Step 12	-
8	<p>Repair the ignition control circuit for a short to voltage.</p> <p>Is action complete?</p>	-	Go to Step 12	-
9	<p>Repair the Ignition control circuit for an open or grounded circuit.</p> <p>Is the action complete?</p>	-	Go to Step 12	-
10	<ol style="list-style-type: none"> 1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. <p>Did you find and correct the problem?</p>	-	Go to Step 12	Go to Step 11
11	<p>Replace the ECM.</p> <p>Is action complete?</p>	-	Go to Step 12	-
12	<p>Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool.</p> <p>Idle the engine at the normal operating temperature.</p> <p>Is DTC 41 indicated?</p>	-	Go to Step 2	Go to Step 13
13	<p>Select the Diagnostic Trouble Code (DTC) option.</p> <p>Does the scan tool display any DTCs that you have not diagnosed?</p>	-	Go to the applicable DTC	System OK

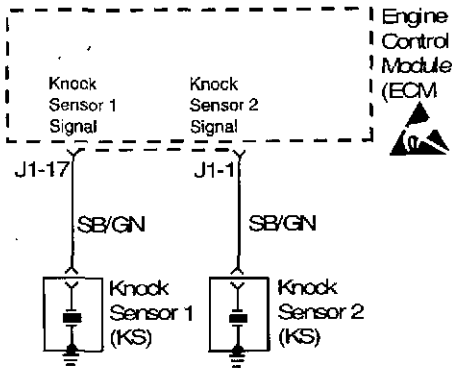
DTC 41 - Ignition Coil 7 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 7?	-	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter. Is the voltage greater than the specified value	1.0 volt	Go to Step 8	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate continuity?	-	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate OL?	-	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	-	Go to Step 12	-
8	Repair the ignition control circuit for a short to voltage. Is action complete?	-	Go to Step 12	-
9	Repair the Ignition control circuit for an open or grounded circuit. Is the action complete?	-	Go to Step 12	-
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	-	Go to Step 12	Go to Step 11
11	Replace the ECM. Is action complete?	-	Go to Step 12	-
12	Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	-	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	-	Go to the applicable DTC	System OK

DTC 41 - Ignition Coil 8 Control Circuit (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 8?	-	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter. Is the voltage greater than the specified value	1.0 volt	Go to Step 8	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate continuity?	-	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate OL?	-	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	-	Go to Step 12	-
8	Repair the ignition control circuit for a short to voltage. Is action complete?	-	Go to Step 12	-
9	Repair the Ignition control circuit for an open or grounded circuit. Is the action complete?	-	Go to Step 12	-
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	-	Go to Step 12	Go to Step 11
11	Replace the ECM. Is action complete?	-	Go to Step 12	-
12	Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	-	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	-	Go to the applicable DTC	System OK

DTC 44 - Knock Sensor (KS) 1 Circuit (Scan)



Circuit Description

The ECM uses the Knock Sensor(s) in order to detect engine detonation. This detection allows the ECM to retard spark timing based on the KS signal coming into the ECM. DTC 44 will set only if the ECM does not see any activity on the KS signal circuit(s).

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- Loose Knock Sensor(s) in engine block.
- Poor connection at the Knock Sensor(s).

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

If the knock sensor wires are routed too close to secondary ignition wires, the ECM may see the interference as a knock signal, resulting in false timing retard.

Test Description

4. This step ensures the knock sensor is secured properly

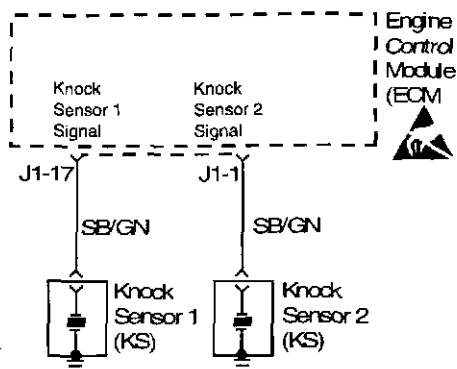
in the engine block.

5. Checks to see that the knock sensor circuit is within specifications.

DTC 44 - Knock Sensor (KS) 1 Circuit (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Important! If you can hear the engine knock, repair the engine mechanical problem before proceeding with this diagnostic table. Check the KS signal circuits for incorrect routing near the spark plug wires. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 3
3	Check the KS signal circuits for any terminals not being fully seated or for incorrect installation. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 4
4	Check knock sensors for being loose in the engine block. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 5
5	1. Install scan tool. 2. Select the option to view the data list. 3. Select to view the knock signal 1 parameter. 4. Disconnect ""J1"" harness from the ECM. 5. Connect a Digital Multi-Meter from ""J1-17"" (knock signal 1) to a known good engine ground near the knock sensor. Is the resistance between the specified value?	93-107K ohms	Go to Step 8	Go to Step 6
6	Locate and repair open or short to ground in the circuit that were out of range. If a problem is found, repair as necessary. Was a problem found and repaired?	-	Verify Repair	Go to Step 7
7	Inspect knock sensor terminal contacts. If OK, replace faulty knock sensor (s). Is the action complete?	-	Verify Repair	-
8	Replace faulty ECM connections or replace faulty ECM. Is the action complete?	-	Verify Repair	-

DTC 44 - Knock Sensor (KS) 2 Circuit (Scan)



Circuit Description

The ECM uses the Knock Sensor(s) in order to detect engine detonation. This detection allows the ECM to retard spark timing based on the KS signal coming into the ECM. DTC 44 will set only if the ECM does not see any activity on the KS signal circuit(s).

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- Loose Knock Sensor(s) in engine block.
- Poor connection at the Knock Sensor(s).

After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

If the knock sensor wires are routed too close to secondary ignition wires, the ECM may see the interference as a knock signal, resulting in false timing retard.

Test Description

4. This step ensures the knock sensor is secured properly

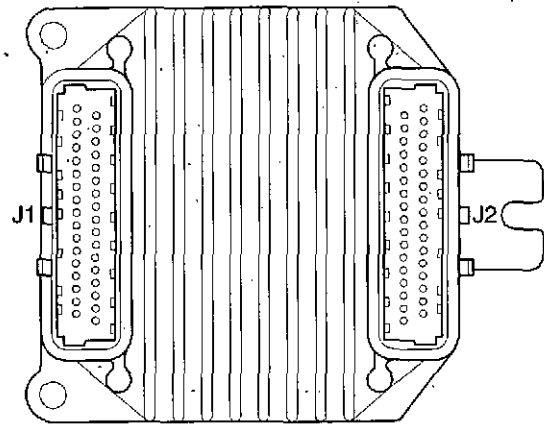
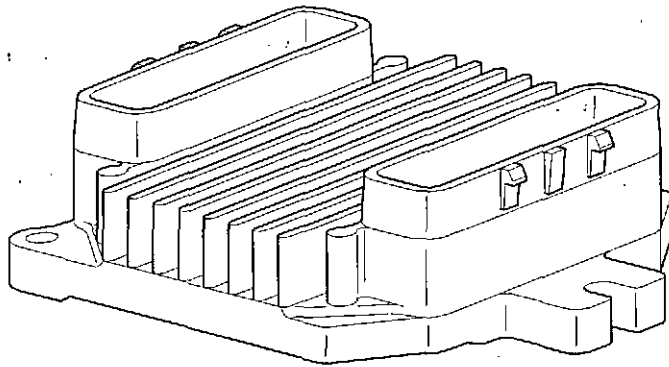
in the engine block.

5. Checks to see that the knock sensor circuit is within specifications.

DTC 44 - Knock Sensor (KS) 2 Circuit (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Important! If you can hear the engine knock, repair the engine mechanical problem before proceeding with this diagnostic table. Check the KS signal circuits for incorrect routing near the spark plug wires. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 3
3	Check the KS signal circuits for any terminals not being fully seated or for incorrect installation. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 4
4	Check knock sensors for being loose in the engine block. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 5
5	1. Install scan tool. 2. Select the option to view the data list. 3. Select to view the knock signal 1 parameter. 4. Disconnect ""J1"" harness from the ECM. 5. Connect a Digital Multi-Meter from "J1-1" (knock signal 2) to a known good engine ground near the knock sensor. Is the resistance between the specified value?	93-107K ohms	Go to Step 8	Go to Step 6
6	Locate and repair open or short to ground in the circuit that were out of range. If a problem is found, repair as necessary. Was a problem found and repaired?	-	Verify Repair	Go to Step 7
7	Inspect knock sensor terminal contacts. If OK, replace faulty knock sensor (s). Is the action complete?	-	Verify Repair	-
8	Replace faulty ECM connections or replace faulty ECM. Is the action complete?	-	Verify Repair	-

DTC 51 - Calibration Checksum Failure (Scan)



3004

Circuit Description

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

This test is also used as a security measure to prevent improper use of calibration or changes to these calibrations that may alter the designed function of MEFI.

Diagnostic Aids

If DTC 51 failed more than once, but is intermittent, replace the ECM.

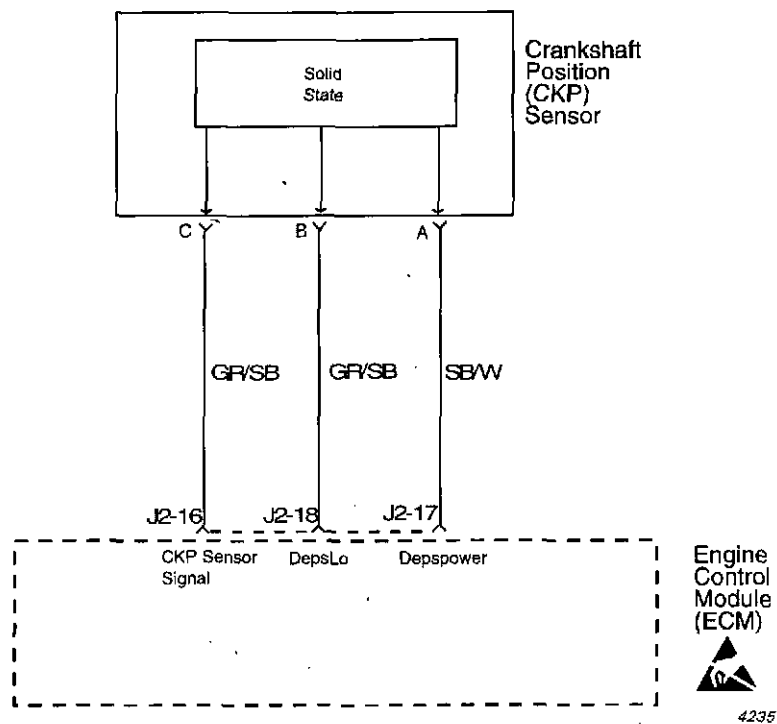
Test Description

2. This step checks to see if the fault is present during diagnosis. If present, the ECM is not functioning properly and must be replaced or reprogrammed.

DTC 51 - Calibration Checksum Failure (Scan)

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

DTC 81 - Crankshaft Position (CKP) Sensor Circuit Fault (Scan Diagnostics)



Circuit Description

The CKP sensor works in conjunction with a 24X reluctor wheel. The CKP sensor has a B+ power supply, a ground and a signal circuit.

As the crankshaft rotates, the reluctor wheel teeth interrupt a magnetic field produced by a magnet within the sensor. The sensor's internal circuitry detects this and produces a signal which the ECM reads. The ECM uses this signal to accurately measure crankshaft velocity which is a variable used in order to detect misfire, and control spark and fueling.

Diagnostic Aids

Check for the following conditions:

- **Poor connection in harness.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Crankshaft reluctor wheel damage or improper installation
- Excessive air gap between the CKP sensor and the reluctor wheel

Excess crankshaft end play causes the CKP sensor

reluctor wheel to move out of alignment with the CKP sensor. This could result in any one of the following:

- A no start
- A start and stall
- Erratic performance

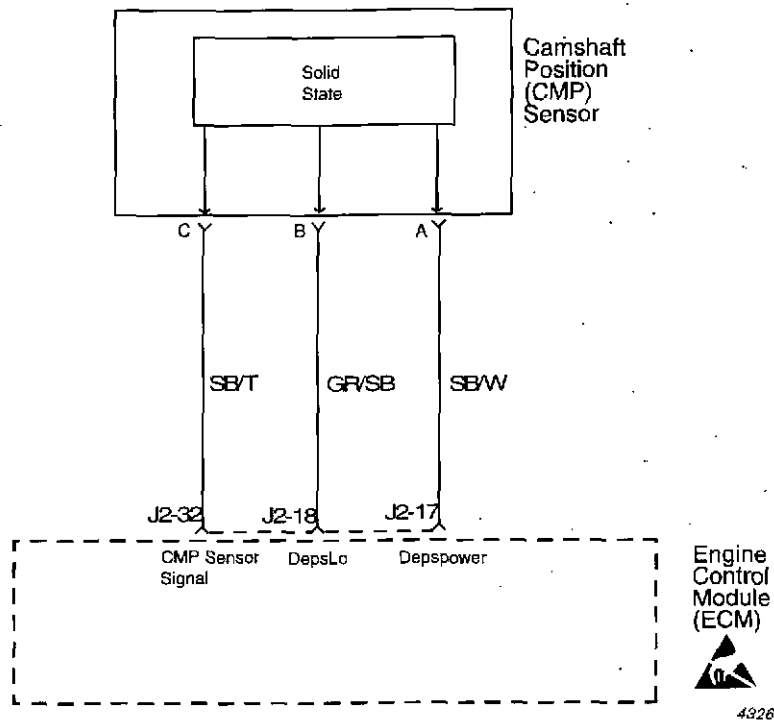
Test Description

2. This test determines if the conditions exist in order to set DTC 55.

DTC 81 - Crankshaft Position (CKP) Sensor Circuit Fault (Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	Does the engine start and continue to run?	-	Go to Step 3	Go to Step 4
3	1. Ignition ON, engine OFF. 2. Disconnect the Crankshaft Position (CKP) sensor harness connector. 3. Using a Digital Volt-Ohm Meter connected to a known good engine ground, measure the voltage at terminal "A" (Depspower) at the CKP sensor harness. Does the DMM display the specified value?	B+	Go to Step 4	Go to Step 7
4	Using the Digital Multi-Meter, measure the voltage between the CKP sensor harness connector terminals "A" (Depspower) and "B" (Depsls). Does the DMM display the specified value?	B+	Go to Step 5	Go to Step 8
5	Using a test lamp connected to harness connector terminal "A" (Depspower), momentarily touch the other end to terminal "C" (CKP sensor signal). Does the fuel pump operate when the ignition voltage was applied to the CKP sensor signal circuit?	-	Go to Step 10	Go to Step 6
6	Jumper terminal "A" of the CKP sensor harness connector to terminal "A" of the CKP sensor using a fused jumper wire. Jumper terminal "B" of the CKP sensor harness connector to terminal "B" of the CKP sensor. Using a Digital Multi-Meter connected to a known good ground, probe terminal "C" (sensor signal) of the CKP sensor. Hand crank the engine. Does the voltage transition between 0 and 7 volts?	-	Go to Step 13	Go to Step 9
7	Locate and repair an open CKP sensor (Depspower) circuit. Was a problem found?	-	Verify Repair	Go to Step 13
8	Locate and repair an open or poor connection in the CKP sensor (Depsls) circuit. Was a problem found?	-	Verify Repair	Go to Step 13
9	Locate and repair open, short to ground, and/or short to voltage in the CKP sensor signal circuit. Was a problem found and repaired.	-	Verify Repair	Go to Step 10
10	1. Remove the CKP sensor. 2. Visually inspect the CKP sensor for physical damage, loose or improper installation or wiring routed too closely to secondary ignition components. 3. Repair the circuit as necessary. Was a problem found and corrected?	-	Verify Repair	-
11	Inspect for poor connections at the CKP sensor. Repair if needed. Was a problem found?	-	Verify Repair	-
12	Replace the faulty CKP sensor? Is the action complete?	-	Verify Repair	-
13	Replace the ECM. Is action complete?	-	Verify Repair	-

DTC 81 - Camshaft Position (CMP) Sensor Circuit Fault (Scan)



Circuit Description

The CMP sensor works in conjunction with a 1X reluctor wheel on the camshaft. The Engine Control Module (ECM) provides a 12 volt reference to the CMP sensor as well as a low reference and a signal circuit.

The CMP sensor determines whether a cylinder is on a firing stroke or on an exhaust stroke. As the camshaft rotates, the reluctor wheel interrupts a magnetic field produced by a magnet within the sensor. The sensor's internal circuitry detects this and produces a signal which the ECM reads. The ECM uses this 1X signal in combination with the crankshaft position (CKP) sensor 24X signal in order to determine crankshaft position and stroke.

Observe that as long as the ECM receives the CKP sensor 24X signal, the engine will start. The ECM can determine top dead center for all cylinders by using the CKP sensor 24X signal alone. The CMP sensor 1X signal is used by the ECM to determine if the cylinder at top dead center is on the firing stroke or the exhaust stroke. The system attempts synchronization and looks for an increase in engine speed indicating the engine started. If the ECM does not detect an increase in engine speed, the ECM assumes it is incorrectly synchronized to the exhaust stroke and re-synchronizes to the exhaust stroke and re-synchronizes to the opposite cam position. A slightly longer cranking time may be a symptom of this condition.

Diagnostic Aids

Check for the following conditions:

- Camshaft reluctor wheel damage
- The sensor coming in contact with the reluctor wheel
- A cracked or damaged sensor
- Foreign material passing between the sensor and reluctor wheel

If you find damage to the reluctor wheel or camshaft, refer to *Camshaft Replacement* in Engine Mechanical.

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

2. This test determines if the conditions exist in order to set DTC 55.

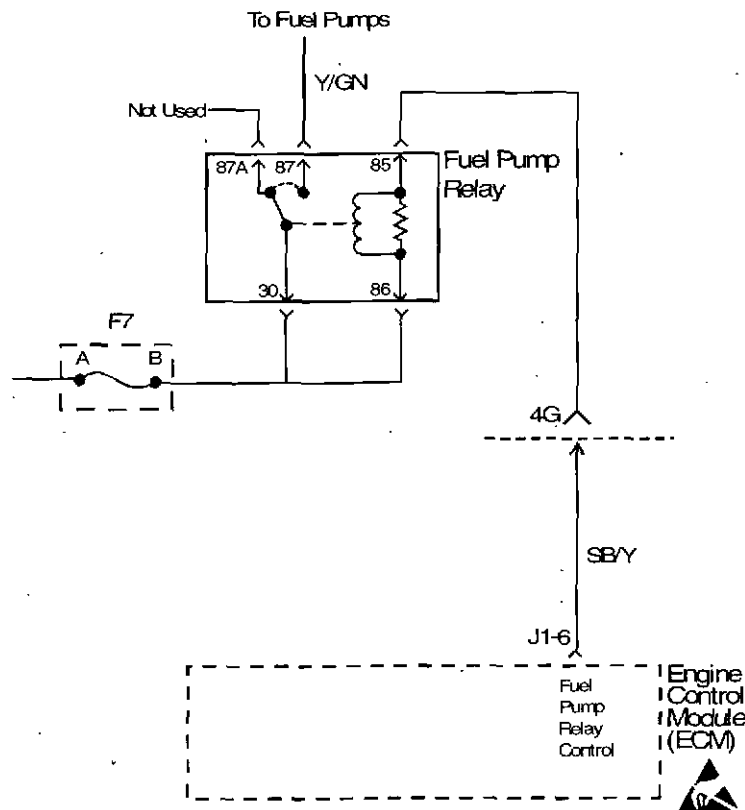
DTC 81 - Camshaft Position (CMP) Sensor Circuit Fault (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> 1. Disconnect the Camshaft Position (CMP) sensor harness connector. 2. Ignition ON, engine OFF. <p>Using a Digital Multi-Meter, connected to a known good engine ground, measure the voltage at terminal "A" (Depspower) at the CMP sensor harness.</p> <p>Does the Digital Multi-Meter display the specified value?</p>	B+	Go to Step 3	Go to Step 5
3	<p>Using a Digital Multi-Meter measure the voltage between the CMP sensor harness connector terminal "A" (Depspower) and terminal "B" (Depslo).</p> <p>Does the Digital Multi-Meter display the specified value?</p>	B+	Go to Step 4	Go to Step 7
4	<ol style="list-style-type: none"> 1. Start the engine. 2. Monitor the CAM signal input - high to low and low to high transition using the scan tool. 3. Using a test lamp connected to the harness connector terminal "A" (Depspower) momentarily touch the other end to terminal "C" (CMP sensor signal). <p>Does the CAM signal input - High to Low and Low to High transition counters increment when the test lamp contacts the signal circuit?</p>	-	Go to Step 14	Go to Step 9
5	<ol style="list-style-type: none"> 1. Turn OFF the engine. 2. Disconnect ECM connector J2. 3. Using a Digital Multi-Meter, measure the resistance of the CMP sensor (Depspower) circuit between the ECM and the CMP sensor. <p>Does the resistance measure with the specified range?</p>	0-5 ohms	Go to Step 6	Go to Step 11
6	<p>Locate and repair a short to ground or poor connections to the CMP sensor (Depspower) circuit.</p> <p>Was a problem found and corrected?</p>	-	Verify Repair	Go to Step 15
7	<p>Ignition OFF</p> <p>Disconnect the ECM J2 connector.</p> <p>Using a Digital Multi-Meter, measure the resistance of the CMP sensor (Depslo) circuit between the ECM and the CMP sensor.</p> <p>Does the resistance measure within the specified range?</p>	0-5 ohms	Go to Step 15	Go to Step 8
8	<p>Locate and repair an open or poor connection in the CMP sensor (Depslo) circuit.</p> <p>Is action complete?</p>	-	Verify Repair	-
9	<ol style="list-style-type: none"> 1. Ignition OFF 2. Disconnect the ECM J2 connector. 3. Using a Digital Multi-Meter, measure the resistance of 	0-5 ohms	Verify Repair	Go to Step 13

DTC 81 - Camshaft Position (CMP) Sensor Circuit Fault (Scan) cont'd

Step	Action	Value	Yes	No
10	Ignition ON, engine OFF. Locate and repair a short to ground or a short to voltage on the CMP sensor circuit. Was a problem found and corrected?	-	Verify Repair	Go to Step 15
11	Locate and repair an open in CMP sensor (Depspower) circuit. Was a problem found and corrected?	-	Verify Repair	Go to Step 15
12	Locate and repair an open in CMP sensor (Depslo) circuit. Was a problem found and corrected?	-	Verify Repair	-
13	Locate and repair an open in the CMP sensor signal circuit. Was a problem found and corrected?	-	Verify Repair	-
14	Locate and repair a poor connections at the CMP connector. Was a problem found and corrected?	-	Verify Repair	Go to Step 16
15	Locate and repair a poor connections at the ECM connector. Was a problem found and corrected?	-	Verify Repair	Go to Step 17
16	Replace the faulty CMP sensor. Is action complete?	-	Verify Repair	-
17	Replace the ECM. Is action complete?	-	Verify Repair	-

DTC 81 - Fuel Pump Relay Driver Circuit High, Low or Open (Scan)



Circuit Description

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

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

Diagnostic Aids

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

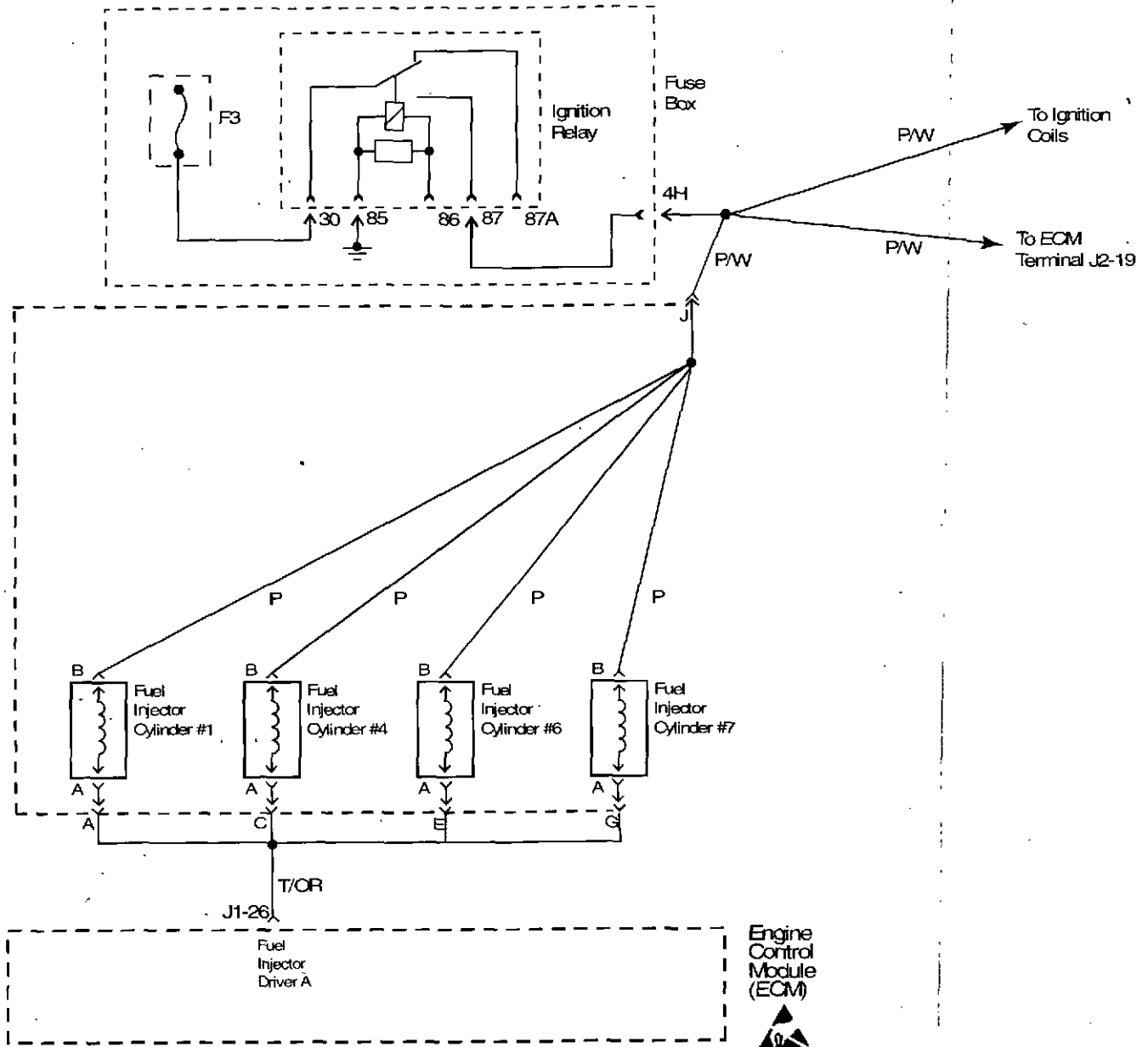
Test Description

2. Listen for an audible click when the relay operates. Command both the ON and OFF states. Repeat the commands if necessary.
3. This test can detect a partially shorted coil which would cause an excessive current flow. Leaving the circuit energized for 2 minutes allows the coil to warm up. When warm, the coil may open, and the current drops to 0, or the coil may short, and the current goes above 0.75 amp.
5. Identify and test the relay coil terminals in order to avoid improper diagnosis.
12. If no trouble is found in the control circuit or the connection at the ECM, the ECM may be faulty. However, this is an extremely unlikely failure.

DTC 81 - Fuel Pump Relay Driver Circuit High, Low or Open (Scan)

Step	Action	Value(s)	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition OFF. 2. Command the relay ON and OFF using the scan tool. Does the relay turn ON and OFF when commanded?	-	Go to Step 3	Go to Step 5
3	1. Ignition OFF 2. Disconnect the ECM J1 connector. 3. Install a 5 amp fused jumper wire from a known good engine ground to the control circuit at the ECM J1 connector pin J1-6. 4. Ignition ON, engine OFF. 5. Using a DMM on the 40 amp scale, measure the current from the relay control circuit in the ECM harness connector to ground for 2 minutes. Important! If the DMM goes to 0 during the current draw test, replace the relay. Does the current draw measure less than the specified value?	0.75A	Go to Diagnostic Aids	Go to Step 4
4	1. Ignition OFF. 2. Disconnect the fuel pump relay connector. 3. Using a DMM measure the resistance from the relay control circuit in the ECM harness connector to ground. Does the DMM display infinite resistance or OL?	-	Go to Step 12	Go to Step 10
5	1. Ignition OFF 2. Disconnect the fuel pump relay connector. 3. Connect a test lamp between the fuel pump relay control circuit (relay pin 85) and the fuel pump relay ignition feed circuit, on the coil side of the relay (relay pin 86), at the fuel pump relay socket in the fuse box 4. Ignition ON, engine OFF. 5. Using a scan tool, command the relay ON and OFF. Does the test lamp turn ON and OFF when commanded?	-	Go to Step 8	Go to Step 6
6	Using a test lamp connected to a known good engine ground, probe the ignition feed circuit, on the coil side of the fuel pump relay harness connector. Is the test lamp illuminated?	-	Go to Step 7	Go to Step 11
7	1. Ignition OFF. 2. Reconnect the relay. 3. Disconnect the ECM connector J2 4. Ignition ON, engine OFF. 5. Using a fused jumper wire connected to a known good engine ground, momentarily probe the relay control circuit in the ECM harness connector. Does the relay turn ON when the circuit is grounded and OFF when the circuit is opened?	-	Go to Step 9	Go to Step 10
8	Locate and repair faulty connections at the relay Was a problem found and repaired	-	Verify Repair	Go to Step 12
9	Locate and repair faulty connections at the ECM. Was a problem found and corrected?	-	Verify Repair	Go to Step 13
10	Repair the faulty connections at the ECM.	-	-	-
11	Repair the faulty ignition feed circuit.	-	-	-
12	Replace the faulty relay	-	-	-
13	Replace the ECM	-	-	-

DTC 81 - Fuel Injector Driver A Circuit High, Low or Open (Scan)



Circuit Description

The Engine Control Module (ECM) enables the fuel injector drivers. An ignition voltage is supplied to the fuel injectors. The ECM controls each fuel injector driver by grounding the control circuit via a solid state device called a driver. The ECM monitors the status of each driver. If the ECM detects an incorrect voltage for the commanded state of the driver, a fuel injector control DTC sets.

Diagnostic Aids

Performing the Fuel Injector Coil test may help isolate an intermittent condition. Refer to *Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 Degrees C (50-95 Degrees F)* or *Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Outside 10-35 Degrees C (50-95 Degrees F)*.

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

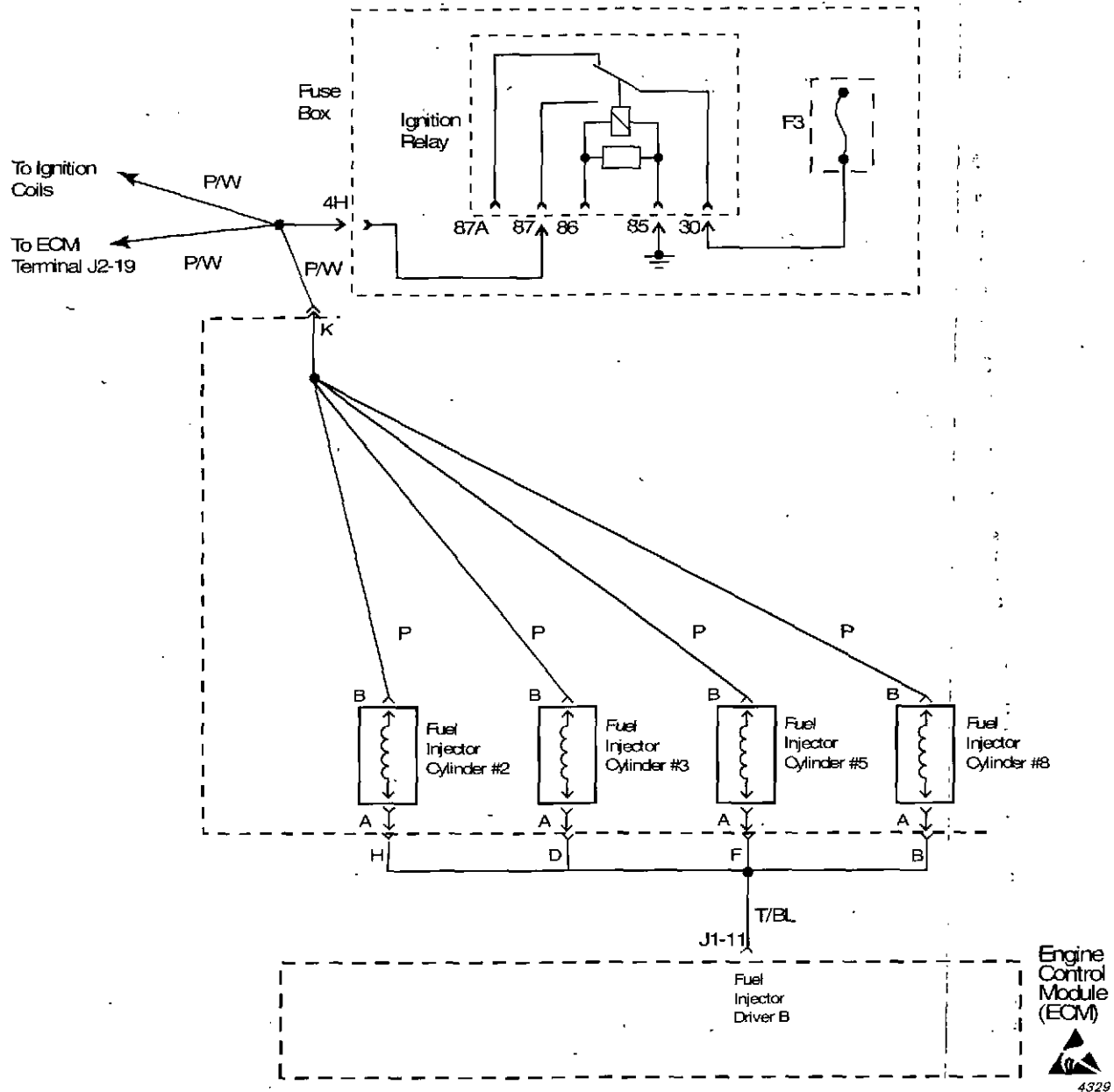
Test Description

- This step tests for voltage at the fuel injector harness connector. The ECM/INJ fuse supplies power to the coil side of the fuel injector harness connector. If the fuse is open, a short to ground on the fuel injector B+ supply circuit is indicated. The ECM/INJ fuse also supplies voltage to the ignition coils. If the fuse is open, inspect the circuits to the ignition coils for a short to ground.
- This test verifies that the ECM is able to control the fuel injector. If the test lamp blinks, then the ECM and wiring are OK.
- This step tests if a ground is constantly being applied to the fuel injector.

DTC 81 - Fuel Injector Driver A Circuit High, Low or Open (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> 1. Disconnect the appropriate harness connectors of the four fuel injectors. 2. Ignition ON, engine OFF. 3. Using a test lamp connected to a known good engine ground, probe the ignition voltage circuits for each fuel injector on the harness connector. <p>Does the test lamp illuminate in all four circuits?</p>	-	Go to Step 3	Go to Step 8
3	<ol style="list-style-type: none"> 1. Connect the fuel injector test lamp J 34730-2C between the control circuit and the ignition voltage circuit of the fuel injector harness connector. Repeat for all four fuel injectors 2. Start the engine. <p>Does the test lamp blink on all four injector harness connections?</p>	-	Go to Step 7	Go to Step 4
4	Does the test lamp remain illuminated at all times on any of the four fuel injector harness connectors?	-	Go to Step 6	Go to Step 5
5	<p>Locate and repair open or short to ground or short to voltage in the fuel injector control circuit.</p> <p>Was a problem found and corrected?</p>	-	Verify Repair	Go to Step 8
6	<p>Locate and repair a short to ground in the fuel injector control circuit.</p> <p>Was a problem found and corrected?</p>	-	Verify Repair	Go to Step 11
7	<p>Locate and repair poor connections at the harness connector for the fuel injector.</p> <p>Was a problem found and corrected?</p>	-	Verify Repair	Go to Step 10
8	<p>Locate and repair poor connections at the harness connector of the ECM.</p> <p>Was a problem found and corrected?</p>	-	Verify Repair	Go to Step 11
9	<p>Repair an open or short to ground in the fuel injector ignition voltage circuit.</p> <p>Important! The ECM/INJ fuse (F3) also supplies voltage to the ignition coils. If the fuse is open, inspect all related circuits for a short to ground.</p> <p>Was a problem found and corrected?</p>	-	Verify Repair	-
10	<p>Replace the fuel injector.</p> <p>Is action complete?</p>	-	Verify Repair	-
11	<p>Replace the ECM.</p> <p>Is action complete?</p>	-	Verify Repair	-

DTC 81 - Fuel Injector Driver B Circuit High, Low or Open (Scan Diagnostics)



Circuit Description

The Engine Control Module (ECM) enables the fuel injector drivers. An ignition voltage is supplied to the fuel injectors. The ECM controls each fuel injector driver by grounding the control circuit via a solid state device called a driver. The ECM monitors the status of each driver. If the ECM detects an incorrect voltage for the commanded state of the driver, a fuel injector control DTC sets.

Diagnostic Aids

Performing the Fuel Injector Coil test may help isolate an intermittent condition. Refer to *Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 Degrees C (50-95 Degrees F)* or *Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Outside 10-35 Degrees C (50-95 Degrees F)*.

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

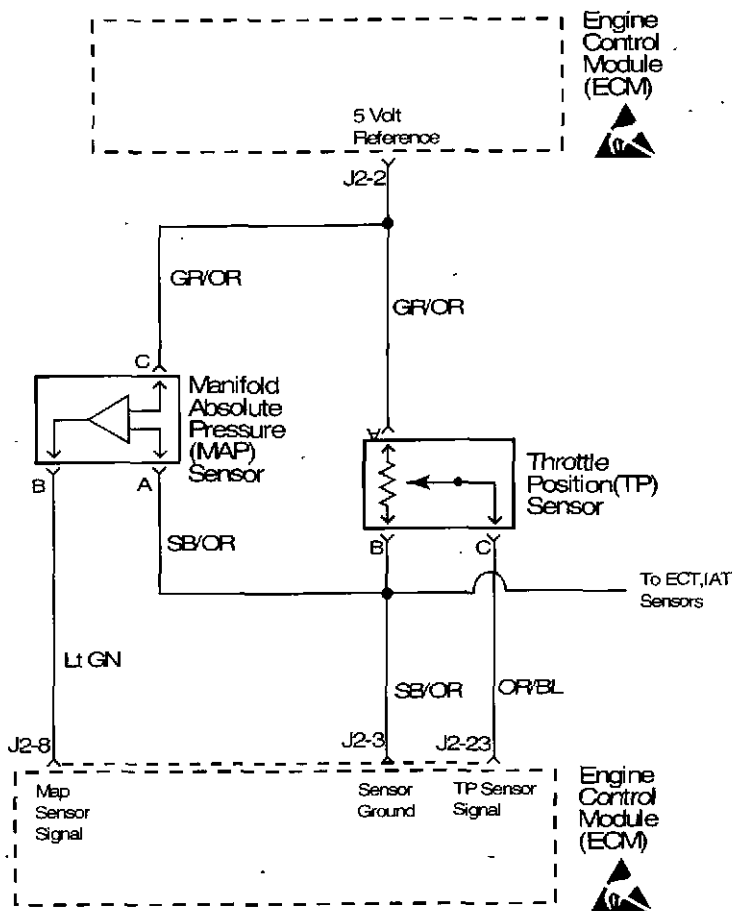
Test Description

- This step tests for voltage at the fuel injector harness connector. The ECM/INJ fuse supplies power to the coil side of the fuel injector harness connector. If the fuse is open, a short to ground on the fuel injector B+ supply

DTC 81 - Fuel Injector Driver B Circuit High, Low or Open (Scan Diagnostics)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> 1. Disconnect the appropriate harness connectors of the four fuel injectors. 2. Ignition ON, engine OFF. 3. Using a test lamp connected to a known good engine ground, probe the ignition voltage circuits for each fuel injector on the harness connector. <p>Does the test lamp illuminate in all four circuits?</p>	-	Go to Step 3	Go to Step 8
3	<ol style="list-style-type: none"> 1. Connect the fuel injector test lamp J 34730-2C between the control circuit and the ignition voltage circuit of the fuel injector harness connector. Repeat for all four fuel injectors 2. Start the engine. <p>Does the test lamp blink on all four injector harness connections?</p>	-	Go to Step 7	Go to Step 4
4	Does the test lamp remain illuminated at all times on any of the four fuel injector harness connectors?	-	Go to Step 6	Go to Step 5
5	<p>Locate and repair open or short to ground or short to voltage in the fuel injector control circuit.</p> <p>Was a problem found and corrected?</p>	-	Verify Repair	Go to Step 8
6	<p>Locate and repair a short to ground in the fuel injector control circuit.</p> <p>Was a problem found and corrected?</p>	-	Verify Repair	Go to Step 11
7	<p>Locate and repair poor connections at the harness connector for the fuel injector.</p> <p>Was a problem found and corrected?</p>	-	Verify Repair	Go to Step 10
8	<p>Locate and repair poor connections at the harness connector of the ECM.</p> <p>Was a problem found and corrected?</p>	-	Verify Repair	Go to Step 11
9	<p>Repair an open or short to ground in the fuel injector ignition voltage circuit.</p> <p>Important! The ECM/INJ fuse (F3) also supplies voltage to the ignition coils. If the fuse is open, inspect all related circuits for a short to ground.</p> <p>Was a problem found and corrected?</p>	-	Verify Repair	-
10	<p>Replace the fuel injector.</p> <p>Is action complete?</p>	-	Verify Repair	-
11	<p>Replace the ECM.</p> <p>Is action complete?</p>	-	Verify Repair	-

DTC 81 - 5 Volt Reference Circuit Out of Range (Scan)



4330

Circuit Description

The Engine Control Module (ECM) uses a common 5 volt reference circuit as a sensor feed. This circuit supplies 5 volts to the Manifold Absolute Pressure (MAP) sensor and the Throttle Position (TP) sensor. The ECM monitors the voltage on the 5 volt reference circuit. This DTC sets if the voltage is out of range.

Diagnostic Aids

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

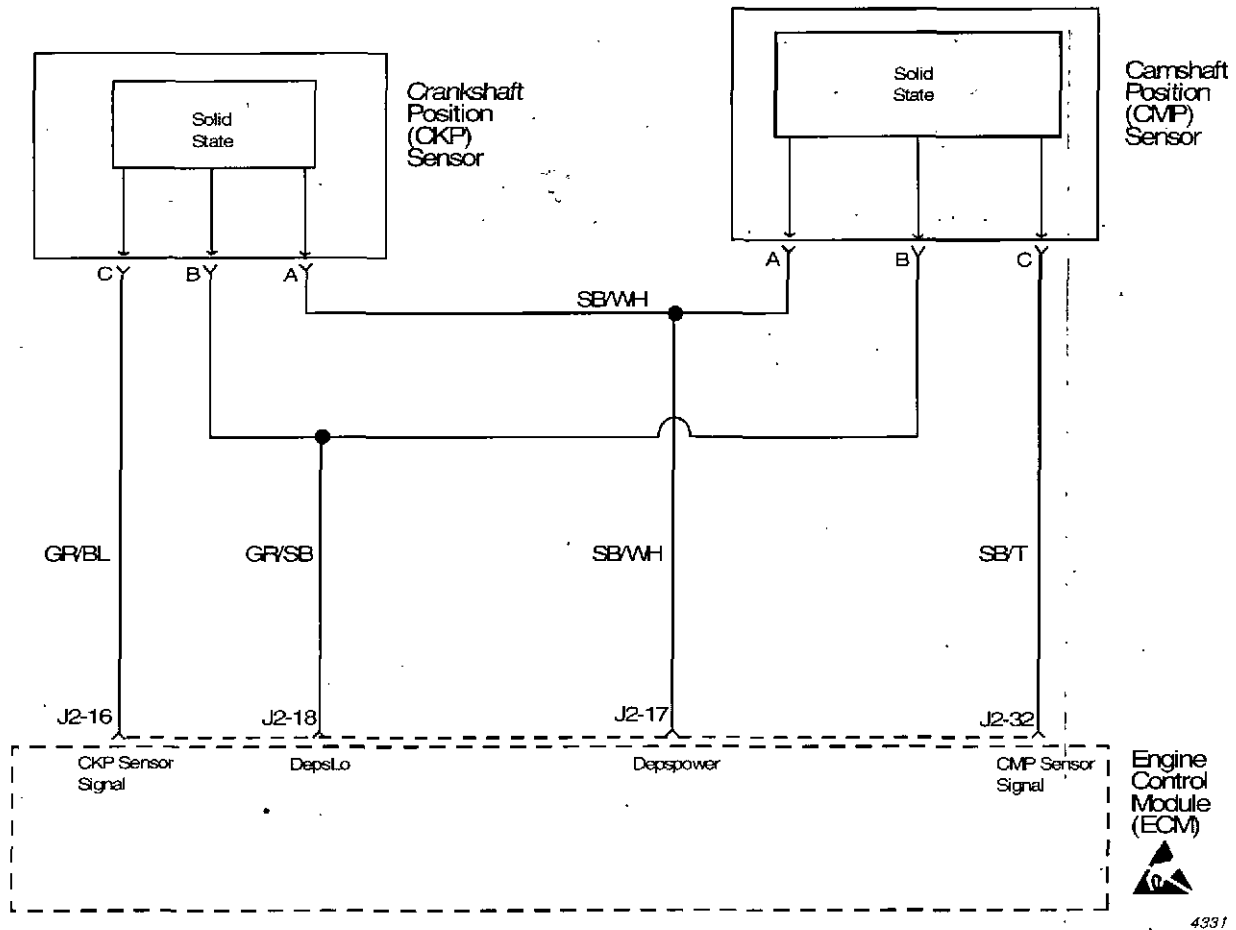
Test Description

3. The 5 volt reference circuit may be shorted to another ECM circuit. The shorted circuit may not be apparent when the ECM harness connector is disconnected.

DTC 81 - 5 Volt Reference Circuit Out of Range (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	<ol style="list-style-type: none"> 1. Disconnect the ECM harness connector J2 2. Ignition ON, engine OFF. 3. Using a Digital Multi-Meter connected to a known good engine ground, probe the other lead of the Digital Multi-Meter to the 5 volt reference circuit (J2-2) at the ECM harness connector. <p>Does the circuit measure more than the specified value?</p>	5.1 volts	Go to Step 6	Go to Step 3
3	<p>Before proceeding, remove the following fuses:</p> <ol style="list-style-type: none"> 1. F3 2. F7 <ol style="list-style-type: none"> 1. Disconnect the MAP sensor and the TP sensor harness connectors 2. Using a Digital Multi-Meter, test the continuity from the 5 volt reference circuit to all other ECM circuits at the ECM J2 harness connector. <p>Do any of the circuits indicate a resistance within the specified range?</p>	0-2 ohms	Go to Step 7	Go to Step 9
4	<ol style="list-style-type: none"> 1. Ignition OFF. 2. Disconnect the ECM connector J2. 3. Using a test lamp connected to B+, probe the 5 volt reference circuit (J2-2) at the ECM harness connector. <p>Does the test lamp illuminate?</p>	-	Go to Step 8	Go to Step 5
5	<p>Using a Digital Multi-Meter, test the continuity from the 5 volt reference circuit to all other ECM circuits at the ECM J2 harness connector.</p> <p>Do any of the circuits indicate a resistance within the specified range?</p>	0-2 ohms	Go to Step 7	Go to Step 9
6	<p>Locate and repair a short to voltage on the 5 volt reference circuit.</p> <p>Is action complete?</p>	-	Verify Repair	-
7	<p>Locate and repair short between the 5 volt reference circuit and the ECM circuit that had continuity.</p> <p>Is action complete?</p>	-	Verify Repair	-
8	<p>Locate and repair short to ground on the 5 volt reference circuit.</p> <p>Is action complete?</p>	-	Verify Repair	-
9	<p>Replace the ECM.</p> <p>Is action complete?</p>	-	Verify Repair	-

DTC 81 - Depspower Circuit Out of Range (Scan)



Circuit Description

The Engine Control Module (ECM) uses a dedicated 5 volt reference-circuit for the Crankshaft Position (CKP) sensor and the Camshaft Position (CMP) sensor. This circuit supplies 5 volts to only the CKP and the CMP sensor circuits. This circuit is referred to as Depspower. The ECM monitors the voltage on the Depspower circuit. This DTC sets if the voltage is out of range.

Diagnostic Aids

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

3. The Depspower circuit may be shorted to another ECM circuit. The shorted circuit may not be apparent when the ECM harness connector is disconnected.

DTC 81 - Depspower Circuit Out of Range (Scan)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System Check
2	<p>1. Disconnect the ECM harness connector J2.</p> <p>2. Ignition ON, engine OFF.</p> <p>Using a Digital Multi-Meter connected to a known good engine ground, probe the other lead of the Digital Multi-Meter to the Depspower circuit (J2-17) at the ECM harness connector.</p> <p>Does the circuit measure more than the specified value?</p>	5.1 volts	Go to Step 6	Go to Step 3
3	<p>Before proceeding, remove the following fuses:</p> <ul style="list-style-type: none"> • F3 • F7 <p>1. Disconnect the CKP sensor and the CMP sensor harness connectors.</p> <p>2. Using a Digital Multi-Meter, test the continuity from the Depspower circuit to all other ECM circuits at the ECM J2 harness connector.</p> <p>Do any of the circuits indicate a resistance within the specified range?</p>	0-2 ohms	Go to Step 7	Go to Step 9
4	<p>1. Ignition OFF.</p> <p>2. Disconnect the ECM connector J2.</p> <p>3. Using a test lamp connected to B+, probe Depspower circuit (J2-17) at the ECM harness connector.</p> <p>Does the test lamp illuminate?</p>	-	Go to Step 8	Go to Step 5
5	<p>Using a Digital Multi-Meter, test the continuity from Depspower circuit to all other ECM circuits at the ECM J2 harness connector.</p> <p>Do any of the circuits indicate a resistance within the specified range?</p>	0-2 ohms	Go to Step 7	Go to Step 9
6	<p>Locate and repair a short to voltage on the Depspower circuit.</p> <p>Is action complete?</p>	-	Verify Repair	-
7	<p>Locate and repair short between the Depspower circuit and the ECM circuit that had continuity.</p> <p>Is action complete?</p>	-	Verify Repair	-
8	<p>Locate and repair short to ground on the Depspower circuit.</p> <p>Is action complete?</p>	-	Verify Repair	-
9	<p>Replace the ECM.</p> <p>Is action complete?</p>	-	Verify Repair	-

Symptoms

Important Preliminary Checks Before Starting

Before using this section you should have performed the "On-Board Diagnostic (OBD) System Check" and determined that:

- The ECM and MIL (Malfunction Indicator Lamp) are operating correctly.
- There are no DTC(s) stored.
- Ensure that the engine is not in RPM reduction mode. The ECM turns certain injectors off when the ECM detects certain conditions such as engine over-temp.
- Verify the customer complaint and locate the correct symptom in the table of contents. Check the items indicated under that symptom.

Visual/Physical Check

Several of the symptom procedures call for a careful Visual/Physical Check. The importance of this step cannot be stressed too strongly - it can lead to correcting a problem without further checks and can save valuable time. This check should include:

- ECM grounds and sensor connections for being clean, tight and in their proper location.
- Vacuum hoses for splits, kinks and proper connections. Check thoroughly for any type of leak or restriction.
- Air leaks at throttle body mounting area and intake manifold sealing surfaces.
- Ignition wires for cracking, hardness, proper routing and carbon tracking.
- Wiring for proper connections, pinches and cuts.
- Moisture in primary or secondary ignition circuit connections.
- Corrosion on electrical connections and exposed throttle body linkages.

Intermittents

Important: Check for improper installation of electrical components if an intermittent condition exists. Inspect for aftermarket theft deterrent devices, lights, cellular phones, etc. If you cannot locate an intermittent condition, a cellular phone signal communication may cause the condition.

Important: Problem may or may not turn "ON" the Malfunction Indicator Lamp (MIL) or store a DTC. DO NOT use the Diagnostic Trouble Code (DTC) tables for intermittent problems. The fault must be present to locate the problem.

Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful visual/physical check. Check for the following conditions:

- Poor mating of the connector halves, or a terminal not fully seated in the connector body (backed out or loose).
- Improperly formed or damaged terminals and/or connectors.
- All connector terminals in the problem circuit should be carefully checked for proper contact tension.
- Poor terminal to wire connection (crimping). This requires removing the terminal from the connector body to check. Refer to "Wiring Harness Service" in the *General Information* section.

The vehicle may be driven with a J 39200 Digital Multimeter connected to a suspected circuit. An abnormal voltage when malfunction occurs is a good indication that there is a fault in the circuit being monitored.

A scan tool may also be used to help detect intermittent conditions. The Snapshot feature (if applicable) can be triggered to capture and store engine parameters within the scan tool when the malfunction occurs. This stored information then can be reviewed by the service technician to see what caused the malfunction.

To check loss of DTC memory, disconnect TP sensor and idle engine until the MIL comes "ON." DTC 22 should be stored and kept in memory when ignition is turned "OFF." If not the ECM is faulty. When this test is completed, make sure that you clear the DTC 22 from memory using "Clearing DTC Procedure."

An intermittent MIL with no stored DTC may be caused by the following:

- Ignition coil shorted to ground and arcing at ignition wires or plugs.
- MIL wire to ECM shorted to ground.
- Poor ECM grounds.
- Check for an electrical system interference caused by a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.
- Check for improper installation of electrical options such as lights, radios, etc.
- Check that knock sensor wire(s) are routed away from spark plug wires, ignition system components and charging system components.
- Check for secondary ignition components shorted to ground, or an open ignition coil ground (coil mounting brackets).
- Check for components internally shorted to ground such as starters, alternators or relays.

All Ignition Coil wiring should be kept away from the alternator. Check all wires from the ECM to the ignition coils for poor connections.

If problem has not been found go to "ECM Connector Symptom Tables" at the end of *Symptoms* section.

Hard Start Symptom

Checks	Action
Definition: Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.	
Preliminary	<ul style="list-style-type: none"> • Refer to important Preliminary Checks before starting in Symptoms section. • Check the ECM grounds for being clean, tight and in the proper locations. • Search Service Bulletins.
Sensor/System	<ul style="list-style-type: none"> • Check the engine coolant temperature (ECT) sensor for being shifted in value. Connect a Scan tool. Compare the engine coolant temperature against the intake air temperature (IAT) on a cold engine. The ECT sensor and IAT sensor values should be within 3°C (5°F) of each other. If the ECT sensor is out of range with the IAT sensor, check the resistance of the ECT sensor. Replace the ECT sensor if the resistance is not within specification. If the sensor is within specification, check and repair the ECT signal circuit for high resistance. • Check the camshaft position (CMP) sensor for proper mounting and or a bad connection. A long crank time occurs if the ECM does not receive a CMP signal.
Fuel System	<ol style="list-style-type: none"> 1. Check the fuel pump relay operation. The fuel pump should turn ON for 2 seconds when you turn ON the ignition. 2. A faulty fuel pump check valve allows the fuel in the lines to drain back to the tank after the engine stops. 3. Check for incorrect fuel pressure. 4. Check for a restricted fuel filter. 5. Check for a contaminated fuel condition.
Ignition System	<ul style="list-style-type: none"> • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> • Correct heat range • Wet plugs • Cracks • Wear • Improper gap • Burned electrodes • Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds.
Engine Mechanical	<ul style="list-style-type: none"> — Excessive oil in combustion chamber - Leaking valve seals. — Low cylinder compression — Combustion chambers for excessive carbon buildup. Clean the chambers using top engine cleaner. Follow the instructions on the can. — Inspect the following components for incorrect basic engine parts: <ol style="list-style-type: none"> 1. Cylinder Heads 2. Camshaft 3. Pistons, etc. <p>Refer to the appropriate procedures in Engine Mechanical.</p>

Surges Symptom

Checks	Action
<p>Definition: Engine power variation under steady throttle or cruise. Feels like the vessel speeds up and slows down with no change in throttle position.</p> <p>Note! Make sure that the vessel is checked in calm water. Light chop or small seas can produce a surging sensation.</p>	
Preliminary	<ul style="list-style-type: none"> • Refer to Important Preliminary Checks Before Starting in Symptoms. • Check the ECM grounds for being clean, tight and in the proper locations. • Search for Service Bulletins.
Fuel System	<ul style="list-style-type: none"> • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check that each injector harness is connected to the correct injector or cylinder according to the firing order. • Check the items that cause an engine to run rich long term. • Check the items that cause an engine to run lean long term.
Ignition System	<ul style="list-style-type: none"> • <i>Wet down the secondary ignition system with water from a spray bottle.</i> Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> — Correct heat range — Wet plugs — Cracks — Wear — Improper gap — Burned electrodes — Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds.
Engine Mechanical	<ul style="list-style-type: none"> • Ensure that the engine is not overheating, causing the engine to go into RPM reduction mode.
Additional Checks	<ul style="list-style-type: none"> • Visually check the vacuum hoses for splits, kinks and proper connections and routing.

Lack of Power, Sluggishness or Sponginess Symptom

Checks	Action
Definition: Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.	
Preliminary	<ul style="list-style-type: none"> — Refer to Important Preliminary Checks Before Starting in Symptoms. — Check the ECM grounds for being clean, tight and in the proper locations. — Search for Service Bulletins. — Remove the flame arrestor and check for dirt or for being restricted.
Sensor System	<ul style="list-style-type: none"> • Ensure that the engine is not going into RPM reduction mode. • Use a scan tool in order to monitor the knock sensor system for excessive spark retard activity.
Fuel System	<ul style="list-style-type: none"> • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check the fuel injectors. Refer to Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 degrees C (50-95 Degrees F). • Check the items that cause an engine to run rich long term. • Check the items that cause an engine to run lean long term.
Ignition System	<ul style="list-style-type: none"> • Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> Correct heat range Wet plugs Cracks Wear Improper gap Burned electrodes Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds.
Engine Mechanical	<ul style="list-style-type: none"> • Excessive oil in combustion chamber - Leaking valve seals. • Low cylinder compression • Combustion chambers for excessive carbon buildup. Clean the chambers

Detonation/Spark Knock Symptom

Checks	Action
<p>Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.</p>	
<p>Preliminary</p>	<p>Refer to Important Preliminary Checks Before Starting in <i>Symptoms</i>. Check the ECM grounds for being clean, tight and in the proper locations. Search for Service Bulletins. If the scan tool readings are normal, refer to supporting text of the Diagnostic Check, and there are no engine mechanical faults, fill the fuel tank with a known high quality fuel that meets the vessels minimum octane requirements. Refer to <i>Fuel System Specifications</i>. Test the vessel and re-evaluate the performance.</p>
<p>Fuel System</p>	<ul style="list-style-type: none"> • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check the items that cause an engine to run lean long term.
<p>Ignition System</p>	<ul style="list-style-type: none"> • Check the spark plugs for being the proper heat range.
<p>Engine Cooling System</p>	<ul style="list-style-type: none"> • Check for obvious overheating problems. Insufficient coolant flow through the engine. Wrong or stuck thermostat. Inoperative water supply pump.
<p>Engine Mechanical</p>	<ul style="list-style-type: none"> • Excessive oil in combustion chamber - Leaking valve seals. • Low cylinder compression • Combustion chambers for excessive carbon buildup. Clean the chambers using top engine cleaner. Follow the instructions on the can. • Inspect the following components for incorrect basic engine parts: Cylinder Heads Camshaft Pistons, etc. <p>Refer to the appropriate procedures in Engine Mechanical.</p>

Hesitation, Sag or Stumble Symptom

Checks	Action
<p>Definition: Momentary lack of response as the throttle is increased. Can occur at any vessel speed. Usually more pronounced when first trying to make the vessel move, as from a stop. May cause the engine to stall if severe enough.</p>	
Preliminary	<ul style="list-style-type: none"> — Refer to Important Preliminary Checks Before Starting in <i>Symptoms</i>. — Check the ECM grounds for being clean, tight and in the proper locations. — Search for Service Bulletins.
Sensor System	<ul style="list-style-type: none"> • Check the MAP sensor operation. • Check the TP sensor operation.
Fuel System	<ul style="list-style-type: none"> • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check the fuel injectors. Refer to Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 degrees C (50-95 Degrees F). • Check the items that cause an engine to run rich long term. • Check the items that cause an engine to run lean long term.
Ignition System	<ul style="list-style-type: none"> • Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> Correct heat range Wet plugs Cracks Wear Improper gap Burned electrodes Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds.
Engine Cooling System	<ul style="list-style-type: none"> • Check the engine thermostat for proper operation and heat range.
Additional Checks	<ul style="list-style-type: none"> • Check the alternator output voltage. Repair the charging system if the alternator output voltage is less than 10 volts or more than 16 volts.

Cuts Out, Misses Symptom

Checks	Action
<p>Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. This condition is not normally felt above 1,500 RPM. The exhaust has a steady spitting sound at idle or low speed.</p>	
Preliminary	<ul style="list-style-type: none"> — Refer to Important Preliminary Checks Before Starting in Symptoms. — Check the ECM grounds for being clean, tight and in the proper locations. — Search for Service Bulletins.
Fuel System	<ul style="list-style-type: none"> • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check the items that cause an engine to run rich long term. • Check the items that cause an engine to run lean long term.
Sensor System	<ul style="list-style-type: none"> • Use a scan to in order to monitor the knock sensor system for excessive spark retard activity.
Ignition System	<ul style="list-style-type: none"> • Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> Correct heat range Wet plugs Cracks Wear Improper gap Burned electrodes Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds. • Visually and physically inspect the secondary ignition for the following: <ul style="list-style-type: none"> Ignition wires arcing to ground Ignition wires for proper engagement to spark plug and coil Ignition coils for cracks or carbon tracking
Engine Mechanical	<ul style="list-style-type: none"> • Check engine mechanical for the following: <ul style="list-style-type: none"> Low compression Sticking or leaking valves Worn camshaft lobes Valve timing Bent push rods Worn rocker arms Broken Valve Springs Excessive oil in the combustion chamber - Leaking valve seals.

Cuts Out, Misses Symptom (cont'd)

Checks	Action
Engine Mechanical (cont'd)	<p>— Inspect the following components for incorrect basic engine parts:</p> <ul style="list-style-type: none"> Camshaft Cylinder heads Pistons, etc. <p>Refer to the appropriate procedures in Engine Mechanical.</p>
Additional Checks	<ul style="list-style-type: none"> • Inspect the exhaust system for possible restriction. • Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. A sudden increase in indicated RPM with little change in actual engine RPM change indicates EMI is present. Check for high voltage components near ignition control circuits if a problem exists. • Check the intake manifold and the exhaust manifold passages for casting flash.

Poor Fuel Economy Symptom

Checks	Action
<p>Definition: Fuel economy, as measured by actual fuel used, is noticeably lower than expected. Also, fuel economy is noticeably lower than it was on this vessel at one time, as previously shown by actual measurement.</p>	
Preliminary	<p>— Refer to Important Preliminary Checks Before Starting in Symptoms.</p> <p>— Check the ECM grounds for being clean, tight and in the proper locations.</p> <p>— Search for Service Bulletins.</p> <ul style="list-style-type: none"> • Check how the vessel is operated. <ul style="list-style-type: none"> Is there excessive loads being carried? Is the acceleration rate too much, too often? <p>Remove the flame arrestor element and check for dirt or for restrictions.</p>
Fuel System	<ul style="list-style-type: none"> • Check the type, quality and alcohol content of the fuel. Oxygenated fuels have lower energy and may deliver reduced fuel economy. • Check the fuel injectors. Refer to Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35°C (50-95°F). • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check that each injector harness is connected to the correct injector and cylinder. • Check for foreign material accumulation in the throttle bore, coking on the throttle valve or on the throttle shaft. Also check for throttle body tampering. • Check the items that cause an engine to run rich long term.
Sensor System	<ul style="list-style-type: none"> • Check the air intake system and crankcase for air leaks. • Check the crankcase ventilation valve for proper operation. Place a finger over the inlet hole in the valve end several times. The valve should snap back. If not, replace valve. • Use a scan tool in order to monitor the knock sensor (KS) system for excessive spark retard activity.

Poor Fuel Economy Symptom (cont'd)

Checks	Action
Ignition System	<ul style="list-style-type: none"> • Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> Correct heat range Wet plugs Cracks Wear Improper gap Burned electrodes Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds. • Visually and physically inspect the secondary ignition for the following: <ul style="list-style-type: none"> Ignition wires arcing to ground Ignition wires for proper engagement to spark plug and coil Ignition coils for cracks or carbon tracking
Engine Cooling	<ul style="list-style-type: none"> • Check for water flow restrictions. • Check the engine thermostat for proper operation and for the correct heat range.
Engine Mechanical	<ul style="list-style-type: none"> • Check engine mechanical for the following: <ul style="list-style-type: none"> Low compression Sticking or leaking valves Worn camshaft lobes Valve timing Bent push rods Worn rocker arms Broken Valve Springs Excessive oil in the combustion chamber - Leaking valve seals. — Inspect the following components for incorrect basic engine parts: <ul style="list-style-type: none"> Camshaft Cylinder heads Pistons, etc. <p>Refer to the appropriate procedures in Engine Mechanical.</p>
Additional Checks	<ul style="list-style-type: none"> • Inspect the exhaust system for possible restriction. • Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. A sudden increase in indicated RPM with little change in actual engine RPM change indicates EMI is present. Check for high voltage components near ignition control circuits if a problem. • Check the intake manifold and the exhaust manifold passages for casting flash. • Check for excessive drag on the vessel (e.g. barnacles on bottom and sterndrive).

Rough, Unstable or Incorrect Idle and Stalling Symptom

Checks	Action
<p>Definition: Engine runs unevenly at idle. If severe, the engine or vehicle may shake. Engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.</p>	
<p>Preliminary</p>	<ul style="list-style-type: none"> — Refer to Important Preliminary Checks Before Starting in <i>Symptoms</i>. — Check the ECM grounds for being clean, tight and in the proper locations. — Search for Service Bulletins. — Remove the flame arrestor element and check for dirt or for restrictions
<p>Fuel System</p>	<ul style="list-style-type: none"> • Check the fuel injectors. Refer to Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10°-35°C (50°-95°F). • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check that each injector harness is connected to the correct injector and cylinder. • Check for foreign material accumulation in the throttle bore, coking on the throttle valve or on the throttle shaft. Also check for throttle body tampering. • Check the items that cause an engine to run rich long term. • Check the items that cause an engine to run lean long term.
<p>Sensor System</p>	<ul style="list-style-type: none"> • Check the air intake system and crankcase for air leaks. • Check the crankcase ventilation valve for proper operation. Place a finger over the inlet hole in the valve end several times. The valve should snap back. If not, replace valve. • Check the Cam sensor (CMP) for code 81. Refer to DTC 81 - Crankshaft Position (CKP) Sensor Circuit Fault (Scan Diagnostics). • Check the idle air control (IAC) valve for proper operation. • Use a scan tool in order to monitor the knock sensor (KS) system for excessive spark retard activity.
<p>Ignition System</p>	<ul style="list-style-type: none"> • Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> Correct heat range. Wet plugs. Cracks. Wear. Improper gap. Burned Electrodes. Heavy deposits. • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds. • Visually and physically inspect the secondary ignition for the following: <ul style="list-style-type: none"> Ignition wires arcing to ground Ignition wires for proper engagement to spark plug and coil Ignition coils for cracks or carbon tracking

Rough, Unstable or Incorrect Idle and Stalling Symptom (cont'd)

Checks	Action
Engine Mechanical	<ul style="list-style-type: none"> — Check engine mechanical for the following: <ul style="list-style-type: none"> Low compression Sticking or leaking valves Worn camshaft lobes Valve timing Bent push rods Worn rocker arms Broken Valve Springs Excessive oil in the combustion chamber - Leaking valve seals. • Inspect the following components for incorrect basic engine parts: <ul style="list-style-type: none"> Camshaft Cylinder heads Pistons, etc. <p>Refer to the appropriate procedures in Engine Mechanical.</p>
Additional Checks	<ul style="list-style-type: none"> • <i>Inspect the exhaust system for possible restriction.</i> • <i>Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. A sudden increase in indicated RPM with little change in actual engine RPM change indicates EMI is present. Check for high voltage components near ignition control circuits if a problem exists. Check for faulty motor mounts.</i> • <i>Check the intake manifold and the exhaust manifold passages for casting flash.</i>

Dieseling, Run-On Symptom

Checks	Action
<p>Definition: Engine continues to run after key is turned OFF, but runs very rough. If the engine runs smooth, check the ignition switch and the ignition switch adjustment.</p>	
Preliminary	<ul style="list-style-type: none"> — Refer to Important Preliminary Checks Before Starting in Symptoms. — Check the ECM grounds for being clean, tight and in the proper locations. — Search for Service Bulletins.
Fuel System	<ul style="list-style-type: none"> • Inspect the injectors for a leaking condition.

Backfire Symptom

Checks	Action
Definition:	
Preliminary	<ul style="list-style-type: none"> — Refer to Important Preliminary Checks Before Starting in Symptoms. — Check the ECM grounds for being clean, tight and in the proper locations. — Search for Service Bulletins.
Fuel System	<ul style="list-style-type: none"> • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check the fuel injectors. Refer to Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 degrees C (50-95 Degrees F). • Check that each injector harness is connected to the correct injector and cylinder.
Sensor System	<ul style="list-style-type: none"> • Check the air intake system and crankcase for air leaks. • Check the crankcase ventilation valve for proper operation. Place a finger over the inlet hole in the valve end several times. The valve should snap back. If not, replace the valve. • Use a scan to in order to monitor the knock sensor system for excessive spark retard activity.
Ignition System	<ul style="list-style-type: none"> • Wet down the secondary ignition system with water from a spray bottle. Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output. • Remove the spark plugs and check for the following: <ul style="list-style-type: none"> Correct heat range Wet plugs Cracks Wear Improper gap Burned electrodes Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds. • Visually and physically inspect the secondary ignition for the following: <ul style="list-style-type: none"> Ignition wires arcing to ground Ignition wires for proper routing Ignition coils for cracks or carbon tracking
Engine Cooling	<ul style="list-style-type: none"> Check for restrictions to the water intake. Check the engine thermostat for proper operation and for the correct heat range.

Backfire Symptom (cont'd)

Checks	Action
Engine Mechanical	<p>— Check engine mechanical for the following:</p> <ul style="list-style-type: none"> Low compression. Sticking or leaking valves. Worn camshaft lobes. Valve timing. Bent push rods. Worn rocker arms. Broken valve springs. Excessive oil in the combustion chamber – leaking valve seals. <ul style="list-style-type: none"> • Inspect the following components for incorrect basic engine parts: <ul style="list-style-type: none"> Camshaft. Cylinder heads. Pistons, etc. <p>Refer to the appropriate procedures in the Engine Components Workshop Manual.</p>
Additional Checks	<ul style="list-style-type: none"> • Inspect the exhaust system for possible restriction. • Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. A sudden increase in indicated RPM with little change in actual engine RPM change indicates EMI is present. Check for high voltage components near ignition control circuits if a problem exists. • Check for faulty motor mounts. • Check the intake manifold and the exhaust manifold passages for casting flash. • Visually and physically check the vacuum hoses for splits, kinks and proper connections and routing.

Engine Cable Wiring Diagram

8.1Gi-A, 8.1GSi-A

DPX375, DPX420

- ① Relay, Fuel Pumps
- ② Relay, Start Assist
- ③ Fuse, Fuel Pumps
- ④ Fuse, ECM
- ⑤ Fuse, Trim Tilt Control
- ⑥ Fuse, Spare
- ⑦ Sending Unit, Oil Pressure
- ⑧ Sending Unit, Engine Temperature
- ⑨ Relay, Trim/Tilt
- ⑩ Circuit Breaker, Trim/Tilt Pump
- ⑪ Sending Unit, Trim/Tilt
- ⑫ Knock Sensor Sensor
- ⑬ Knock Sensor Sensor
- ⑭ Intake Air Temperature (IAT)
- ⑮ Manifold Absolute Pressure (MAP)
- ⑯ Switch, Oil Pressure Speed limited Operator Warning (S.L.O.W.)
- ⑰ Sensor, Engine Coolant Temperature (ECT)
- ⑱ Diagnostic Link Connector (DLC)
- ⑲ Idle Air Control (IAC) Motor
- ⑳ Throttle Position (TP) Sensor
- ㉑ Relay, Ignition/Fuel
- ㉒ Master/Slave Connector
- ㉓ Sensor, Crankshaft
- ㉔ Shift interrupt
- ㉕ Audible Alarm

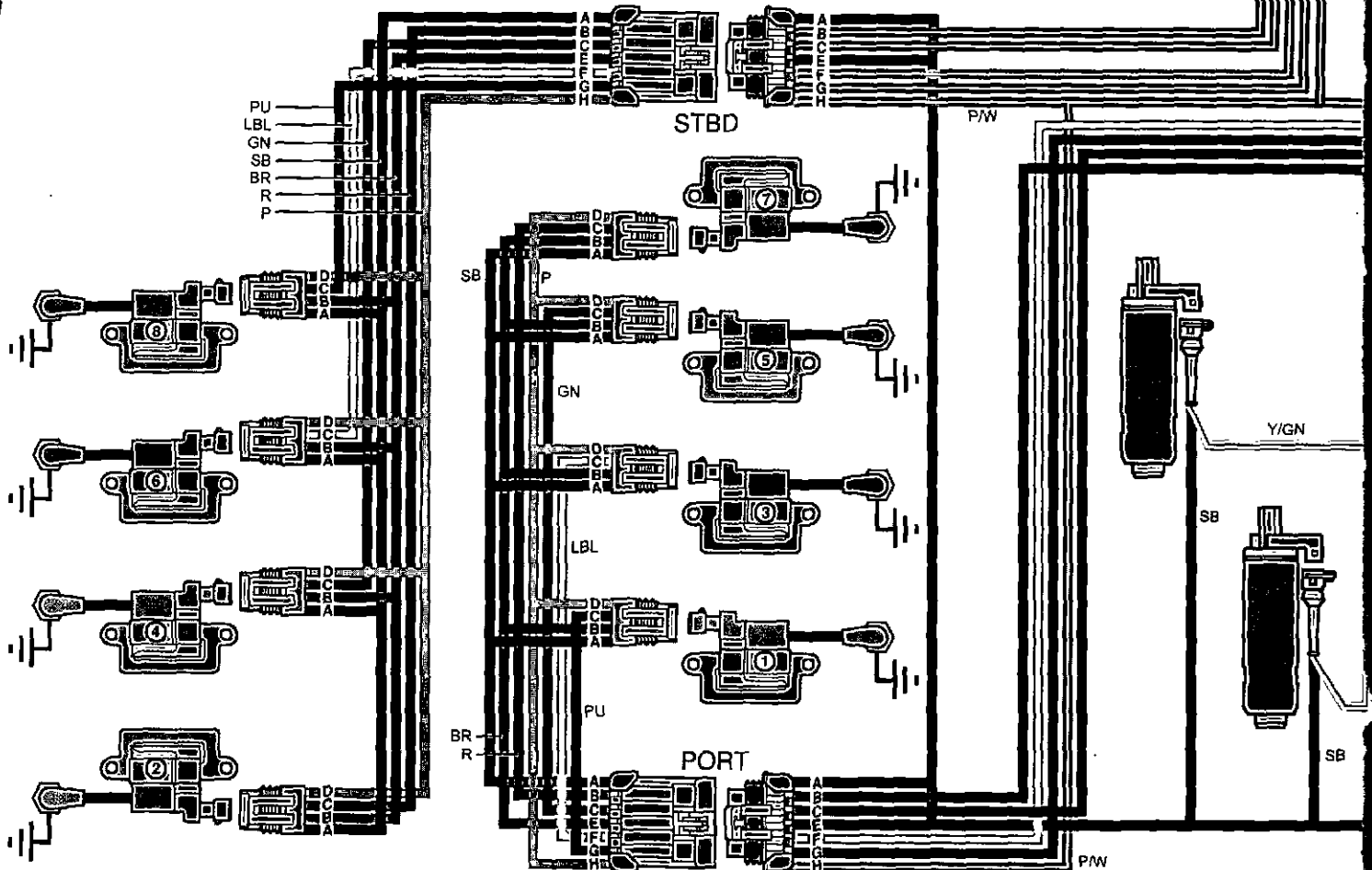
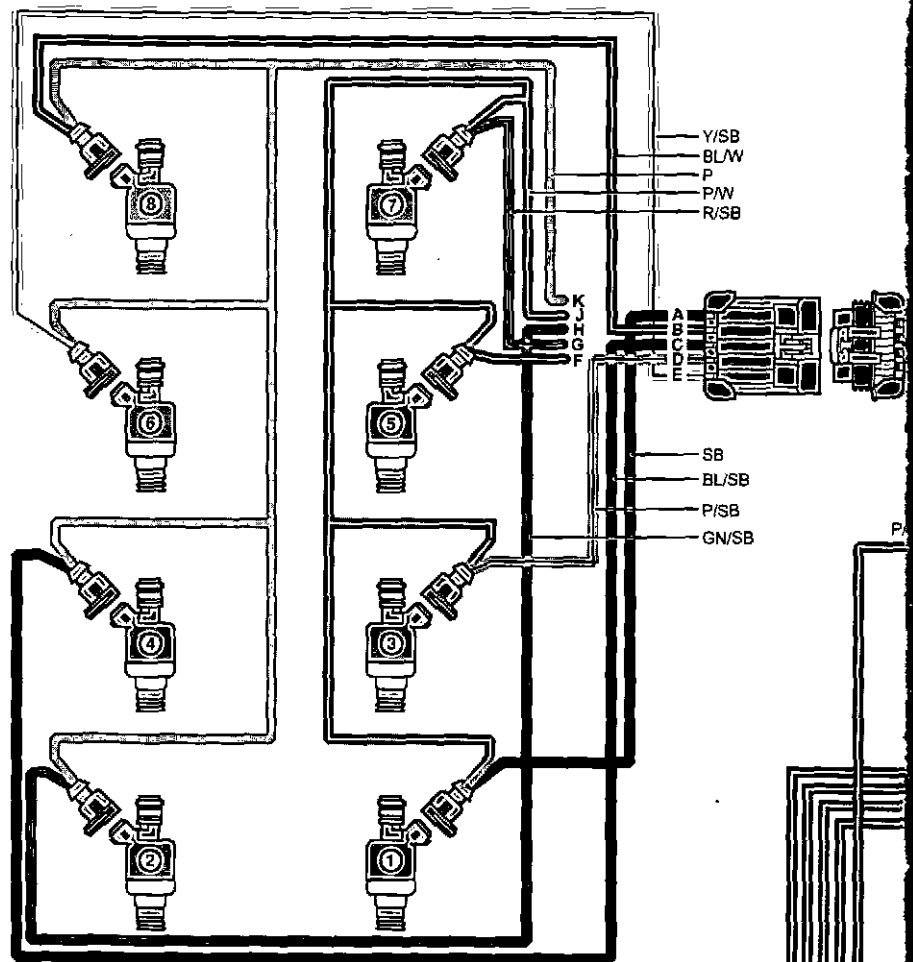


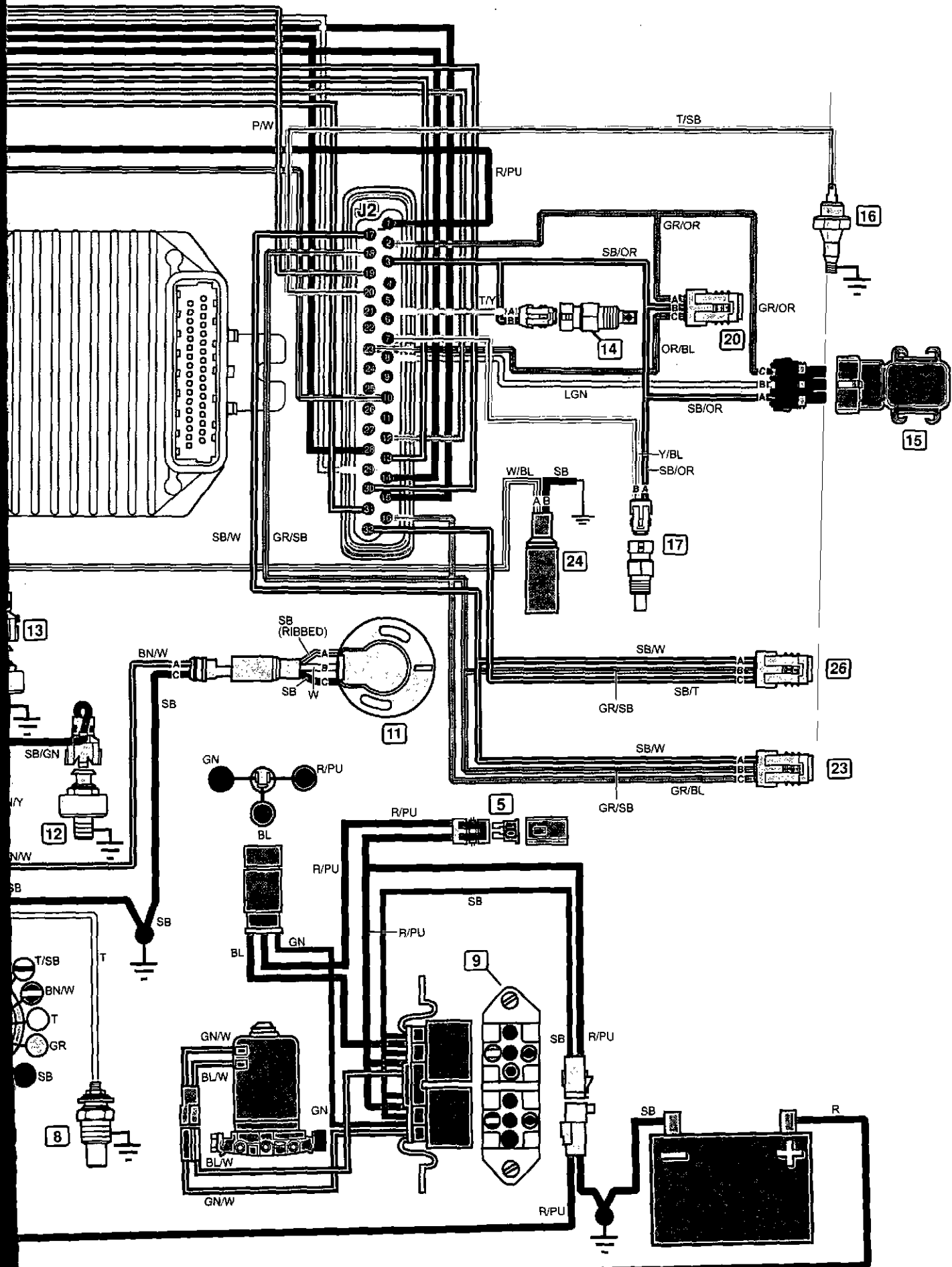
Engine Cable Wiring Diagram

8.1 GSI Models

Cable colors

- BN = Brown
- BL = Blue
- GN = Green
- GR = Grey
- LBL = Light blue
- LGN = Light green
- OR = Orange
- P = Pink
- PU = Purple
- R = Red
- SB = Black
- T = Tan
- VO = Violet
- W = White





Special Tools and Equipment

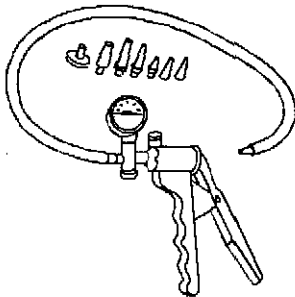
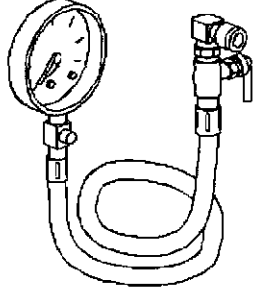
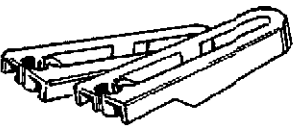
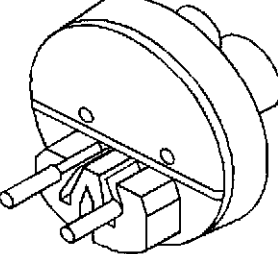
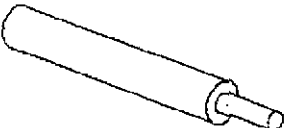
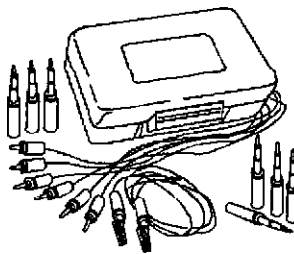
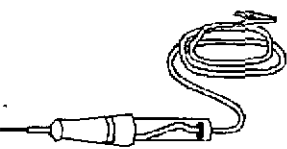
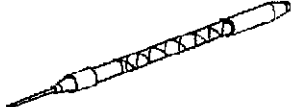
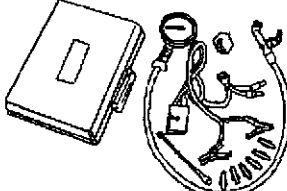
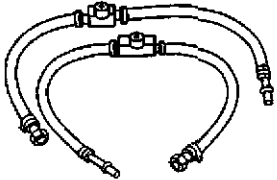

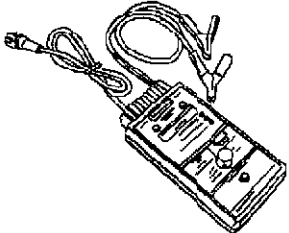

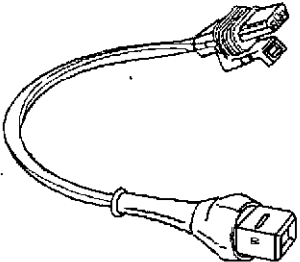
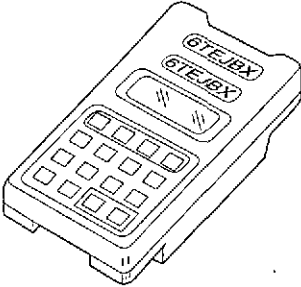
Illustration	Tool Number/Description	Illustration	Tool Number/Description
	<p>J 23738-A Vacuum Pump</p>		<p>J 34730-1A Fuel Pressure Gauge</p>
	<p>J 43013 Fuel Injector Assembly Removal Tool</p>		<p>3851090 Injector Test Lamp</p>
	<p>J 28742-A Weather Pack Terminal Remover</p>		<p>J 35616-A Connector Test Adapter Kit</p>
	<p>J 34142-B Test Lamp</p>		<p>3856012 Metri-Pack Terminal Kit</p>
	<p>3855533 Fuel Pressure Gauge Kit</p>		

Illustration	Tool Number/Description	Illustration	Tool Number/Description
	<p>J 37287 Inlet and Return Fuel Line Shut-Off Adapters</p>		<p>J 39200 Digital Multimeter</p>
	<p>J 39021 Fuel Injector Coil and Balance Tester</p>		<p>J 37088-A Fuel Line Quick Connect Separator</p>
	<p>J 39021-380 Fuel Injector Test Harness</p>		<p>3855947 Scan Tool</p>

Special tools used in this manual that begin with "J" are available on the internet from Kent-Moore division of SPX Corporation:

<http://www.spxkentmoore.com>

Mail:

SPX Corporation
Kent-Moore
28635 Mound Road
Warren, MI 48092-3499

Phone Orders:

1-800-345-2233

1-810-574-2332

Fax Orders:

1-800-578-7375

1-810-578-7375

All other special tools used in this manual are available from your Volvo Penta dealer/distributor.

To locate a dealer visit us on the internet at:

<http://www.penta.volvo.se>

<http://www.vpfluidthinking.com>

Mail:

Volvo Penta of the Americas

1300 Volvo Penta Drive

Chesapeake, VA 23320-9810

Phone: +1 757 436-2800

Fax: +1 757 436-5158

Safety Section

Part A

Marine Products and Safety of People Who Use Them	S-2
Sterndrive Shift System	S-3
Sterndrive Throttle Control System	S-4
Sterndrive Steering System	S-5
Sterndrive Fuel, Electrical System	S-7

Part B

Marine Products and Safety of People Who Fix Them	S-11
Handling Engines	S-11
Handling Lead Acid Batteries	S-12
Gasoline! Handle with Care	S-13
Hazardous Products	S-14

Part A - Marine Products and safety of People Who Use Them

Enjoyable boating is the goal of people who design and build marine products. To reach this goal, manufacturers are careful to make sure...

- Product User is informed. . .
- Products are safe and reliable. . .

It's up to you, the People who. . .

- Install accessories. . .
- Service and Maintain the boat. . .
- Service and maintain the sterndrive. . .

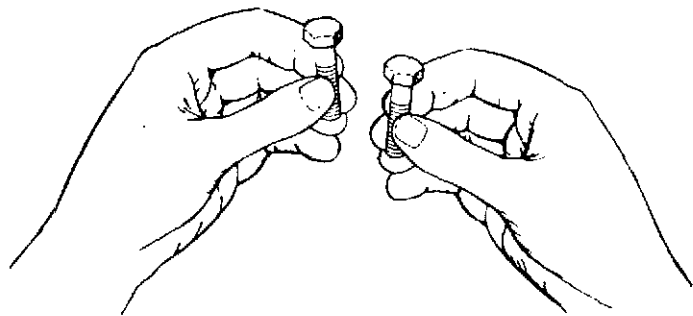
. . . to keep the products safe and reliable.

This section talks about safe boating and how you can help keep it safe. Some things you may know . . . but others you may not.

First!

A word about fasteners . . . plain . . . special . . . all screws, nuts, washers and bolts.

Do Not Substitute Fasteners



They look the same, but . . . are they?

- The Same Size?
- The Same Strength?
- The Same Material?
- The Same Type?
- Standard or Metric Thread?

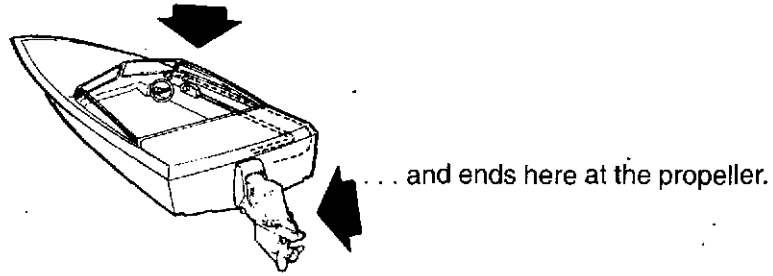
Don't substitute unless you know they are the same in all characteristics.

Second!

- Special locking screws and nuts are often used to attach steering, and remote control components to the sterndrive.
- When you remove any part from the sterndrive; keep track of special screws and nuts. Don't mix with other parts
- When reassembling the sterndrive, use only the special screws and nuts intended to hold steering, and control cables, plus related parts.
- Service with parts of known quality that meet Marine Industry (BIA/ABYC) Standard.

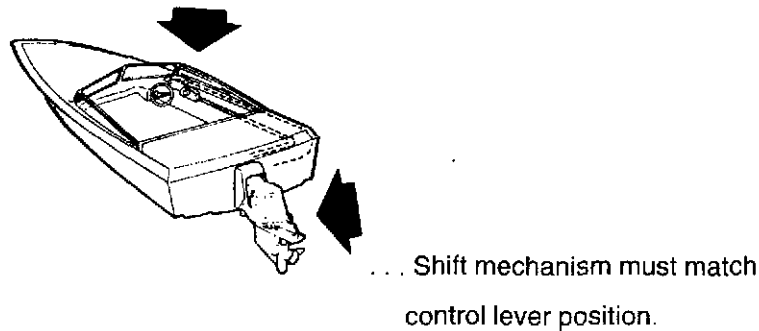
Sterndrive Shift System

The Shift System starts here at the remote control lever. . .



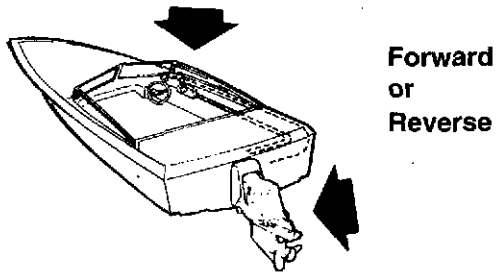
What's Most Important?

When the control lever is in Forward, Neutral or Reverse position . .



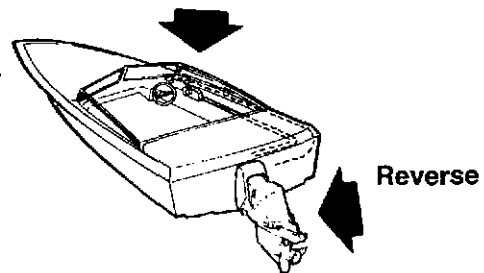
What Could Happen?

● If . . . Neutral




... Propeller is still powered (turning) unknown to operator, or engine will start in gear, boat will move unexpectedly.

● If . . . Forward



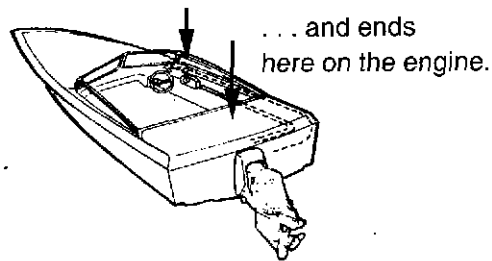
... boat will move opposite to direction intended by operator.

How Can Loss of Shift Control be Minimized? In pre-delivery inspection and when servicing . . .

- Read, understand and follow manufacturers instructions.
- Closely follow the warnings marked with  . . .
- Assemble parts and make adjustments carefully . . .
- Test your work. Don't guess. Make sure propeller does what the operator wants and nothing else.

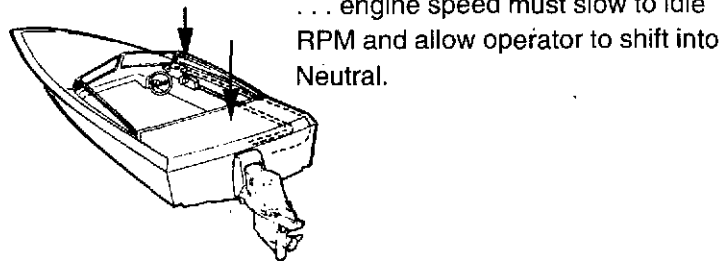
Sterndrive Throttle Control System

The throttle Control System starts here and the remote control lever . . .



What's Most Important?

When the control lever is moved from Forward (or Reverse) to Neutral . . .




Operator must be able to stop propeller.

What Could Happen?

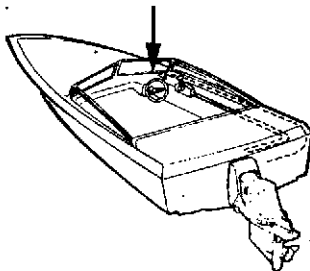
If operator cannot slow the engine to idle RPM and shift into neutral, (stop propeller), operator could panic and lose control of boat.

How Can Loss of Throttle Control be Minimized? In pre-delivery inspection and when servicing . . .

- Read, understand, and follow manufacturers instructions.
- Closely follow the warnings marked with  . . .
- Assemble parts and make adjustments carefully . . .
- Test your work. Don't guess. Make sure engine throttle response is smooth.
- Make sure full throttle operating RPM can be reached so operator won't overload engine

Sterndrive Steering System

The Steering System starts here at the helm . . .



. . . and ends here at the propeller on the sterndrive

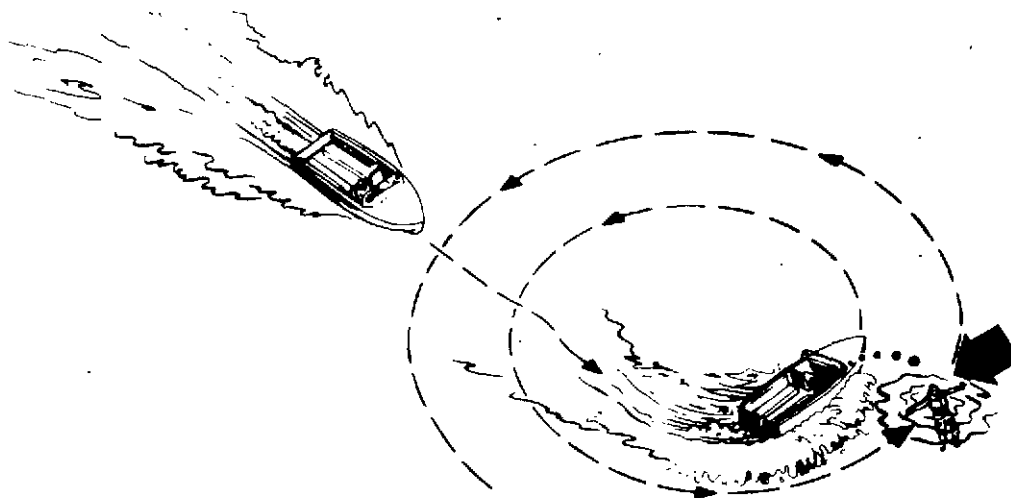
What's Most Important?

The Steering System . . .

- must be installed properly
- must be adjusted properly
- must be lubricated

What Could Happen?


- . . . if steering system comes apart, boat would turn suddenly and circle . . . passengers and/or operator may be thrown into water and could be hit.



- . . . if steering jams, operator may not be able to avoid obstacles. Operator could panic.
- . . . if steering is loose, operator may not be able to maintain a true course, and could result in loss of boat control.

How Can Loss of Steering Control be Minimized?

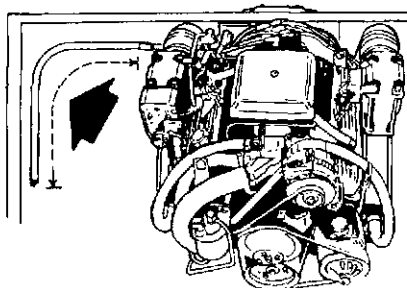
In pre-delivery inspection and when servicing

- use steering components which meet marine industry (BIA/ABYC) standards . . .
- Read, understand, and follow manufacturer's instructions.
- Assemble parts and make adjustments carefully . . .
- Closely follow the warnings marked with  . . .
- Keep parts moving freely . . . lubricate parts as soon as shown in manuals
- Use bolts, nuts, and washers supplied with steering attachment kits

When power assisted or mechanical steering systems are used, check to uncover possible trouble!

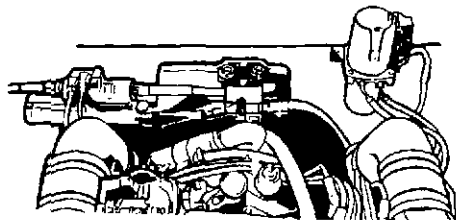
- Cable housing in this area must not be restricted

Why? Unit may go to full turn without turning steering wheel (Power assist models)

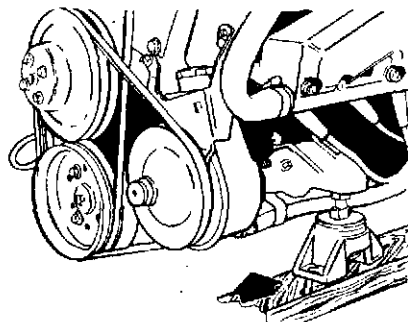


- Steering components must not bind

Why? Possible jamming of steering system.



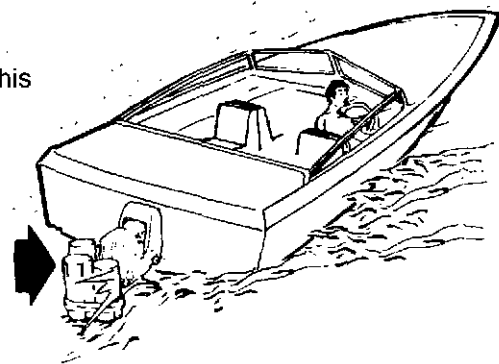
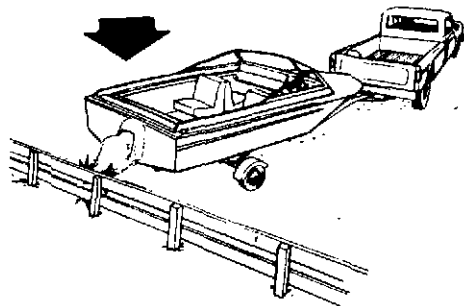
Power steering parts and push/pull cable must be free to move in order to actuate power steering valve when operator turns steering wheel



Engine stringer must not interfere with power steering pump and pulley

Maintain proper belt tension.

- Check for damaged parts . . . impacts to the sterndrive like this



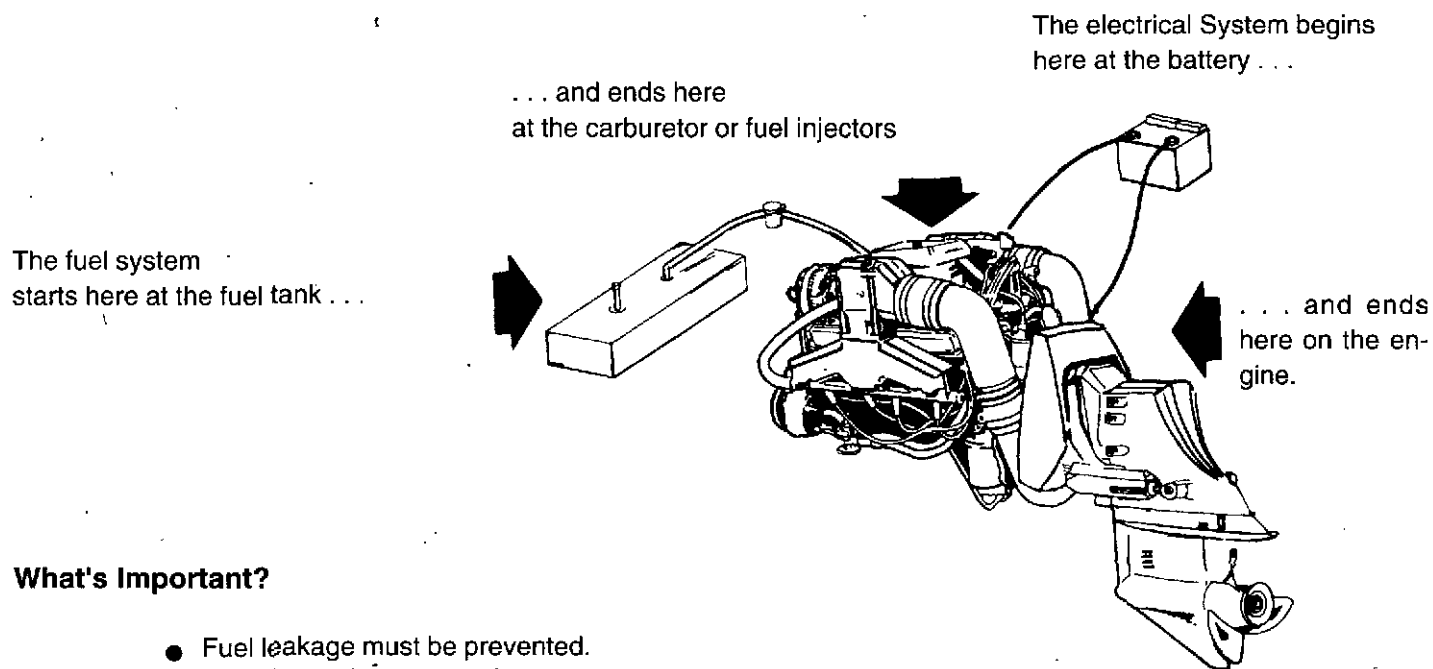
or this . . . or ???

can put stress on steering components. Look for . . .

- Cracked parts
- Bent parts
- Loose fasteners

Replace damaged parts. If weakened, parts could fail later . . . on the water . . . when least expected.

Sterndrive Fuel and Electrical Systems



What's Important?


- Fuel leakage must be prevented.
- Electric sparks must not happen.

What Could Happen?

Gasoline can explode and/ or burn easily:

- When boating, fuel leaking in the engine compartment could be ignited by a spark from a loose wire connection, or a damaged or deteriorated electrical component.

How Can Fire and Explosion Be Minimized?

- Read, understand and follow manufacturers instructions.
- Closely follow the warnings marked with  . . .
- Do not substitute fuel or electrical parts with other parts which may look the same. These parts are designed and manufactured to meet special U. S. Coast Guard safety regulations to prevent fire and explosion.

If you work on marine engines, you must understand these U.S. Coast Guard requirements. If you don't have them, write to . . .

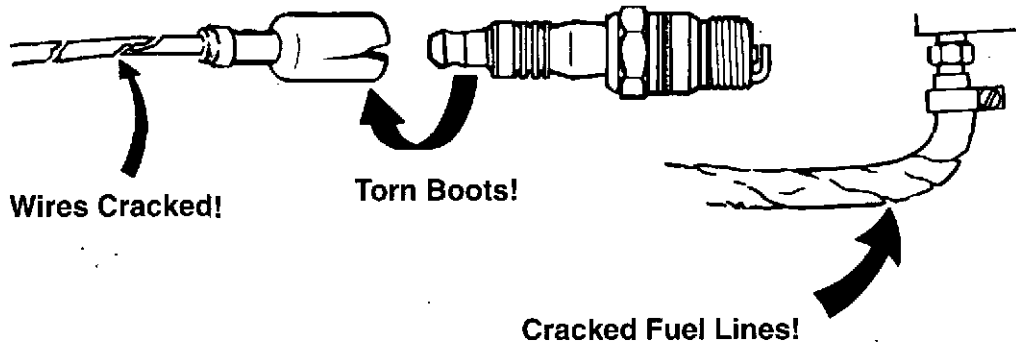
----- ----- -----	<input type="checkbox"/>
National Technical Information Service Springfield, Virginia 22161	

. . . and ask for copies of:

- (1) Electrical System Compliance Guideline (AD/A-049-638)
- (2) Fuel System Compliance Guideline (AD/A-047-767)

These are concise guidelines - easy to read and understand. They explain what must be done to prevent fire and explosions.

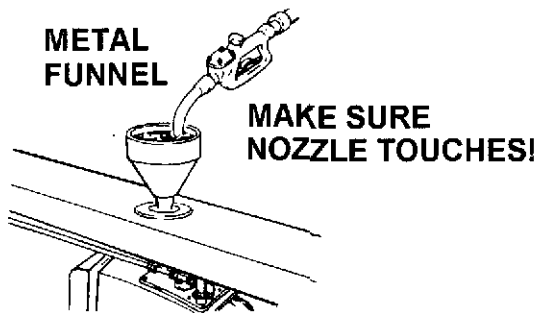
- Always use replacement parts specified by the manufacturer. They meet the U.S. Coast Guard requirements. Most automotive parts do not, especially electrical components that must meet ignition protection requirements of the U.S. Coast Guard regulations.
- When nonmetallic parts look to be in poor shape . . . replace them!



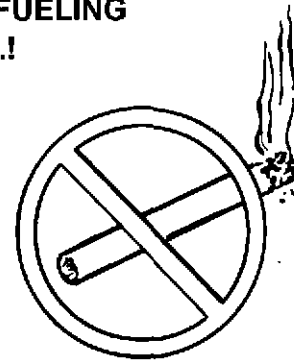
Using parts which meet U.S. Coast guard requirements is only half the job. The other half is your job . . .

It's time for replacement BEFORE sparks and/or fuel leaks occur.

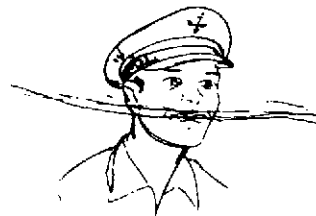
- Replace parts carefully. Make sure nuts and bolts are tight especially when they anchor electrical wires (to prevent sparking). If lock washers are specified - use them. No short cuts or missing parts with either of these CRITICAL safety related systems.
- When refueling, always ground fuel nozzle to the inlet fitting on the boat to prevent the buildup of electrostatic sparks. If you use a funnel, make sure it's metal and ground the fuel nozzle to the funnel.



WHEN REFUELING NEVER . . . !



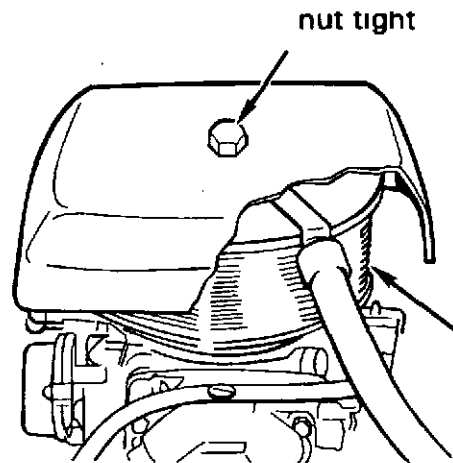
- If you smell gasoline in the engine compartment . . . find its source and stop the leakage.



- Follow "Starting Procedure" outlined in the operator's manual.

Always make sure there are no gasoline fumes in the engine compartment before starting the engine. Open the compartment and use your nose. Don't gamble.

- **Backfire flame arrestor** must be in place and securely attached to the air intake.




Do not alter the backfire flame arrestor.

If loose, damaged, or altered, an engine "backfire" may pass through the flame arrestor assembly into the engine compartment. If fumes are present in compartment, fire and explosion could result.

Summing Up

Now you know some things that can take the joy out of enjoyable boating.

No doubt about it . . . it takes time!

- Reading and understanding instructions.
- Reading and understanding warnings marked with  . . .
- Putting parts together correctly . . .
- Making correct adjustments . . .
- Testing you work.

and making sure

- Worn or damaged parts are replaced,
- Replaced parts are like originals . . . in every way.
- Customer is told of things which need attention . . .

But do you really want the alternative?

Part B - Marine Products and Safety of People* Who Fix Them

Part A talked about safe boating and how you, the mechanic, can help keep it safe for the boater. But what about you? Mechanics can be hurt while . . .

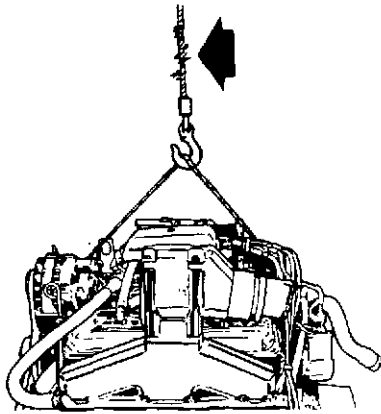
- Servicing boats
- Servicing sterndrives
- Troubleshooting problems
- Testing their work

Some items you'll know . . . others you may not.

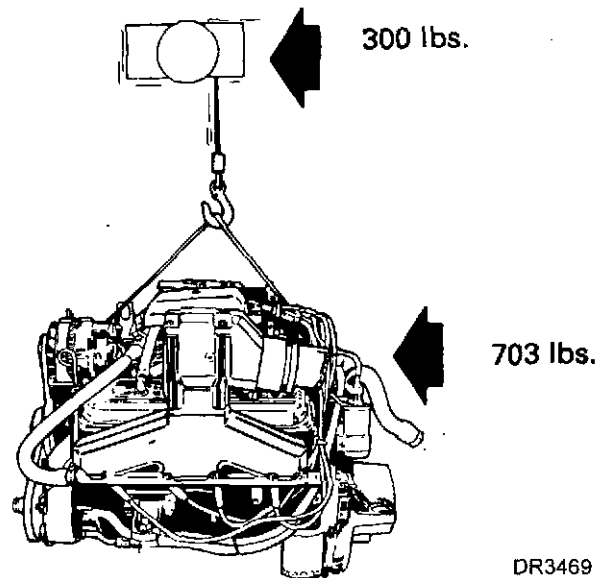
When Lifting Engines

If hoist is poor shape . . . or too small for the job

- Engine may drop suddenly



DR3471



DR3469

- Make sure shop aids have extra capacity — and keep them in good repair!

When Running Engine with Engine Compartment Cover Removed

The engine compartment cover is a guard. When you remove the cover / guard to work on the engine, remember:

- Loose clothing (open shirt sleeves, neckties), long hair, jewelry (rings, watches, bracelets), hands, arms, belts can be caught by moving belts or spinning pulleys
- Handle high voltage ignition components carefully. They can shock you and may cause you to recoil into moving parts.

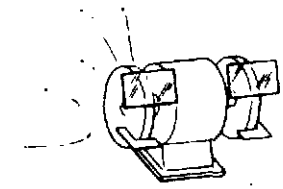
Two people working together on a running engine must look out for each other. Never, ever, hit the key to start the engine before signalling to your partner. (He may be leaning over the engine with his hands on a belt, or a "hot" electrical part, near the propeller, etc.)

*Mechanics, technicians, backyard do-it-yourselfers.

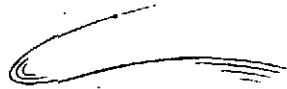
- Exhaust gasses of running engines contain carbon monoxide. . . you can't see it. . . you can't smell it. . . you can't taste it. . . but it's there whenever an engine runs. . . and it's deadly!

When you smell the other gasses in the exhaust, you are inhaling carbon monoxide. Run engines only in well ventilated areas.

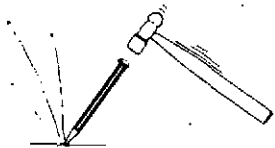
Eyes Need help



- Grinding



- End of Cables



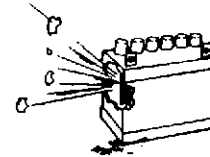
- Chiseling
(steel on steel)
(Tip: Use plastic or brass type hammers.
They don't chip off as easily as steel hammers.)



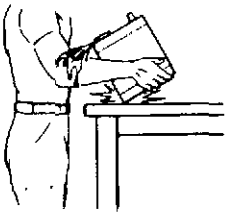
- Sprayed
Cleaners,
Paints



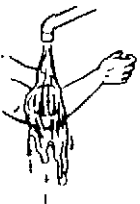
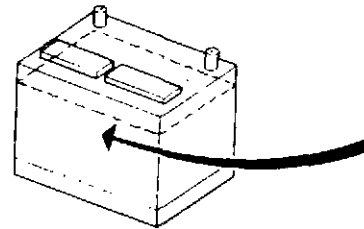
- Acid



Handling Lead Acid Batteries



- If spilled or splashed on any part of body..



Wash with lots of water. . .



- If solution gets into eyes. . . Wash. . . and see a Doctor, fast!

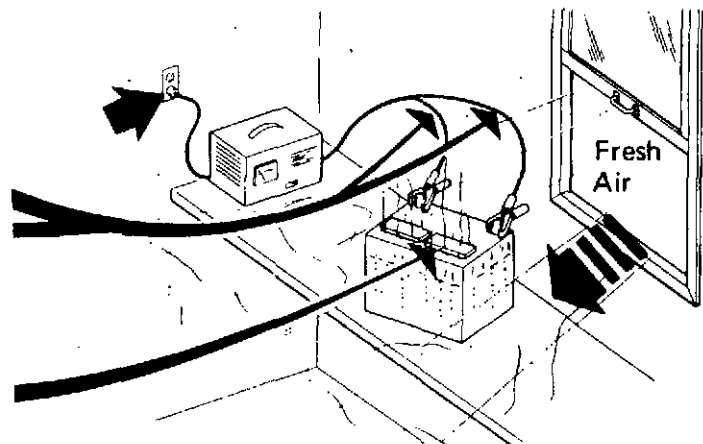


Charging Lead Acid Batteries

1 Attach and remove these cables with charger unplugged from 110 volt wall socket. (Prevents shocks if the charger is defective.)

2 Observe correct polarity when connecting these charger leads.

3 Always charge in a well ventilated area. Charging causes acid solution to give off hydrogen gas through the vents in the caps. . . Make sure vents are open. If clogged, pressure inside may build. . . battery may explode.



Battery gas is explosive!
While charging or discharging,
remember...

No Smoking
No Flames
No Sparks



Never yank cables off
battery posts... it's a sure
way to make lots of
sparks... surrounded by battery gas

Don't check battery condition
by placing metal objects
across posts.

You're sure to make sparks
and serious burns are
possible.

After Charging...

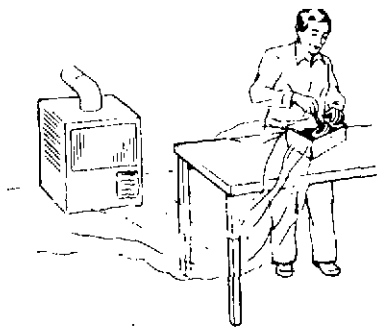


- Shut off charger
- Remove charger plug from wall socket
Then...
- Take charger cable off battery posts

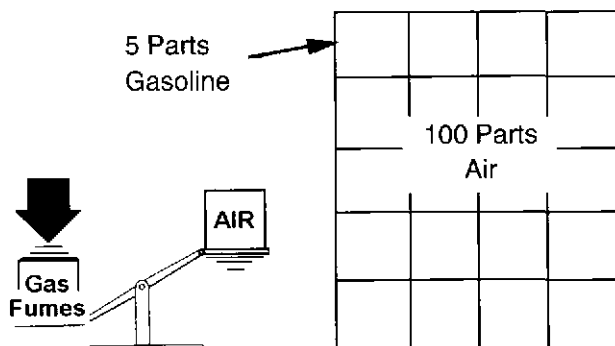
Gasoline! Handle With Care

- When you smell any odor of gasoline,
explosion is possible
- Gasoline fumes are heavier than air and will sink
to the lowest point in the boat or room,
and will stay there... waiting

- If the air around you is quiet... the pilot light in
the heater may ignite the heavy fumes
before your nose ever
smells the fumes...



Gasoline explodes easily and violently when
mixed with air



What Can you Do?

- Store properly...
- Fill portable tanks outside boat to prevent spillage in
boat
- Use fuel for fuel... not for a solvent
- If fumes are smelled (in shop, basement, garage), immediately:
 - Put out open flames, cigarettes, sparking devices
 - Wipe up spill or leak; get towels, rags outside fast
 - Check lowest area for fumes; open doors or win-
dows

Store in sturdy,
sealed gas can
...and...
keep outside

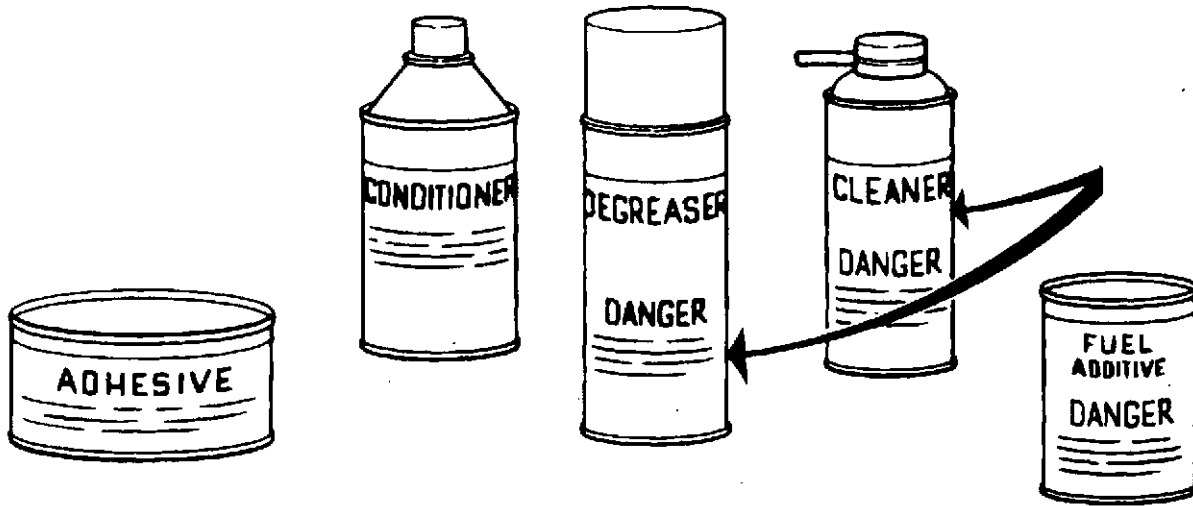


● Know items in and around repair area which can ignite gasoline fumes . . . Control them if fumes are smelled.

- Matches, cigarettes, torches, welders
- Electric motors (with unsealed cases)
- Electric generators (with unsealed cases)
- Light switches
- Appliance pilot lights (furnace, dryer, water heater)
- ??????????

How many of these are in your area?

Hazardous Products



Read the container label. It tells you . . .

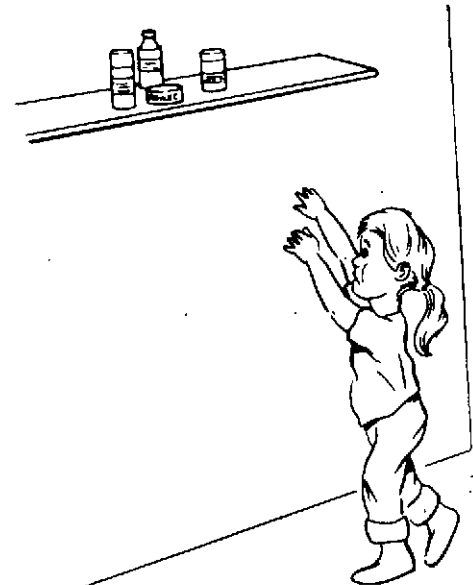
- "How, and where, to use,"
- "How to give First Aid," and have "recommended" first aid materials on hand- should an emergency arise
- "How to dispose of can,"

Remember: Little children are very curious and will try to taste everything, so . . .

. . . yummmmmmmmmmm



Keep containers away from children



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