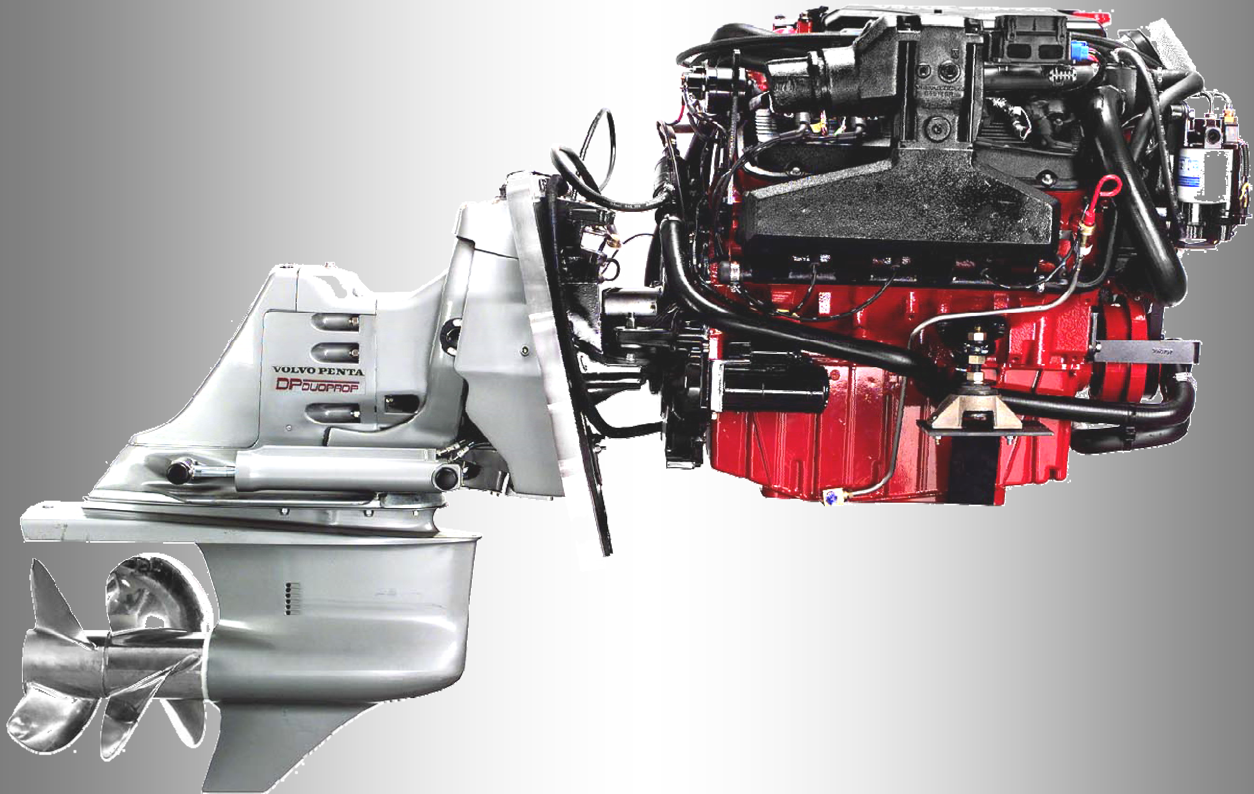
VOLVO PENTA



MEFI PRODUCT TRAINING
THROUGH 2005 MODEL YEAR
STUDENT REFERENCE BOOK

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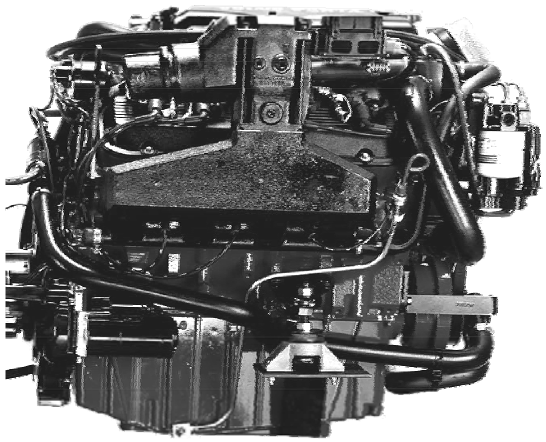
Acronyms

The following is a list of common acronyms used by VPA:

BARO	Barometric Pressure
B+	Battery positive
CAN	Controller Area Network
CARB	California Air Resources Board
CKP	Crankshaft Position Sensor
CKT	Circuit
CMP	Camshaft Position Sensor
CONN	Connector
CYL	Cylinder
DEG	Degree
DI	Distributor Ignition
DIST	Distributor
DLC	Data Link Connector
DTC	Diagnostic Trouble Code
DVOM	Digital Volt Ohmmeter
ECM	Electronic Control Module
ECT	Engine Coolant Temperature Sensor
EEPROM	Electronically Erasable Programmable Read Only Memory
EGC	Electronic Gas Engine Control
EI	Electronic Ignition
EMI	Electromagnetic Interference
ENG	Engine
EPA	Environmental Protection Agency (Federal)
E-STOP	Emergency Stop
GND	Ground
GPH	Gallons Per Hour
IAC	Idle Air Control Stepper Motor
IAFM	Integrated Air Fuel Module
IAT	Intake Air Temperature Sensor
IC	Ignition Control
IGN	Ignition
INHG	Inches of Mercury
INJ	Injector / Injection
I/O	Input / Output
KPA	Kilopascal
KS	Knock Sensor
KV	Kilovolts
MAF	Mass Airflow
MAP	Manifold Air Pressure Sensor
MAT	Manifold Air Temperature
MPI	Multiport Injection / Injected
M/SEC	Millisecond
N/C	Normally Closed
N/O	Normally Open
NTC	Negative Thermal Coefficient
OBD	On-Board Diagnostic System
OPS	Oil Pressure Sensor
PFI	Port Fuel Injection
PROM	Programmable Read Only Memory
PSI	Pounds Per Square Inch
PWM	Pulse Width Modulated
RAM	Random Access Memory
REF HI	Reference Hi (RPM Input)
REF LO	Reference Low (Return)
RFI	Radio Frequency Interference
ROM	Read Only Memory
RPM	Revolutions Per Minute
SLV	Slave Engine
TACH	Tachometer
TBI	Throttle Body Fuel Injection
TCP	Throttle Control Position Sensor
T/MAP	Combination MAP and IAT Sensor
TPS	Throttle Position Sensor
V	Volts
VAC	Vacuum
WOT	Wide Open Throttle

MEFI Fuel Injection

Course Content



- Introduction / Overview
- Safety Brief
- EFI Product Highlights
- MEFI Systems
- Inputs and Outputs
- Ignition Systems
- Fuel Systems
- Power Distribution
- Special Service Tools
- Service Information

Marine Fuel Injection is an adaptation of automotive EFI systems. The concept of EFI has been around for a long time. Electronic Fuel Injection is bringing a new level of performance and enjoyment to the boating world.

In Years past, Volvo Penta engines were equipped with 2 types of EFI systems, Throttle Body Injection (TBI) and Multiport Injection (MPI or PFI). Both systems used the same types of sensors and a similar ECM (Electronic Control Module). This course is designed to cover Speed Density Fuel Injection used on all Volvo Penta fuel injected engines through the 05 model year.

Minimum performance requirements for successful completion of this course are:

1. Class quiz and test final average score of 80% or higher
2. End of class reorganization of tools and equipment, as directed
3. 100% class attendance

Safety Brief

SAFETY AT WORK !

Whenever work is carried out on an engine or transmission during a Product Training session, all Safety Instructions as per our Workshop Manuals and Instruction Book must be obeyed.

Please be advised that proper attire is required at all Volvo Penta training schools. Participants are asked to avoid wearing clothes that expose their legs and toes during classes. Additional common sense for any “horseplay”, language, and smoking is required by everybody.

There is no smoking during class time. Smoking is allowed in designated areas before class, after class and during breaks and lunch.

The instructor will manage and maintain a safe learning environment.

Flooded Cylinders

When you suspect an engine is hydro-locked, always assume the liquid is flammable. Disable the primary ignition system *before* removing the spark plugs.

When cranking an engine without spark plugs installed, always disable the ignition system. Besides damaging the ignition system via 'open' secondary circuits, EFI systems use ignition reference signals to initiate fuel delivery!

Ignition Modules are sensitive to the amount of secondary voltage required to complete the spark plug circuits.

With the spark plug wires removed from any available ground, the module will be driven at maximum dwell saturation time for the coil(s) – read as HEAT. And when that maximum secondary spark is released, it may seek a ground right back through the ignition module – causing instant electronic failure.

When an engine is running with a spark plug wire "hanging", you can bet the module and coil have had their service life compromised. How much depends on how long the wire was "hanging".

To <u>properly</u> disable the ignition system on fuel Injected engines, with the key in the OFF position, unplug the crankshaft position sensor, remove the ignition relay or unplug the J-1 and J-2 connectors from the ECM before cranking the engine.

On carbureted models, unplug or remove both connectors or wires from the ignition coil or unplug the distributor.

This will prevent starting a fire by removing all spark and fuel (injected engines) capability from the engine.

MEFI Fuel Injection

Coast Guard Recommended Refueling Procedures:

✓*Close all hatches and other openings before fueling.*

✓*Extinguish all smoking materials.*

✓*Turn off engines, electrical equipment, radios, stoves, and other appliances.*

✓*Remove all passengers.*

✓*Keep the fill nozzle in contact with the tank and wipe up any spilled fuel.*

✓*Open all ports, hatches, and doors to ventilate when finished.*

✓*Run the blower for at least four minutes.*

✓*Check the bilges for fuel vapors before starting the engine.*

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Class A fires are fires that burn consumables that leave an ash after burning. Class A fires are best fought with water, but can be fought with a number of fire extinguishing agents.

Class B fires are burning liquids. Class B fires are best fought with dry chemical or foam extinguishing agents. Water should be used only as a last resort because it spreads the fire. Never use a straight stream of water to fight a Class B fire.

Class C fires are electrical fires. Class C fires should only be fought using dry chemical extinguishing agents. Class C fires usually turn into Class A fires after the power has been secured.

Class D fires are burning metals fires. Most burning metals produce their own oxygen as they burn so they can't be extinguished with water. Most burning metals react violently with water. They are characterized by a white hot flame and must be fought with smothering agents such as sodium chloride or sand.

The picture above lists common sense refueling practices. Keeping the fill nozzle in contact with the filler neck ensures no static electricity buildup between the two.

Cylinder Balance Testing

CYLINDER BALANCE TEST

A cylinder balance test is used to determine if all cylinders are working equally. This test compares the rpm loss between each cylinder and based on the results, helps isolate the problem area. For example, if a 60 rpm drop occurs on the first seven cylinders, but there is no rpm drop on number eight, then there is a problem with the eighth cylinder tested. This test can also be used to isolate lower engine noise to a particular cylinder.

If for example, a customer complains of a loss of power, or the engine runs "rough," you may have to perform a cylinder balance test. RPM loss varies depending on engine size, configuration and extent of the miss. Cutting out one cylinder on a V8 has less rpm drop than removing one cylinder on a six-cylinder engine. It is easier to identify a weak cylinder with a load on the engine.

The cylinder balance tests in the VP2000 and Diacom disable secondary ignition to individual cylinders while monitoring the change in rpm. These tests should only be performed under a load because weak cylinders show up better with a load on them. **Do not perform this test on engines under NO load, the results will be invalid.**

1. Hook up the VP2000 or Diacom and navigate to the cylinder balance test (power balance test in the VP2000).
2. For Diacom, follow the on screen prompts.
3. Using a screwdriver or other mechanical device, hold the throttle open so that the engine runs at approximately 1500 RPM and conduct a balance test for all cylinders and record the RPM drop, by cylinder, below.

Cyl. # 1 _______ Cyl. # 5 _______

Cyl. # 2 _______ Cyl. # 6 _______

Cyl. # 3 _______ Cyl. # 7 _______

Cyl. # 4 _______ Cyl. # 8 _______

4. Are there any bad cylinders? If so, what are the cylinder number(s)?

____

5. What are the possible causes?

Compression Testing Activity

CYLINDER COMPRESSION TEST

The most common method of measuring compression is with a specially designed pressure gauge. A fitting attached to the gauge is put in place of the spark plug of the cylinder being tested (all spark plugs removed).

Standard Compression Test

For a dry compression test, remove all the spark plugs and insert the compression gauge adapter into the number 1 spark plug hole. Disable the ignition/fuel system by removing the Ignition relay. Be sure the throttle blade is fully open. If the throttle blade is not completely open, incoming air will be restricted and cause lower compression readings. Crank the engine at least five full cycles or until the cylinder has reached its peak compression pressure.

Note: A cycle is two full revolutions of the crankshaft.

Repeat the test steps for all additional cylinders. If one or more cylinders have abnormally low compression readings, perform a wet compression test to verify the results. If the same cylinder or cylinders confirm an abnormally low reading on the second compression test, a problem may exist in that cylinder. A leakdown test will determine where the pressure leak is.

For a wet compression test with a standard compression gauge, add 28.4 ml (1 oz.) of 30-weight oil to the cylinder and perform the compression test again. Adding oil to the cylinder may temporarily seal worn rings to the cylinder walls. If compression readings increase, the piston rings are probably worn. If the compression readings did not change, the valves may not be sealing.

1. Remove all the spark plugs. Remove the Ignition relay. Conduct a dry compression test on 4 cylinders. Record the cylinder number and compression readings below.

   Cylinder # _____ Dry reading _______

   Cylinder # _____ Dry reading _______

   Cylinder # _____ Dry reading _______

   Cylinder # _____ Dry reading _______

What is the condition of the four cylinders that were tested?

____

Compression Testing Activity

Running Compression Test

When a standard compression test does not reveal any concerns a running compression test can detect:

- Broken valve springs
- Worn valve guides
- Bent pushrods
- Worn cam lobes
- Sticking valves
- Intake or exhaust manifold restriction

Theory behind this test: When you perform a standard, static compression test, you are checking cylinder sealing, not breathing (volumetric efficiency). This test looks at an individual cylinders ability to breathe.

Say the engine is running at 18 inches of vacuum, barometric pressure is about 30 inches, so the difference (30 – 18 = 12) is what the engine is inhaling. 12 inches of mercury is equal to about 6 psi absolute air pressure. Compressed to about 9:1 ratio, you should get 6 X 9 =56 psi pressure if all the air makes it into the cylinder and then gets exhaled. Therefore, your idle reading on a running compression test is about 60 psi.

Note: Leaving the Schrader valve in will affect your reading.

An engine idles at about 600-900 rpm, and the starter motor obviously cannot crank the engine as fast as the engine idles. Most manufactures' specifications require the engine to crank at 80-250 rpm. Therefore, we are checking the compression of an engine at cranking speed to determine the condition of an engine that does not run at that speed.

Some would think that the compression would be substantially higher because the valve overlap of the cam is more effective at higher engine speeds and this would tend to increase the compression. Actually, the compression pressure of a running engine is much lower than cranking compression pressure. This results from the volumetric efficiency. The engine is revolving faster, and therefore there is less time for air to enter the combustion chamber. With less air to compress, the compression pressure is lower. Typically, the higher the engine rpm is, the lower the running compression.

- Compression (cranking) 125-160
- Compression at idle 60-90
- Compression at 2,000 rpm 30-60

Similar to the cranking compression test, the running compression of all cylinders should be equal. Therefore, a problem is not likely to be detected by its value, but by how far the running compression varies from the other cylinders.

Use the procedure below to perform a running compression test.

Compression Testing Activity

Note: This test is done with a conventional gauge.

RECORD ALL READINGS BELOW

1. Remove the spark plug from one of the 4 cylinders that were used for the static test.
2. Remove the Schrader valve from the compression gauge.
3. Screw the compression gauge into the spark plug hole.
4. Ground the spark plug wire, or unplug the coil for coil near plug engines, and disconnect the fuel injector.
5. Start the engine.
6. Record the gauge reading at maximum sweep of the needle below. To see the maximum sweep of the needle, use a piece of paper to cover the gauge face through the center of the gauge and rotate the paper until the needle disappears. Then back the paper up until the needle reappears. **(pivot the paper around the center of the gauge)**
7. Turn off the engine.
8. Remove the compression gauge, reinstall the spark plug and wire, and connect the fuel injector.
9. Repeat steps 1-8 for the 3 more cylinders. Use the same 3 cylinders that were used for the static compression test. Allow a 10 percent variance from the highest to the lowest cylinder.

Running Compression Readings

Cyl. # 1 _______ psi **Cyl. # 3 _______ psi**

Cyl. # 2 _______ psi **Cyl. # 4 _______ psi**

Cylinder Leakdown Testing

CYLINDER LEAKDOWN TEST

The cylinder leakdown test is an accurate way of determining engine condition. The test detects if exhaust and intake valves are not seating properly, and checks for any leaks between adjacent cylinders or into the water jacket. The cylinder leakdown test also checks for any causes of combustion and compression pressure losses.

WARNING: On a Closed Cooling System Engine Do Not Remove The Cooling System Pressure Cap With The System Hot And Under Pressure Because Serious Burns From Coolant Can Occur.

1. On a closed cooling system engine, check the coolant level and fill as necessary. Do not install the cooling system pressure cap.
2. Start the engine and operate it until it reaches normal operating temperature.
3. Turn off the engine.
4. Remove the spark plugs. On a raw water cooled engine, disconnect the exhaust bypass hoses from the T-stat housing and install the clear-hose test set up. Tie the bypass hoses still connected to the T-stat housing to a vertical position and back fill the hoses to ensure that the engine is full of water.
5. Remove the oil filler cap.
6. Remove the air cleaner.
7. Calibrate the tester according to the manufacturer's instructions. The shop air source for testing should maintain 483 kPa (70 psi) minimum or 1379 kPa (200 psi) maximum. The recommended pressure is 689 kPa (100 psi).

WARNING: Each Piston Must Be Exactly TDC When Checked, Otherwise The Engine Could Spin A Half Turn And Cause Injury.

8. Perform the test procedures on each cylinder according to the manufacturer's instructions. While testing, listen for pressurized air escaping through the throttle body, tailpipe, and oil filler cap opening. Check for bubbles in the radiator coolant.

All gauge pressure indications should be equal, with no more than 25 percent leakage. For example: At 552 kPa (80 psi) input pressure, a minimum of 414 kPa (60 psi) should be maintained in the cylinder.

Record your readings on the next page.

Cylinder Leakdown Testing

Leakdown Test Readings

Cyl. # 1 _______ psi

Cyl. # 2 _______ psi

Cyl. # 3 _______ psi

Cyl. # 4 _______ psi

Cyl. # 5 _______ psi

Cyl. # 6 _______ psi

Cyl. # 7 _______ psi

Cyl. # 8 _______ psi

What is the condition of the cylinders of this engine?

____

____

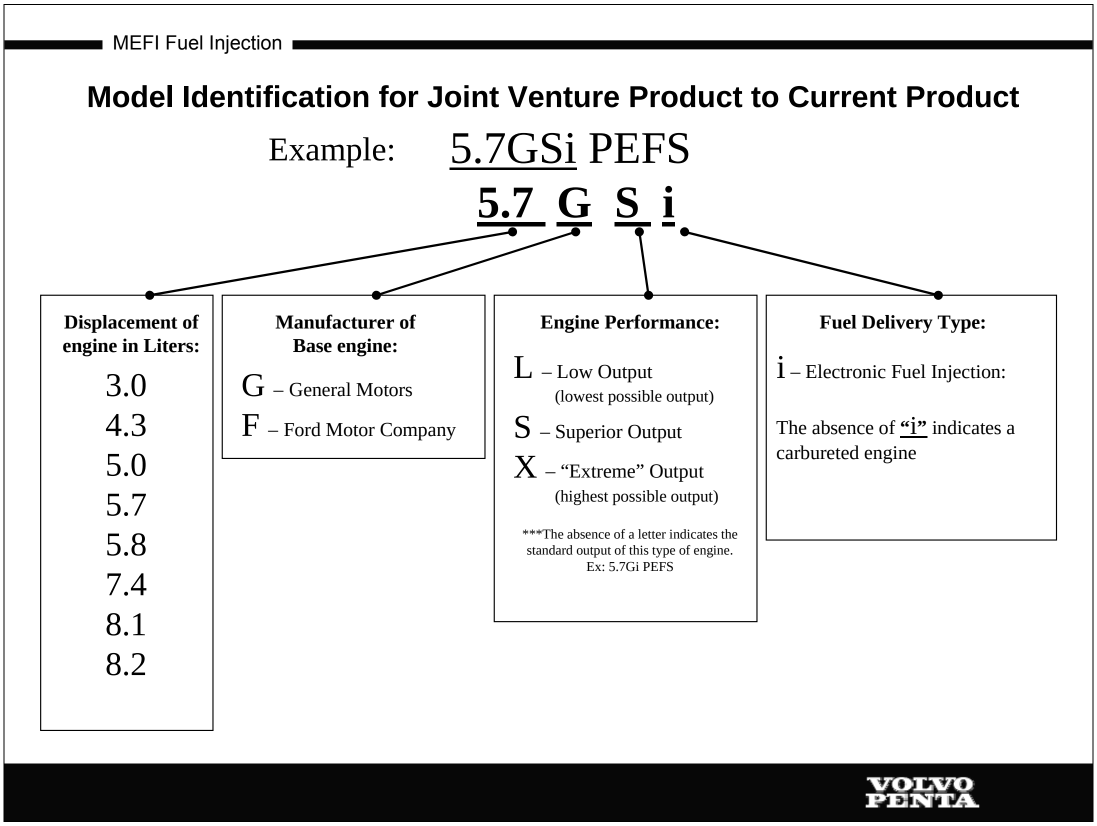
____

8.1Gi/GXi

This is what we start with. The engines arrive from GM in different states of assembly according to which engine it is (carbureted or fuel injected). The engine is then marinized at our plant in Lexington, TN.

8.1Gi/GXi

This is what we build. Fully marinized and ready for shipment.



Engine model designation begins with the displacement of the engine in liters. The next digit denotes the engine manufacturer. All of our current engines are GM blocks. The next digit denotes a subjective power rating. This rating doesn't indicate horsepower. It can only be used comparing engines. If there is a Gi and a GXi of the same displacement, side by side, then the GXi has more horse power than the Gi. The small " i " at the end indicates that the engine is fuel injected. The absence of the " i " in the model number indicates that the engine is carbureted.

Example: 5.7GSi PEFS

P EF S

Type of Steering

M- Mechanical
P - Power Assisted
X - Xact

Parts and Service Literature Reference Code

MD
HU
NC
LK
BY
WT
EF

Between 1994 and 2001 Volvo Penta used a two character alphabetical code to designate which parts and service manuals to use while servicing these engines. These codes do not translate into specific meanings. Volvo Penta does not use "Model Year" designations and therefore a serial number or specific model number must be obtained in order to reference the correct service literature.

-A
-B
-C

As of 2001, Volvo Penta started using a single letter designation that ascends as engine or model year changes occur. This is still a reference to which service literature to use.

Additional Engine Information

A series of unidentified letters that may designate changes or options with an engine that will be notated in a service or parts catalog when multiple procedures or parts may be a factor .

****** Special Note: ******

An Inboard application will include a capital "I" in the model designation. Ex. **7.4Gi IEFS**.

Later models, a capital "F" indicates a freshwater cooling option.
Ex: **8.1GXi-BF**

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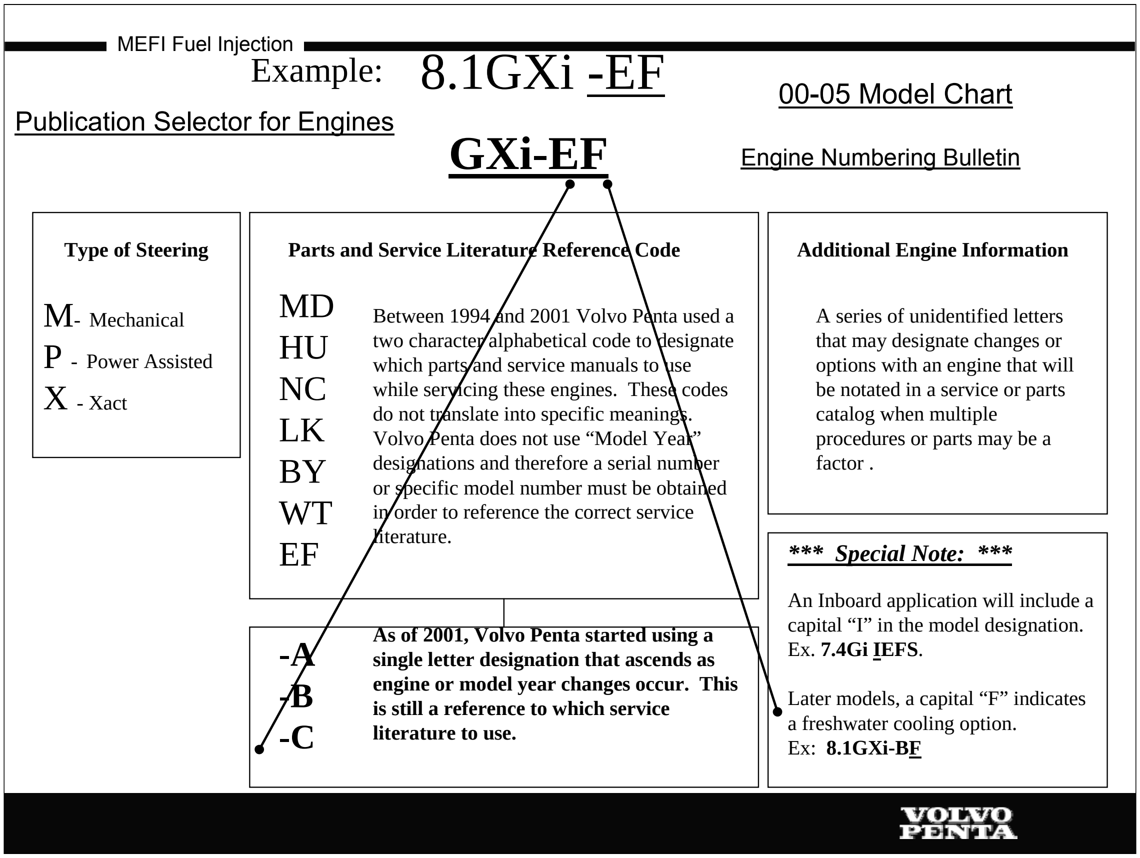
The next digit (in the older numbering system) is the type of steering the boat is equipped with. The next 2 digits (in the old numbering system) indicate which service and parts literature is to be used. The new numbering system is shown on the next page and also parts bulletin P-00-0-3 which is located a couple of pages later in in this book.



This is an example of an 2005 8.1GXi-EF engine package. This is a high output 8.1L with a closed cooling system. This means that the engine cooling system contains a mixture of antifreeze and water. This mixture gets cooled by raw water (water the boat is operating in) in a heat exchanger located somewhere on the engine.

To determine correct manual usage for the engine you are working on, first determine which model you are working on, then open the Publication Selector for Engines "pdf" file (using the Adobe Acrobat Reader program) and while holding the control key down type the letter F (the find function). In the find function type the engine model being worked on and press enter.

This document is available on www.vppn.com (Partner Network Website) in the Technical Information section. The file can then be saved to the dealer's computer. This file is updated periodically.

Also available through Partner Network is a search feature to find all publications by serial number.

2000 - 2005 Gas Engine Build Chart   3.0L, 4.3L(all) and 5.0L Carb

		EF 2000	EF 2001	MY 2002, SOFA 1 (6/01)	MY 2002, SOFA 2 (10/01)	MY 2003, SOFA 1
3.0 Carb	**3.0 GL**	← **NONE BUILT** →				30 GLM-A Designation 3869170 30 GLP-A Designation 3869171 Same 135 HP Rating as 3.0 GS Dash Mounted Warning Horn New Style Flush Attachment **RED**
	3.0 GS	30GSMEFS 3869051 30GSPEFS 3869052 4 Point Engine Mounts Serpentine Belt **GREY** Crankshaft Mount Seawater Pump Audio Warning Horn	30 GSM-A Designation 3869105 30 GSP-A Designation 3869106 Cooling Flow Changed **GREY**	30 GSM-B Designation 3869111 30 GSP-B Designation 3869112 Exhaust Overheat Sensor Flush Attachment **RED**	30 GSM-C Designation 3869147 30 GSP-C Designation 3869148	← **NONE BUILT** →
4.3 Carb	**4.3 GL**	43GL PEFS 3869053 Roller Rockers Audio Warning Horn (Keeps V-Belts) **GREY**		43GL-A Designation 3869113 Exhaust Overheat Sensors Flush Attachment Platinum Spark Plugs **RED**		43GL-B Designation 3869174 Shrouded Ex. Overheat Sensor Dash Mounted Warning Horn New Style Flush Attachment **RED**
4.3 EFI	**4.3Gi**	43Gi PEFS 3869055 Serpentine Belt Audio Warning Horn Fuel Module **GREY** **TBI MEFI 3**		← **NONE BUILT** →		
	4.3GXi	← **NONE BUILT** →		43GXi-A Designation 3869114 Exhaust Overheat Sensors Flush Attachment Rating 205 hp-> 225hp **TBI MEFI 3** **RED**	43GXi-B Designation 3869132 43GXi-BF Designation 3869155 225HP **IAFM System** **MEFI 4 ECM** **RED**	43GXi-C Designation 3869176 43GXi-CF Designation 3869178 Dash Mounted Warning Horn **IAFM System** **MEFI 4 ECM** **RED**
5.0 Carb		50GLPEFS 3869056 Audio Warning Horn (Keeps V-Belts) **GREY**		50GL-A Designation 3869115 Exhaust Overheat Sensors Flush Attachment Platinum Spark Plugs **RED**	50GL-B Designation 3869162 Exhaust Overheat Sensors Flush Attachment Platinum Spark Plugs **GM HI Ignition System** **RED**	50GL-C Designation 3869181 Shrouded Ex.Overheat Sensors Dash Mounted Warning Horn New Style Flush Attachment **GM HI Ignition System** **RED**

2000 - 2005 Gas Engine Build Chart

3.0L, 4.3L(all) and 5.0L Carb

		MY 2003, SOFA 2 (01/01/03)	MY 2004	MY 2005
3.0 Carb	3.0 GL	30 GLM-B Designation 3869211 30 GLP-B Designation 3869212 135 HP Same as MY03 SOFA 1 **CARB** certified **RED**	30 GLM-C Designation 3869249 30 GLP-C Designation 3869250 135 HP **CARB** certified **RED**	30 GLM-C Designation 3869249 30 GLP-C Designation 3869250 135 HP **CARB** certified **RED**
	3.0 GS	←	**NONE BUILT**	→
4.3 Carb		43GL-C Designation 3869213 Same as MY03 SOFA 1 **CARB** certified **RED**	43GL-D Designation 3869251 **CARB** certified **RED**	43GL-D Designation 3869251 **CARB** certified **RED**
4.3 EFI	4.3Gi	←	**NONE BUILT**	→
	4.3GXi	43GXi-D Designation 3869214 43GXi-DF Designation 3869215 Same as MY03 SOFA 1 **CARB** certified **IAFM MEFI 4 ECM** **RED**	43GXi-E Designation 3869252 43GXi-EF Designation 3869253 43OSi-E Designation 3869268 43OSi-EF Designation 3869269 **IAFM MEFI 4b ECM** **RED**	43GXi-E Designation 3869252 43GXi-EF Designation 3869253 43OSi-E Designation 3869268 43OSi-EF Designation 3869269 **IAFM MEFI 4b ECM** **RED**
5.0 Carb		50GL-D Designation 3869216 Same as MY03 SOFA 1 **CARB** certified **GM HI Ignition System** **RED**	50GL-E Designation 3869254 **CARB** certified **GM HI Ignition System** **RED**	50GL-E Designation 3869254 **CARB** certified **GM HI Ignition System** **RED**

2000 - 2005 Gas Engine Build Chart

5.0L EFI and 5.7L Carb

		EF 2000	EF 2001	MY 2002, SOFA 1 (6/01)	MY 2002, SOFA 2 (10/01)
5.0 EFI	**5.0Gi**	50Gi PEFS Designation 3869057 MAT Sensor Added Serpentine Belt Audio Warning Horn Fuel Module **TBI MEFI 3** **GREY**		**NONE BUILT**	
	5.0GXi	**NONE BUILT**		50GXi-A Designation 3869116 Exhaust Overheat Sensors Flush Attachment Rating 250 hp-> 270hp **TBI MEFI 3** **RED**	50GXi-B Designation 3869134 50GXi-BF Designation 3869156 270HP **IAFM System** **MEFI 4 ECM** **RED**
5.7 Carb	**5.7GL**	**NONE BUILT**		57GL-A Designation 3869146 Exhaust Overheat Sensors Flush Attachment Platinum Spark Plugs Rating 250 hp -> 260 hp **RED**	57GL-B Designation 3869163
	5.7GS	57GS PEFS 3869058 Audio Warning Horn (Keeps V-Belts) **GREY**		**NONE BUILT**	

		MY 2003	MY 2003 SOFA 2 (10/01/03)	MY 2004	MY2005
5.0 EFI	**5.0Gi**	**NONE BUILT**			
	5.0GXi	50GXi-C Designation 3869183 50GXi-CF Designation 3869185 Dash Mounted Warning Horn **IAFM System** **MEFI 4 ECM** **RED**	50GXi-D Designation 3869217 50GXi-DF Designation 3869218 Same as MY03 SOFA 1 **CARB** certified **IAFM MEFI 4 ECM** **RED**	50GXi-E Designation 3869255 50GXi-EF Designation 3869256 50OSi-E Designation 3869270 50OSi-EF Designation 3869271 **IAFM MEFI 4b ECM** **RED**	50GXi-E Designation 3869255 50GXi-EF Designation 3869256 50OSi-E Designation 3869270 50OSi-EF Designation 3869271 **IAFM MEFI 4b ECM** **RED**
5.7 Carb	**5.7GL**	57GL-C Designation 3869188 Shrouded Ex. Overheat Sensors Dash Mounted Warning Horn New Style Flush Attachment **GM HI Ignition System** **RED**	57GL-D Designation 3869219 Same as MY03 SOFA 1 **CARB** certified **GM HI Ignition System** **RED**	57GL-E Designation 3869257 **CARB** certified **GM HI Ignition System** **RED**	**NONE BUILT**
	5.7GS	**NONE BUILT**			

2000 - 2005 Gas Engine Build Chart

5.7 EFI, 7.4 and 8.2L

		EF 2000	EF 2001	MY 2002, SOFA 1 (6/01)	MY 2002, SOFA 2 (10/01)
5.7 EFI	5.7Gi	← NONE BUILT →		57Gi-A Designation 3869117 Exhaust Overheat Sensors Flush Attachment 280 hp **TBI MEFI 3** **RED**	57Gi-B Designation 3869136 57Gi-BF Designation 3869157 280 hp rating **IAFM System** **MEFI 4 ECM** **RED**
	5.7GSi	57GSi PEFS Designation 3869059 MAT Sensor Added Serpentine Belt Audio Warning Horn Fuel Module **TBI MEFI 3** **GREY**		← NONE BUILT →	
	5.7GXi		57GXi-A Designation 3869096 Modified Intake 1.61 ratio Rocker Arms 310 hp **TBI MEFI 3** **RED**	57GXi-B Designation 3869118 Modified Intake 1.61 ratio Rocker Arms Rated 315hp -> 320 **TBI MEFI 3** **RED**	57GXi-C Designation 3869137 57GXi-CF Designation 3869158 1.61 ratio Rocker Arms 320hp **IAFM System** **MEFI 4 ECM** **RED**
7.4 EFI	7.4Gi	74Gi PEFS 3869060 Serpentine Belt Audio Warning Horn Fuel Module **GREY** **MEFI 3**	← NONE BUILT →		
	7.4GSi	74GSi PEFS 3869061 Serpentine Belt Audio Warning Horn Fuel Module **GREY** **MEFI 3**	← NONE BUILT →		
8.2 EFI		82GSi PEFS 3869062 Serpentine Belt Audio Warning Horn Fuel Module **GREY** **MEFI 3**	← NONE BUILT →		

2000 - 2005 Gas Engine Build Chart

5.7 EFI, 7.4 and 8.2L

		MY 2003	MY 2003 SOFA 2 (01/01/03)	MY 2004	MY 2005
5.7 EFI	5.7Gi	57Gi-C Designation 3869189 57Gi-CF Designation 3869190 Dash Mounted Warning Horn **IAFM System** **MEFI 4 ECM** **RED**	57Gi-D Designation 3869220 57Gi-DF Designation 3869221 Same as MY03 SOFA 1 **CARB** certified **IAFM MEFI 4 ECM** **RED**	57Gi-E Designation 3869258 57Gi-EF Designation 3869259 57OSi-D Designation 3869272 57OSi-DF Designation 3869259 **IAFM MEFI 4b ECM** **RED**	57Gi-E Designation 3869258 57Gi-EF Designation 3869259 57OSi-D Designation 3869272 57OSi-DF Designation 3869259 **IAFM MEFI 4b ECM** **RED**
	5.7GSi	← **NONE BUILT** →			
	5.7GXi	57GXi-D Designation 3869193 57GXi-DF Designation 3869194 Dash Mounted Warning Horn **IAFM System** **MEFI 4 ECM** **RED**	57GXi-E Designation 3869222 57GXi-EF Designation 3869223 Same as MY03 SOFA 1 **CARB** certified **IAFM MEFI 4 ECM** **RED**	57GXi-F Designation 3869260 57GXi-FF Designation 3869261 57OSXi-D Designation 3869274 57OSXi-DF Designation 3869275 **IAFM MEFI 4b ECM** **RED**	57GXi-F Designation 3869260 57GXi-FF Designation 3869261 57OSXi-D Designation 3869274 57OSXi-DF Designation 3869275 **IAFM MEFI 4b ECM** **RED**
7.4 EFI	7.4Gi	← **NONE BUILT** →			
	7.4GSi	← **NONE BUILT** →			
8.2 EFI		← **NONE BUILT** →			

2000 - 2005 Gas Engine Build Chart

8.1L

		EF 2000	EF 2001	MY 2002, SOFA 1 (6/01)	MY 2002, SOFA 2 (10/01)
8.1 EFI	**8.1Gi**	← **NONE BUILT** →	81Gi-A Designation 3869087 New Engine Model 375 hp Distributorless Ignition **MEFI 4 ECM** **RED**	81Gi-B Designation 3869119 Exhaust Overheat Sensors Flush Attachment 375 hp **MEFI 4 ECM** **RED**	
	8.1GSi	← **NONE BUILT** →	81GSi-A Designation 3869088 New Engine Model 420 hp Distributorless Ignition **MEFI 4 ECM** **RED**	← **NONE BUILT** →	
	8.1GXi	← **NONE BUILT** →		81GXi-A Designation 3869123 Exhaust Overheat Sensors Flush Attachment 420 hp **MEFI 4 ECM** **RED**	

		MY 2003	MY 2003 SOFA 2 (01/01/03)	MY 2004	MY 2005
8.1 EFI	**8.1Gi**	81 Gi-C Designation 3869197 81 Gi-CF Designation 3869198 Dash Mounted Warning Horn New Style Coils **MEFI 4 ECM** **RED**	81 Gi-D Designation 3869224 81 Gi-DF Designation 3869225 Same as MY03 SOFA 1 **CARB** certified **MEFI 4 ECM** **RED**	81 Gi-E Designation 3869262 81 Gi-EF Designation 3869263 81 OSi-A Designation 3869280 **CARB** certified **MEFI 4b ECM** **RED**	81 Gi-F Designation 3869283 81 Gi-FF Designation 3869284 81 OSi-B Designation 3869287 New Fuel Pump Module **MEFI 4b ECM** **RED CARB** certified
	8.1GSi	← **NONE BUILT** →			
	8.1GXi	81 GXi-B Designation 3869199 81 Gi-BF Designation 3869200 Dash Mounted Warning Horn New Style Coils **MEFI 4 ECM** **RED**	81 GXi-C Designation 3869226 81 Gi-CF Designation 3869227 Same as MY03 SOFA 1 **CARB** certified **MEFI 4 ECM** **RED**	81 GXi-D Designation 3869264 81 Gi-DF Designation 3869265 **CARB** certified **MEFI 4b ECM** **RED**	81 GXi-E Designation 3869285 81 GXi-EF Designation 3869286 New Fuel Pump Module **CARB** certified **MEFI 4b ECM** **RED**

Parts Bulletin

Group	Number	Version
P-00-0	3	01

VOLVO PENTA

Volvo Penta of the Americas
1300 Volvo Penta Drive
Chesapeake, Virginia 23320-9810

How to identify a Volvo Penta gas engine

Models: later model gas engines

Distribution: Parts Date: Jan-2005 Binder: Parts Replaces: VPA 51-900

To help you easily find parts and service information about our products, Volvo Penta has developed online search tools that are available only on our website, Partner Network. As an example, in July, 2004 we launched a serial number search for gas engines and drives. You can enter the product's serial number and the system will provide you with all of the catalogs, manuals and bulletins that apply to that product. The system also provides links to online versions of these documents. New tools such as this are added perodically to make it easier for you to find information about the Volvo Penta products you are servicing. This is another way to insure that you have the latest, most current information about our products. Contact your dealer business specialist to sign up for the Partner Network.

The engine model name can also be used to search for parts or information. The text that follows explains the model names used by Volvo Penta for gas engines. Understanding these model names will help in finding the correct parts and information for the engines, whether you're searching on-line or in paper publications.

Several methods have been used to provide the gas engines with unique model names. Some were based on horsepower ratings. More recent names are based on the displacement of the engine in liters. Each time the name was changed, it was due to some change in the parts content of the engine. Sometimes the changes were minor, sometimes they were major. The changes may or may not affect the parts that you need for a repair. The safest method is to always search with the complete model name.

There are three distinct periods of gas engine production, each with a different naming method. Each is explained below;

Red Engines, early

Very early engines, built until the late 1980's, were named based on the displacement (early) or horsepower (later) of the engines. The name started with AQ (sterndrive engine), BB (inboard) or MB (inboard). Next came the number for the displacement or horsepower. Most of these also included a one letter suffix, for version control. An AQ271A is older (and different) than a AQ271B.

EXAMPLES: AQ260A, AQ171C, AQ200F, BB260A

These engine names then changed to a system based on displacement. The names were a three digit number, followed by a letter. The first two digits of the number represented the displacement. The 43 in 434A meant the engine was a 4.3L. The third digit was used for version control. A 430 and a 431 are both 4.3L's, however the last digit indicates there is difference between the engines. The numbers at the third digit were not always sequential. 430's were built before 431's, however 432's and 434's were built at the same time.

The letter at the end was also used for version control and was sequential. A 500A was built before a 500B.

These engines went out of production in 1993.

EXAMPLES: 432A, 500B, 251A, 740B

Nothing in the names in either of these sytems relates in any way to years of production. Some of these engines were in production for less than a year, others for many years.

Charcoal Engines

These engines were built during the joint venture with OMC and were painted a dark charcoal color. They were usually named by long character strings that contain two numbers followed by a series of letters.

· The character string starts with two numbers, which are the displacement in liters.

· Next is a letter that indicates who made the base engine.

G=GM, F=Ford

· After that, one or two letters that note the fuel system and/or output.

L=limited, S=superior,
X=exceptional, i or I=fuel injected
(no I means carburetted)

· Then one letter for the steering system.
P=power steering, M=manual,
X=Exact steering, I=inboard

· The next two letters are the most important for finding parts. These are random letter pairs called model designators that indicate the years of production for the engine. All parts information for these engines is based on these letter codes.

Model Designators

letter code	years of production
MD	1993-1994
HU	1994-1995
NC	1995-1996
LK	1996-1997
BY	1997-1998
WT	1998-1999
EF	1999-2000

· The next letter is also random and is used for version control. An “A” may not be the first version. A “C” may not have been built before an “S”. An “S” in one engine’s name may not mean the same thing as an “S” in another engine’s name, especially if the engines have different displacements or production years. When needed this code is noted in the parts publications.

· Some names have the letters “CE” at the end. This indicates the engine meets certain emmission requirements. The only service part affected is the ECU. These part numbers are noted when needed in the catalogs.

These engines went out of production in 2000.

EXAMPLES:

4.3GLPBYC = 4.3L, G=GM, L=limited output, carburetted (no i), P=power steering, BY=model designator, C=service code for version control

5.8FSiPNCACE = 5.8L, Ford, Superior output, injected, power steering, NC=model designator, A service code, CE=certified emmissions

7.4GLPHUS = 7.4L, GM,limited output, carburetted, power steering, HU=model designator, S service code

3.0GLMMDA = 3.0L, GM,limited output, carburetted, manual steering, MD=model designator, A service code

Red Engines, current

Beginning in 2000 the gas engines are painted red again. The naming system was also changed. The first part of the name is the same as the charcoal engines, up to the letters for the fuel system.

· The two numbers are the displacement.

· Next is a letter that indicates who made the base engine. New engines have been added that use Volvo Penta's new Ocean Series sterndrives, these engines have an OS for this letter.

· After that, one or two letters that note the fuel system and/or output.

· For 3.0L only, there is an M or P for the steering

· For Inboard engines only, there is an I after the lower case i.

· Then a dash (-) followed by a one or two letter suffix.This is the major change from the charcoal engines above.

The first letter is the version control, this is present on all models. –A is the first version, -B was the second version, etc... There is no link between the suffix and production years. All engines with –A were not built the same year. A 5.7GXi-B and a 5.0GXi-B are not similar. A 4.3GL-D is newer than and different from a 4.3GL-C.

The second letter, if present is always an F, it notes that the engine is freshwater cooled.

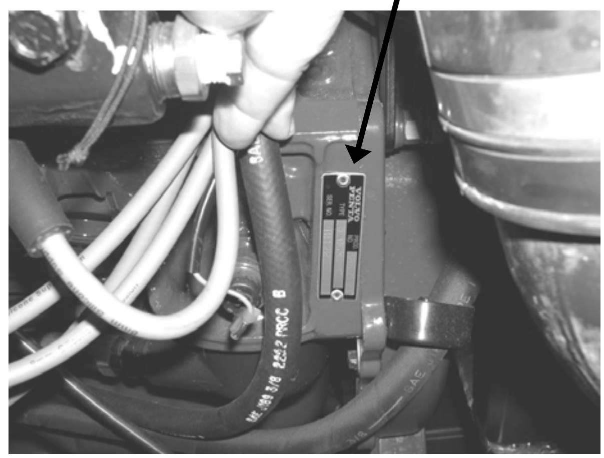
EXAMPLES:

3.0GLM-C
4.3GXi-DF
5.0OSi-E
8.1GXiI-B

ID Tags

ID Tag for Engine, drive and TSK

ID Tag for Engine



All engines have two engine ID tags, one is a sticker located somewhere near the front and top of the engine. In current production engines, the tag is located on the “rain hat” or plastic engine cover. The other tag is riveted to the engine block, left bank just forward of the flywheel housing. These tags contain the model number for the engine, the serial number of the engine and the specification number for the engine.

The tag on the rain hat should also have the stickers for the transom shield and the drive (if applicable) attached to it.

Service Bulletin

Group	Number	Version
26-6	**8**	**01**

VOLVO PENTA

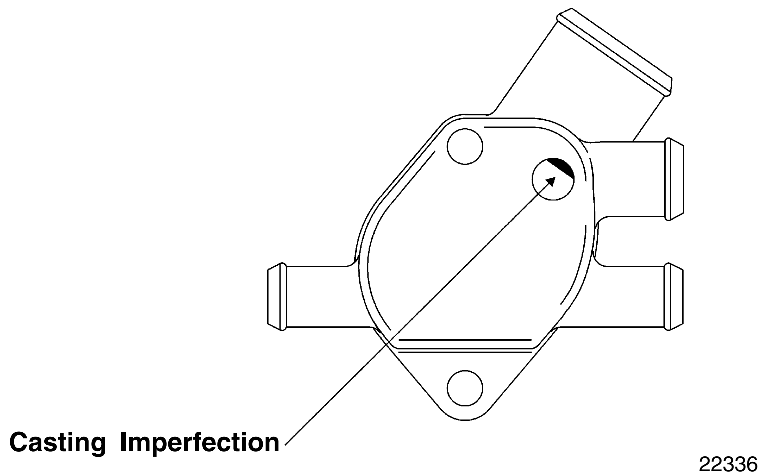
Volvo Penta of the Americas
1300 Volvo Penta Drive
Chesapeake, Virginia 23320-9810
USA

Component

Engine Models
8.1Gi, 8.1GSi, 375DPX and 420DPX

Distribution: M Date: 07-2002 Binder: C Page: 1(2)

During our routine auditing process of production, we have found certain inconsistencies within the thermostat housing of the 8.1 engines (P/N 3860872). Casting imperfections might be present that would prevent correct water flow through this housing. Certain intake water temperatures and ambient air temperatures could produce water temperatures within the engine that could activate the alarm, thus causing the engine to enter “Power Reduction Mode”.



If you are investigating a high speed overheat condition, you should check this housing for anything (debris, casting slag) that can restrict the water flow to the exhaust manifolds. Inspect all hoses for kinked or collapsed hoses. The engine cooler is the first place the water is routed after the seawater pump, this tube type cooler should be checked for blockage.

If all the above items have been checked and eliminated, the passage for incoming water through the hosing may be improperly sized. The following procedure explains how to be sure this possibility is eliminated.

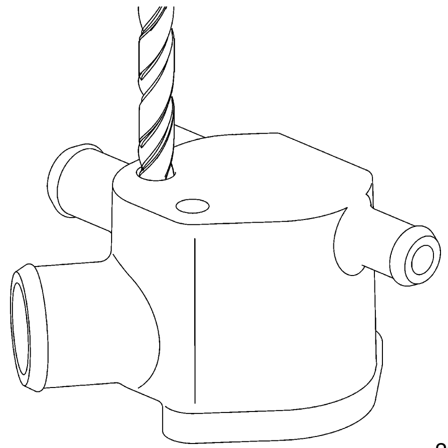
NOTE ! To ensure the best accuracy while drilling and tapping, this procedure should be done with the housing removed from the engine.

NOTE ! Drain and remove all hoses from the thermostat housing.

1. Remove the 90° pipe to hose fitting for the cooling hose to the fuel cell.

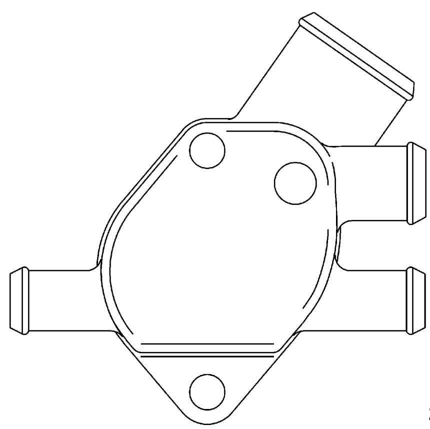
2. Clamp the housing securely.

3. Using a 9/16” drill bit, apply tape 2 1/8” from the bottom of the bit.
4. Drill straight down through the passage 2 1/8” from the top of the housing.



22337

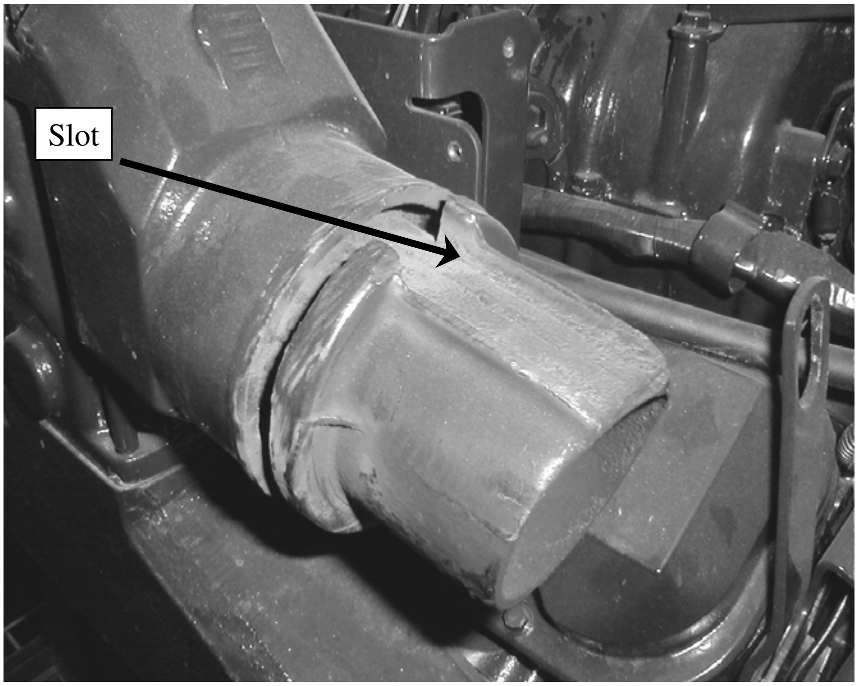
5. Using a die grinder or similar, remove any remaining raised portions or castings.



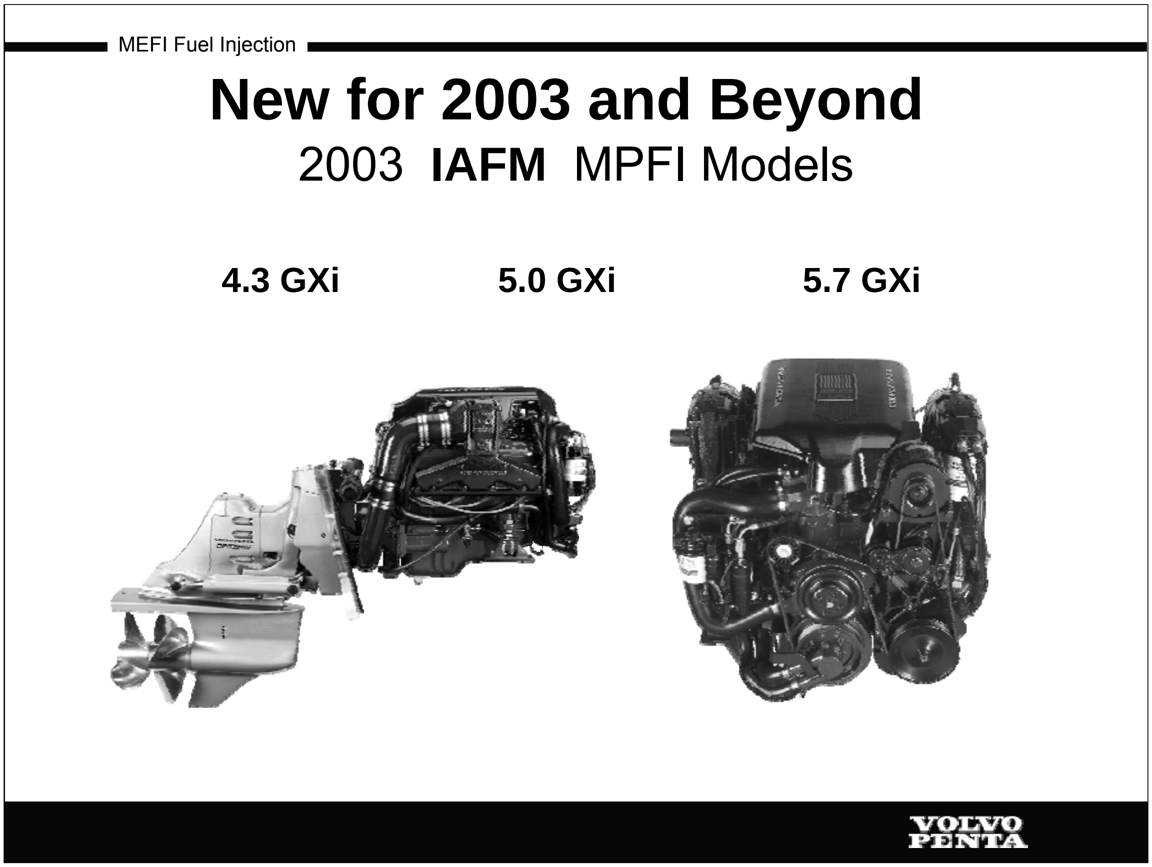
22338

6. Tap the hole with a 3/8” NPT tap.
7. Clean any excess shavings and
8. Apply Volvo Penta sealing compound P/N 1141571 to a 3/8” to 1/4” NPT reducing bushing and install.
9. Install the pipe to hose fitting for the fuel cell cooling hose.
10. Apply red spray paint (P/N 3810286) to the housing if necessary before reinstalling the housing.
11. Reinstall the housing using a new gasket.
12. Test run the engine and check for leaks.

Exhaust Rib



8.1L extra hose clamp: The extra hose clamp at the rib is to force the flow of exhaust cooling water to the top slot of the elbow. This directs water to the crossover tube between the elbows and prevents crossover tube heat damage. This extra hose clamp is a midyear addition and from the outside, doesn't appear to have any function. The new bellows have a molded indentation for all 5 hose clamps. All 8.1L engines with the crossover tube should have 5 hose clamps on each bellows to prevent hose overheating.



The acronym (first used in 2003) IAFM stands for a new multi port fuel injection system called **Integrated Air Fuel Module**. This is a combination of intake manifold, throttle body, and injectors. This setup changes these engines from TBI to MPI type engines.

With this new system, Volvo Penta has increased the power output of our marine gasoline engines up to 20 more HP. With power ratings of up to 320 HP, the upgraded engines become faster and more reliable.

In Fall of 2001 Volvo Penta stopped producing throttle body injected gasoline engines. For 2005 we offer carbureted and Multi-port Fuel Injected (MFI) engines.

In carbureted engines, Volvo Penta offers the 3.0GL, 4.3GL, 5.0GL and the 5.7GL

In the IAFM multi port configuration, Volvo Penta offers the six cylinder 4.3L, the V8 small block 5.0L, and the 5.7L.

The big block 8.1L is again offered as MPFI, although it is not of IAFM configuration. For 05, the 8.1L uses a returnless fuel system. There is only one fuel line to the fuel rail and the pressure regulator has been moved from the fuel rail to the fuel pump module.

Changes for 2004

EFI ENGINES

New exhaust bellows to reduce noise and vibration on the 5.0, 5.7 and 8.1L engines.

New 8.1L oil cooler

New emissions calibrations

A second knock sensor on the 4.3Gxi, 5.0Gxi, 5.7Gi and the 5.7Gxi

New ECM anti-knock strategy for all EFI engines

EVC (Electronic Vessel Control) compatible harnesses for all EFI engines

New ECM for all engines: MEFI 4b Same functionality, just new hardware

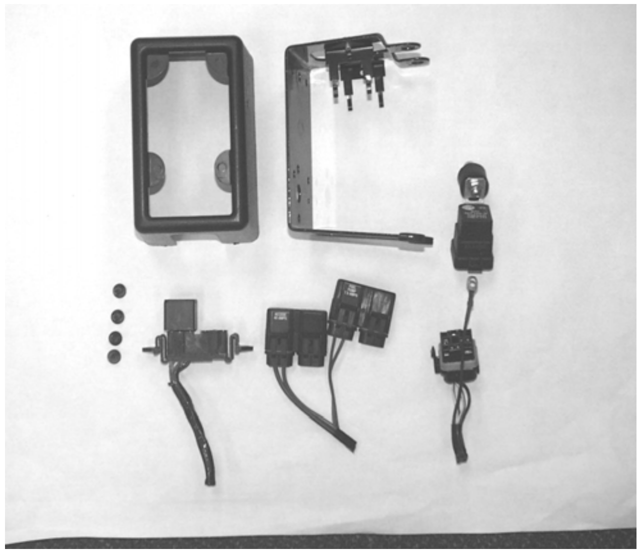
CARBURETED ENGINES

New Tyco electrical supply box with new engine harnesses

New emissions calibrations

There were very few changes for the 2005 model year. The changes are noted above.

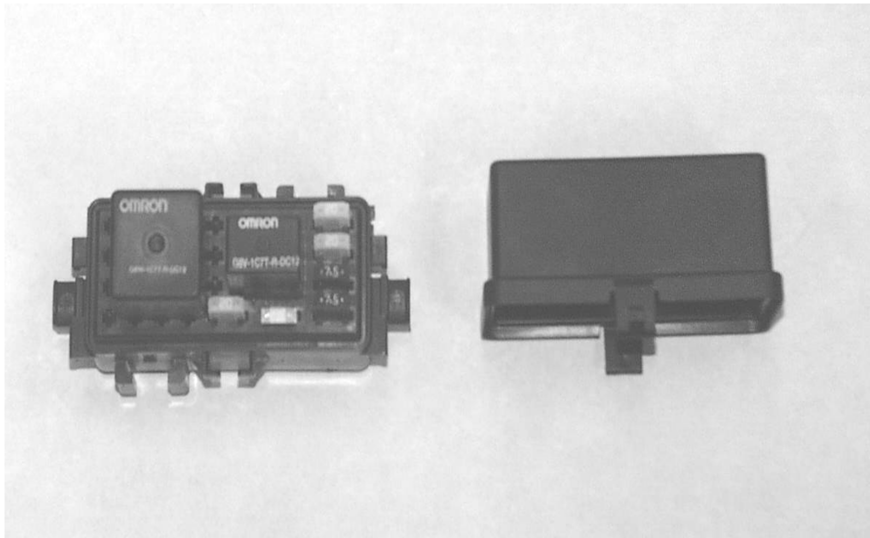
On Carbed Engines, THIS ….



Individual fuses and relays got integrated into one box.

MEFI Fuel Injection

Becomes, THIS !

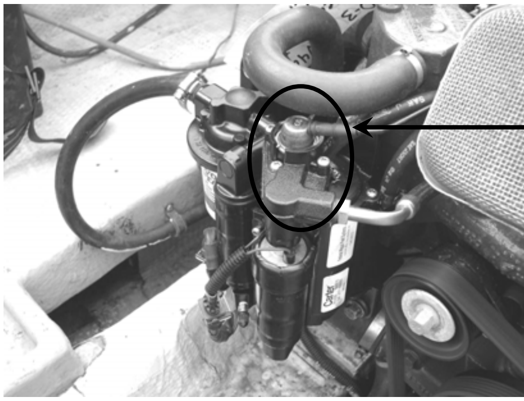


A single fuse box similar to the fuel injected engines.

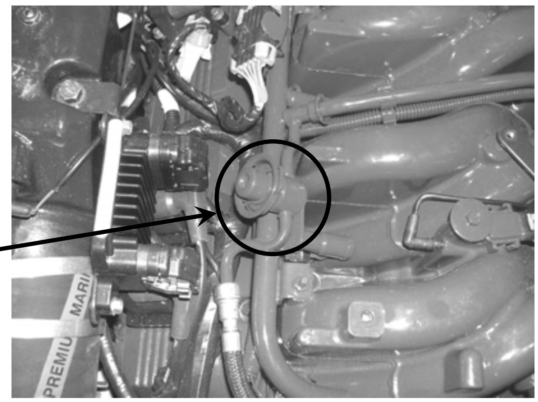
MEFI Fuel Injection

Changes for 2005

EFI ENGINES



New fuel pump module for 8.1L with fuel pressure regulator



Fuel rail now has a pulse damper and NO regulator

VOLVO PENTA

NEW FUEL SYSTEM FOR THE 8.1L ENGINES:

The new 8.1L fuel pump module has the pressure regulator mounted on the high pressure pump. This change requires a new vacuum hose to the regulator and new fuel lines. There is now only one fuel line to the fuel rail.

The pulse damper on the rail dampens fuel pump pulses in the rail providing a smooth flow of fuel to the injectors.

Other EFI changes include new ECM calibrations, a new flush fitting (shown on next page) and improved Bussman box isolation with rubber isolators.

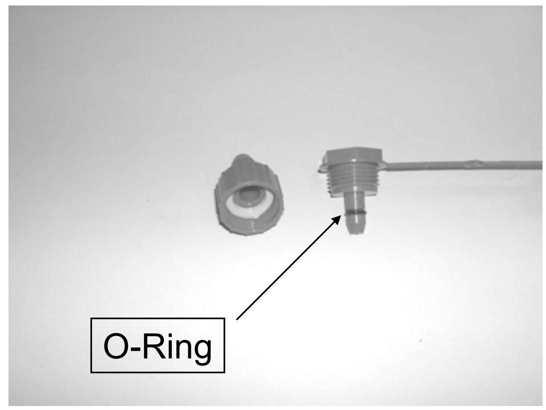
All V6's and small block V8's get a new thermostat housing for improved temperature regulation.

MEFI Fuel Injection

Changes for 2005

NEW FLUSH FITTING FOR ALL ENGINES

New antifreeze for 05



This is the new flush fitting. It has a positive O-ring seal in addition to the conventional hose seal. The O-ring should periodically be lubricated with a drop or two of engine oil.

The older blue flush fitting can be upfitted with this new style, o-ring sealed, flush fitting; however both halves of the new fitting have to be used together. The half that connects to the engine hose has a relief cut in it for the o-ring. If just the cap is changed, the o-ring will be cut by the old lower fitting.

CAUTION: Care should be used with the old blue fitting. If it isn't tight, it can cause an air leak to the inlet side of the raw water pump causing an overheat situation and damage to the pump impeller.

Starting with engine serial number 4012133180, all closed cooling system engines shipped from Lexington with have Ethylene Glycol antifreeze installed. This information is covered in Service Bulletin 26-1-10 dated 7/04

Service Bulletin

Group	Number	Version
26-1	10	01

Volvo Penta of the Americas
1300 Volvo Penta Drive
Chesapeake, Virginia 23320-9810
USA

Coolant Change

Models
3869253, 3869256, 3869259, 3869261, 3869269, 3869271, 3869273, 3869275, 3869284, 3869286, 3869288

Distribution: M   Date: 7-2004   Binder: C   Page: 1(1)

Coolant Change for Fresh Water Cooled Gasoline Engines

Volvo Penta Fresh Water Cooled engines built after July 12, 2004 and commencing with serial number 4012133180 will be shipped from the factory with Ethylene Glycol coolant. This is the same specification coolant that is recommended in the owner's manual and is offered for service through Volvo Parts. Volvo Penta coolant is available as listed below:

part no. 381081

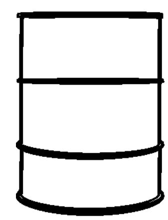
Six pack of one gallon containers

6 x 1 gallon

23425

part no. 3810287

Fifty five gallon metal drum



55 gallons

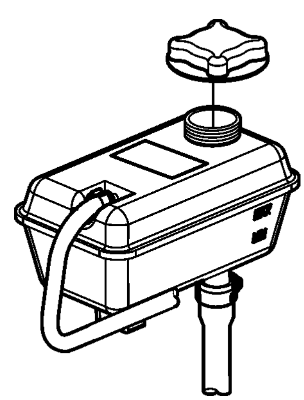
23426

Important Note:

·Ethylene Glycol must be used to "top-off" or refill engines shipped with Ethylene Glycol starting with the above serial number.

·Ethylene glycol can be used to "top-off" or refill engines shipped with Propylene Glycol with serial numbers lower than the above serial number.

·Propylene Glycol must never be used to "top-off" or refill engines that contain Ethylene Glycol.



23424

MEFI IV GM/Delphi Based Engine Models EFI Model Similarities (Big Block vs. Small Block)

- Crankshaft position sensor and reluctor ring (CKP)
- Camshaft position sensor (CMP)
- Multiport injection
- Single fuel pump assembly for all models (except 05 8.1L)
- No ignition timing adjustment
- Cylinder balance “drop test” capability with scan tool (capability is in MEFI 4 ECM)
- Temperature controlled rev limiter

All the MEFI IV controlled engines have these items in common. The cylinder drop test is available using the diagnostic tools.

MEFI Fuel Injection

8.1L MPFI

Differences from IAFM

- 40PSI (+/- 4 PSI) fuel rail pressure
  (note: error in ‘early’ manuals)
- 8 individual ignition coils and leads
- No distributor to set
- Different component locations

VOLVO PENTA

There are important differences between the engines that still must be noted other than those shown in the picture above.

The early 8.1L Workshop manual (7797351) incorrectly stated that fuel pressure should be 50-62 PSI.

IAFM stands for Integrated Air Fuel Module. IAFM is a special package consisting of an intake manifold, throttle body and injectors that is installed on Volvo Penta’s MPI V6 and small block V8 engines.

I A F M

Model Differences

4.3, 5.0 and 5.7 GM Based IAFM Multi Port Engines

- 50-60 PSI fuel rail pressure
- TBI fuel pump module not compatible
- Single ignition coil
- Spark distributed through a distributor housing
- Critical distributor housing positioning, but no timing specification
- Different component locations

VOLVO PENTA

Do not move the distributor housing on the V6 and small block V8 engines unless the service manual states to do so. There is no timing adjustment for these engines. All timing advance is controlled by the ECM. Turning the distributor in the block only changes the air gap between the rotor and the distributor cap.

The higher fuel pressure rating for the multiport V6, 5 liter and 5.7 liter engines requires a new fuel cell (MOAS) compared to earlier throttle body models.

MEFI Fuel Injection

MEFI Systems

Marine

Electronic

Fuel

Injection

Volvo Penta has used 5 Electronic Control Modules (ECM's). MEFI 1, MEFI 3, MEFI 4, MEFI 4b and for 1 ½ years, a Ford engine with Ford controls. MEFI 4b is the production module for all 2004's and 2005's. MEFI 2 was not used by Volvo Penta. The ECM is the control center of the electronic fuel injected engine.

The ECM is nothing more than a computer. A computer consists of a Central Processing Unit (CPU), known as a micro-processor, memory and storage. The micro-processor is the thinking part of the ECM. It is capable of following a predetermined set of commands (programs) and can manipulate data.

There are 3 types of memory, Random Access Memory (RAM), Read Only Memory (ROM) and Electronic Erasable Programmable Read Only Memory (EEPROM).

RAM is the micro-processors "scratch pad". The processor uses this to store ever changing sensor values as it makes calculations. Diagnostic Trouble Codes (DTC) are stored here until power is removed (battery disconnected or ECM unplugged). All data is erased from RAM whenever power is removed.

ROM is permanent memory, it cannot be erased, this is where the main operating program is stored. ROM does not need power to retain its memory.

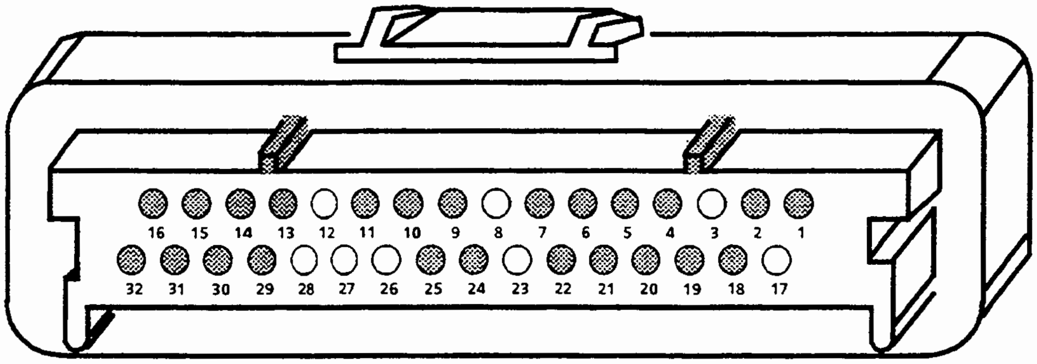
EEPROM is where the engine calibration is stored, DTCs are stored here from RAM when the power is removed. EEPROM does not need power to retain its memory.

MEFI 1

- Used on GM engines from 1994 to 1998
- “MD” thru “BY” models
- “J-1” and “J-2” connectors at either end
- Earliest versions were slightly longer but identical internally

All MEFI J-1 and J-2 connectors are not inter-changeable and are indexed differently so they can not readily be plugged in backwards.

All MEFI 1,3,4 and 4b J1 connectors are indexed the same. All MEFI 1,3,4 and 4b J2 connectors are indexed the same. This makes it possible to plug in the wrong ECM on an engine.

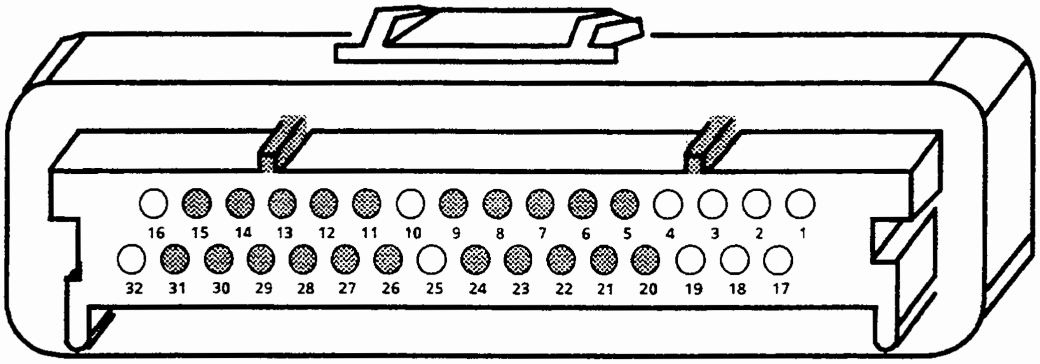


J - 1

ECM 32 WAY OUTPUT CONNECTOR

ECM PIN NUMBER	CKT (WIRE) NUMBER	CKT (WIRE) COLOR	CIRCUIT DESCRIPTION
J1 - 1	485	BLK	KNOCK SENSOR (KS) SYSTEM
J1 - 2	410	YEL	ENGINE COOLANT TEMPERATURE (ECT) SENSOR SIGNAL
J1 - 3			
J1 - 4	911	DK GRN	I/O FLUID LEVEL SWITCH (OPTIONAL)
J1 - 5	916	YEL	MASTER/SLAVE ECM (TWIN ENG. ONLY)
J1 - 6	931	BRN	OIL PRESSURE SWITCH (OPTIONAL)
J1 - 7	451	WHT/BLK	DIAGNOSTIC "TEST" (SERVICE MODE)
J1 - 8			
J1 - 9	432	LT GRN	MAP SENSOR SIGNAL
J1 - 10	417	DK BLU	TP SENSOR SIGNAL
J1 - 11	439	PNK/BLK	IGNITION 12V
J1 - 12			
J1 - 13	813	BLK	SENSOR GROUND (IAT, TP, TRIM)
J1 - 14	450	BLK/WHT	ECM GROUND
J1 - 15	416	GRY	5 VOLT REF (TP, TRIM, SENSORS)
J1 - 16	440	ORN	BATTERY 12V
J1 - 17			
J1 - 18	461	ORN/BLK	SERIAL DATA (SCAN TOOL COMMUNICATION)
J1 - 19	940	LT GRN	WATER FLOW SWITCH (OPTIONAL)
J1 - 20	1174	BRN	OIL LEVEL SWITCH (OPTIONAL)
J1 - 21	942	PNK	EMERGENCY STOP SWITCH (OPTIONAL)
J1 - 22	920	LT BLU	TRANS TEMP/TRIM SET (OPTIONAL)
J1 - 23			
J1 - 24	472	TAN	IAT SENSOR SIGNAL
J1 - 25	910	WHT	TRIM SENSOR SIGNAL
J1 - 26			
J1 - 27			
J1 - 28			
J1 - 29	814	BLK	SENSOR GROUND (MAP, ECT)
J1 - 30	450	BLK/WHT	ECM GROUND
J1 - 31	416	GRY	5 VOLT REF (MAP SENSOR)
J1 - 32	440	ORN	BATTERY 12V

6-22-93
MS 11767



J - 2

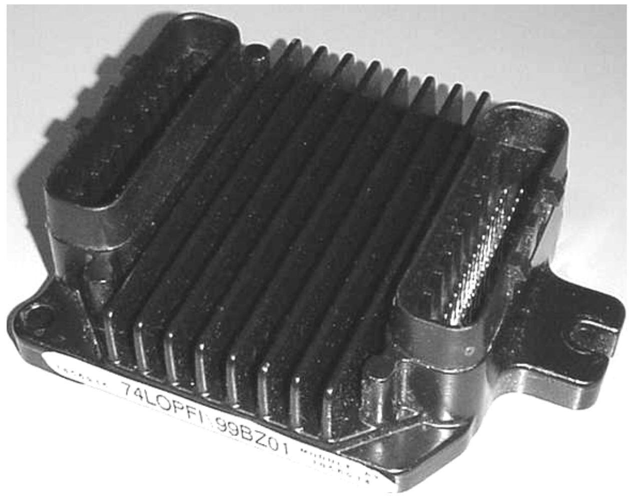
ECM 32 WAY OUTPUT CONNECTOR

ECM PIN NUMBER	CKT (WIRE) NUMBER	CKT (WIRE) COLOR	CIRCUIT DESCRIPTION
J2 - 1			
J2 - 2			
J2 - 3			
J2 - 4			
J2 - 5	468	LT GRN	INJECTOR DRIVER (CYL'S 1,4,6,7)
J2 - 6	453	BLK/RED	DISTRIBUTOR REF LOW
J2 - 7	901	WHT	PORT FUEL JUMPER
J2 - 8	430	PPL/WHT	DISTRIBUTOR REF HIGH
J2 - 9	465	DK GRN/WHT	FUEL PUMP RELAY DRIVE
J2 - 10			
J2 - 11	112	DR GRN	COOLANT LAMP OUTPUT (OPTIONAL)
J2 - 12	914	PPL	RPM REDUCTION WARNING BUZZER (OPTIONAL)
J2 - 13	442	BLU/BLK	IDLE AIR CONTROL (IAC) COIL "A" LOW
J2 - 14	443	GRN/WHT	IDLE AIR CONTROL (IAC) COIL "B" HIGH
J2 - 15	450	BLK/WHT	FUEL INJECTOR GROUND
J2 - 16			
J2 - 17			
J2 - 18			
J2 - 19			
J2 - 20	450	BLK/WHT	FUEL INJECTOR GROUND
J2 - 21	467	DK BLU	INJECTOR DRIVER (CYL'S 2,3,5,8)
J2 - 22	901	WHT	PORT FUEL JUMPER
J2 - 23	423	WHT	IGNITION CONTROL (IC)
J2 - 24	424	TAN/BLK	IC BYPASS
J2 - 25			
J2 - 26	912	DK BLU	I/O FLUID/WATER FLOW LAMP - OUTPUT (OPTIONAL)
J2 - 27	31	TAN	OIL PRESSURE LAMP OUTPUT (OPTIONAL)
J2 - 28	441	BLU/WHT	IDLE AIR CONTROL (IAC) COIL "A" HIGH
J2 - 29	444	GRN/BLK	IDLE AIR CONTROL (IAC) COIL "B" LOW
J2 - 30	930	GRY	OIL LEVEL LAMP OUTPUT (OPTIONAL)
J2 - 31	419	BRN/WHT	MALFUNCTION INDICATOR LAMP OUTPUT (OPTIONAL)
J2 - 32			

6-22-93
MS 11766

MEFI 3

- Used on GM engines from 1999 to 2001
- “WT” and “EF” models
- “J-1” and “J-2” connectors at right angles
- Integrated Knock Module
- Not inter - changeable with MEFI 1 module



Faster micro-processor.

Additional memory.

Additional inputs and outputs.

Smaller and lighter.

Functions with the Delco High Energy Ignition (HEI) system.

Uses inputs from a distributor mounted ignition module for RPM and cylinder position. The “Ref High” wire from the distributor module to the ECM is the ECM’s RPM input. All Speed Density Fuel Injection systems have to have an RPM input in order for the engine to run.

Previous external knock module is now incorporated inside the MEFI 3 controller.

MEFI Fuel Injection

MEFI 4 and 4b

- **First used on the 2001 8.1Gi-A, GSi-A (MEFI 4)**
- **Drives 8 coils, controlling spark advance at each individual cylinder**
- **Uses input from individual Crank and Cam position sensors for RPM & cylinder position**

VOLVO PENTA

MEFI is more than just a fuel delivery system, it is an engine control system, it monitors:

Inputs:

Crankshaft rotational position. **(CKP)** This sensor tells the ECM that a piston is coming to TDC and how fast it is coming

Camshaft position. **(CMP)** This sensor tells the ECM which piston is coming to TDC.

Manifold absolute pressure. **(MAP)** This sensor relays intake manifold pressure to the ECM. The ECM uses MAP and CKP together to determine airflow through the engine.

Throttle position. **(TPS)** This sensor is used as an electronic replacement for a carburetor's accelerator pump. It is also used to determine closed throttle for idle mode of operation.

Engine coolant temperature. **(ECT)** This sensor is used as an electronic replacement for a carburetor’s choke and fast idle cam. Cold engines need more fuel to run and a faster idle to keep them running.

Intake air temperature. **(MAT** or **IAT)** This sensor provides air temperature information so that the ECM can advance timing for cooler air temperatures or retard timing for high intake air temperatures

Presence of engine knock. **(KS)** This input provides engine knock information so that the ECM can retard timing in case of spark knock or advance the timing when spark knock goes away.

Battery voltage **(B+)** This input is used to help control injector pulsewidth. High voltage shortens pulsewidth and low voltage lengthens pulsewidth.

MEFI Fuel Injection

MEFI 4 and 4b

- **Externally the unit can only be distinguished from the MEFI 3 module by the “Delphi” sticker and the Volvo Penta calibration sticker**
- **Calibrations, recalibration software, and scantool software for MEFI 3 systems are *__not__* compatible with MEFI 4 systems**

VOLVO PENTA

It then applies this incoming information to calibration tables, and controls:

__Outputs__:

Injection pulse width. (Injectors)

Engine idle speed. (Idle Air Control motor or IAC)

Spark advance. (By triggering the firing of the ignition coil)

Fuel pumps. (By turning on the fuel pump relay)

The ECM program is very specific to a particular engine’s configuration of camshaft, intake manifold, valve and injector size. Interchanging an ECM from another engine may cause performance problems. Always use the ECM as specified by the Volvo Penta part number in the applicable parts catalog.

2000 (EF) and newer: all 2000 and newer TBI’s are MEFI 3 and all 2000 and newer MPI’s are MEFI 4 or 4b except the 7.4L and 8.2L which are MPI and MEFI 3 (EF was last of these engines).

All 2004 and 2005 EFI engines use the MEFI 4b controller.

1994 – 1998 EFI engines were MEFI 1.

MEFI 3 started in 99 and the last ones were built in 2001.

All scan tools identify the MEFI module as to which version it is.

MEFI 4 and 4b Cold Engine Rev Limiter

We use a cold engine rev limit feature based on ECT, to prevent high RPMs on a cold engine. Limit will come into play as follows:

	Gi	GXi
68 deg F (20C)	4000rpm	4000rpm
104 deg F (40C)	4600rpm	4600rpm
140 deg F (60C)	4800rpm	5200rpm

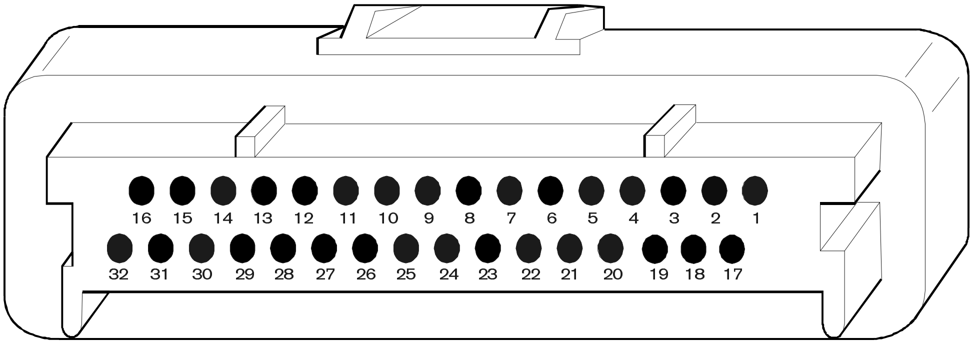
The cold engine rev limiter limits listed above are approximate and can change.

The purpose of this feature is to reduce the chance of engine damage due to an engine being run at high rpm’s while still cold.

When the rev limiter is engaged, the ECM kills ½ of the injectors until the rpm comes down below the rev limit. Then the ECM re-engages the disabled injectors until the rpm limit is reached again. This can be viewed using the scan tool as “RPM Reduction --- ON or OFF”.

With this system, full rated rpm of the engine can NOT be reached until ECT climbs above 140-145 degrees (F). (60-63 degrees C)

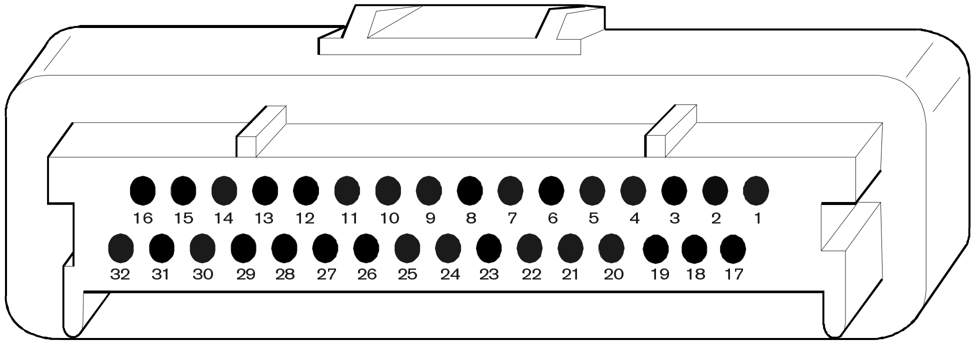
J-1 ECM 32 Pin Connector



J1-1	SB/GN	Knock sensor number 2 signal AC voltage input from Port or left bank knock sensor
J1-2	W/SB	Diagnostic test terminal 2.5V from ECM on this circuit, when grounded with engine running = service mode
J1-3	Y/GR	Master/Slave 11.5V from ECM. Ungrounded indicates Master status, grounded indicates slave status
J1-4		
J1-5		
J1-6	SB/Y	Fuel pump relay control When grounded by ECM, the fuel pump relay is energized
J1-7		RPM Change state
J1-8	T/SB	Alarm When grounded by ECM the warning horn sounds
J1-9		
J1-10		
J1-11	T/OR	Fuel injector B driver Low side driver for cylinders 1,4,6 and 7's fuel injectors
J1-12		
J1-13	SB	ECM ground This circuit combined with J1-28 and J1-29 are the ECM's return path to the battery
J1-14	GR	Tachometer output 12V square wave output from ECM for 8.1L RPM 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 number 1 signal AC voltage input from Port or left bank knock sensor
J1-18		
J1-19		Exhaust temperature sensor This is the "General Warning # 1 input" circuit. 11.5V from ECM looking for a ground. Grounded when riser switch is closed (hot)
J1-20		Shift interrupt 11.5V from ECM grounded during DPX shift, to reduce engine torque output at closed throttle
J1-21		
J1-22		
J1-23		
J1-24		
J1-25		
J1-26	T/BL	Fuel injector A driver Low side driver for cylinders 2,3,5 and 8's fuel injectors
J1-27	GN/Y	Check engine light Low side driver, ECM grounds this circuit to illuminate the MIL
J1-28	SB	ECM ground See J1-13
J1-29	SB	ECM ground See J1-13
J1-30	P/BL	Idle air control (IAC) coil B high
J1-31	BN/Y	Idle air control (IAC) coil A low
J1-32		

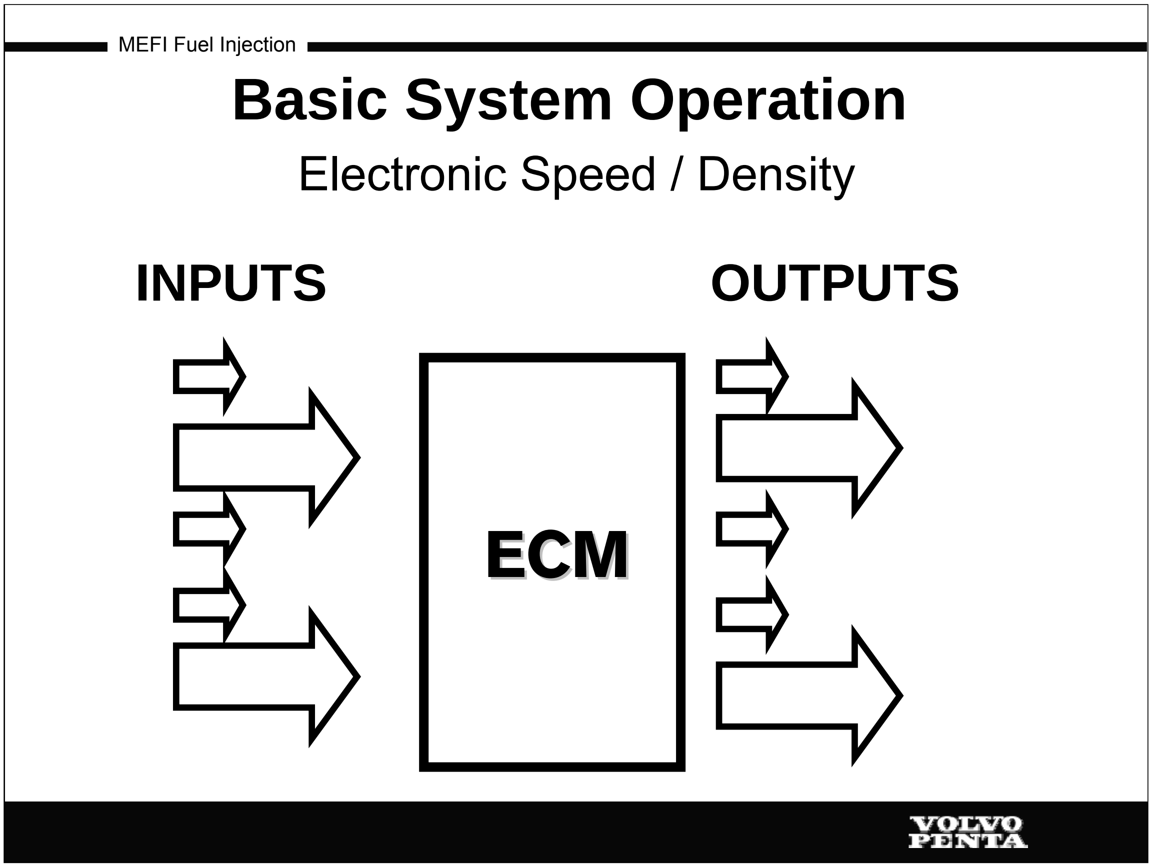
22657

J-2 ECM 32 Pin Connector



J2-1	R/PU	Battery Feed	
J2-2	GR/O	5 Volt reference	Voltage feed to MAP and TPS
J2-3	SB/O	Sensor ground	Isolated sensor return circuit to ECM from most sensors to eliminate electrical noise
J2-4			
J2-5			
J2-6			
J2-7	Y/BL	ECT sensor signal	Analog signal from sensor back to ECM
J2-8	Lt GN	MAP sensor signal	Analog signal from sensor back to ECM
J2-9		CAN Bus High	Data bus used with EVC-mc only
J2-10	O/SB	Serial data	Communications from ECM to scan tool
J2-11			
J2-12	BL/W	Ignition control H	Trigger signal from ECM to cylinder # 3 ignition coil (8.1L only)
J2-13	GN/W	Ignition control F	Trigger signal from ECM to cylinder # 5 ignition coil (8.1L only)
J2-14	R	Ignition control D	Trigger signal from ECM to cylinder # 2 ignition coil (8.1L only)
J2-15	PU	Ignition control B	Trigger signal from ECM to cylinder # 8 ignition coil (8.1L only)
J2-16	GR/BL	Crank sensor	Analog signal from sensor back to ECM
J2-17	SB/W	DESPOWER	Dedicated 11.2-11.5V power feed for CKP and CMP sensors
J2-18	GR/SB	DEPSLO	Dedicated sensor return for CKP and CMP sensors
J2-19	P/W	Ignition feed	B+ from ignition relay to ECM. Used by ECM as it's wakeup signal
J2-20	T/SB	Oil pressure input	5V from ECM to oil pressure switch, with no oil pressure the switch is closed and circuit grounded
J2-21	T/Y	IAT sensor signal	Analog signal from sensor back to ECM
J2-22			
J2-23	O/BL	TP sensor signal	Analog signal from sensor back to ECM
J2-24		CAN Bus Low	Data bus used with EVC-mc only
J2-25			
J2-26			
J2-27			
J2-28	GN	Ignition control G	Trigger signal from ECM to cylinder # 4 ignition coil (8.1L only)
J2-29	Lt BL	Ignition control E	Trigger signal from ECM to cylinder # 6 ignition coil (8.1L only)
J2-30	R/W	Ignition control C	Trigger signal from ECM to cylinder # 7 ignition coil (8.1L only)
J2-31	PU/W	Ignition control A	Trigger signal from ECM to cylinder # 1 ignition coil (8.1L only) , trigger signal to single ignition coil for all other engines
J2-32	SB/T	Cam sensor signal	Analog signal from sensor back to ECM

22658



For diagnostic purposes there are only 5 parts to the entire system:

1: The necessary INPUTS

2: The wiring for those inputs (from the input to the ECM)

3: The ECM (the control device or decision maker)

4: The necessary outputs

5: The wiring for those outputs (from the ECM to the output)

<u>Any electrical problem has to occur in one of those five areas !</u>

<u>Types of Inputs and Outputs:</u>

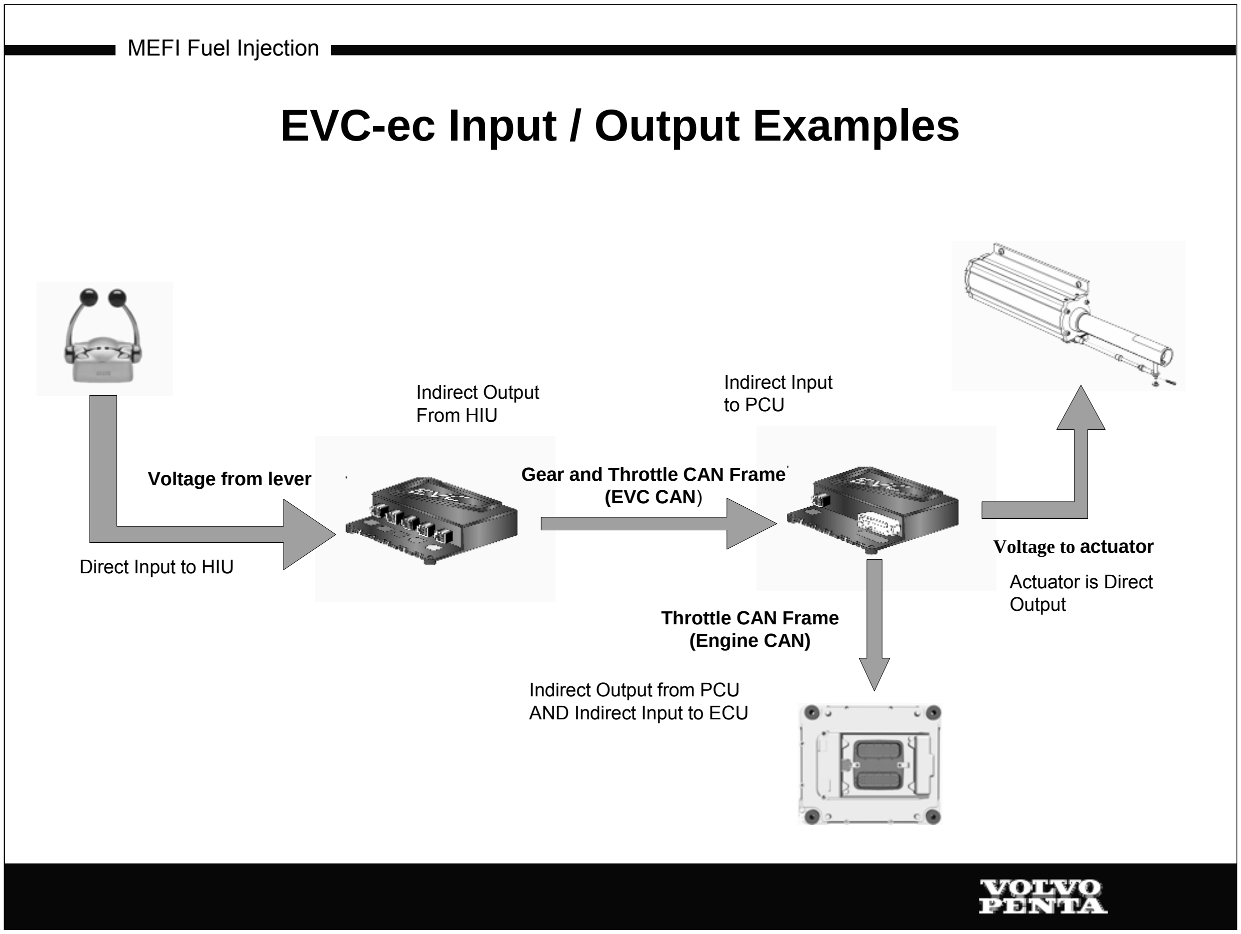
<u>Direct Inputs</u>: Direct inputs are inputs hardwired to the module.

<u>Direct Outputs</u>: Direct outputs are outputs hardwired to the module.

<u>Indirect Inputs</u>: These are inputs hardwired to some other module but used as an input to this module. They are received over a bus communication system.

<u>Indirect Outputs</u>: These are output messages or requests over a bus system to another controller

Examples of these are shown on the next page using and EVC-ec system.



Throttle lever voltage from the potentiometer is a **direct input** (hard wired) to the HIU. The HIU sends throttle lever voltage input over the CAN bus as an **indirect output** to the ECU.

The ECU receives throttle lever voltage as an **indirect input** over the CAN BUS. The ECU translates the throttle lever voltage input into shift lever position and gear request and sends the shift request back to the PCU as an **indirect output**. The shift actuator is hardwired to the PCU, so it is a **direct output** of the PCU. The ECU uses the throttle status **indirect input** to anticipate load and increase/decrease fuel to the engine as requested.

SPEED DENSITY SYSTEM

$$\frac{RPM}{MAX\ RPM} \times \frac{MAP}{BARO} \quad (X)\ \underline{ECT}\ (X)\ \underline{IAT}\ (X)\ \underline{TPS}\ (X)\ \underline{B+} \quad = \text{Pulse Width}$$

Load + Modifiers = Pulse Width

Speed Density fuel injection is a term used to describe the calculated process by which the ECM determines the correct amount of fuel to inject for the operating conditions. The most important input is engine speed and the second most important is density of the air in the intake, thus Speed Density.

"**MAX RPM**" and "**BARO**" in the equation above are for reference points. Without these reference points, "**MAP**" and "**RPM**" would be meaningless.

"**MAX RPM**" is where the rpm limiter is set and "**BARO**" is the barometric pressure for that "key on" weather and altitude and sets the starting point for fuel delivery.

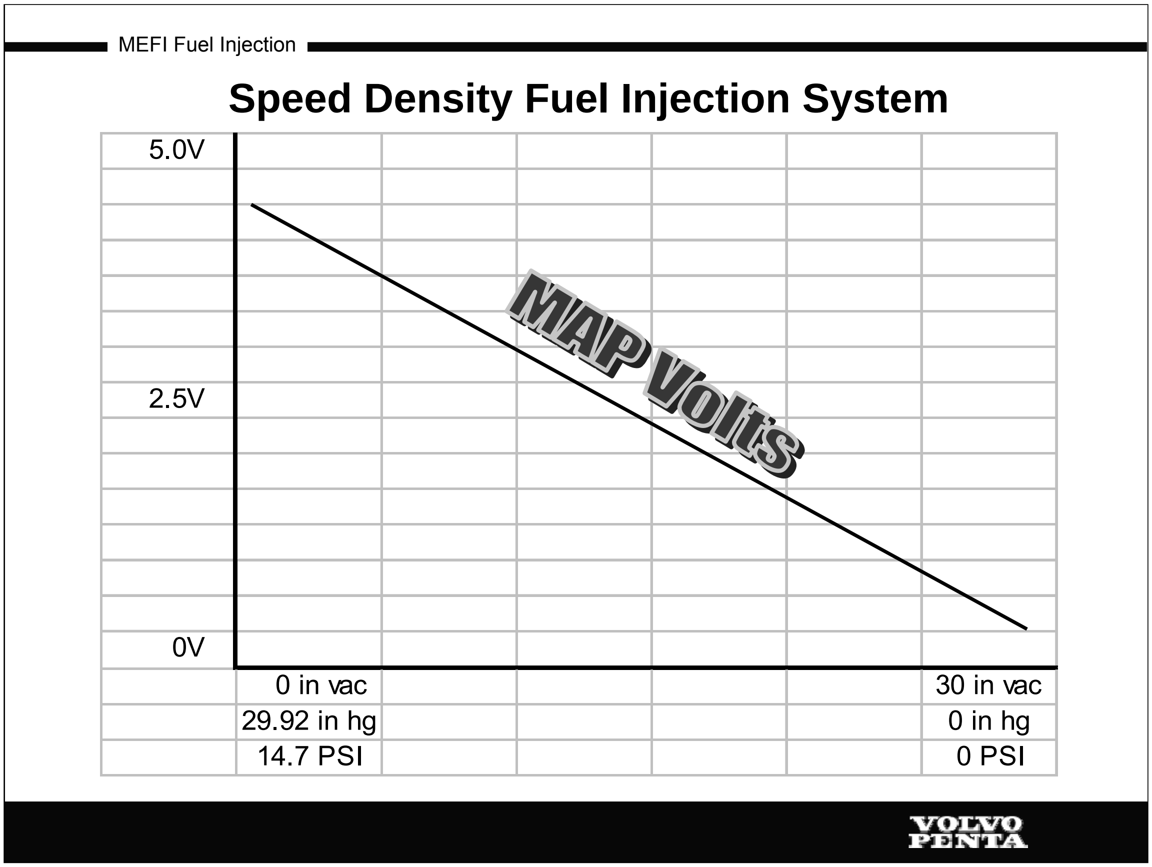
ECT: Cold engine gets more fuel and more timing; hot engine gets less fuel and less timing.

IAT: Cold air gets more fuel and timing; hot air gets less fuel and less timing

TPS: TPS only has an effect on fuel when it is moving. Rapid opening: add more fuel, rapid closing: subtract fuel. When TPS is constant it has no effect on fuel delivery. This is the EFI replacement for the carbureted accelerator pump.

B+: Fuel injectors are rated to flow a given volume of fluid at a given **supply voltage** at a particular pulsewidth at a given pressure.

KS: When engine knock is present, the ECM can add fuel and or retard timing to eliminate knock.



Volvo Penta marine electronic fuel injection systems are "Speed Density" systems whether they are TBI or MPI systems.

The ECM uses the RPM signal (CKP from MEFI 4 engines and "Ref High" from MEFI 1 and 3 engines) to compute **speed** and the MAP signal to measure air **density** in the intake manifold.

The Manifold Absolute Pressure (MAP) sensor input determines how much fuel the running engine receives. MAP is the sensor that has the greatest authority in controlling pulsewidth (after the engine is running).

After the PCM determines the base pulsewidth based on the CKP and MAP inputs, it will be further modified based on throttle position, coolant temperature, and intake air temperature.

Volvo Penta scan tools read in inches of mercury (in hg) or PSI not inches of vacuum. To convert from "in hg" to "in vac", take the number 30 and subtract the number in "in hg" and the result is "in vac".

Example: 12 in hg in the chart above. 30 - 12 = 18 (in vac)

To convert inches of mercury to PSI, divide by 2.

Example: 14 in hg in the chart above. 14 divided by 2 = 7 (PSI).

MEFI Fuel Injection

Spark Table: MAP vs. RPM

RPM	Spark Advance (Degrees BTDC)				
3600	34.80	34.10	31.99	30.94	29.88
3200	34.10	33.05	31.99	29.88	28.12
2800	33.05	33.05	33.05	28.83	26.02
2400	29.88	29.88	29.88	26.02	23.91
2000	24.96	24.96	24.96	21.80	20.04
1600	20.04	20.04	20.04	17.93	16.88
1200	9.84	9.84	11.95	13.01	14.06
1000	7.03	7.03	8.09	9.84	11.95
800	4.92	4.92	7.03	8.44	9.84
600	4.92	4.92	7.03	8.44	9.84
	12 inHG	18 inHG	24 inHG	27 inHG	30 inHG

Intake Manifold Pressure

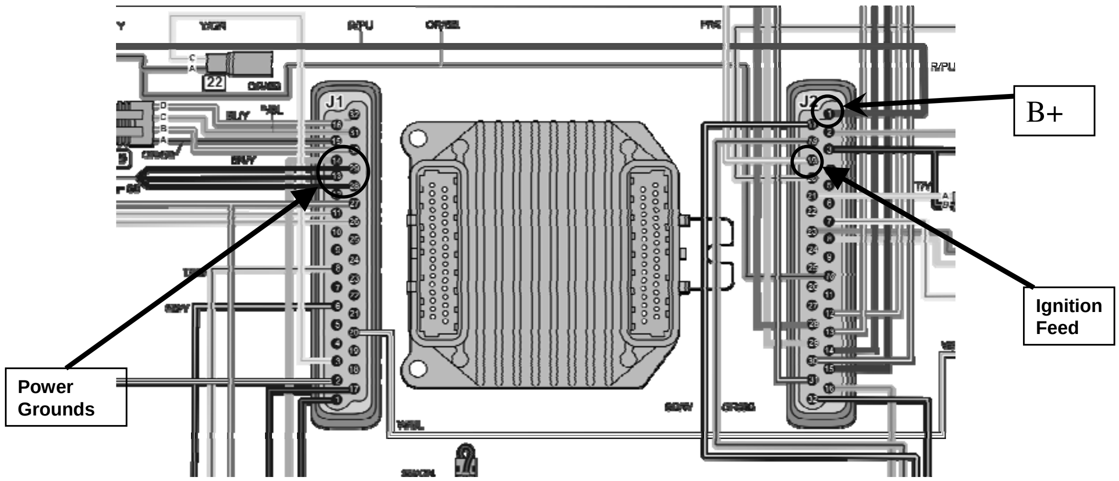
The ECM calculates total degrees of spark advance based upon the engine RPM and MAP sensor inputs. This combination of base timing and calculated advance forms the IC signal and controls spark timing.

Fuel injected engines need fuel and spark at the right times. Carbureted engines have the same fuel and spark requirements. The table above shows the electronic replacements for the old mechanical and vacuum advance systems used on older carbureted engines.

The table above is an actual spark table from one of Volvo Penta’s fuel injected engines. As RPM increases with no change in MAP, timing advances (**mechanical advance**). As pressure decreases (vacuum increases) with no change in RPM, timing increases (**Vacuum advance**).

MEFI Fuel Injection

ECM Power & Grounds



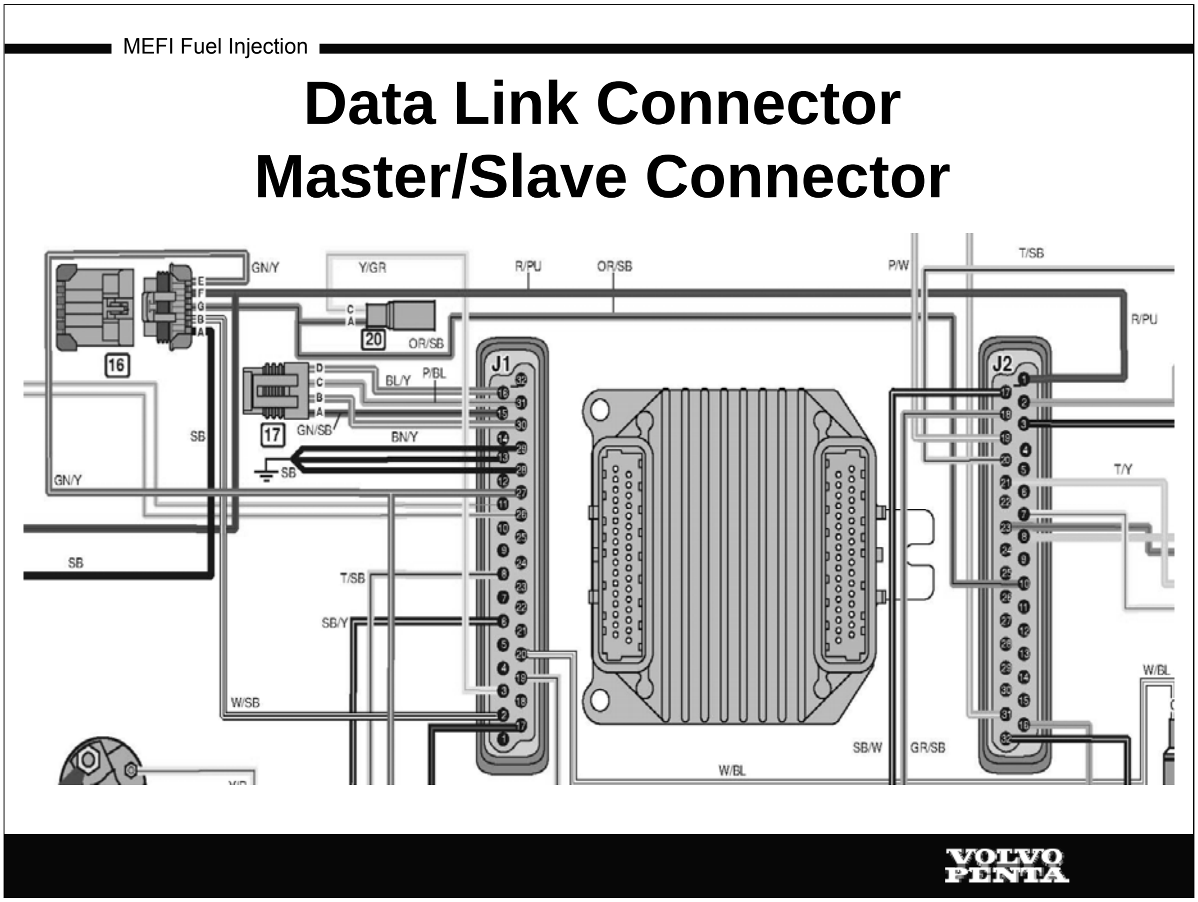
VOLVO PENTA

The MEFI 4 ECM has 3 power grounds. They are located in the J1 connector at pins 13, 28, and 29. Prior to the 2003 model year, all 3 ground back at the engine flywheel housing on the grounding studs. Starting with the 2003 model year the 3 grounds are isolated from the other grounds. That means that the eyelet (with 3 wires) is located remotely and away from the 2 ground studs on the back of the engine. If all 3 grounds are open the engine will not start or run and the scan tool will be unable to communicate with the ECM. A ground point that is loose or corroded can cause a poor running engine that is hard to diagnose.

The MEFI 4 ECM has 1 continuous battery feed circuit located in connector J2 at pin 1. This circuit is used by the ECM to internally provide all other circuits out of the ECM with power. The ECM also uses this as the B+ input for fuel injector pulsewidth. It can be seen on the scan tool as “Battery Voltage”.

The MEFI 4 ECM has 1 ignition feed circuit located in connector J2 at pin 19. This feed circuit comes from the ignition relay and should have B+ on it anytime the key is on. This circuit is the “wake up” signal to the ECM.

All of these circuits have to be functioning properly for the ECM to function properly. A loss of any of these circuits can cause anything from a poor running engine to a “will crank but not start” condition. Loss of either the B+ or the ignition feed will also cause a “no communication with the scan tool” condition in addition to the “no start” condition.



The data link connector (DLC) has 5 wires in a 10 cavity connector. **Cavity A** (black) is the ground for the scan tool (VP-2000, Techmate). If this ground is open, the scan tool will not communicate with the ECM. **Cavity B** (white with a black tracer, or black with a white tracer) contains the diagnostic test terminal circuit. The ECM puts 2.5V on this wire. When this wire is grounded with no CKP (crank sensor) input, the ECM flashes codes at **cavity E** (green with a yellow tracer) by toggling the wire to ground through J1-27. Some vessels will have a check engine light bulb connected to this wire. If the wire at **cavity B** is grounded with the engine running, then service mode is entered and the engine will idle at 1000 rpm and timing is locked down to base timing.

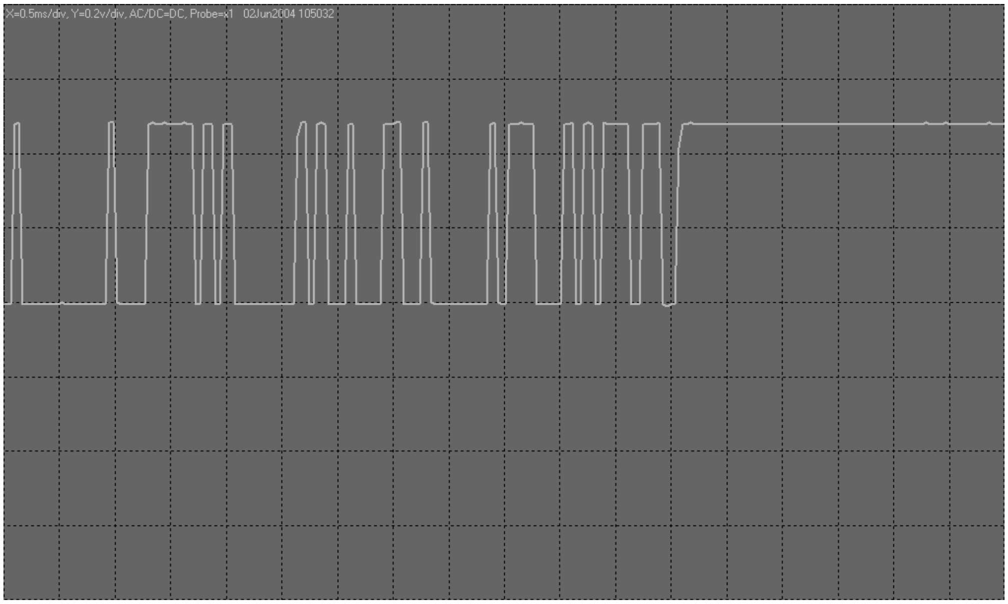
Cavity F (red with a purple tracer) is power for the scan tool (VP-2000, Techmate). This is the same circuit that powers up the ECM at connector J2 pin 1. Loss of this circuit to the DLC will cause loss of communication between the ECM and the scan tool due to no power at the scan tool.

Cavity G (orange with a black tracer) is the serial communication wire. All communication between the scan tool and the ECM occurs over this wire.

The Master/Slave connector has 2 wires, the orange with a black tracer and a yellow with a green tracer. The yellow with a green tracer wire is the master/slave wire. The ECM puts 11.5v on this wire. When this wire is grounded, it indicates to that ECM that it is the slave ECM in a twin engine setup. The orange with a black tracer is the communication wire. If the technician has a master/slave cable kit (3857221), the engines can be temporarily connected together so the scan tool (VP-2000 or Diacom) can gather information from both engines at the same time.

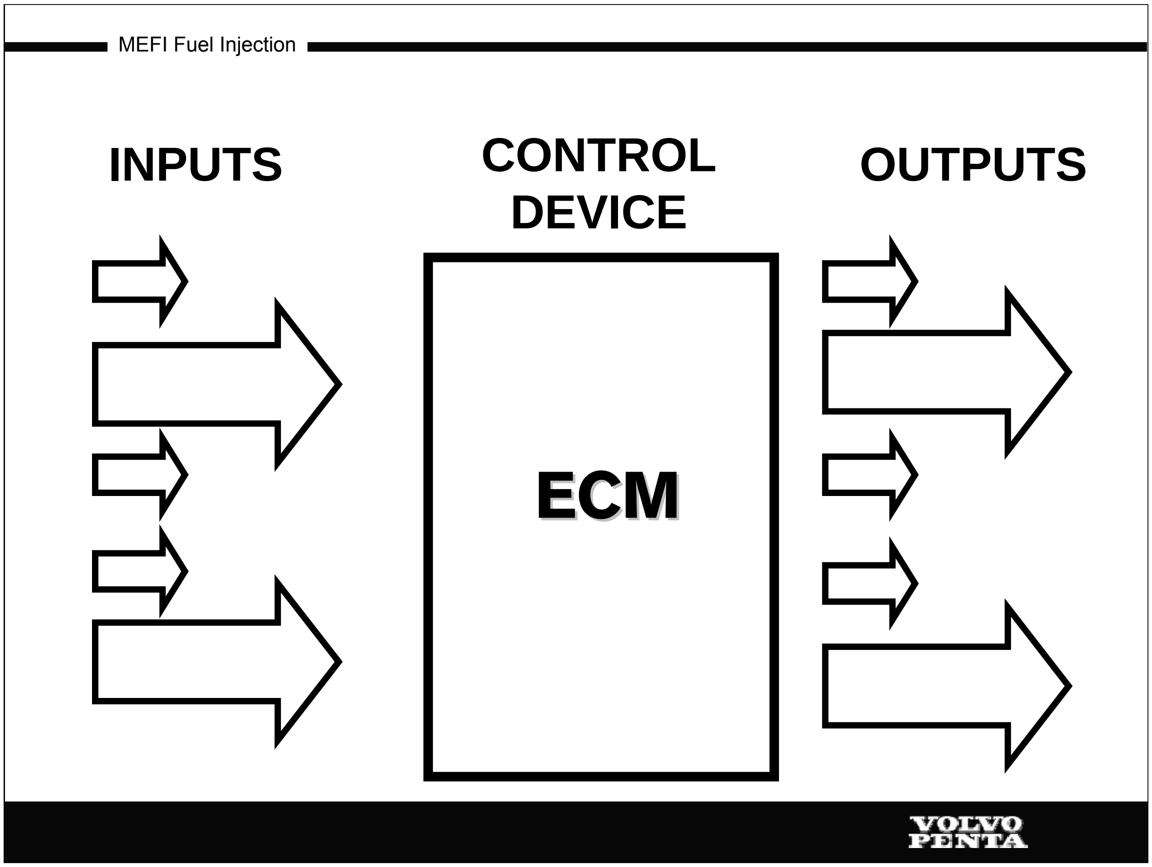
MEFI Fuel Injection

Serial Communications



This is serial communications as it occurs in the serial communication circuit (cavity G). This can be viewed with an oscilloscope. It can also be viewed as a fluctuating voltage with an AC voltmeter. The MEFI controllers (ECM's) broadcast engine operating parameters out on the serial communications wire continuously anytime the key is in the run or start positions. The scan tool translates the information back into a form that is usable by the technician.

This oscilloscope trace was taken right at the DLC cavity G. Seeing this at the DLC verifies that the ECM can send information, the serial communications wire is not shorted to ground or shorted to voltage and has continuity back up to the DLC (Data or Diagnostic Link Connector).



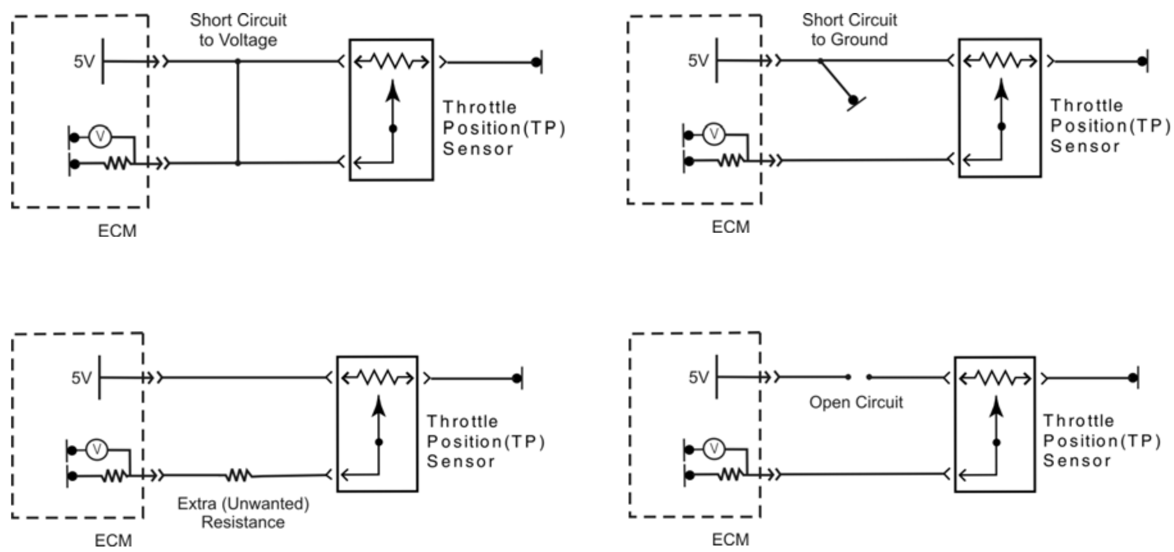
The ECM is a control device. It receives information from sensing devices as **inputs**, makes decisions and then controls load devices called **outputs**.

The available types of inputs to the ECM are sensors and switches.

The available types of outputs from the ECM are solenoids, relays, ignition coil(s) and a stepper motor.

Remember, the ECM's decisions are only as good as the input information. If bad information is input to the ECM, then the ECM will make bad decisions. Bad decisions cause running problems.

Possible Wiring Problems

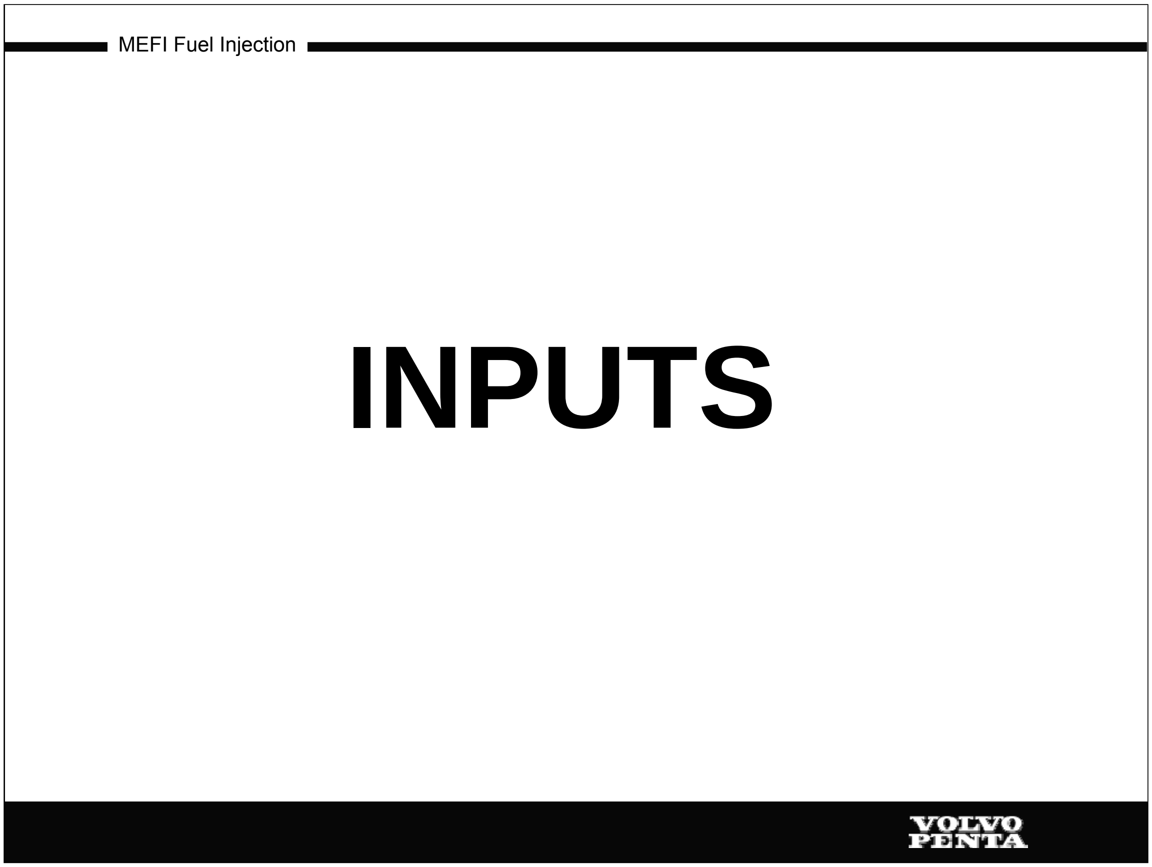


VOLVO PENTA

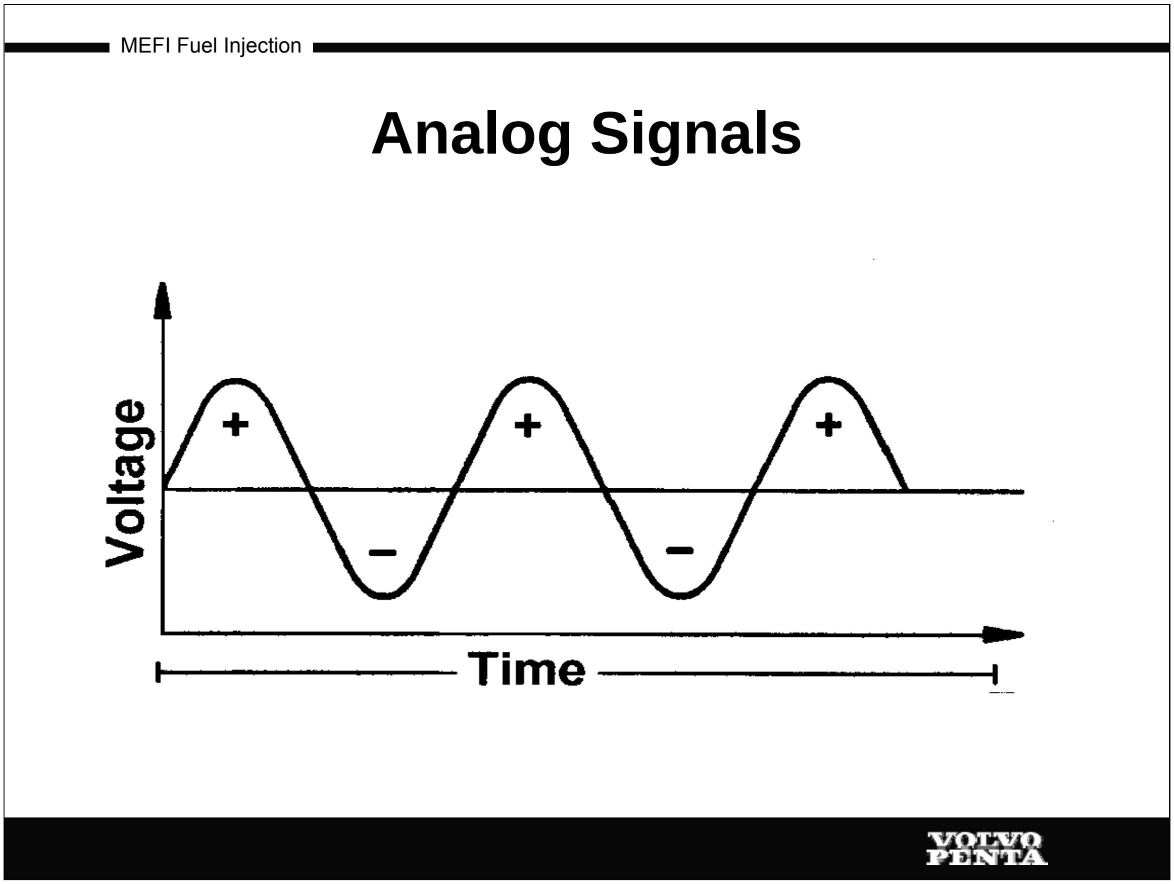
There are only 4 types of electrical problems that can occur in a wire. These 4 are: Open Circuit, Circuit Shorted to Ground, Circuit Shorted to Voltage and Unwanted (extra) Resistance due to corrosion. All 4 are pictured above. The effect that the problem has on the circuit depends on which problem is present and what wire is it in.

All Diagnostic books are written to find opens, shorts to ground and shorts to voltage. These 3 types are easily found with a voltmeter, an Ohmmeter or a test light.

Unwanted resistance due to corrosion is the hardest to find because the extra resistance usually doesn’t set any fault codes. The extra resistance <u>does</u> cause the circuit to flow less current which causes a voltage drop to or from a sensor, or it reduces current flow to an output (load device) which may cause the output to malfunction. Unwanted resistance due to corrosion usually will not set a DTC because the circuit still functions, just not properly.



All of the following are inputs to the ECM used for pulsewidth and timing calculations.



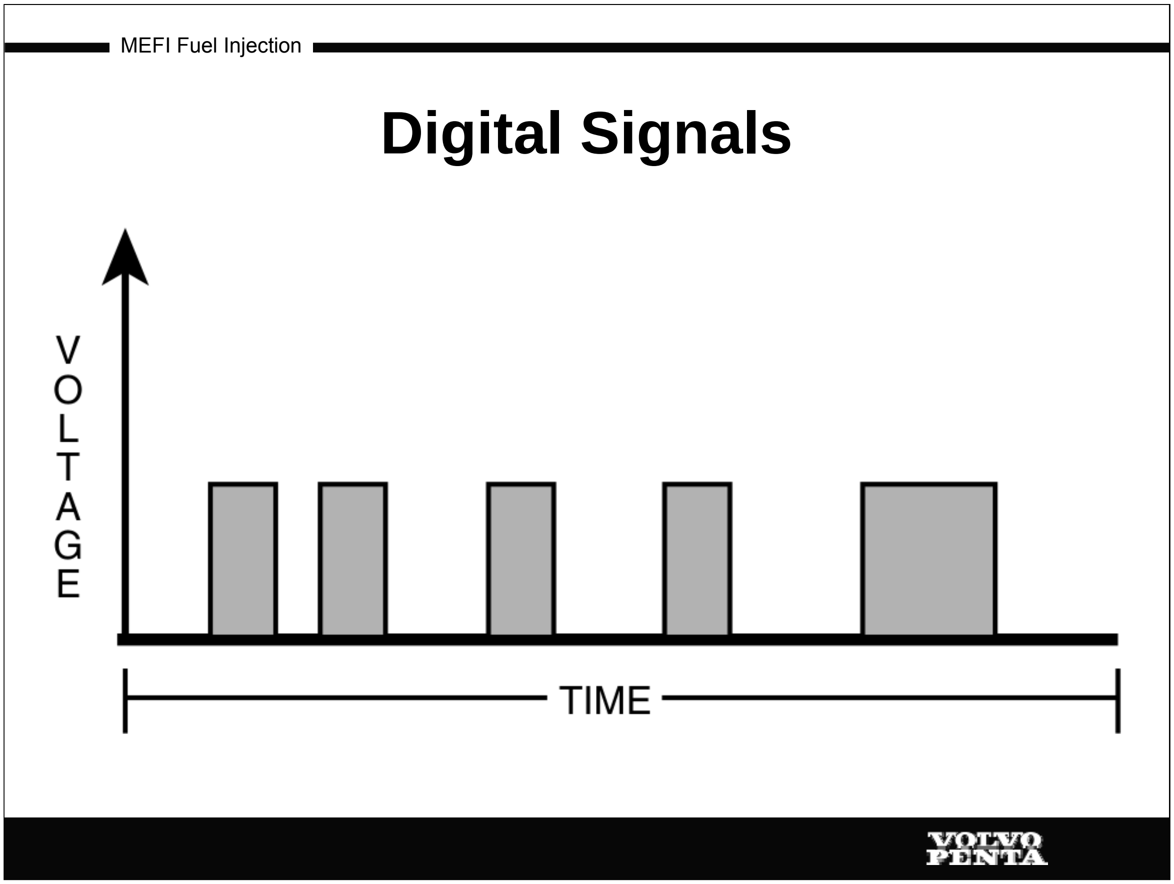
Types of voltage input to an ECM:

Besides causing current flow in circuits, voltage can be used as a signal. Voltage signals can send information by changing levels, changing shape (waveform) or changing speed (frequency). Computers basically accept 2 types of voltage signal inputs.

ANALOG SIGNALS:

These signals are continuously variable. This means that the signal can be any voltage in a design range.

Analog signals usually give information about a condition that is continuously changing. Coolant temperature, MAP and throttle position are all examples of signals that are constantly changing (analog).



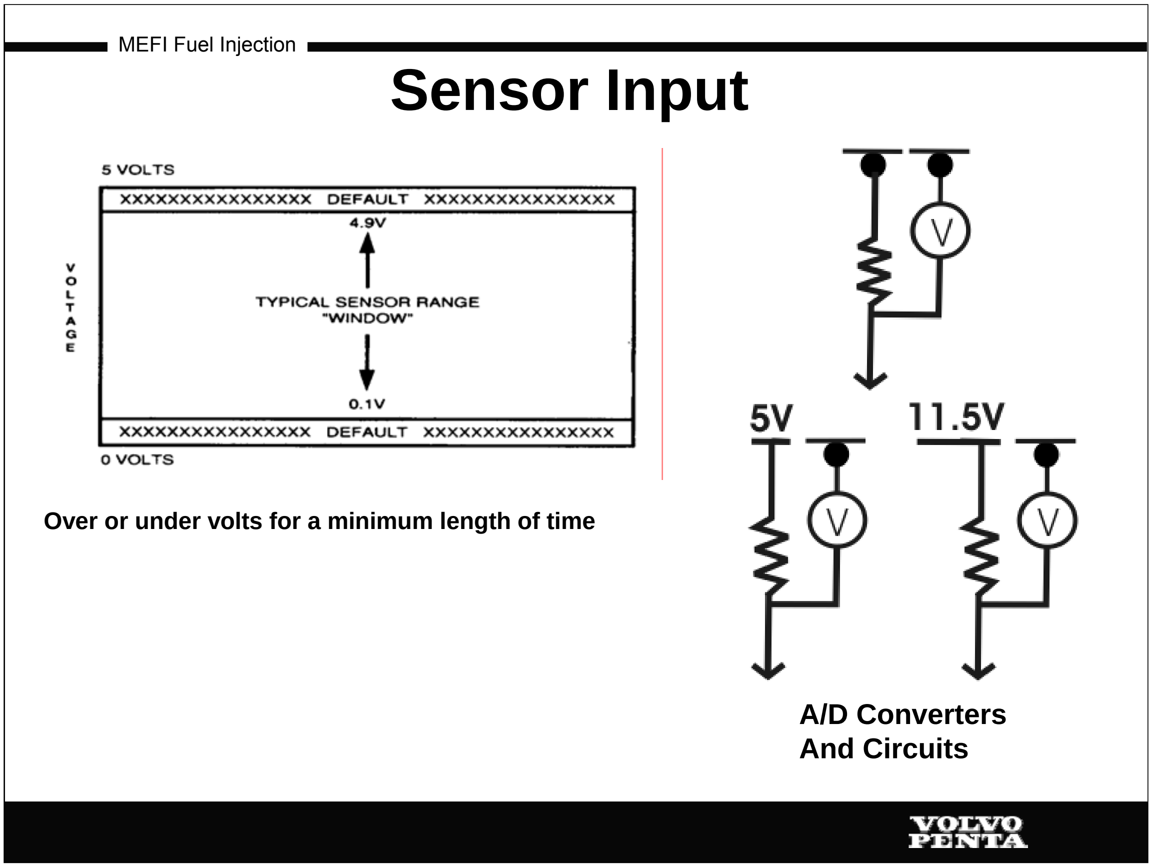
DIGITAL SIGNALS:

In a computer, all data must be reduced to an electrical switch. A switch has only 2 possible states, “on” and “off”, so it has only 2 numerical symbols, 1 (on) and 0 (off). Because there are only 2 symbols it is known as “Binary”.

Each 1 and each 0 is known as a “bit”, 8 bits together is known as a “Byte” or a word. Computers can store thousands of bytes of data, the only limit is the size of the memory. For example, the MEFI 4 can store up to 2 thousand bytes (2K) of calibration data, where as the MEFI 1 can only handle 512. This means the engine parameters can be monitored and adjusted in finer increments, such as 50 RPM instead of 200 RPM.

Digital Binary is used by computers to communicate with one another and within itself. To a computer 10011101 might mean “turn on the fuel pump”.

Examples of digital inputs to the ECM are MEFI 4 CKP and CMP signals, Ref Hi input for MEFI 1 and MEFI 3 engines, the oil pressure switch and the exhaust riser temperature switches. The switches tell the ECM about a switch open or closed status. The CKP, CMP and Ref Hi inputs form a repeating high/low pattern that the ECM interprets as crankshaft speed and piston location.



The ECM receives voltage signals from the sensors via A/D (Analog to Digital) converters. These A/D converters are the ECM’s voltmeters. The normal voltage signal from a sensor may range from as low as 0.1 volt, to as high as 4.9 volts. This would be the sensor’s operating parameter or “window”. Each sensor has a different operating window.

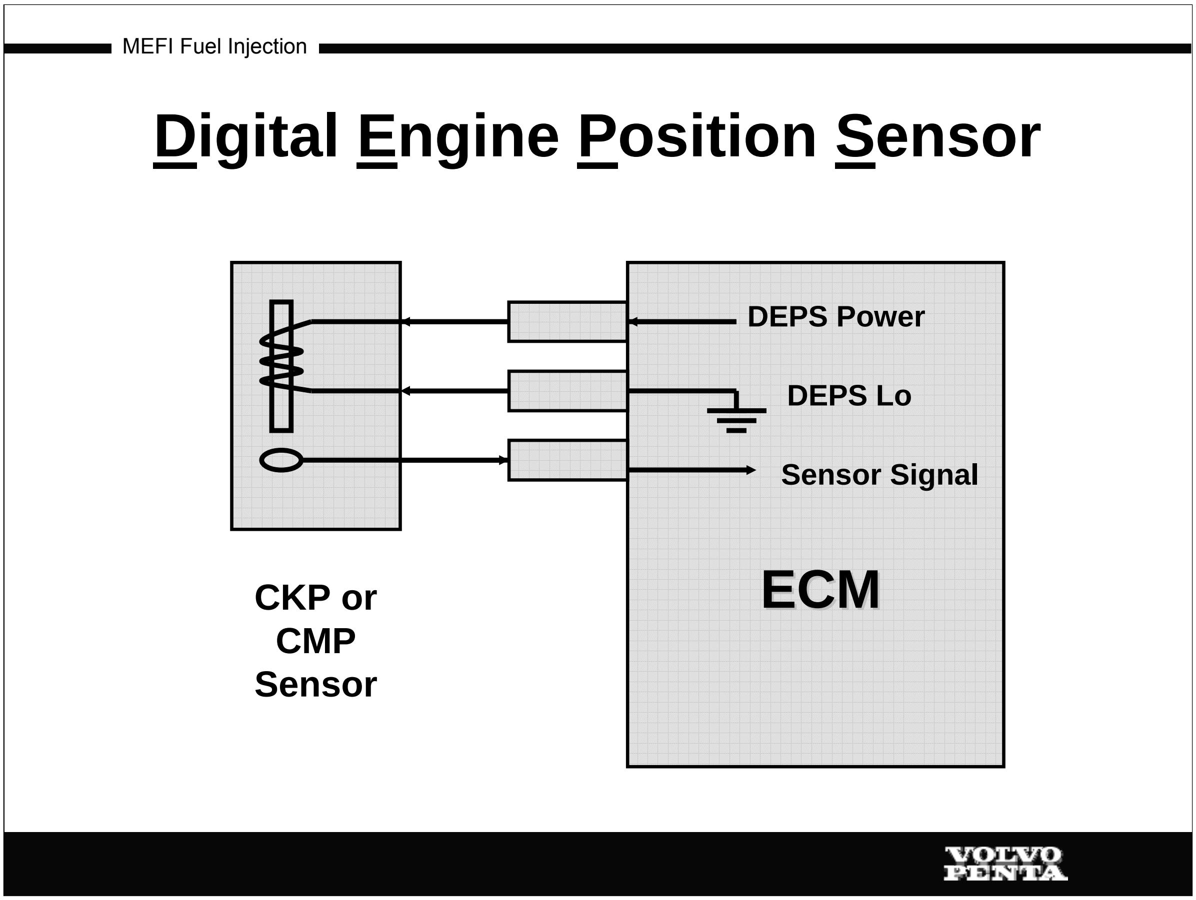
If a sensor is within acceptable parameters, the ECM does not detect a problem. When a sensor signal voltage input falls outside of this window, the ECM sees this as an invalid input voltage and after a programmed length of time will store a DTC. Once a DTC is set, the ECM defaults to a preprogrammed value for the lost sensor to restore limited engine performance.

A sensor can report back incorrect information but the signal voltage still be within the operating window. This can cause engine performance problems without setting a DTC.

Mechanical problems usually do not set a DTC, however, if severe enough, could possibly drive a sensor outside it’s operating window.

Remember; to set a DTC, a sensor’s voltage must go out of range for a minimum length of time. If the sensor voltage goes out of range, but comes back before the timer has timed out, no DTC will be set. The ECM will believe the sensor input and react to it. This will cause some sort of owner complaint about runability with no fault codes.

Some rationality checks are also performed.

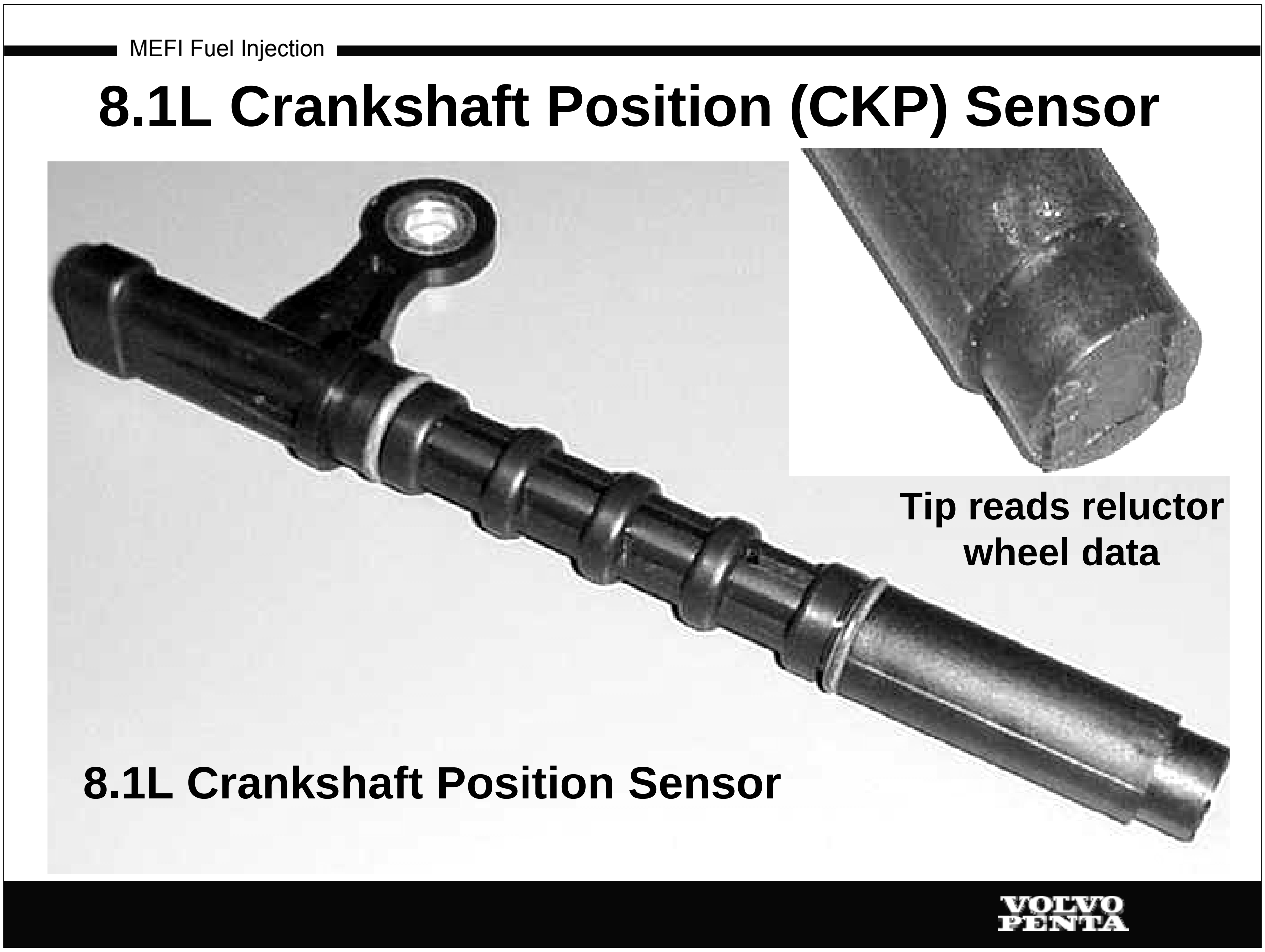


The DEPS generates a digital signal that is sent back to the ECM.

DEPS stands for "Digital Engine Position Sensor". Two ECM terminals provide a clean power supply (J2-17) and return or ground (J2-18) for digital sensors such as the crankshaft sensor (CKP) and the camshaft sensor (CMP) used on MEFI 4 MPI engines.

DEPS Power is a regulated and filtered +11.5 volt DC supply specifically for digital engine position sensors and is also used to power the cam sensor in a High Voltage Switch distributor on the small block V8's and the 4.3 V6

Devices other than digital engine sensors should NOT be connected to J2-17 and J2-18 because of the potential to create electrical noise that may interfere with engine operation.



The 8.1 crankshaft position sensor (CKP) is located on the left rear of the engine block. It is a magneto resistive type sensor. The CKP works in conjunction with a 24x (teeth) reluctor wheel.

As the crankshaft rotates, the reluctor wheel teeth interrupt a magnetic field produced by a magnet within the sensor. The CKP then outputs a 24x signal to the ECM.

The CKP is used to tell the ECM that a piston is coming to top dead center and how fast it is coming.

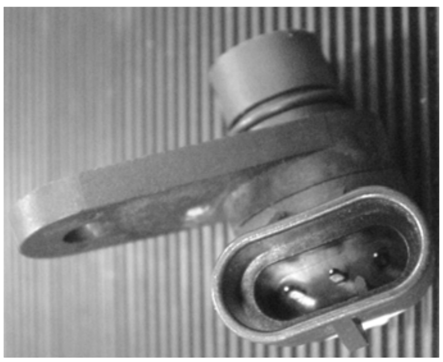
The IAFM CKP uses a 4x reluctor which will be discussed in the ignition systems section of this course.

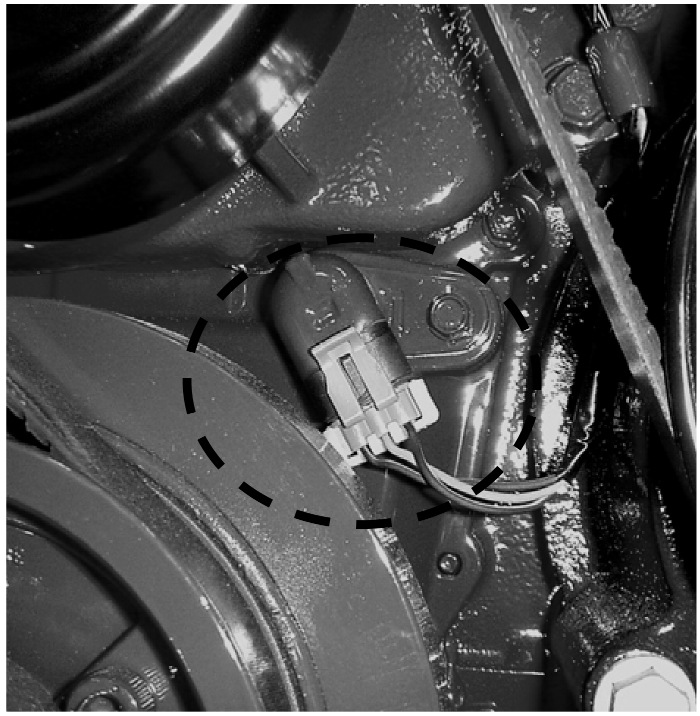
MEFI Fuel Injection

8.1L Camshaft Position (CMP) Sensor

Camshaft Position Sensor

Identifies which piston is at TDC





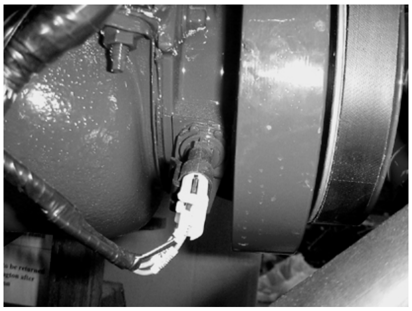
The 8.1L camshaft position sensor (CMP) is mounted on the front of the engine. It is a magneto resistive type sensor. The cam position sensor detects the half moon “slot” on the camshaft timing gear.

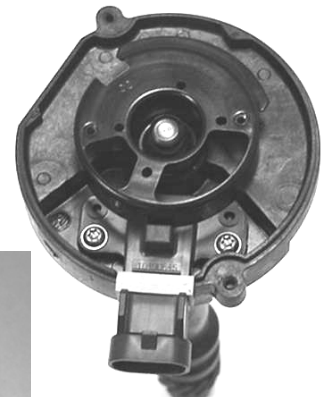
The purpose of the CMP is to tell the ECM which piston is coming to top dead center.

The 8.1L CKP alone provides enough crankshaft information to run the engine in a waste spark mode if the CMP is lost before cranking. The IAFM engines don’t need CMP input to start or run.

There are 3 different groups of parts for the 8.1L CMP. The earliest was a one groove gear. The later was a 2 groove gear and a sensor with 2 magnets. The 2004 and newer setup uses the 2 groove gear, 2 magnet sensor with a new style connector and a new timing cover that moves the sensor in relation to the cam gear. None of the 3 different setups are interchangeable.

4.3, 5.0, 5.7L Crank Sensor (CKP) and Cam Sensor (CMP)

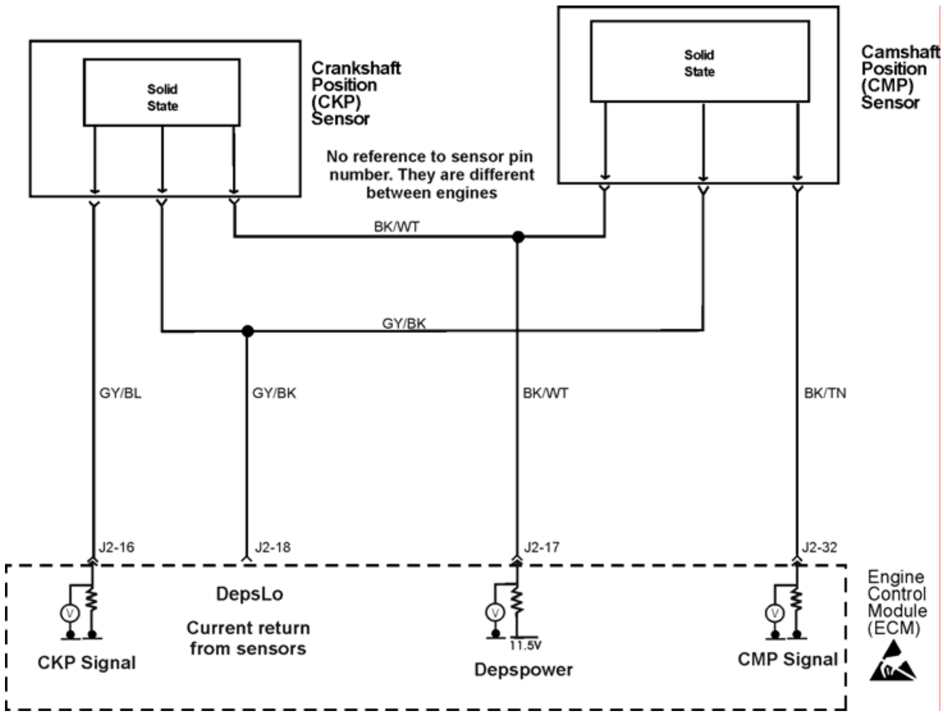




Above are the crank and cam sensors for the 4.3, 5.0, and 5.7L MEFI 4 engines. Just like the 8.1L, the sensors are feed power from the Depspower circuit and current is returned to the ECM via the DepsLo circuit. Depspower and DepsLo are shared circuits between the CMP and CKP sensors. Each sensor has it's own signal wire back to the ECM. All of the CMP and CKP sensors used on the MEFI 4 engines produce an 11.5V square wave pattern on their signal wires in accordance with the number of teeth on each sensor's reluctor. The IAFM engines use a 4X (4 teeth) CKP reluctor for the 5.0L and 5.7L and a 3x reluctor for the 4.3L. Both the 8.1L and the IAFM engines use a 1X (1 tooth) CMP reluctor. The 8.1L CMP reluctor is milled into the cam gear and the IAFM shutter is in the distributor (as pictured above).

MEFI Fuel Injection

CKP or CMP Sensor Circuit

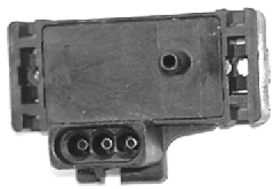


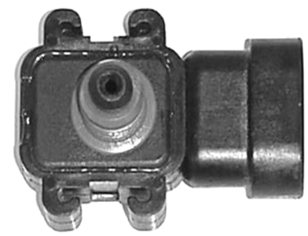
Remember that a number of sensors share power feeds and sensor return wires, but each sensor on the engine has to have its own signal wire. That is the wire that the ECM looks at to receive a signal from the sensor.

The CMP and CKP sensors share DepsPower and DepsLo. As the crankshaft turns, the reluctor passes the tip of the CKP sensor and the cam reluctor (or vane) passes the tip of the CMP sensor. As the reluctor passes by, voltage enters the signal wire. After the reluctor tooth passes by, the voltage level on the signal wire drops to 0V. So as the reluctor teeth pass by the sensor a square wave voltage signal is transmitted up the signal wire to the ECM. The ECM uses the A/D converter (voltmeter) on the signal wire to “see” and interpret the signal.

CKP and CMP faults codes are usually generated when one signal is present and the other is missing. CKP signal input can be seen with a scan tool as “Engine RPM”. CMP input can be seen on a scan tool as “Cam Retard”. To use these as diagnostic tools, crank the engine and observe the “Engine RPM”. If RPM is greater than 0, then the ECM sees the CKP input. To check the CMP input, crank the engine and ensure that there is CKP input. As you crank the engine now look at “Cam Retard”, if cam retard is moving off of 0 degrees, then the ECM sees CMP input. No MEFI 4 ECM requires CMP input to start and run the engine. CKP input is required for any Speed Density fuel injection system to run.

Manifold Absolute Pressure Sensor (MAP)





MEFI 1 and 3 **8.1L**

VOLVO PENTA

The Manifold Absolute Pressure (MAP) sensor is a pressure transducer that measures changes in the intake manifold pressure. It takes this pressure and converts it into a voltage signal. The output is directly proportional to the intake manifold pressure. (inverse to manifold vacuum)

A closed throttle will result in a low voltage. (low pressure)

Wide open throttle will produce a high voltage. (high pressure)

The ECM uses the “key on” voltage to read barometric pressure which sets the fuel curve for the engine while it is running. This baro read voltage is **critical** to engine operation. If the “key on” baro reading is lower than the actual barometric pressure (due to a problem in the MAP or MAP circuit), then the engine will be starved for fuel. Conversely, if the key on baro reading is higher than the actual barometric pressure, the engine will receive too much fuel through out the entire range of engine operation.

The only ways to validate the barometric pressure reading from the MAP is to compare the ECM’s baro reading to a barometer or compare it to a known good engine in the same area.

MEFI Fuel Injection

IAFM TMAP Sensor

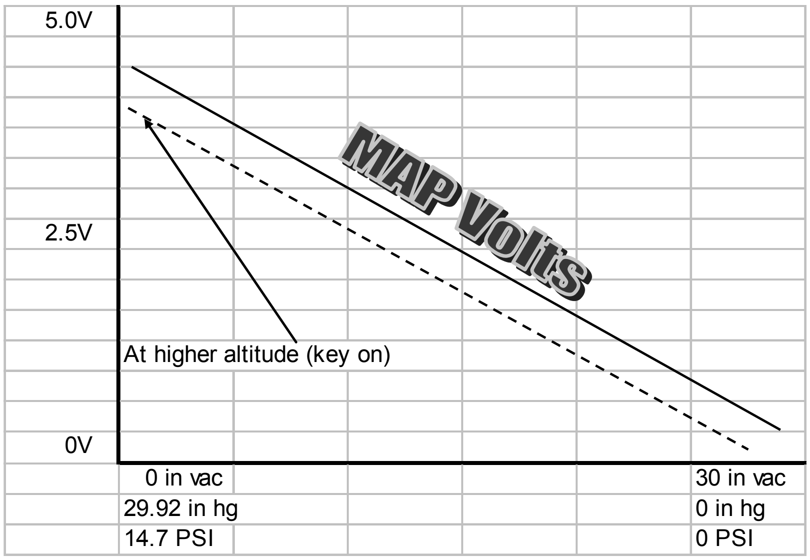
Combination MAP and IAT

This IAFM T/MAP sensor is used on the MPI 4.3L, 5.0L and 5.7L engines. The “T” in T/MAP stands for temperature. This sensor measures barometric pressure, intake manifold pressure and intake manifold air temperature.

This sensor is a four wire sensor, using the additional wire for the manifold or intake air temperature signal (MAT or IAT). The IAT shares the sensor return or ground with the MAP.

The thermistor for intake air temperature measurement is pictured above. It is yellow in color. See the Intake Air Temperature sensor section for it’s operation.

Speed / Density Fuel System



VOLVO PENTA

The solid line in this chart represents the voltage output from a MAP sensor through the whole vacuum range at sea level.

The dotted line represents the same sensor output at a higher altitude. Notice the entire voltage output from the MAP sensor is lower, which means the engine will get less fuel throughout the entire rpm range of the engine.

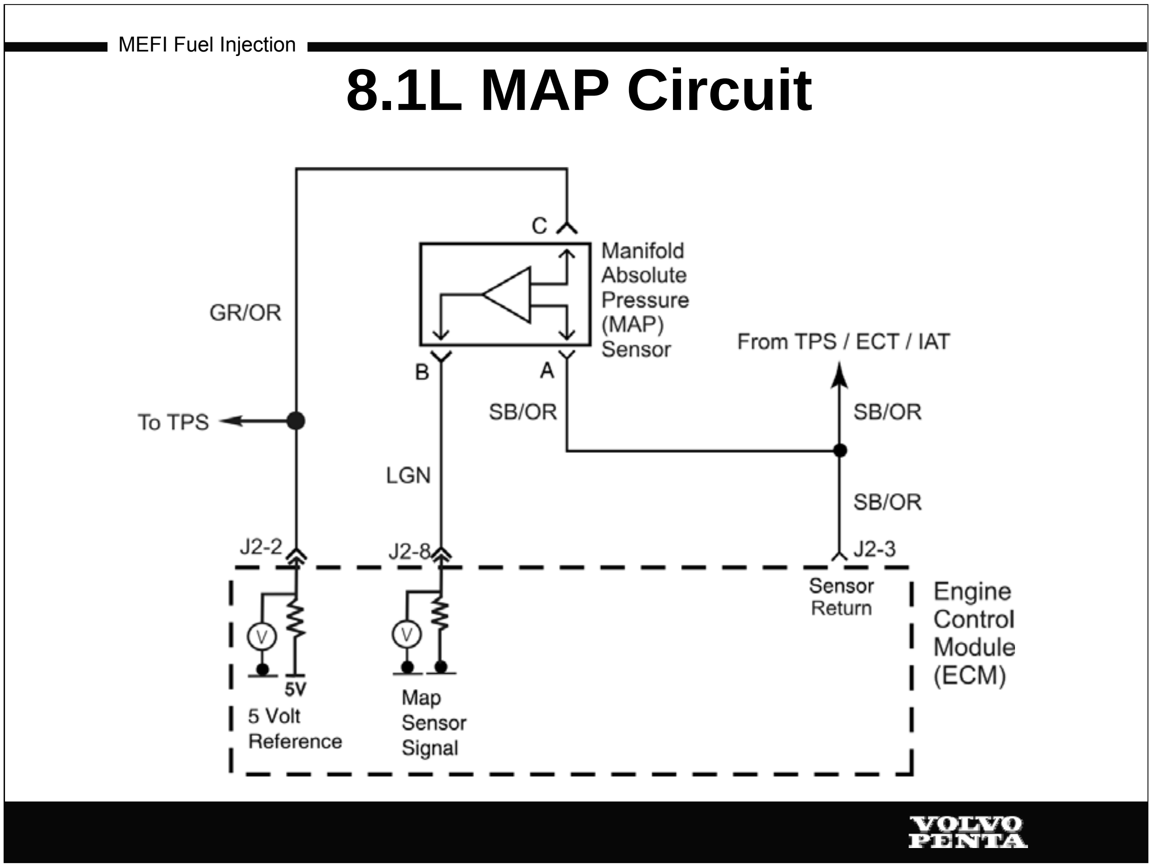
At altitude, less oxygen in the air means less fuel needed.

The same holds true on days when the atmospheric pressure outside is lower (i.e. a storm is present).

Make a habit of checking MAP key on voltage and key on baro readings to establish what is normal for your area for a particular engine package.

Also compare the "Baro derived from MAP" with a barometer reading to check MAP sensor accuracy.

A MAP sensor that reads baro incorrectly <u>WILL</u> cause a running problem that won't set a fault code



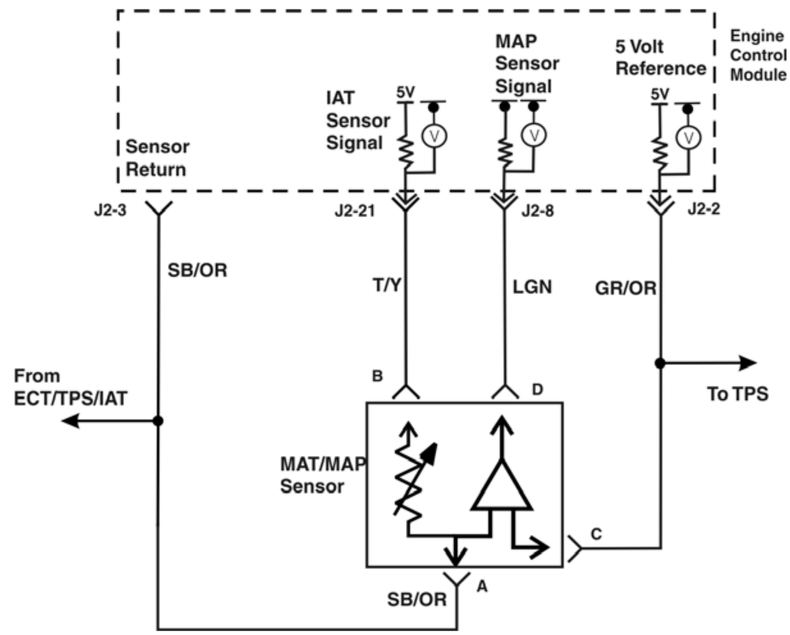
The ECM sends a 5 volt reference voltage to the MAP sensor. This 5V feed is “watched” by the ECM’s A/D converter. If the voltage is too high or too low a “5V Reference out of range” fault code is set.

The sensor responds to changes in the manifold pressure and returns a signal voltage (a portion of the supply voltage) on the signal wire. This signal will vary from about 1.0-1.5 volts at idle to about 4.0- 4.8 volts at WOT. The ECM sees this signal input through the A/D converter on the signal wire. Almost all inputs to the ECM that come in through an A/D converter can be seen by a scan tool. For the MAP sensor, this is “MAP Volts”. The 5V Reference voltage level is monitored by the ECM but can not be seen with a scan tool.

There are 3 fault codes for the MAP sensor : “MAP Voltage High”, “MAP Voltage Low” and “5V Reference Out Of Range”. The “5V Reference Out Of Range” can be set by either the MAP or TPS as it is a shared circuit.

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with RPM and set the appropriate fault code.

IAFM T/MAP Circuit

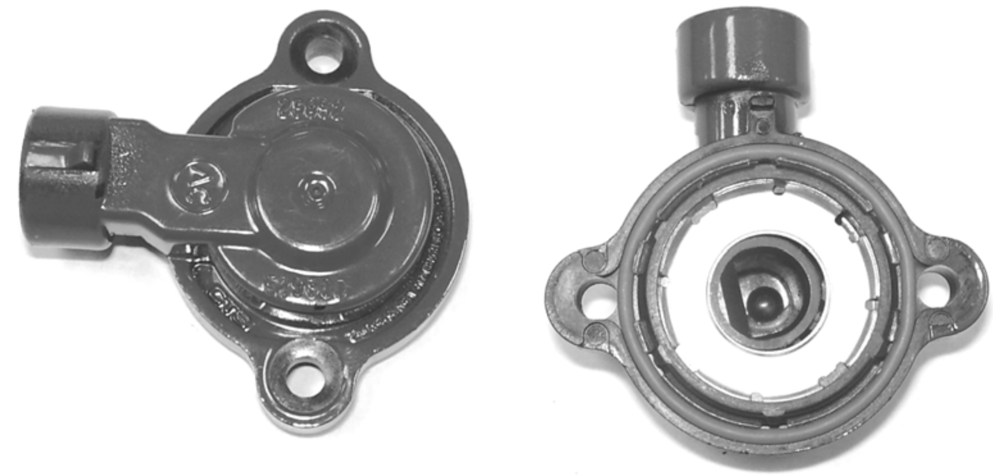


The T/MAP on the IAFM engines (4.3L, 5.0L and 5.7L MPI) works the same way as an 8.1L MAP except the IAFM engines incorporate the IAT in the MAP sensor.

The MAP and the IAT share the sensor return (ground). IAT functionality is discussed later in this book.

MEFI Fuel Injection

Throttle Position Sensor (TPS)

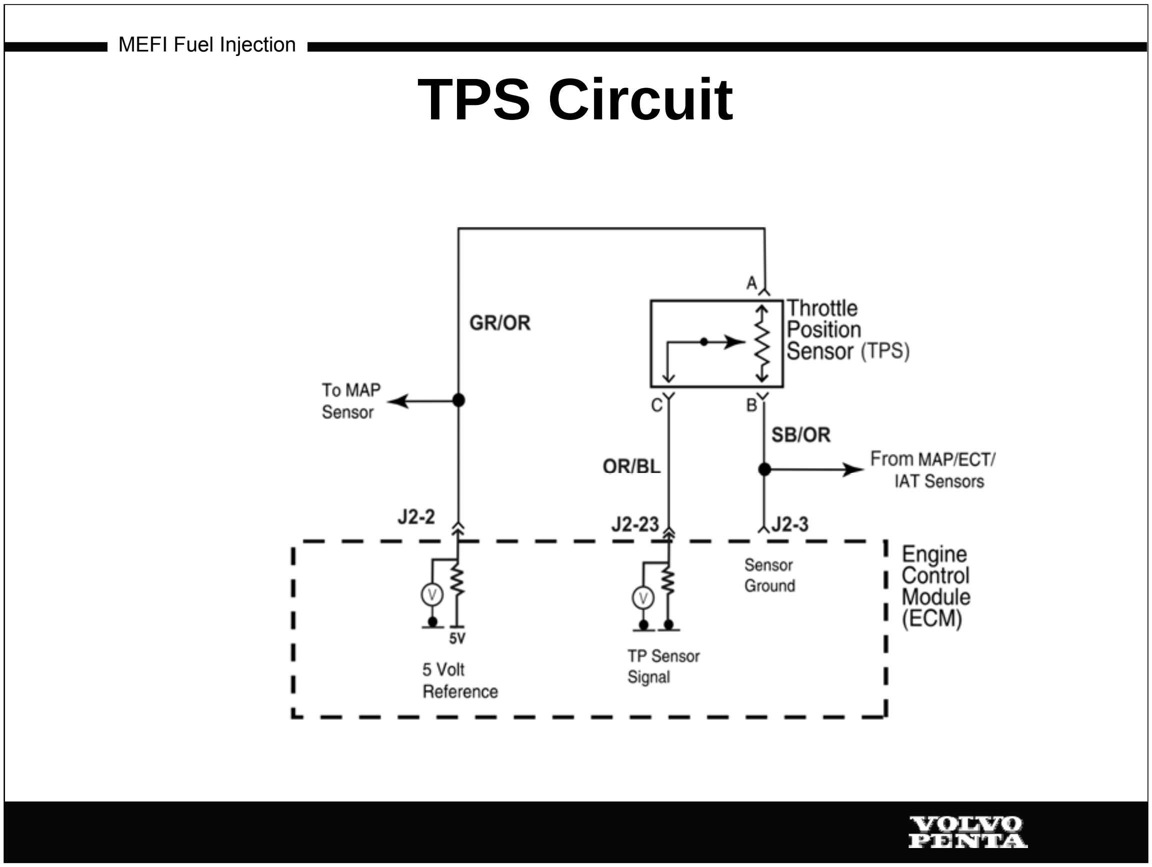


VOLVO PENTA

The Throttle Position Sensor (TPS) is a potentiometer connected to the throttle shaft on the throttle body. At closed throttle the voltage output is low. The voltage increases proportionately as the throttle is opened. The ECM uses the TPS signal to control the idle air controller and acceleration enrichment.

The following information is available with the scan tool: TPS voltage, TPS percent throttle, and Closed throttle (yes/no). TPS voltage is the actual input to the ECM. TPS Percent is a calculated value that is the difference between actual TPS voltage and learned TPS minimum. Closed throttle is a calculated value based off of TPS percent. If TPS percent is below 2%, then closed throttle is “yes”. Above 2% closed throttle is “no”.

MEFI 3 and 4 TPS’s are non-adjustable.



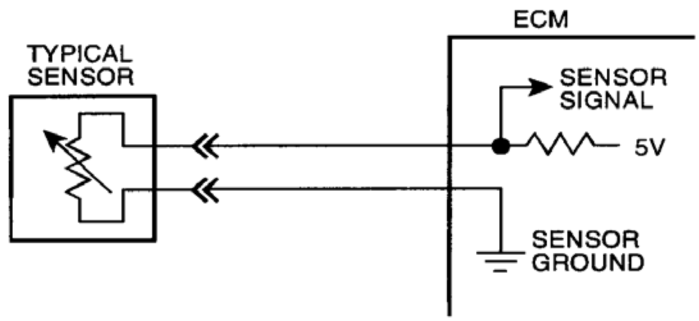
The TPS and the MAP sensor share the 5 volt reference feed. The A/D converter on the 5 volt reference feed is used to detect whether the 5 volts is present or not. If the voltage is not there a “5v reference out of range” fault code. One possible cause of this fault is the 5 volt reference circuit being shorted to ground.

The ECM watches the A/D converter on the signal wire. If the voltage goes too close to 0v, then a “TPS voltage low” fault is set. If the voltage goes too close to 5v, then the ECM sets a “TPS voltage high” fault.

Remember, the fault codes are set by what voltage the ECM “sees” at the A/D converter. As an example, a TPS voltage low fault could be set by an open in the signal wire, a shorted signal wire, or an open in the 5 volt reference feed.

A good quick check of the TPS circuitry is to disconnect the TPS and with a voltmeter check from cavity A to a known good ground. If the voltmeter measures 5 volts, then measure between cavities A and B. If the voltmeter still reads 5 volts, then the sensor return is good. Then short the 5 volt reference into the signal wire and read TPS Volts with a scan tool. If the scan tool reads 5 volts, then the signal wire is good and the ECM can read the voltage with the A/D converter.

Two Wire Temperature Sensor



Two Wire Sensor

This type of sensor is basically a variable resistor in series with a fixed resistor of a known value within the ECM. The variable resistor in the sensor determines how much current flows in the circuit. The amount of current flow determines how much of the 5 volts on the signal wire drops across the fixed resistor. The ECM reads the voltage level between the fixed resister and the variable resistor. This is known as a voltage divider circuit. The most commonly used variable resistors are called “Thermistors”. A thermistor changes resistance with temperature variations.

All thermistors used on Volvo Penta engines are of the Negative Temperature Coefficient type (NTC), resistance goes down as temperature goes up.

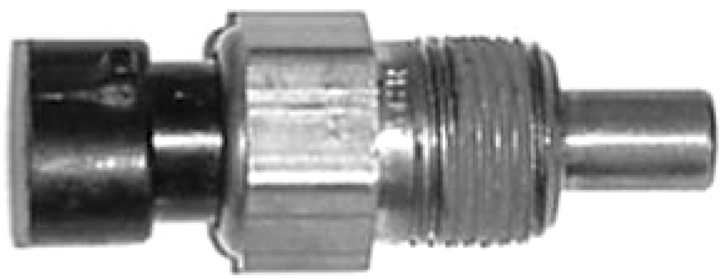
Temp	Resistance	Signal Voltage
UP	DOWN	DOWN
DOWN	UP	UP

The scan tool only displays the current temperature indicated by the sensor. If that value is out of limits for the ECM, the ECM sets a fault code and uses a default value preprogrammed into the ECM. That value is not displayed on the scan tool.

The fault codes set are “High Temperature Indicated or ECT Voltage Low” and “Low Temperature Indicated or ECT Voltage High”.

MEFI Fuel Injection

Engine Coolant Temperature Sensor (ECT)



VOLVO PENTA

The ECM uses the ECT signal to calculate engine temperature to determine if the engine is cold, at normal operating temperature or overheating.

The MEFI 4 engines have a temperature controlled rev limiter. The purpose of this is to prevent engine damage from running a cold engine at high RPM. This feature will prevent the engine from achieving full RPM until it has reached operating temperature. The approximate limits are as follows:

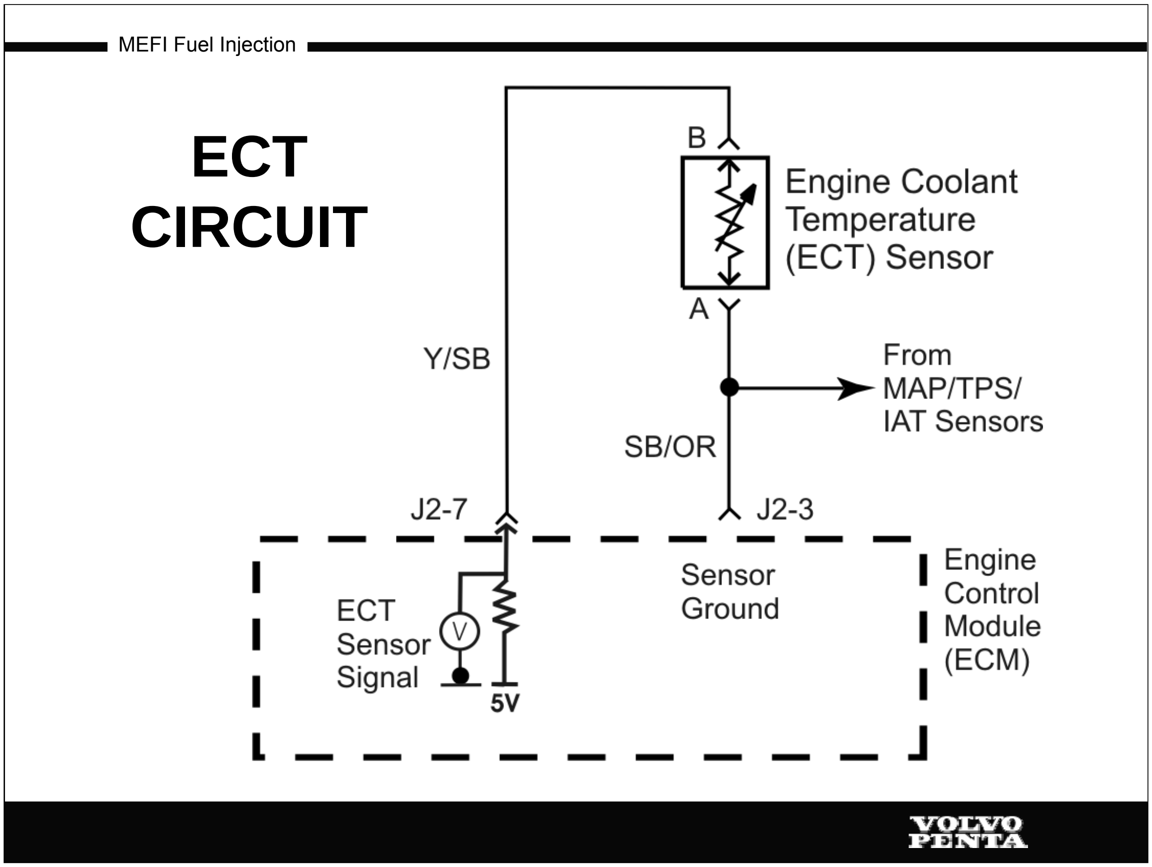
68 degrees F……4000 rpm.

104 degrees F…..4600 rpm.

140 degrees F+…Full throttle operating range.

Note: different engines have different rpm limits, however above approximately 140 degrees F all engines are allowed max rpm.

(Unplugging this sensor will default the Scan tool to -39 degrees F, the ECM will be using an non-displayed default value).



The ECM sends out 5 volts to the sensor on the signal wire. As the temperature of the sensor changes, it's resistance changes. As the sensor's resistance decreases, the current flow in the circuit increases. As the current increases, the voltage drop across the fixed resistor in the ECM increases. This causes the voltage available at the A/D converter (between the fixed resistor and the sensor) to be lower as the sensor's temperature rises.

An open circuit in either the signal wire or the sensor return will set a "voltage high" fault. A "voltage high" fault is also a "low temperature indicated" fault.

The EFI manual has temperature/resistance charts for both the ECT and the IAT sensors. These charts are located at the DTC test for the fault.

MEFI Fuel Injection

Intake Air Temperature Sensor (IAT)

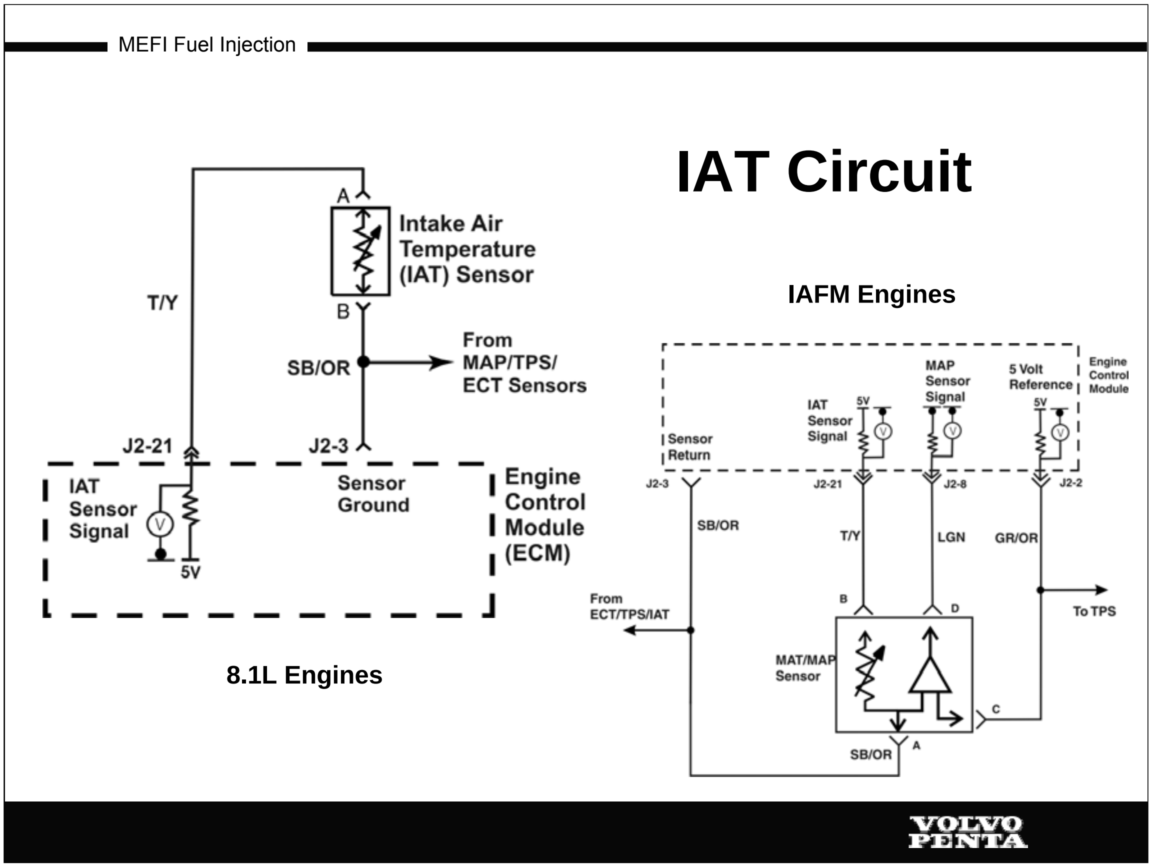
VOLVO PENTA

The 8.1L IAT sensor is a negative temperature coefficient thermistor. The ECM uses IAT sensor inputs to make corrections to the air/fuel ratio and the spark curve as air temperature changes. Spark advance is limited after air temperature exceeds a certain level.

The 8.1L IAT sensor is part of the flame arrestor. A new sensor comes with the flame arrestor attached.

The IAFM IAT/MAT functions the same way. It is part of the MAP sensor.

The sensor pictured above is a MEFI 3 IAT.

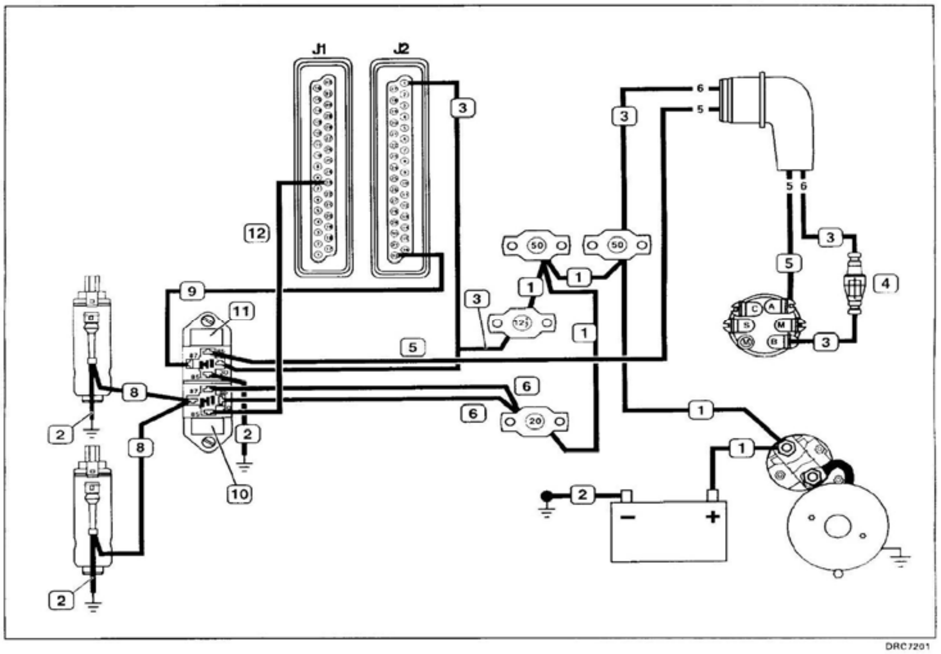


The ECM sends out 5 volts to the sensor on the signal wire. As the temperature of the sensor changes, it’s resistance changes. As the sensor’s resistance decreases, the current flow in the circuit increases. As the current increases, the voltage drop across the fixed resistor in the ECM increases. This causes the voltage available at the A/D converter (between the fixed resistor and the sensor) to be lower as the sensor’s temperature rises.

An open circuit in either the signal wire or the sensor return will set a “voltage high” fault. A “voltage high” fault is also a “low temperature indicated” fault.

The EFI manual has temperature/resistance charts for both the ECT and the IAT sensors. These charts are located at the DTC test for the fault.

B+



MEFI 3

B+ is a fuel delivery modifier. As battery voltage goes down, injector pulsewidth must go up for the volume of fuel delivery from the injector to remain constant. As the voltage goes up, the injector will open more easily and quickly, so injector pulsewidth must go down to maintain the correct volume of fuel in the cylinder.

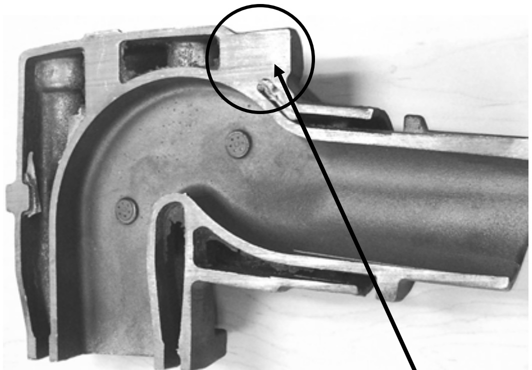
MEFI 3, 4 and 4b ECM's have a limited range of pulsewidth adjustment for B+. Therefore, if the voltage supply to the ECM is low, the engine will run too lean and if the voltage supply to the ECM is too high the engine will run too rich. Either condition will cause a poor running condition.

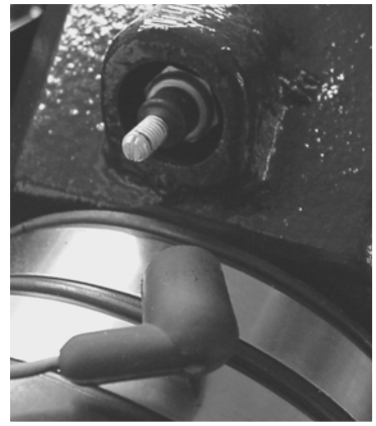
This B+ voltage input can be viewed with a scan tool. It is named "Battery Voltage".

The wiring diagram above is a typical MEFI 1 or 3 wiring diagram. These MEFI wiring diagrams were divided up by system. This picture is the B+ and fuel pump systems. MEFI 4 EFI system wiring diagrams show the entire engine system on one diagram.

On MEFI 3 and MEFI 4 systems J2-1 provides B+ information to the ECM and also provides all power for the ECM.

Exhaust Temperature Switch





Switch is
Mounted here
(drilled and tapped first)

VOLVO PENTA

The switch is located in a protected housing in the manifold. The switch is not mounted in the exhaust stream or the cooling water flow. It only “sees” the temperature of the riser elbow metal. In the picture above, the hole for the switch has not been drilled and tapped. It is <u>NOT</u> drilled all the way through into the exhaust stream.

The switches can be knocked out of calibration by being hit or the stud being turned. If the stud for the harness connector is turned, even slightly, the switch is no longer any good and must be replaced.

These switches are either wired in parallel with the oil pressure switch or they are wired in parallel with themselves on their own separate circuit.

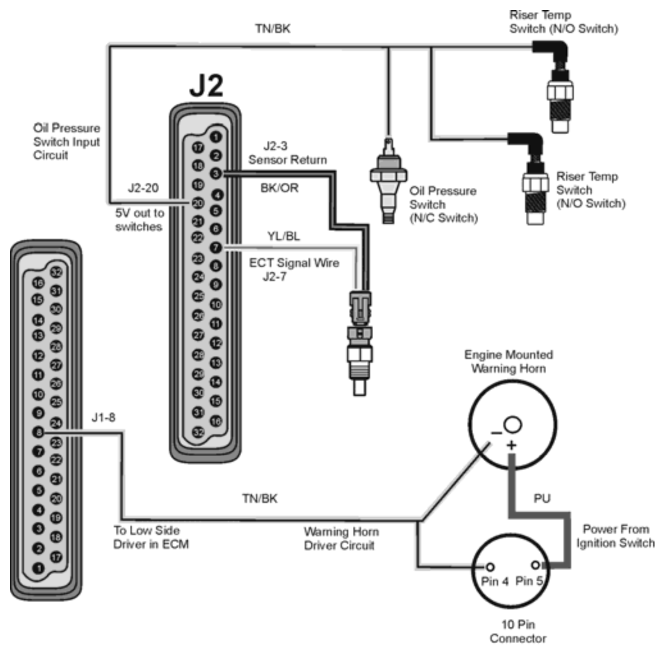
There are 2 systems that use these switches. They are usually referred to as the Engine Mounted Horn system and the Remote Mounted Horn system.

The Engine Mounted Horn system was used on the models built between 2001 and 2002. In 2003 we switched to the Remote Mounted Horn system. The operation of these 2 systems is discussed on the following pages.

Monitored items for both systems are: oil pressure, engine water temperature and exhaust riser temperature.

MEFI Fuel Injection

Engine Protection Mode System



Engine Mounted Horn System (01-02)

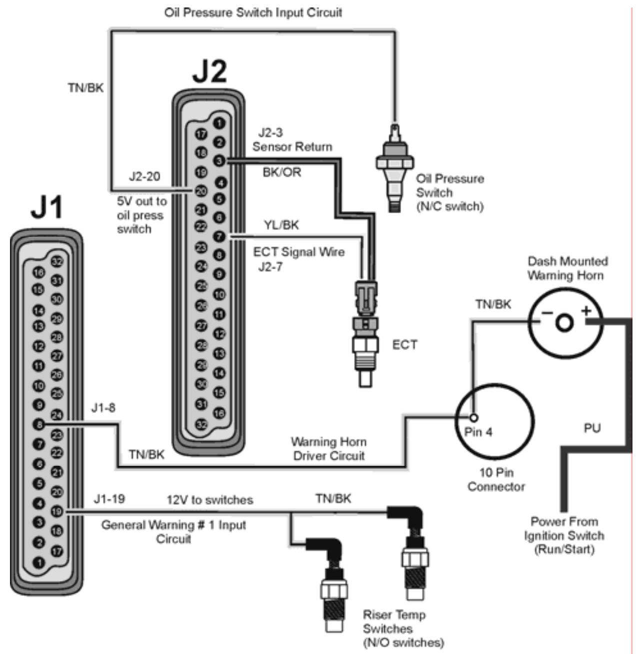
01-02 Model Years - Engine Mounted Horn System

Horn operation: The horn will sound 2 short beeps at each key on as a horn check. This is an audible check so that the operator will know that the horn is working. The horn will sound an “intermittent beep” when there is an “active” DTC stored in the ECM memory. This intermittent beep is one long beep followed by two short beeps. The horn also sounds if S.L.O.W. (Speed Limiting Operational Warning) mode or “engine protection mode” is activated. The horn sounds a steady beeping sound when S.L.O.W. Mode has been activated.

System operation: The exhaust temperature switches and the oil pressure switch are all wired in parallel on the oil pressure switch input circuit to the ECM at connector J2-20. The ECM sends out 5 volts looking for a ground through any one of the 3 switches. The riser switches are normally open switches and the oil pressure switch is a normally closed switch. As soon as either one of the 3 switches closes (with the engine running longer than approximately 20 seconds), a “low oil pressure” fault is set in the ECM’s memory and the warning horn sounds. If the problem goes away, there is an approximately 20 second delay before S.L.O.W. mode is cleared and the warning horn is deactivated. Complete system operation and diagnosis is covered in the 7742218 diagnostic book between pages 252 and 255. Both systems use the ECT input for S.L.O.W. mode, and engine response to that input is the same for both systems and is explained on the next page.

This system can be equipped with an optional remote mounted horn at the helm.

Engine Protection Mode System



Remote Mounted Horn System (03-05)

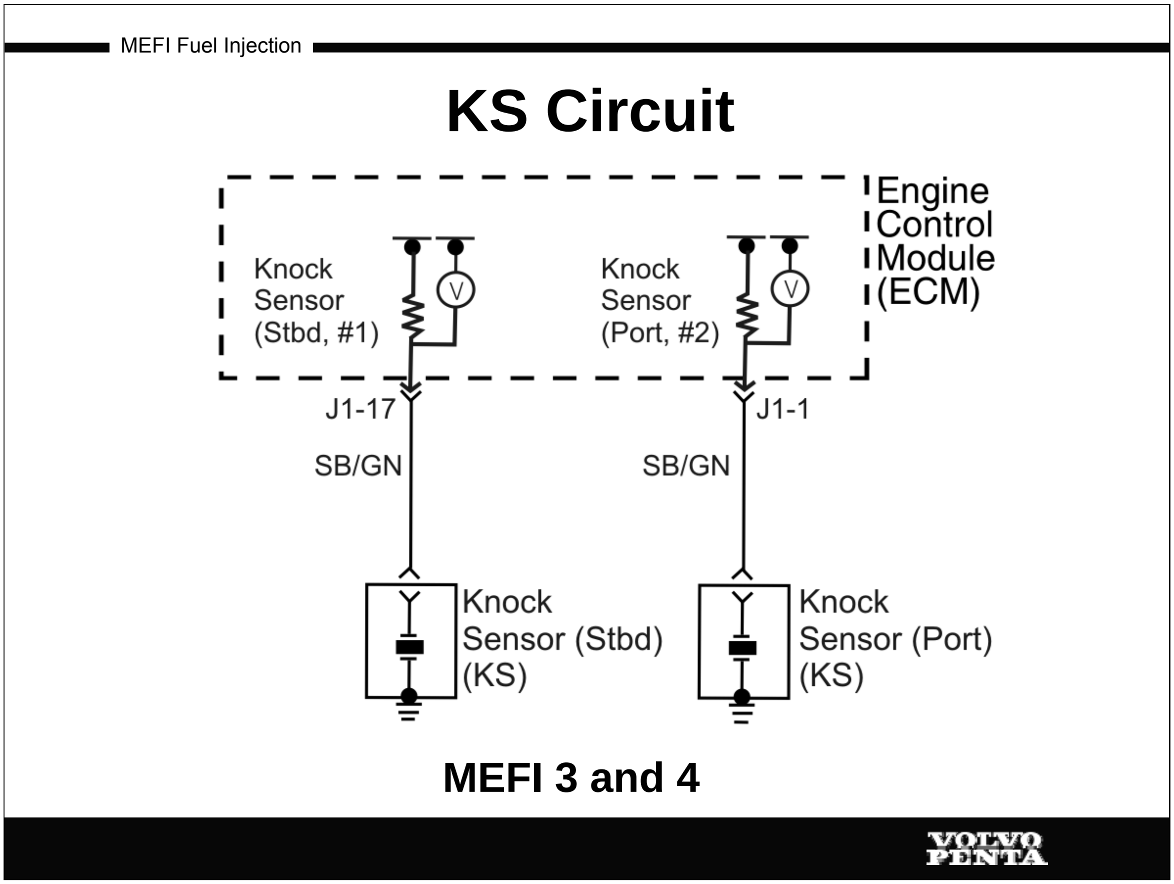
<u>03 through 05 model years - Remote Mounted Horn System:</u>

<u>Horn operation:</u> The only difference in horn operation between the two systems is that the remote horn system doesn't activate the warning horn for active DTC's. All other horn functions are unchanged

<u>System operation:</u> The exhaust temperature switches input has been moved from the oil pressure switch input circuit to a new circuit at J1-19. This circuit is the "General Warning #1 Input" circuit. These switches are the only items on the general warning # 1 input circuit. Once the engine has been running approximately 20 seconds, if one of the exhaust temperature switches closes (due to high temp), S.L.O.W. mode is activated, the warning horn sounds a steady beeping sound and a "General Warning # 1" fault code is set in the ECM's memory. The oil pressure switch input is still located on J2-20, but it is the only item on that circuit. While S.L.O.W. mode is activated, if the switch that activated S.L.O.W. mode returns to it's normal state, the ECM waits approximately 20 seconds (to ensure that the change is valid) and then cancels S.L.O.W. mode.

The ECT input is monitored for S.L.O.W. mode also. If the engine coolant temperature rises above a set value then S.L.O.W. mode is activated until the temperature drops below a set point. System operation and diagnosis is covered in the 7742218 diagnostic book on pages 255 through 259.

While in S.L.O.W. mode, in addition to sounding the warning horn, the ECM kills ½ of the fuel injectors anytime the RPM exceeds 2500. The ECM turns them back on once RPM has dropped below 1200.

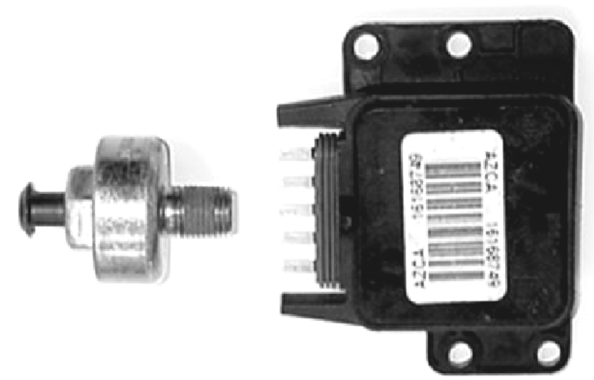


The ECM uses the knock sensor to detect detonation. The knock sensor is a piezoelectric device, or a crystal that creates a voltage when subjected to mechanical vibration. The knock sensor will produce a very low AC voltage signal anytime the engine is running. It will produce a larger AC voltage when detonation is present. When knock is detected the ECM can retard ignition timing to reduce knock.

Little or no activity on the knock circuit at the ECM will set a DTC 44.

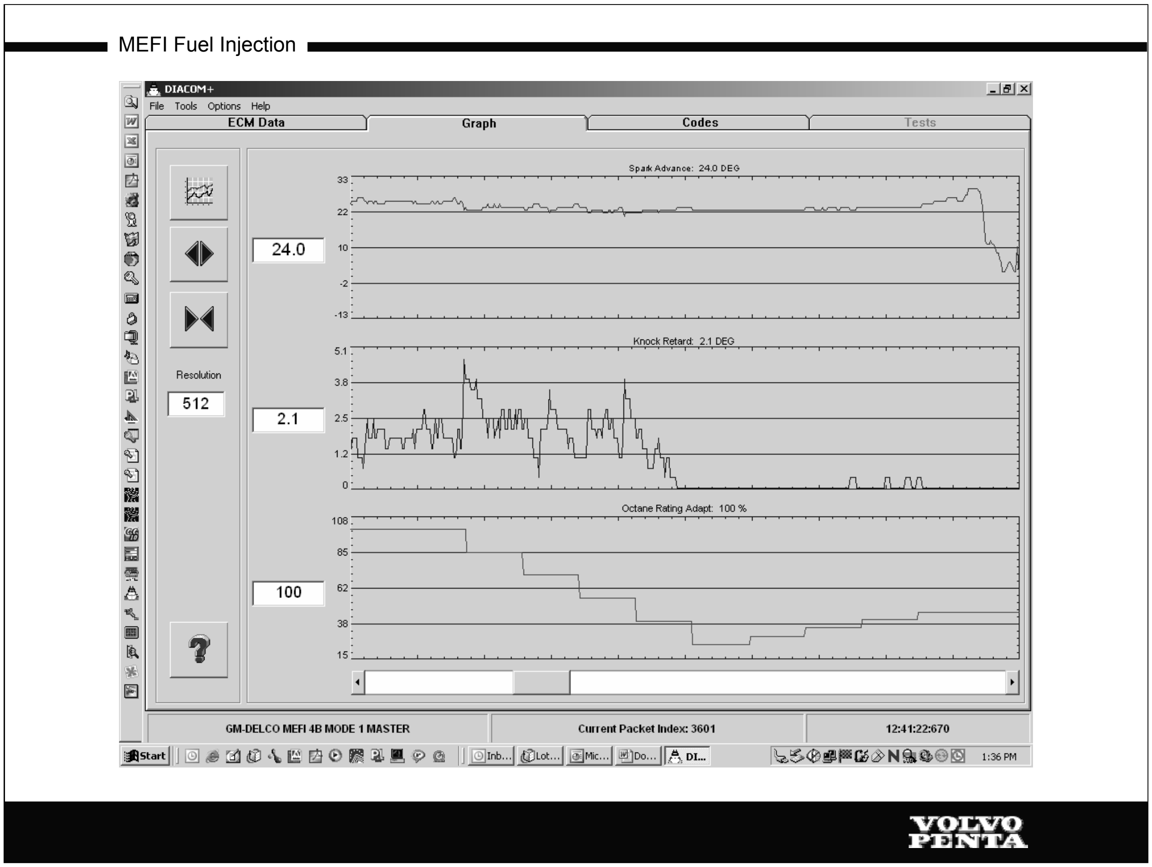
If either knock sensor signal wire is routed too close to a spark plug wire, the ECM may translate the induced voltage as a knock signal, resulting in a false timing retard. This would cause an engine running problem that would look like the result of poor fuel quality.

Knock Sensor (KS) & Module



MEFI 1

The knock module is used in the MEFI 1 systems. During no knock conditions it sends an 8-10 volt signal to the ECM. When knock is detected it will remove the signal from the ECM. The ECM will then retard the timing as much as 10%. The knock system was fully incorporated into the ECM with the introduction of the “WT” models equipped with the MEFI 3 system. All MEFI 3 and 4 systems have a knock system built into the ECM.



A summary of the knock system follows. There are 2 different systems for modifying spark advance based off of knock sensor input for MEFI 4 engines. The first is the knock system. It is active above idle after a minimum temperature and run time have been met. It can retard timing up to approximately 10 degrees based on input from the knock sensor. The other system is the octane rating system which only operates in the upper 1/3 of the power band. The octane rating system fine tunes the spark advance under high RPM high load conditions. The octane rating system works as follows.

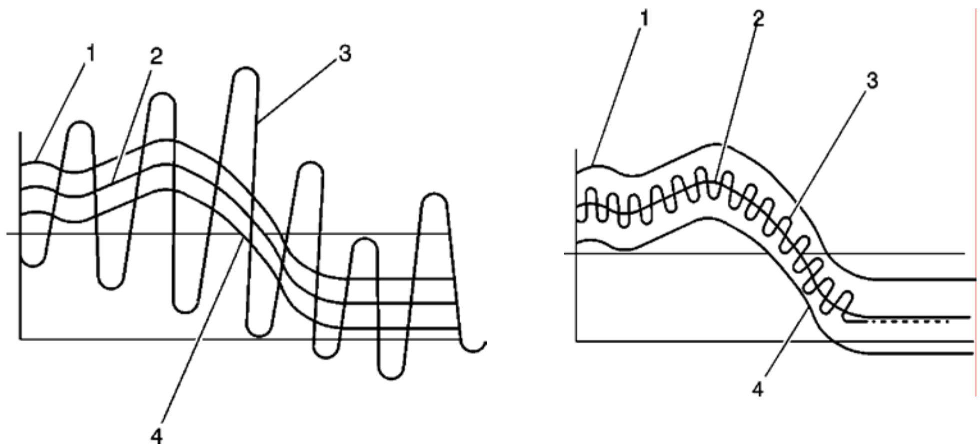
The MEFI 4 system has 2 spark tables, one for high octane (approx 93) and one for low octane (approx 87). Once the engine is above a certain temp, a run timer has timed out and the engine is in the upper 1/3 of RPM and load rating for the engine, the octane rating system will fine tune the spark advance to obtain the optimum spark timing for that particular operating condition. The 2 tables are based on RPM and MAP.

As an example, one engine's high octane table may show 29 degrees of spark advance at 4600 rpm with 3" of vacuum in the intake. The low octane table for the engine's same operating condition may show 26 degrees of spark advance. Once the octane rating system is active, as the knock sensors show that the cylinders are knocking, the ECM will step timing down from 29 towards 26 degrees to make the knock go away. After the knock is gone, the system will start advancing the timing back towards 29 degrees until the knock sensor just starts to indicate knock. The system will always try to maximize spark advance to where knock just starts to be indicated.

All of this shows up on the scan tool and Diacom under octane rating. 100% means that the value from the high octane table is being used and 0% means that value from the low octane table is being used. Obviously, ratings between 0 and 100% are using values between the high and low table values.

MEFI Fuel Injection

Knock Sensor Diagnostics

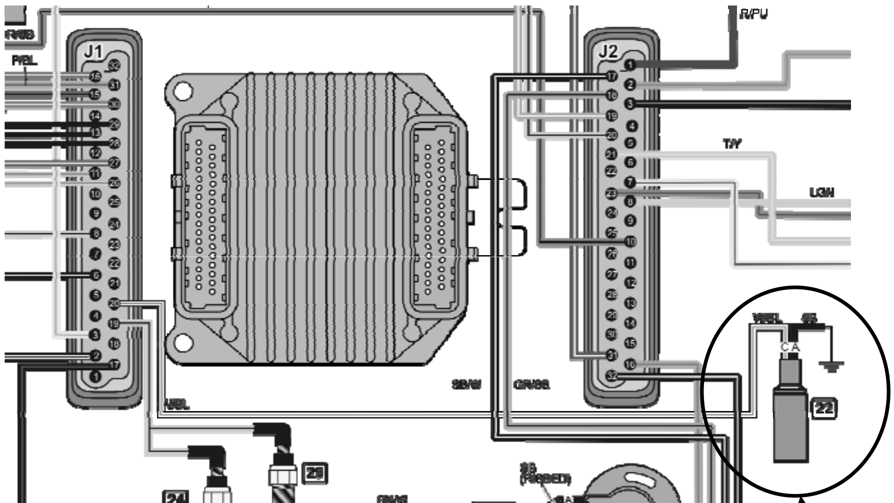


Normal **Abnormal**

The ECM checks the knock sensor and related wiring by comparing the actual knock signal to the assigned voltage range. A knock sensor signal (#3 in the above diagrams) should vary outside the assigned voltage range (#1 is the upper limit and #4 is the lower limit) as shown in the normal KS (knock sensor) figure. If the ECM detects a KS signal within the assigned voltage range as shown in the abnormal KS figure, then a code 44 is set for the affected knock sensor.

Technician diagnostics for the sensor and circuit include checking continuity through the sensor and circuit, and hooking up an AC voltmeter or an oscilloscope to the sensor and gently tapping on the sensor with a metal object. Tapping on the sensor should produce an AC voltage on the voltmeter.

Shift Interrupt Input



Shift interrupt connector

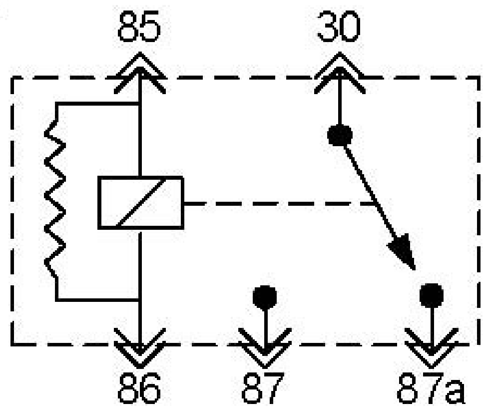
The shift interrupt input is only used in high horsepower DPX applications (DPX 375, 420, 500 and 600). The white with a blue tracer wire from ECM connector J1 pin 20 has 11-11.5 volts on the wire supplied from the ECM. The ECM watches for this voltage to be pulled to ground. If the vessel is equipped with a shift interrupter switch, it is located in the shifter assembly. As the shifter is moved from neutral towards clutch ahead or astern, the switch closes and grounds the circuit. By the time the shifter has reached the clutch position the switch is again open. When the ECM sees this input it then looks at throttle position and engine RPM. If the engine is at idle, the ECM kills half of the injectors in order to reduce torque output of the engine during the shift.

To summarize: any time the circuit is pulled to ground <u>AND</u> the engine is at idle (closed throttle), the ECM will kill half the injectors.

This connector looks identical to the trim sender connector and sometimes gets plugged into the trim sender. This will cause a loss of half of the injectors at closed throttle when the drive is trimmed down.

MEFI Fuel Injection

Relays



ISO Relays

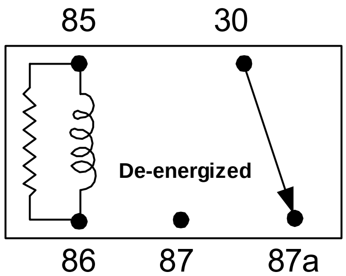
Click to view

All ISO relays are wired in this manner. Pins 85 and 86 are the control circuit for activation of the relay. When the relay is de-energized, pin 30 is connected to pin 87a. Once 85 and 86 have power and ground, the relay is then energized and pin 30 is now connected to pin 87. See the ISO Relay sheet for relay pin configurations for the relay and the receptacle.

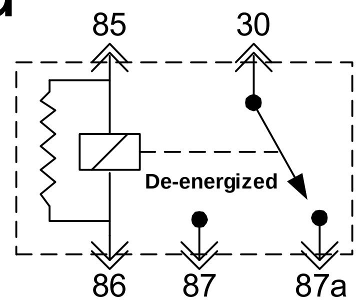
In standard ISO relay wiring, pin 86 is power for the control circuit and pin 85 is the ground for the control circuit. Pin 30 is connected to B+ for the load path and pin 87 is the power supply circuit for the load that the rely operates.

Relays are used so that high current circuits can be controlled by low current circuits. The ECM can handle the relatively low current of the relay control circuit, but not the high current flow that the load (such as the fuel pumps) carries.

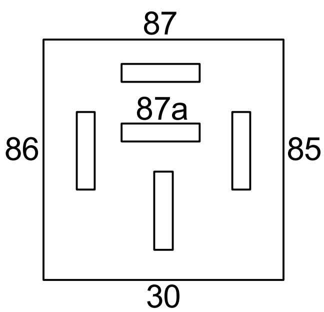
ISO Standard Relays



Old Symbol

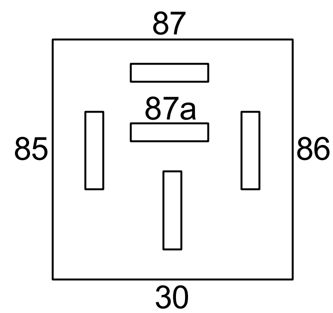


New Symbol

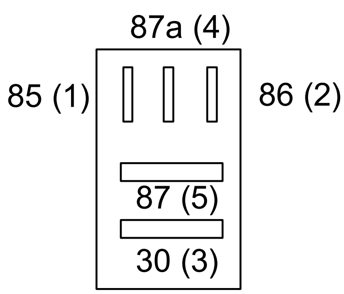


Bottom View of Relay

Full ISO

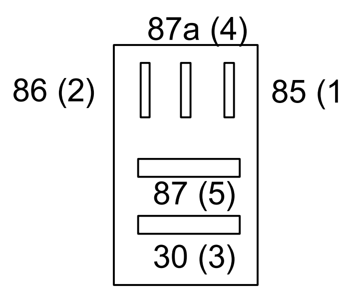


View of Connector

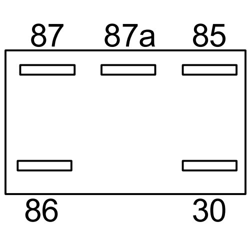


Bottom View of Relay

Half ISO

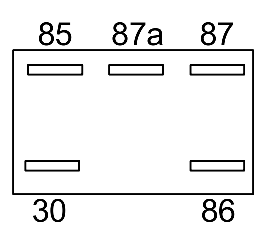


View of Connector



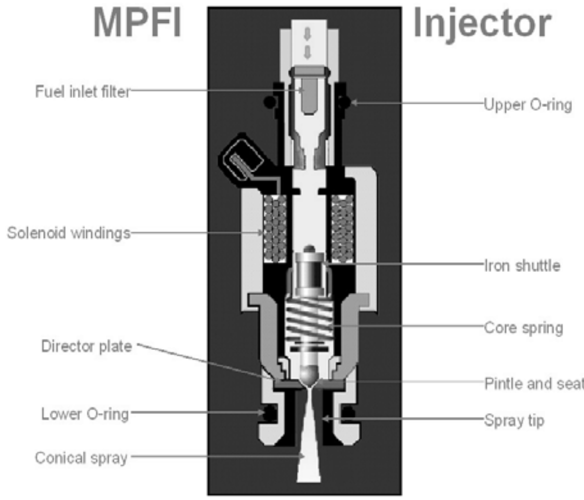
Bottom View of Relay

Half ISO



View of Connector

Fuel Injector

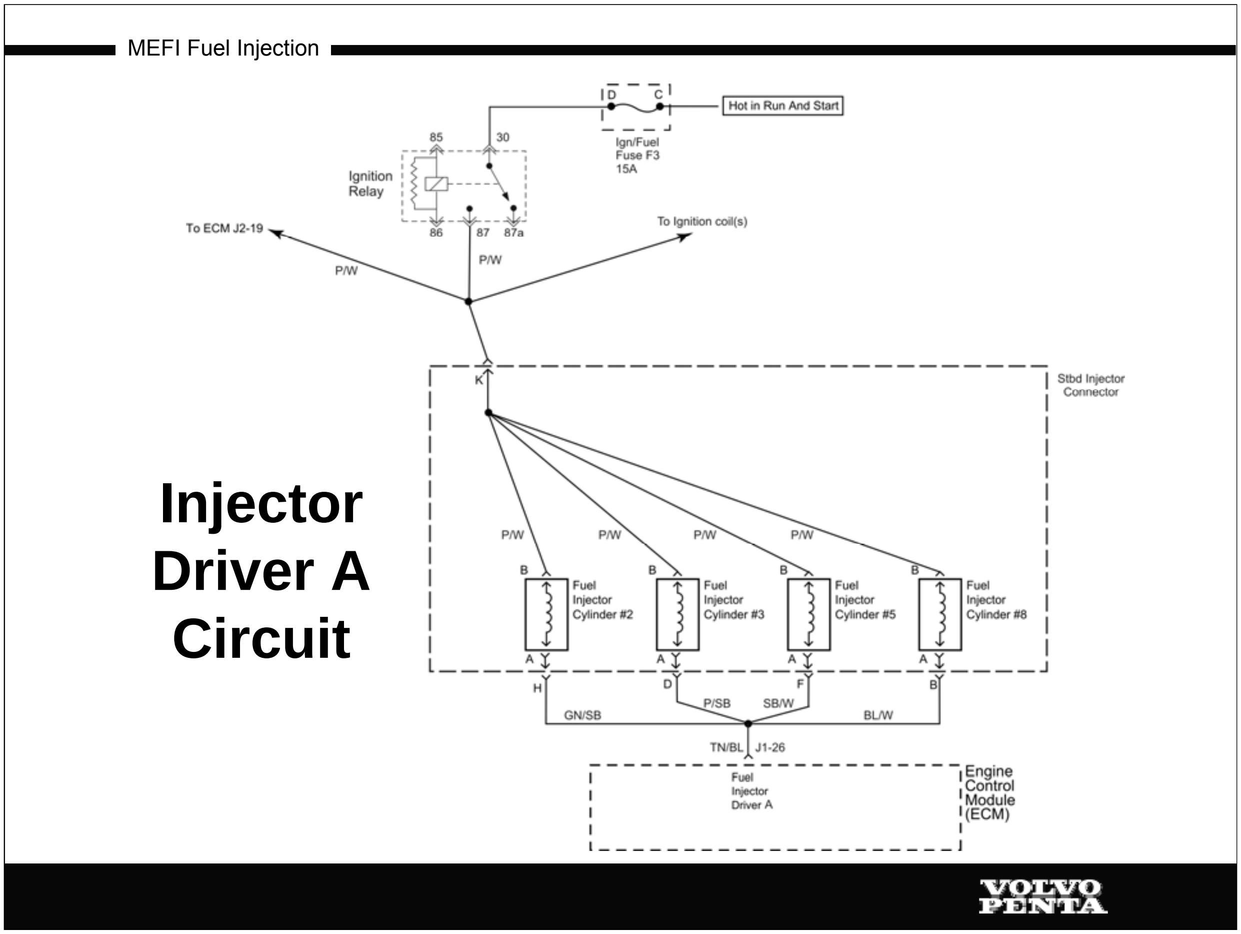


03-04 wiring sample

Click to view wiring

VOLVO PENTA

Fuel injectors are electric solenoids. They are spring loaded closed and opened electrically. They are supplied voltage from the Ignition relay and are grounded by the ECM. There are only 2 fuel injector drivers for the MPI engines. Four injectors are fired by each driver. All four on each driver are fired at the same time. The amount of time (in milliseconds) that the injector is grounded is the amount of time the injector is open. This is the injector's pulsewidth.

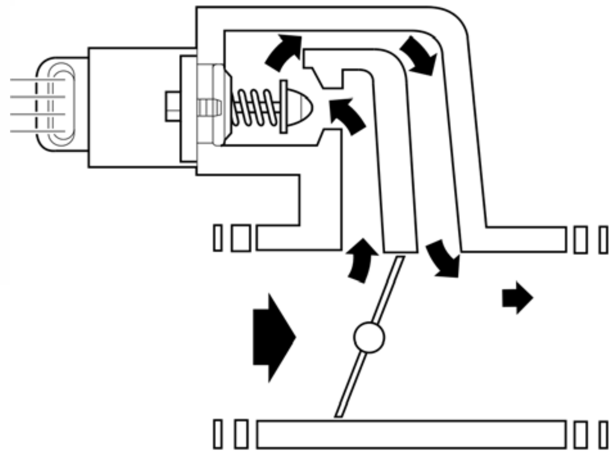


The diagram above shows the injector driver "A" circuit. The injector driver circuit is a "Low Side" driver meaning that the ECM controls the "Low" or ground side of the circuit. Each injector driver fires 4 injectors, 2 from each side of the engine. The injector driver B circuit drives the other 4 injectors.

There is only 1 fault code for each of the injector driver circuits, injector driver circuit A or B "High, Low or Open". This fault code is set by what the ECM "sees" on the driver circuit back at the ECM. There are 4 parallel circuits through the injectors in 1 driver circuit. For the fault code to set, the open has to be (in the diagram above) above the splice in the feed circuit or below the splice in the ground or driver circuit back to the ECM. If any injector has an open circuit in it, the code will NOT set. This is because there are still 3 more circuits (the other 3 injectors in that driver) carrying current. On the other hand, if the circuit is shorted to ground anywhere in the circuit, the fault will set. If the short is on the feed side, then the circuit protection device (fuse) will blow. If the short is in the ground or driver circuit, then the injectors will remain open with the key on until the injector coils melt and go open circuit (or short together and then blow the fuse).

Remember basic electricity; opens in parallel circuits only affect the leg that has the open. Short circuits affect the entire circuit.

Idle Air Control Valve (IAC)



One of the major benefits of an EFI engine is its ability to maintain proper idle speed. The ECM will immediately compensate for increased load by providing additional fuel, air and spark timing, thereby maintaining proper idle rpm. Adding fuel is easy, the ECM simply holds the injectors open longer. Adding air, however, is a bit more complicated. On GM based EFI systems this is accomplished with a computer controlled motor in the throttle body. This motor is called an Idle Air Control motor (IAC). It is used along with a spark scatter strategy to control idle speed.

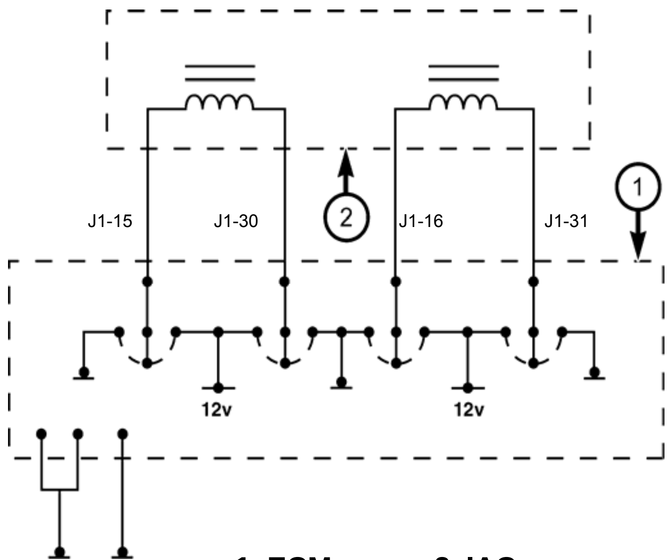
An IAC is a stepper motor, the ECM controls the movement by sending voltage pulses to the IAC's 2 coils, thereby causing the motor to take one or more steps in a particular direction. As the IAC opens, more air is allowed to bypass the throttle blade, increasing idle speed. As the IAC is closed, less air bypasses the throttle blade, reducing idle speed.

The ECM "tracks" the intended IAC position by counting the step pulses it has sent the motor. Since the IAC does not provide "feedback" to the ECM indicating its actual position the ECM must "reset" the IAC periodically to ensure that it is where the ECM believes it to be. On most MEFI 4 ECM's, once per key cycle the ECM will "reset" the IAC by driving it in the closed direction for a predetermined length of time followed by driving it in the open direction for another predetermined length of time and then returning it to the desired number of steps. Additionally, each time the the ignition key is turned off, the ECM remains electrically active for several seconds. One of the actions it performs during this period is it "parks" the IAC at a predetermined location in anticipation of the next start. At the next "key on" the ECM will move the IAC either open or closed from the park position based on ECT input.

MEFI 4 and 4b engines perform an IAC reset (full closed to full open and back to preset position) the first time 2500 RPM is achieved each key cycle.

MEFI Fuel Injection

IAC Circuit



1. ECM **2. IAC**

IAC motors are a different breed of DC motor and require a special electronic circuit to rotate. An IAC cannot be connected directly to a battery to operate.

The IAC has 2 internal coils and 4 external connections. The 2 internal coils are commonly referred to as Coil A and Coil B. The 2 coils are identical. The IAC has an internal permanent magnet, but unlike most DC motors, no brushes or commutator to wear or replace.

The ECM commands the IAC to turn CW or CCW by applying an alternating DC voltage in a specific sequence to the 2 coils through H drivers. The 2 H driver circuits act like 2 sets of 2 switches. By controlling the voltage polarity on each coil, the ECM causes the IAC to step in the desired direction. When voltage is set to both drivers (one at a time) in one direction (polarity), the IAC steps in one direction, one step at a time. When the 2 drivers are operated in the opposite polarity (one after the other), then the IAC is stepped in the opposite direction. On some engines the total number of allowed steps is 145, on others it is 245 steps.

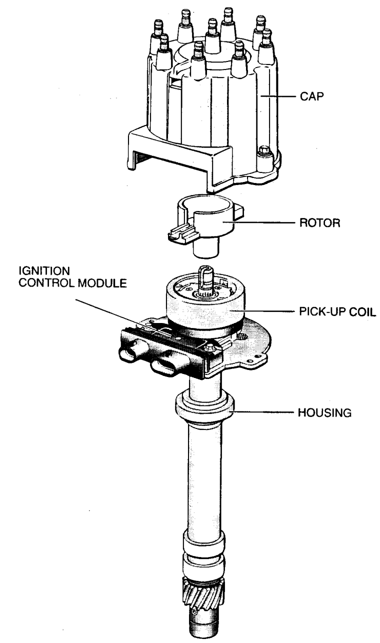
MEFI 4 engines also have an anti-stall program called “IAC follower”. This is an IAC count in addition to the actual IAC steps. When this program is active, the “IAC follower” must count down to 0 before the IAC is moved in the closed direction.

On a diagnostic scan tool, the “IAC Position” value reflects the ECM’s assumed position of the IAC. The key word being ASSUMED.

Failure of the IAC motor or circuitry will NOT set a code.

Ignition Systems:
Delco Distributor Ignition
(Carbureted, TBI and 7.4/8.2L MPI)

Delco Distributor Ignition



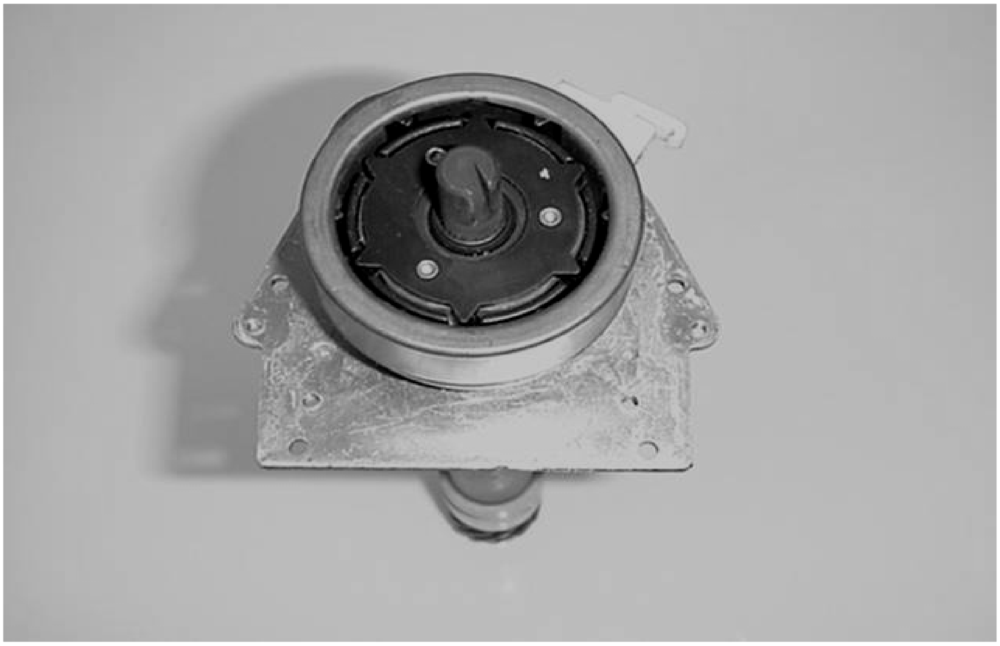
All Delco distributor ignition (DI) systems include these essential components: battery,distributor, ignition coil, ignition switch, spark plugs,primary and secondary wiring. The DI system is connected to the ECM. The ECM monitors various engine sensors, computes the desired spark timing and signals the ignition control (IC) module in the distributor to change timing.

The high energy ignition (HEI) distributor is made up of a housing, an IC module, a pick-up coil assembly, a rotor and a cap.

The distributor used on marine engines is designed for the marine environment. The distributor base plate is equipped with 2 special vents to prevent fuel vapors from igniting.

This ignition system is used on carbureted, TBI and 7.4/8.2L MPI engines.

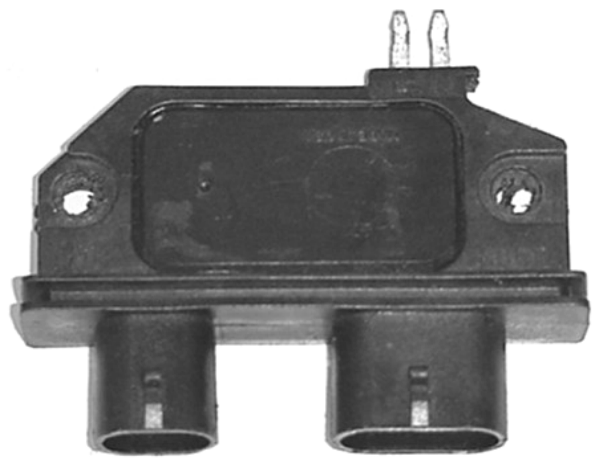
Pick-up Assembly



VOLVO PENTA

The pick-up coil assembly consists of a stationary pole piece with internal teeth, a pick-up coil and a magnetic timer core that rotates with the distributor shaft. When the teeth of the timer core align with the teeth of the pole piece, an AC voltage signal is induced. This AC voltage signals the ECM or the IC module to turn off the primary ignition current, which causes the magnetic field in the ignition coil to collapse, inducing high voltage in the secondary windings, producing a spark at the plugs.

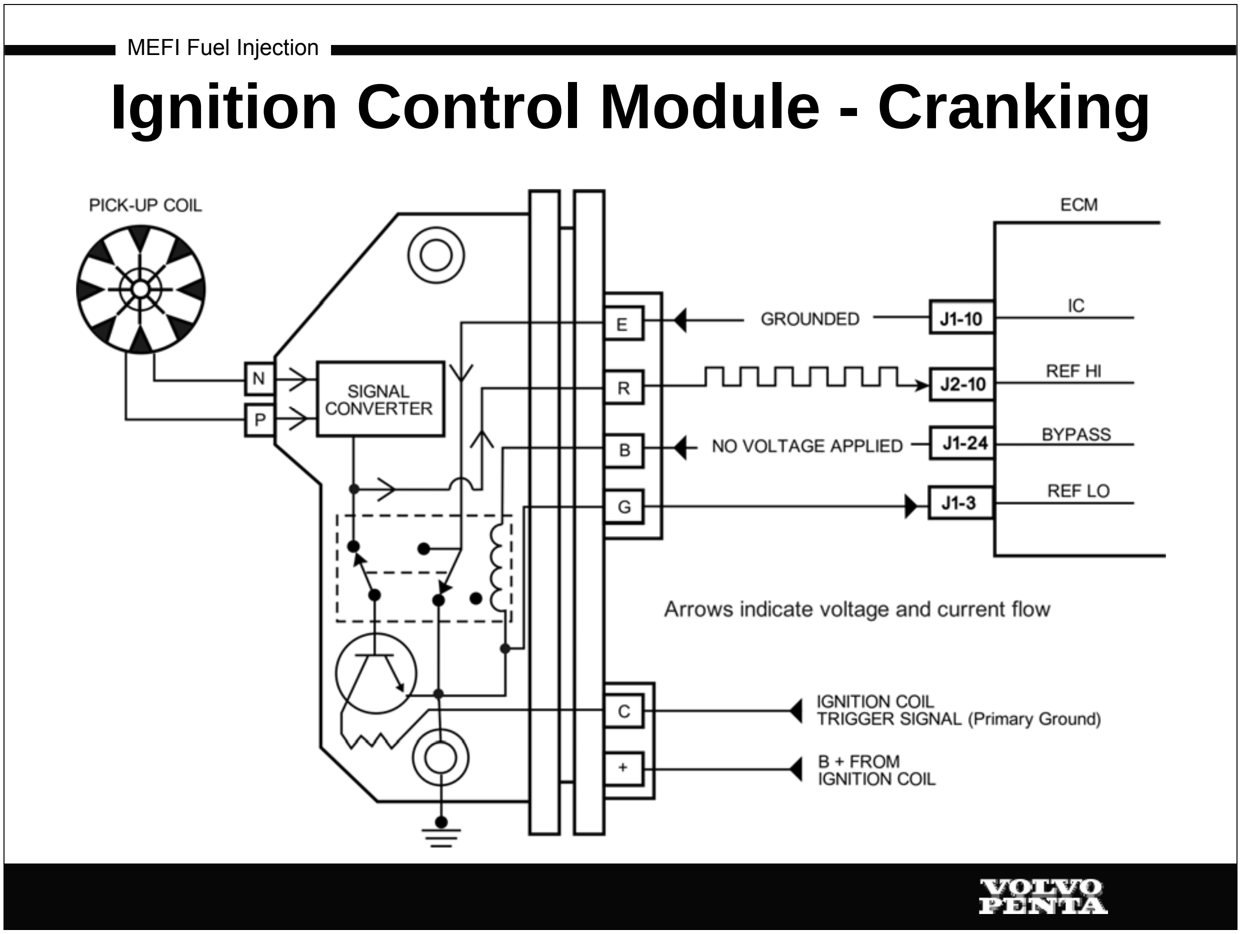
Ignition Control Module



The IC module is located in the distributor. It is mounted with 2 screws that are used as a ground. This module is a solid state device with transistorized relays and switches for controlling circuits.

The IC module has several functions:

1. It changes the AC signal, produced by the pick-up coil, into a digital square wave signal.
2. It sends the digital signal as a reference signal (Ref Hi) to the ECM for ignition and fuel injector control.
3. It provides a ground reference (Ref Lo).
4. It provides a limited means of controlling spark advance without ECM input, Module Mode (crank mode).
5. It provides a means for the ECM to control spark advance, Ignition Control Mode (running mode).
6. It provides the trigger signal for the ignition coil.



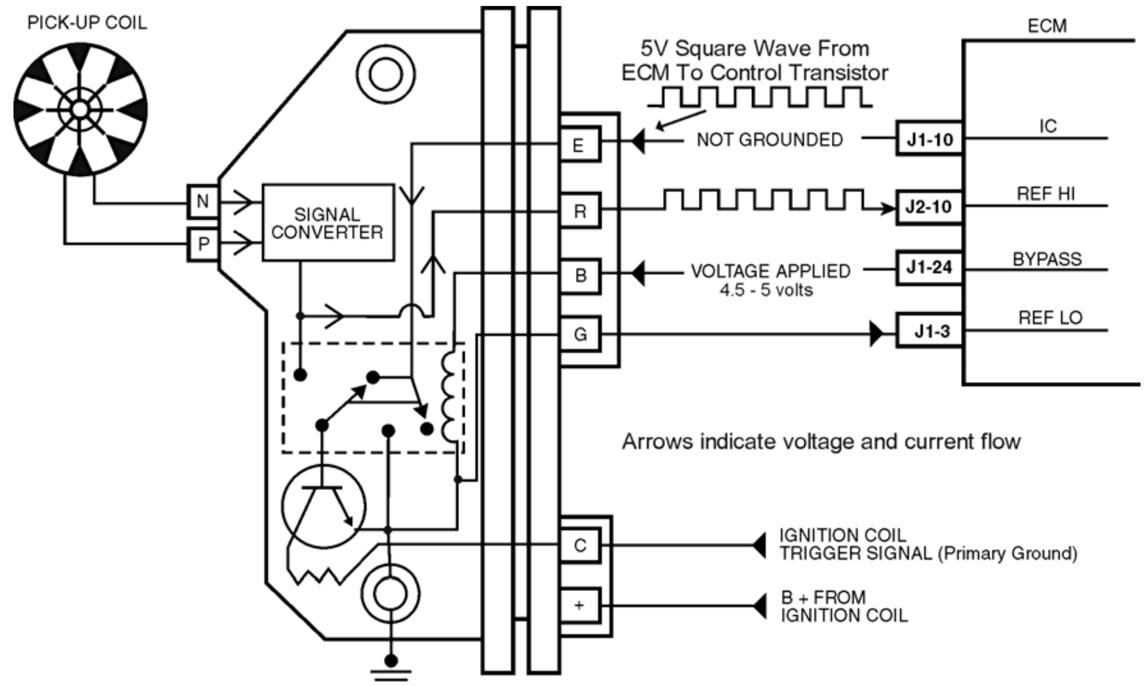
The picture above describes IC operation during cranking. To help understand how the circuit operates, a relay with a double set of of contacts is shown inside the IC module. Actually solid state circuitry is used, but for illustration purposes a relay makes it easier to visualize and explain.

Module Mode (cranking mode)

During cranking, the relay is de-energized, allowing a set of contacts to connect the pick-up coil to the base of the transistor. When the pick-up coil applies a positive voltage the transistor turns “on”, when voltage is removed the transistor turns “off”. When it is off the primary current stops and a spark is developed. Cranking is defined as RPM below 400, at this time the ECM has grounded the IC line at terminal “E” and has no voltage applied to the by-pass line at terminal “B”. At this point the IC module has ignition control.

A small amount of advance is built into the IC module, in case the engine remains or defaults to module mode.

Ignition Control Module - Running

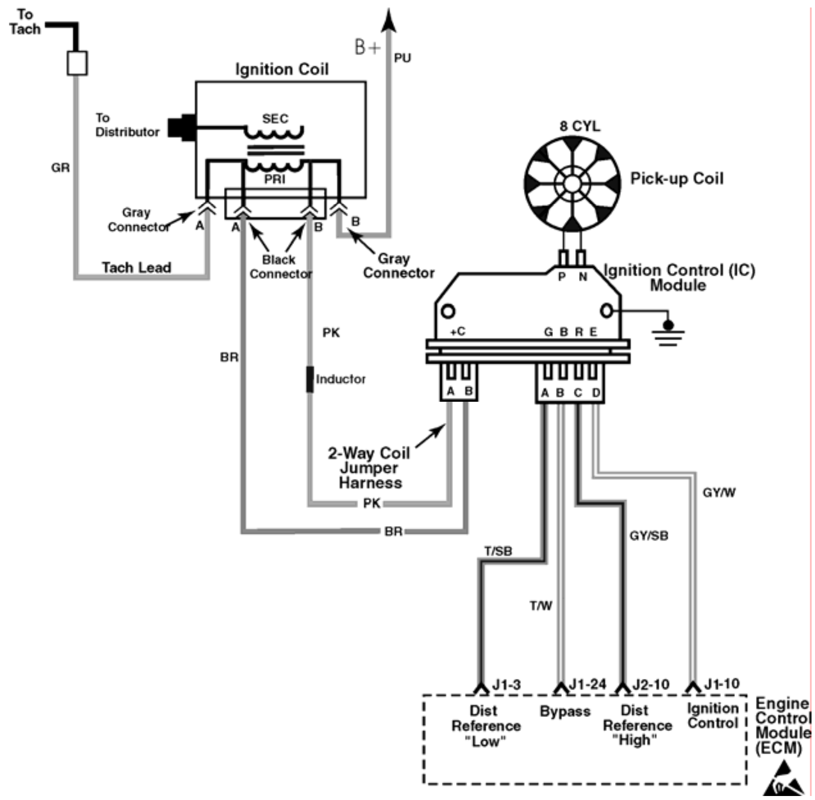


Ignition Control Mode (running mode)

When the RPM exceeds 400, the ECM considers the engine running and applies 5 volts on the by-pass at terminal "B". This energizes the "relay" and causes the contact to open, this un-grounds the IC line and connects it to the base of the transistor. This switches ignition control to the ECM. Now the ECM is sending the trigger signal to the base of the transistor over the IC circuit and controlling the firing of the ignition coil primary circuit.

The Ref Lo signal at terminal "G" is a ground. This is the low current ground or return back to the ECM for the electronics in the IC module. The high current that comes from the ignition coil gets grounded through the module mounting bolts. It is important that there is a good ground through these bolts. A poor ground will result in a poor running engine.

See page 4-6 in the "EF" manual or pages 38 and 39 of 742218 manual for results of incorrect operation such as an open IC line or grounded IC line, etc.



MEFI 3 Ignition System

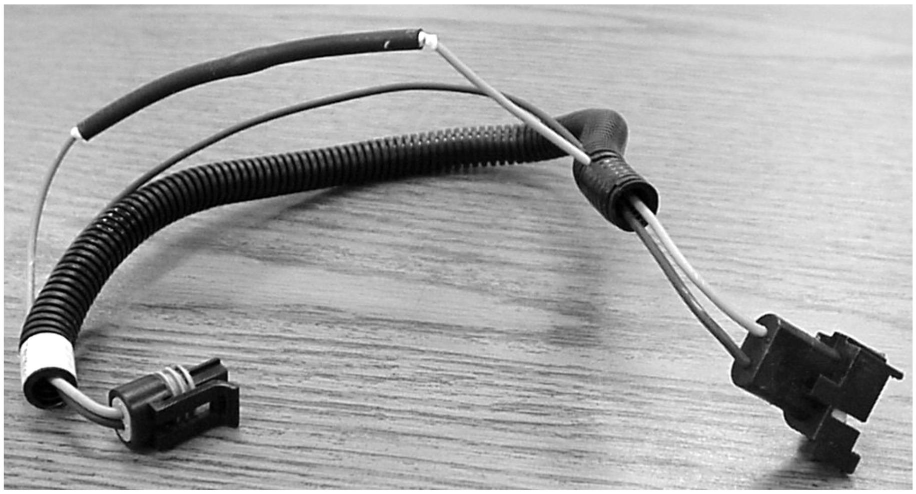
The ignition coil has 2 connectors, one black and one gray. The black connector has the power feed back to the ignition module and the ignition coil primary ground circuit. The power feed to the ignition module is pink and the primary ground is brown. The gray connector contains the power feed for the ignition coil and the tach lead. The power feed for the ignition coil is purple and the tach lead is gray. The purple wire is the output from the ignition relay.

Current flows into the ignition coil through the purple wire, through the primary winding and on to the ignition module via the brown wire. Current is also supplied out of the coil on the pink wire to power up the IC module. The IC module high current ground is through the mounting bolts. Loose mounting bolts can cause a poor running engine due to weak spark.

When the IC module grounds the brown wire the coil is saturated and builds up a large magnetic field. When the IC module or the ECM want to fire the ignition coil, the IC module shuts down the current flow in the primary and that induces a high voltage into the secondary winding that is supplied to the distributor.

MEFI Fuel Injection

Inductor Wiring Harness



VOLVO PENTA

The primary circuit pink wire, between the the ignition coil and the distributor 2 wire plug, contains an inductor to protect boat electronics against Electro-Magnetic Interference (EMI) generated by the ignition system itself.

If the inductor fails (open circuit), then power to the Ignition Module in the distributor will be lost. The engine will die and will not restart. Check the pink wire for continuity. Occasionally the wire breaks and intermittently opens the circuit, depending on the movement or location of the harness. If this happens, the engine may misfire or shutdown, but may restart.

Ignition Systems: 8.1L Distributorless Ignition System

(Coil Near Plug, MEFI 4)

VOLVO PENTA

8.1 Gi/GXi

Ignition Components

•One coil per cylinder

•Coil assemblies are interchangeable

The 8.1L engine is the only engine we have at this time that uses the distributorless ignition system.

This systems consists of 8 individual ignition coils, 8 individual ignition control circuits, a camshaft position sensor(CMP) and a crankshaft position sensor (CKP).

There is an IC circuit for each coil, each circuit is connected to the ECM. The ECM triggers each coil and makes all the timing decisions.

The ignition timing is not adjustable, there are no timing marks on the balancer or the timing chain cover.

Failure of an IC circuit will set DTC 41.

The 8 ignition coils are individually mounted above each cylinder on the rocker covers, the coils are fired sequentially.

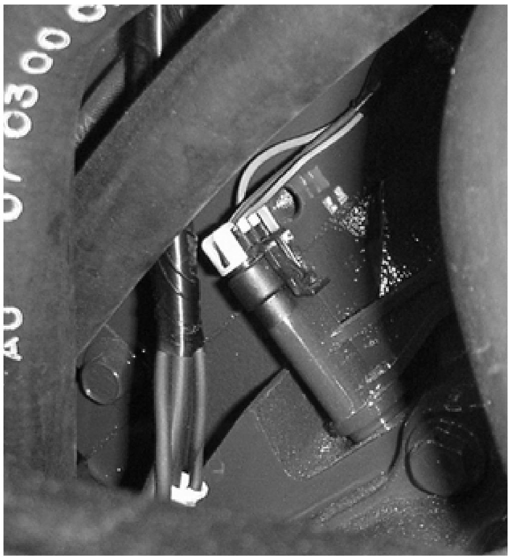
The coils secondary output voltage is very high, more than 40,000 volts.

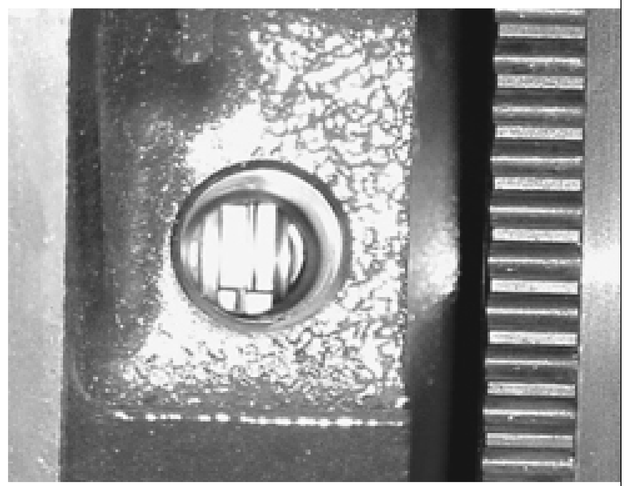
The assembly is completely interchangeable, coils are identical and wire colors are duplicated.

8.1 L

Ignition Components

Crankshaft Position (CKP) Sensor





Reluctor wheel permanently mounted to crankshaft

VOLVO PENTA

The 8.1 crankshaft position sensor (CKP) is located on the left rear of the engine block. It is a magneto resistive type sensor. The CKP works in conjunction with a 24x reluctor wheel.

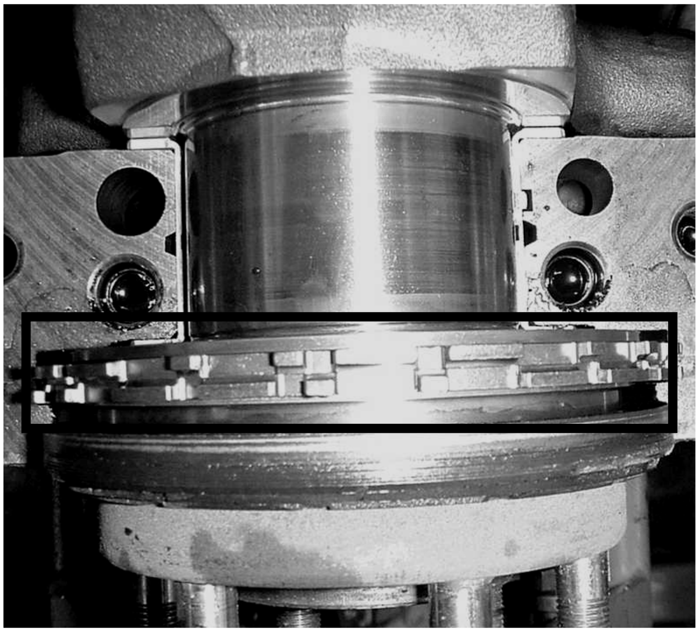
As the crankshaft rotates, the reluctor wheel teeth interrupt a magnetic field produced by a magnet within the sensor. The CKP then outputs a 24x signal to the ECM.

The ECM then uses this signal to accurately measure crankshaft velocity which is a variable used in order to detect misfire, control spark and fuel.

The crankshaft position sensor is installed to contact reluctor wheel and wear to the correct clearance gap.

All CKP signals are output as a digital waveform.

8.1 L
Ignition Components
Reluctor Wheel



•**Permanently pressed onto crankshaft**

•**Gives exact position of crank within each 90 degress of its rotation**

•**Sensor is installed to contact wheel and wear to correct air gap**

VOLVO PENTA

The 24x reluctor wheel is permanently pressed onto the rear of the crankshaft.

The wheel uses 2 different width notches that are 15 degrees apart. This pulse width encoded pattern allows cylinder position identification within 90 degrees of rotation, in some cases, within 45 degrees. The wheel also has dual track notches that are 180 degrees out of phase, this design allows for quicker starts and accuracy.

If the CMP input is lost before cranking the engine, the engine will still start, but starts in a waste spark mode. This means that 2 ignition coils are fired at one time. The coils will be on companion cylinders. Companion cylinders on the 8.1L are 1 and 6, 8 and 5, 7 and 4, and 2 and 3. One of the 2 cylinders being fired will be on the compression stroke and the other will be on the exhaust stroke. Loss of the CMP input does not affect injector firing.

8.1Gi/GXi

Camshaft Position (CMP) Sensor

•Reads Cam position each 180 degrees

Detects half - moon slots cut in timing gear This is second generation gear

The camshaft position sensor (CMP) is mounted on the front of the engine.

The reluctor wheel has double (redundant) trigger machined into the front of the camshaft gear. The CMP senses the 1-tooth-per-revolution reluctor of the timing gear.

The CMP determines whether #1 cylinder is on the compression stroke or the exhaust stroke. It reads cam position within 180 degrees.

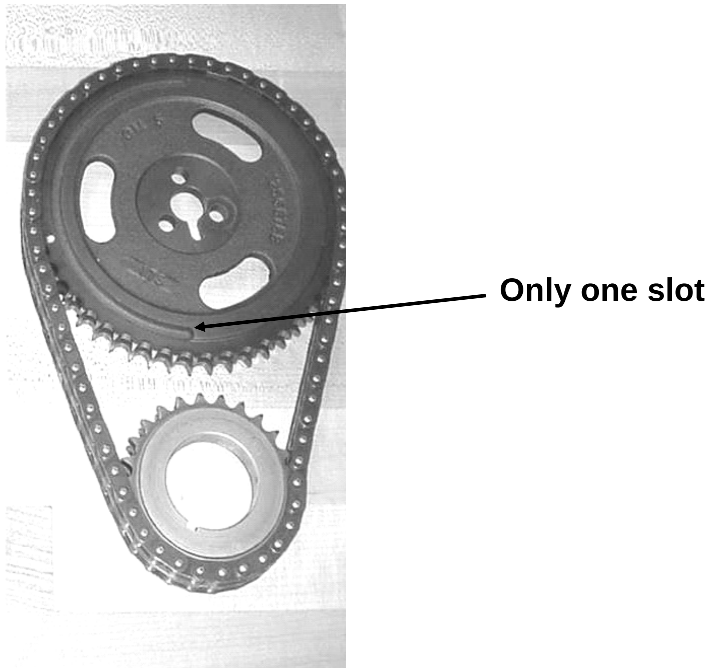
As the camshaft rotates, the reluctor interrupts a magnetic field produced by the sensor. The sensor’s internal circuitry detects this and sends a signal to the ECM.

The ECM uses this 1x signal from the CMP sensor in combination with the 24x signal from the CKP sensor in order to determine crankshaft position and stroke.

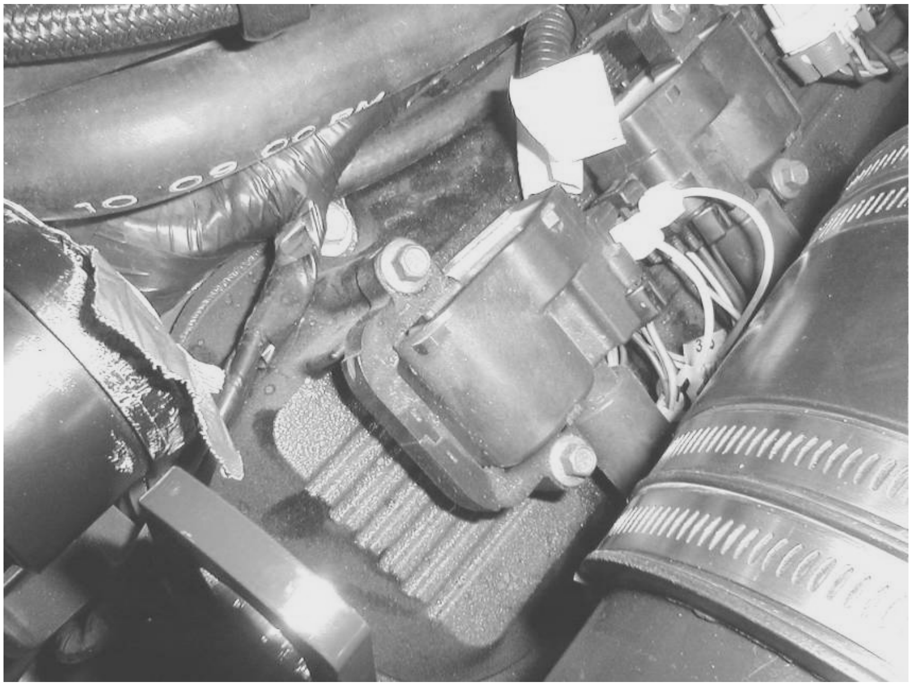
As long as the ECM receives the CKP 24x signal, the engine will start.

A failure of this sensor will set a DTC 81, Loss of CMP.

8.1L First Generation Gear



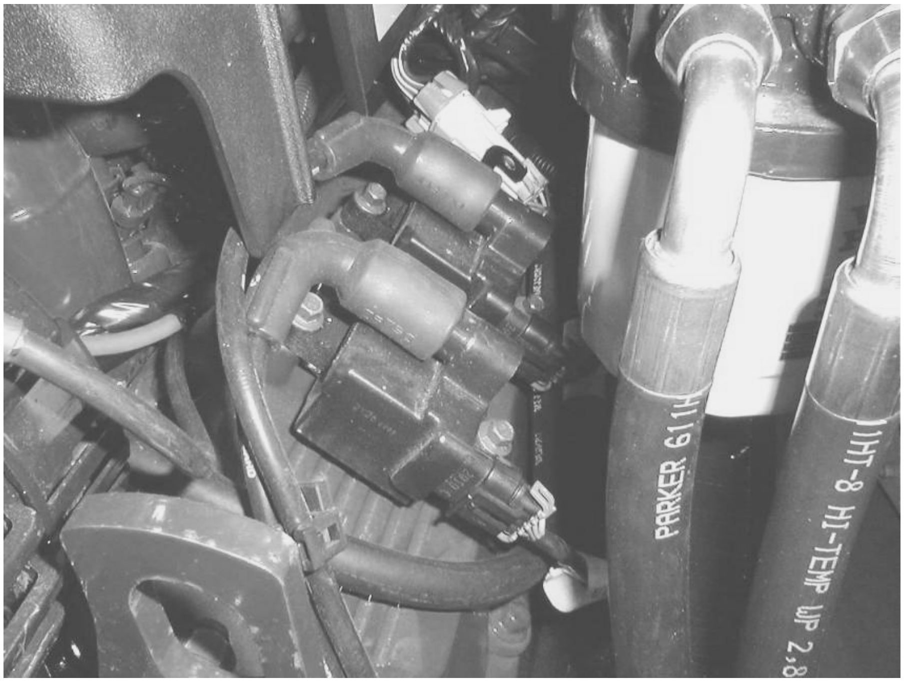
8.1L First Generation Ignition Coil



VOLVO PENTA

The first generation of ignition coils sat on black valve covers and the wire to the plug connected to the coil on the bottom of the coil (towards the plug).

8.1L Second Generation Ignition Coil



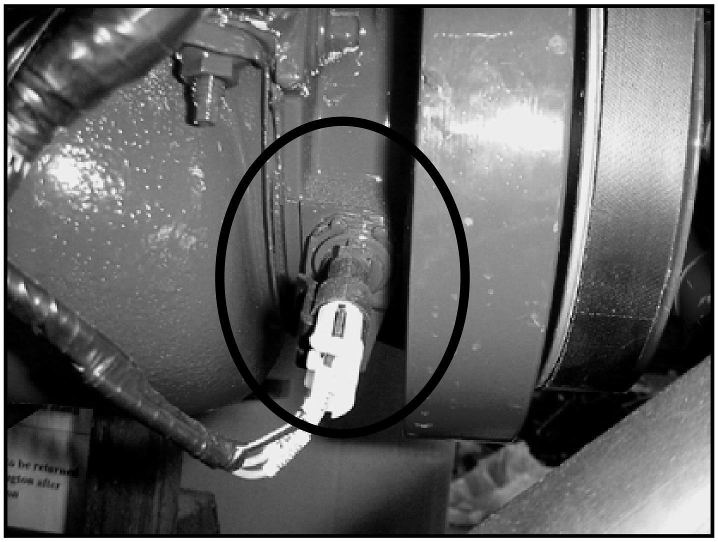
The second generation of ignition coils sit on red valve covers and the wire to the plug connects to the top of the coil (towards the center of the block). These 2 sets of ignition coils and valve covers are not interchangeable. The ECM software between the two systems are also incompatible.

All 8.1L long blocks come with these new style coils. If the engine being replaced has the first generation coils, then the ECM will need to have new software installed to correctly operate the new style coils. If this software is not installed, the engine will not run properly.

Ignition systems: High Voltage Switch Ignition System

(MEFI 4 and 4b, IAFM)

Crankshaft Position Sensor



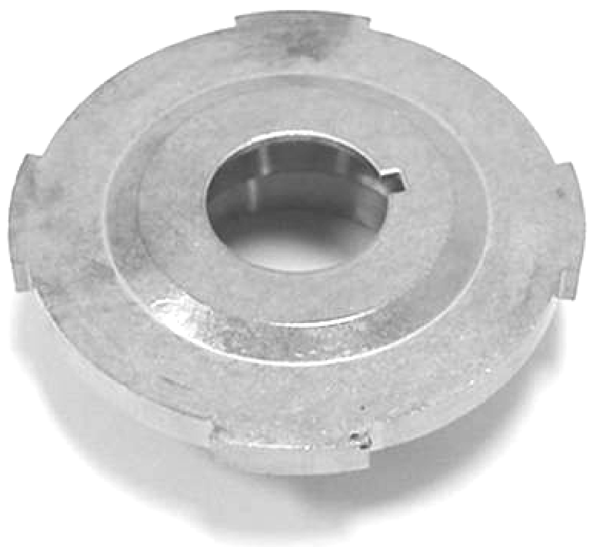
VOLVO PENTA

The crankshaft position sensor is mounted on the front of the engine, just behind the crankshaft balancer.

It is a magneto-resistive type sensor that works in conjunction with a 4x reluctor wheel.

The ECM uses the signal from the crankshaft position sensor, along with the camshaft position sensor signal for spark control, tachometer and fuel control.

Crankshaft Position Sensor Reluctor Ring



VOLVO PENTA

This 4x reluctor ring is positioned onto the front of the crankshaft, note the key for proper wheel alignment.

MEFI Fuel Injection

High Voltage Switch

The High Voltage Switch looks and more or less acts like a distributor. It distributes the high voltage from the coil to the spark plugs, it also contains the camshaft position sensor.

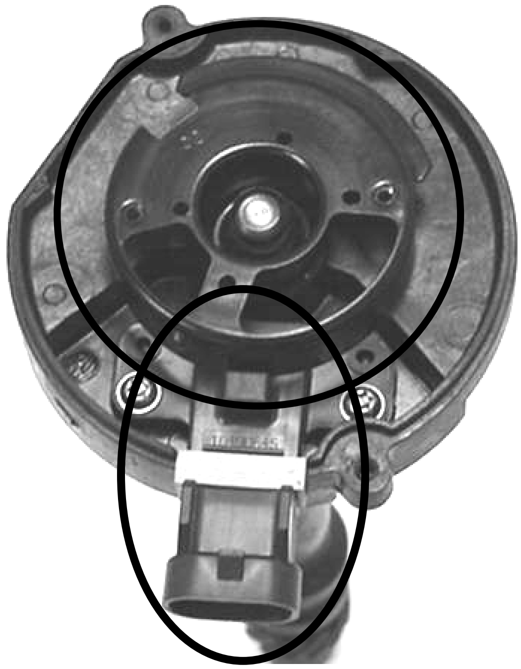
The High Voltage Switch ignition system is used on our new MEFI 4 IAFM engines.

This system features a camshaft driven distributor, an ignition control module, a crankshaft position sensor, a camshaft position sensor, and an ignition coil.

The distributor has a composite base which incorporates the camshaft position vane switch and a rotary vane cup.

The ECM takes the input signal from the cam and crank sensors, outputs an ignition control signal to the ignition control module, the IC module then triggers the coil.

Camshaft Position Sensor

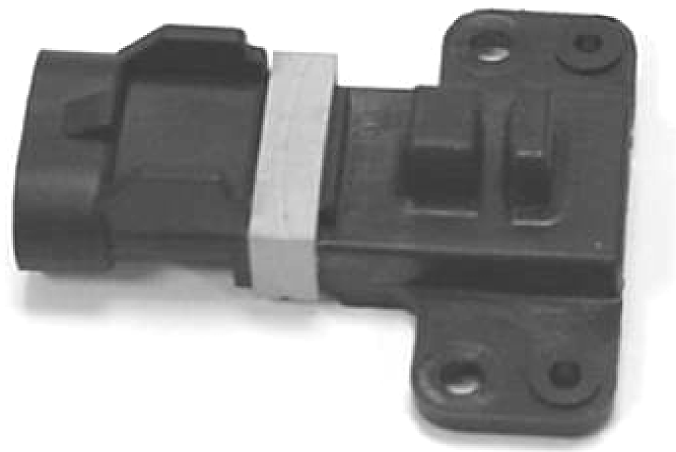


VOLVO PENTA

The camshaft position sensor works by using a magnetic vane switch assembly (green oval) and a rotary vane cup (red circle).

The rotary vane cup, made of ferrous metal, is used to trigger the signal on and off.

Magnetic Vane Switch Assembly



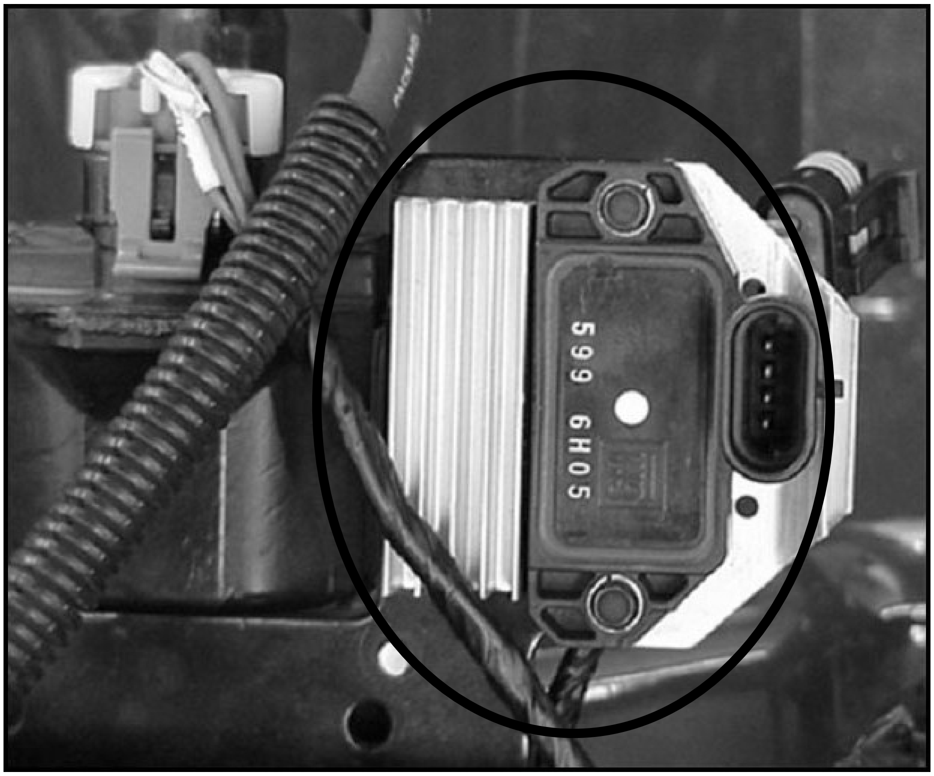
The vane switch (CMP) is an encapsulated package consisting of a pick-up on one side and a permanent magnet on the other side.

When the window of the vane cup is between the magnet and the pick-up, a magnetic field is completed between the pick-up and the magnet.

As a vane passes through the opening the field is shunted back to the magnet, during this time voltage is produced as the vane passes through the opening. When the vane clears the opening, the window edge causes the signal to go to 0 volts.

This signal is used by the ECM for camshaft position.

Ignition Control Module



VOLVO PENTA

The external ignition control (IC) module is mounted on a bracket with the coil on the back of the engine. This is a one piece assembly.

The IC module contains the coil driver. It receives an ignition timing signal from the ECM and triggers the coil.

Pin A…..Ignition Voltage

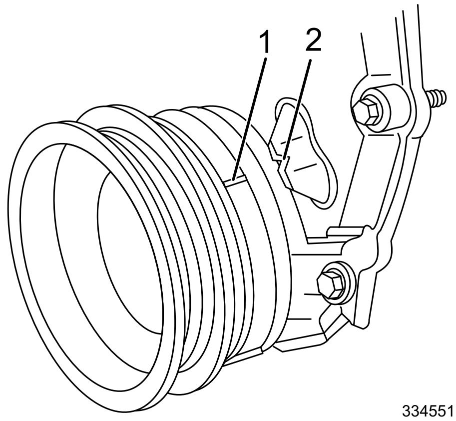
Pin B…..Ignition Timing Signal

Pin C…..Ground

Pin D…..Coil Driver

NOTE! If the crankshaft was moved while distributor was out, complete ignition timing procedure must be followed. See below.

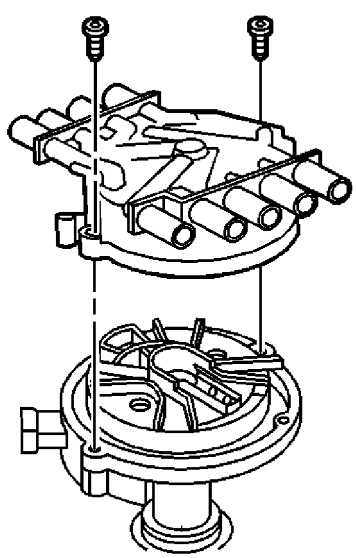
Gi and GXi models



334551

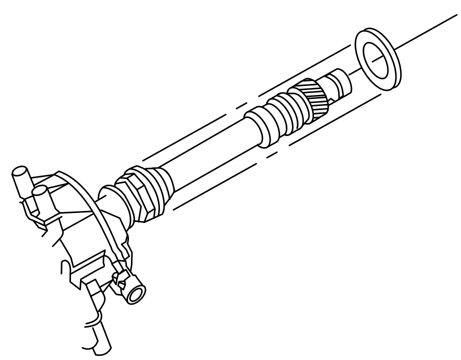
GL models: See *Electric, Fuel and Ignition Workshop Manual* 7743454.

1. Rotate the crankshaft balancer clockwise until the alignment marks on the crankshaft balancer (1) are aligned with the tabs on the engine front cover (2) and the number 1 piston is at top dead center of the compression stroke.



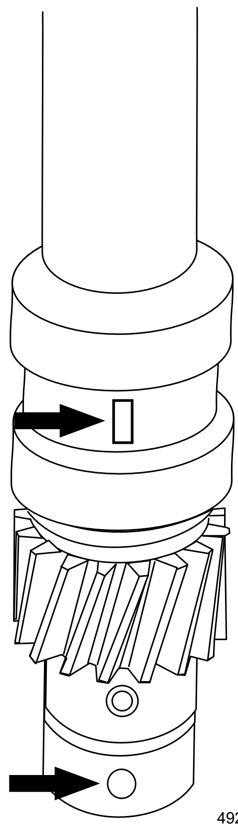
500690

2. If not already removed, remove and discard the distributor cap screws.
3. Remove the distributor cap

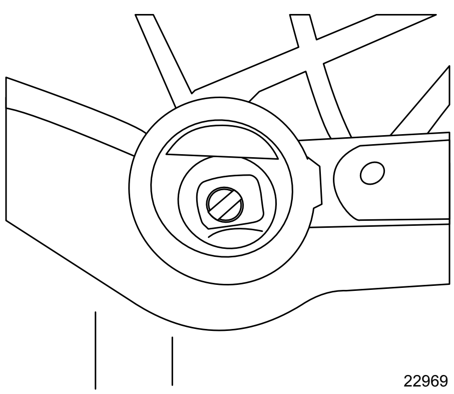


523516

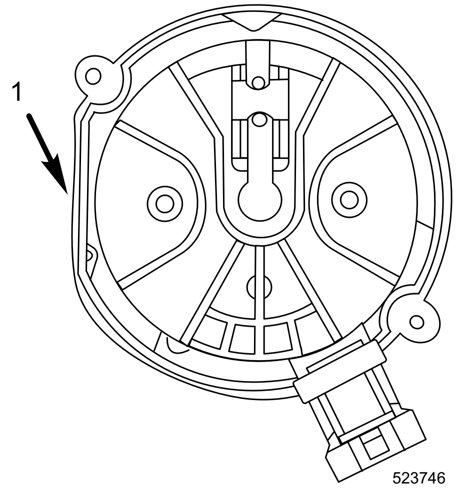
4. Install NEW distributor gasket onto the distributor.



5. Align the indent hole on the distributor gear with the paint mark on the distributor housing.

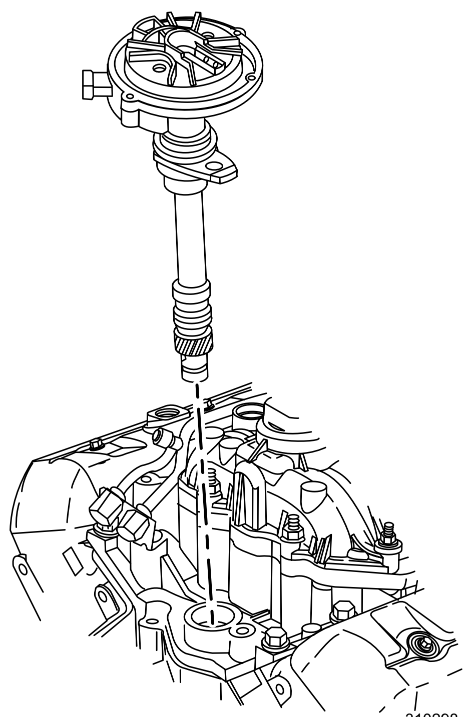


6. Align the slotted tang in the oil pump driveshaft with the distributor driveshaft. Rotate the oil pump driveshaft with a screwdriver if necessary.



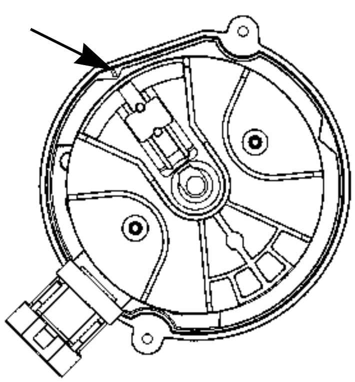
523746

7. Align the flat (1) in the distributor housing toward the front of the engine.



310298

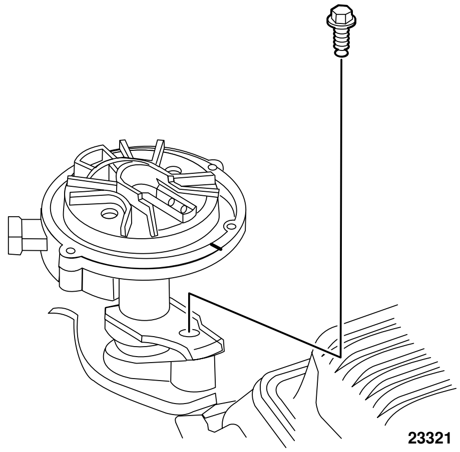
8. Install the distributor and distributor clamp. The flat in the distributor housing must be pointing toward the front of the engine.



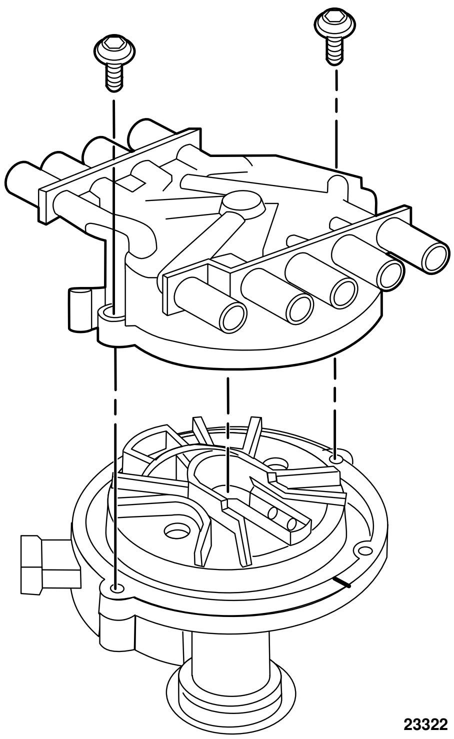
68505

9. Once the distributor is fully seated, align the distributor rotor segment with the number 8 pointer (1) that is cast into the distributor base.

Note! If the distributor rotor segment does not come within a few degrees of the number 8 pointer, the gear mesh between the distributor and camshaft may be off a tooth or more. Repeat the procedure again in order to achieve proper alignment.



10. Install the distributor clamp bolt. and Tighten the bolt to 25 N.m (18 lb. ft.).



11. Install the distributor cap and NEW distributor cap bolts.Tighten the screws to 2.4 N.m (21 lb. in).
12. Set timing, GL Models see *Electrical Fuel and Ignition Workshop Manual* 7743454. Gi and GXi Models see *EFI Diagnostic Workshop Manual* 7742218 *On Board Repair.*

Alternator with mounting bracket.

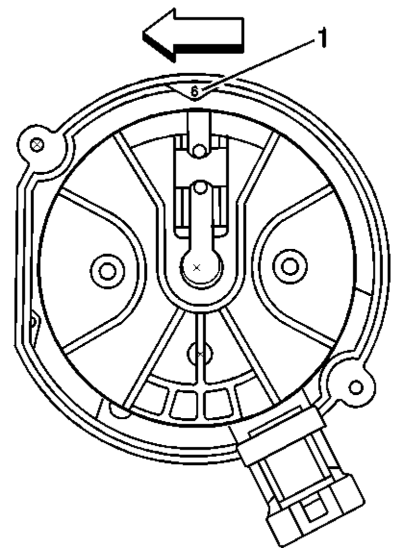
13. Install distributor cap and high tension leads. See the General Information section in Electrical/Ignition/Fuel Service Manual for correct firing order and spark plug wire routing.
14. Install oil pressure sending unit.

Connect:

15. All electrical connections. Apply black neoprene dip, or equivalent, on all exposed connections.
16. Fuel lines to carburetor and fuel pump or throttle body and fuel pump/vapor separator.
17. Throttle cable.
18. All water hoses, and close all drain petcocks.
19. Both crankcase ventilation hoses.
20. Battery cables.

9. Once the distributor is fully seated, align the distributor rotor segment with the number 6 pointer (1) that is cast into the distributor base.

   If the distributor rotor segment does not come with a few degrees of the number 6 pointer (1), the gear mesh between the distributor and camshaft may be off a tooth or more. Repeat the procedure again in order to achieve proper alignment.



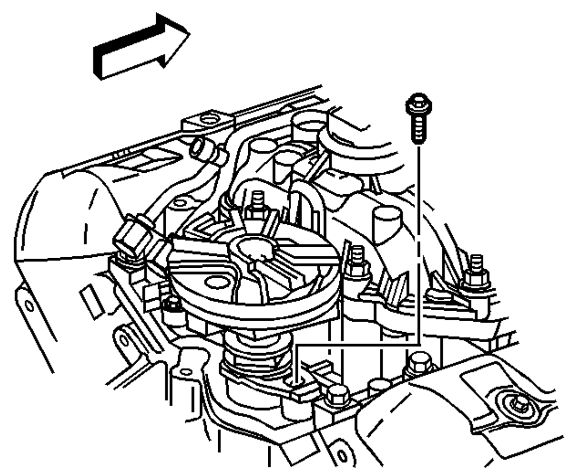
334555

Notice: Refer to *Fastener Notice* in Cautions and Notices.

10. Install the distributor clamp bolt.

    Tighten

    Tighten the distributor clamp bolt to 25 N·m (18 lb ft).



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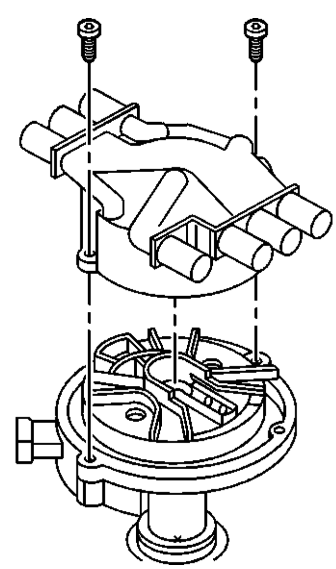
11. Install the distributor cap and NEW distributor cap bolts.

    Tighten

    Tighten the distributor cap bolts to 2.4 N·m (21 lb in).



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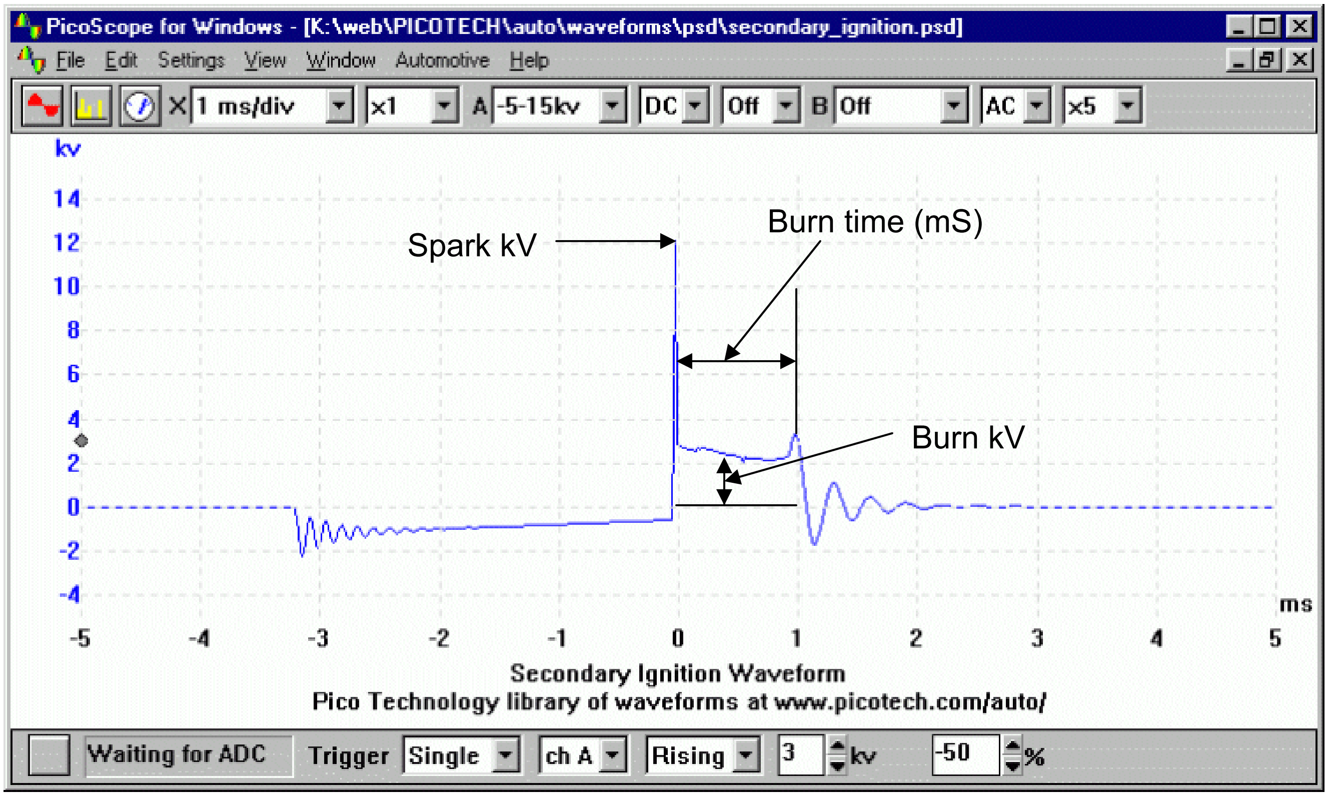


SECONDARY IGNITION

The secondary ignition waveform pictured above shows the 3 critical elements of the waveform. They are spark kV, burn kV, and burn time (in milliseconds). **Spark kV** is the amount of voltage required to start the spark across the plug gap. **Burn kV** is the amount of voltage required to keep the spark jumping the plug gap. **Burn time** is the amount of time (in milliseconds) the spark is jumping the plug gap.

All 3 of these elements vary with the manufacturer's design of the plug and the condition of the plug (i.e. gap, fouling. etc….). The most important element is that all cylinders should show approximately the same readings (within 25% of each other). Normal Spark kV readings are in the range of 4-17kV. Rich mixtures burn easier so the spark kV will be lower, lean mixtures require a higher kV to start the spark and maintain it. Wide plug gaps cause higher kV's and narrow plug gaps cause lower kV's. Plug or coil wires with high resistance cause higher kV's. As cylinder load increases kV's will increase, but the richer mixture at high load will keep them from rising much. Spark and burn kV's are tied together, as one increases or decreases the other will follow to some degree. Normal burn kV's range from about .5kV to 5kV.

Burn time is also called spark duration. Burn time is affected by the same elements as spark and burn kV's are (i.e. wire resistance, plug manufacturer, plug wear, mixture, etc..). Burn time normally ranges from about .5 to 2.5 mS in duration.

Primary/Secondary Ignition Testing

Problems in the secondary ignition system are indicated by high or low spark kV or burn kV and long or short burn time.

SECONDARY IGNITION TESTING

1. Hook up the supplied secondary ignition tester to the coil wire of the 5.0L or any plug wire on the 8.1L. Ensure there is a good ground for the alligator clip and that there is a minimum of ½ inch clearance between the inductive pickup of the tool and all other plug or coil wires.
2. Set the rotary switch on the kV tester to the Spark kV position. The left side of the screen reads the active reading in the wire. The right side of the screen shows the recorded minimum and maximum readings. To reset the readings turn the rotary knob to Off and then back to the desired function.
3. Test each plug wire and the coil wire and record your readings below.

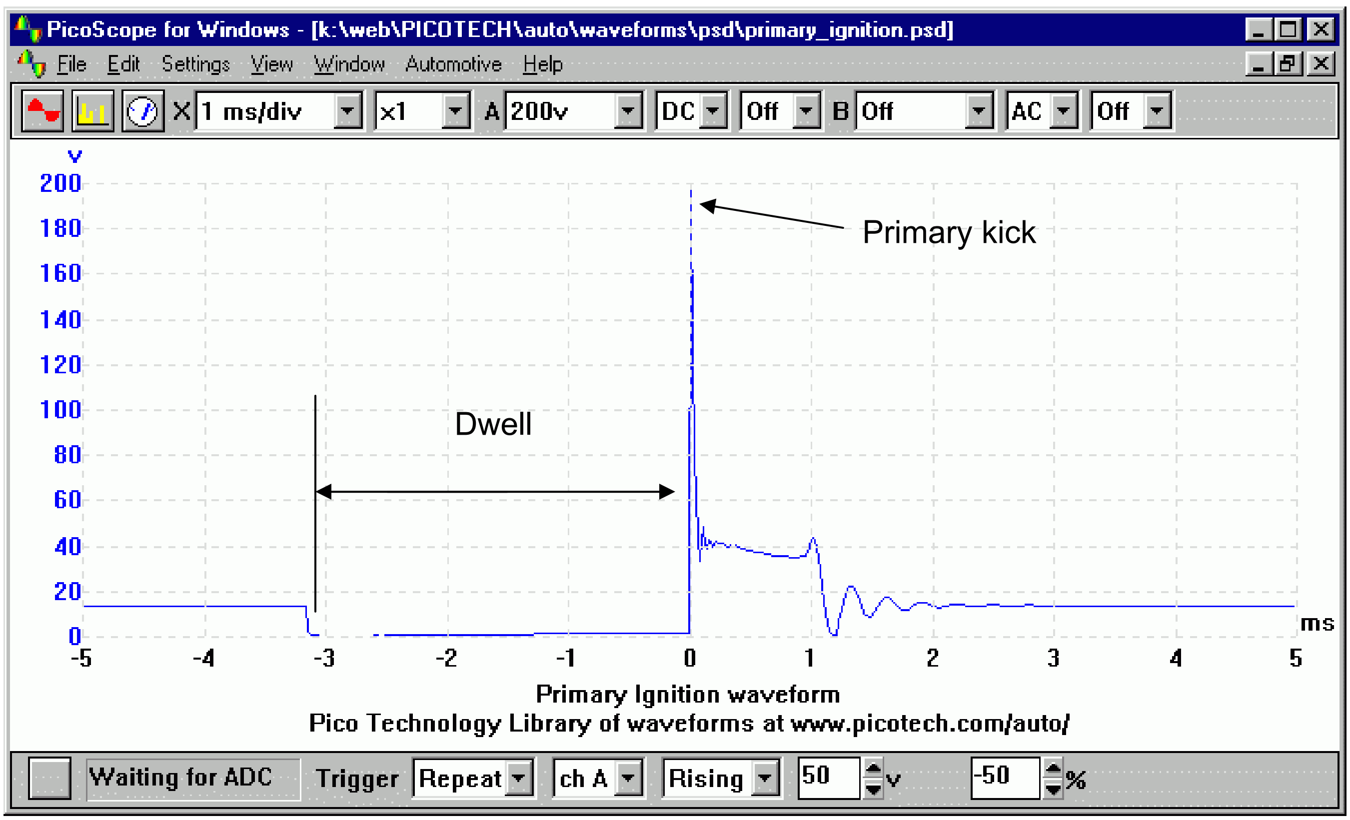
Cyl.# 1 _______	Max _______ Min _______	Cyl. # 5 _______	Max _______ Min _______
Cyl.# 2 _______	Max _______ Min _______	Cyl.# 6 _______	Max _______ Min _______
Cyl.# 3 _______	Max _______ Min _______	Cyl.# 7 _______	Max _______ Min _______
Cyl.# 4 _______	Max _______ Min _______	Cyl.# 8 _______	Max _______ Min _______
Coil Wire _______	Max _______ Min _______		

4. What is the condition of the secondary ignition system of your engine?

____

PRIMARY IGNITION

The secondary ignition system voltage is dependent on the operation of the primary ignition system. Think of the primary system as the input to the ignition coil and the secondary system as the output of the ignition coil. If there is poor input to the coil, there will be poor output. So if testing of the secondary reveals a problem, then the next logical thing to check is the primary ignition system. If the secondary system checks out ok, then there is no need to check the primary. Below is an oscilloscope picture of a typical primary ignition waveform. Look familiar?



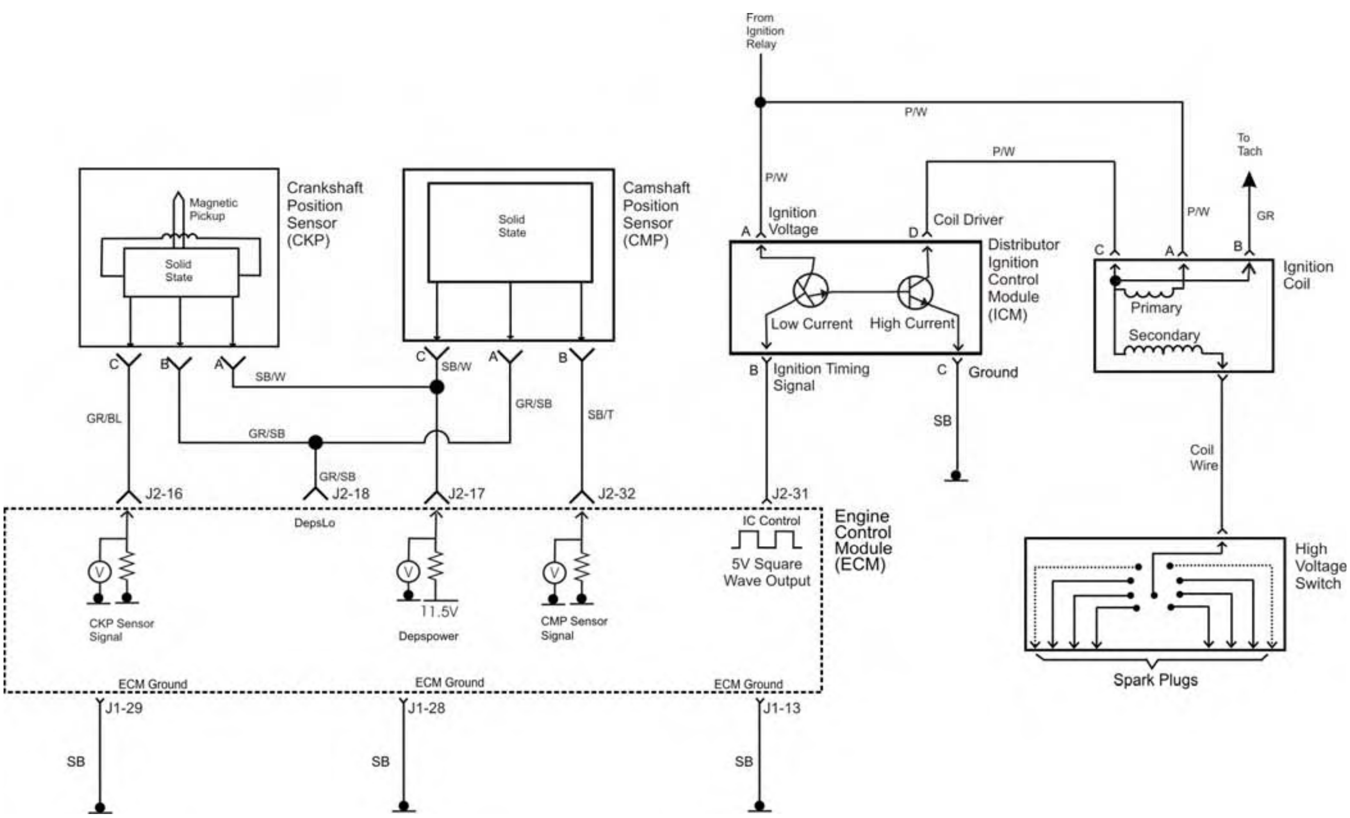
What if you don't have an oscilloscope? Is there any way to test the ignition primary? Not really. An oscilloscope is the only tool that can accurately show what is happening in the primary circuit with the engine running or cranking, but even with an oscilloscope the 8.1L primary circuit can't be checked because most of it is internal to the ignition coil. With Volvo Penta's ignition systems, the coil primary circuit is controlled by the Ignition Control (IC) signal input to either the coil (8.1L) or the ignition control module (ICM) from the ECM. So the coil primary only reacts to the IC input. No IC input to the coil or ICM, no coil primary operation. Since the IC circuit is an output from the ECM, there has to be some input that the ECM looks at to determine when to send the IC signal. That input is the crankshaft position sensor (CKP).

Primary/Secondary Ignition Testing

So the whole picture here is that the ECM sees the CKP input and sends a signal out over the IC circuit to the ICM or the ignition coil (8.1L) to trigger the coil primary which induces voltage into the secondary ignition system. A breakdown anywhere in the system causes failure of the whole system.
Taking what you have learned here, answer the following questions on the 5.0GXi-C engine.

1. In the picture below, which terminal (at the ignition coil) is the ignition coil primary ground circuit?

   TERMINAL ___________



2. With the ignition switch on and engine not running, disconnect the ICM connector and measure the voltage at pin D. What is the reading?

   _________ volts

3. What does this voltage reading tell you about the condition of the coil primary circuit?

   ____

4. How many volts are there at the ICM connector pin A? __________ volts. What would happen if this voltage wasn't here?

   ____

   ____

5. What is the function of pin B at the ICM connector? _____________________________

6. What is the function of pin C at the ICM connector? _____________________________

7. With the ICM connector disconnected, hook up a voltmeter (using the AC voltage function) to terminal B. Crank the engine and read the voltmeter while the engine is cranking. What is your voltmeter reading? ________ VAC (normal reading is 1-4 VAC)

8. What does this voltage reading mean? ____

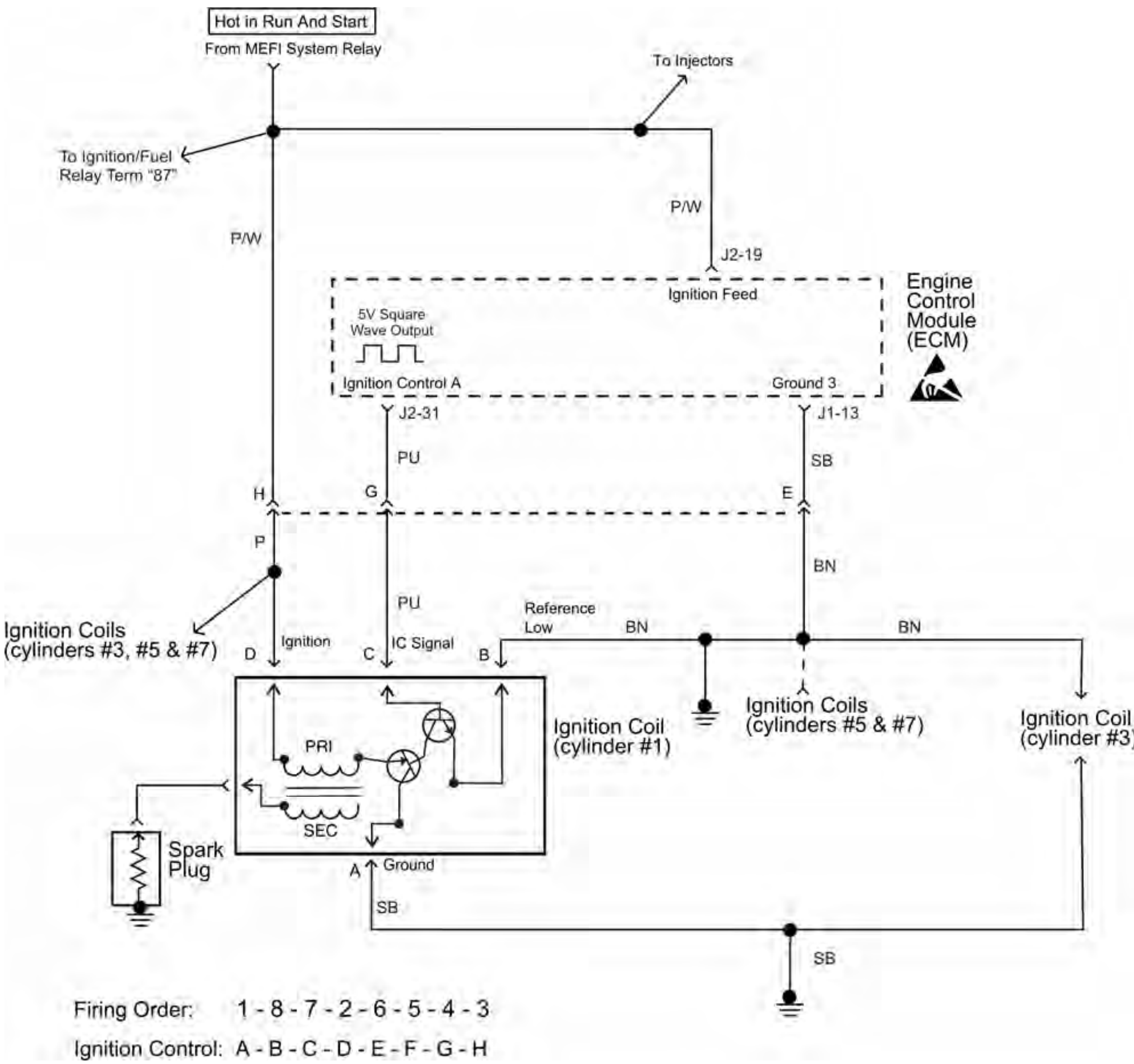
   ____

9. Turn the key off, reconnect disconnected connectors, remove voltmeter and inform your instructor that you have finished.

Continue on next page

Primary/Secondary Ignition Testing

Using the engine and the diagram below, answer the following questions about the 8.1Gi-A engine.



1. Disconnect the injector for cylinder #1. Disconnect the #1 ignition coil. With the ignition switch on and the engine not running, measure the voltage at terminal D of the ignition coil connector. What is the reading? _________ VDC

2. Where does this voltage come from? ____

3. The ignition coil connector terminals B and A are grounds and go to the ground studs located at the rear of the engine. Hook up a voltmeter set to read Hz (frequency) to terminal C (IC signal circuit) of the ignition coil connector. Start the engine and read the frequency of the IC circuit. A properly working circuit should read 3-20 Hz. What is the reading of the circuit being tested? __________ Hz

4. Shut engine down.

5. If the reading was 0 Hz, what could be wrong? ________________________________

   ____

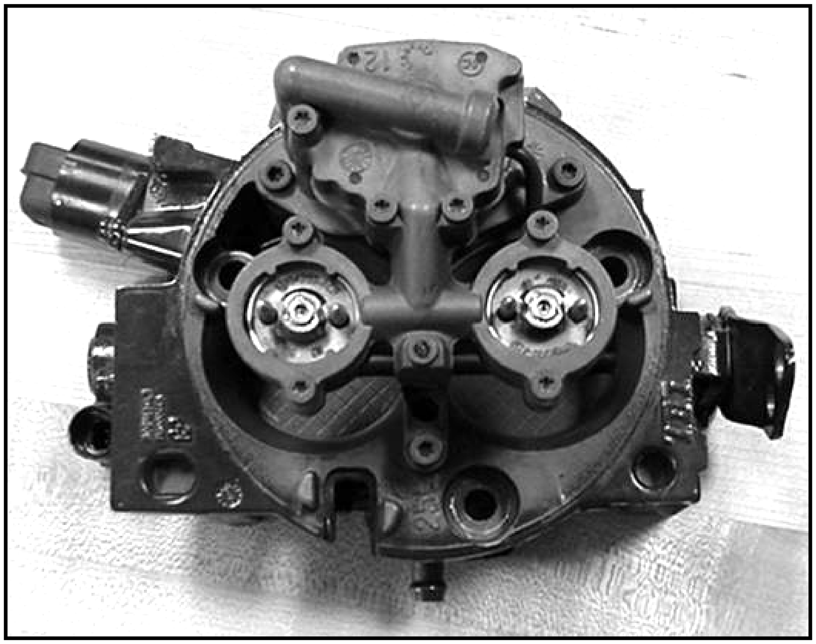
6. Can the ignition coil primary circuit be tested for an open circuit with an Ohmmeter?

   ____

7. Reconnect the injector and ignition coil. Start engine and ensure proper engine operation and clear any DTC's with the scan tool.

Fuel Systems:
Throttle Body Fuel Injection

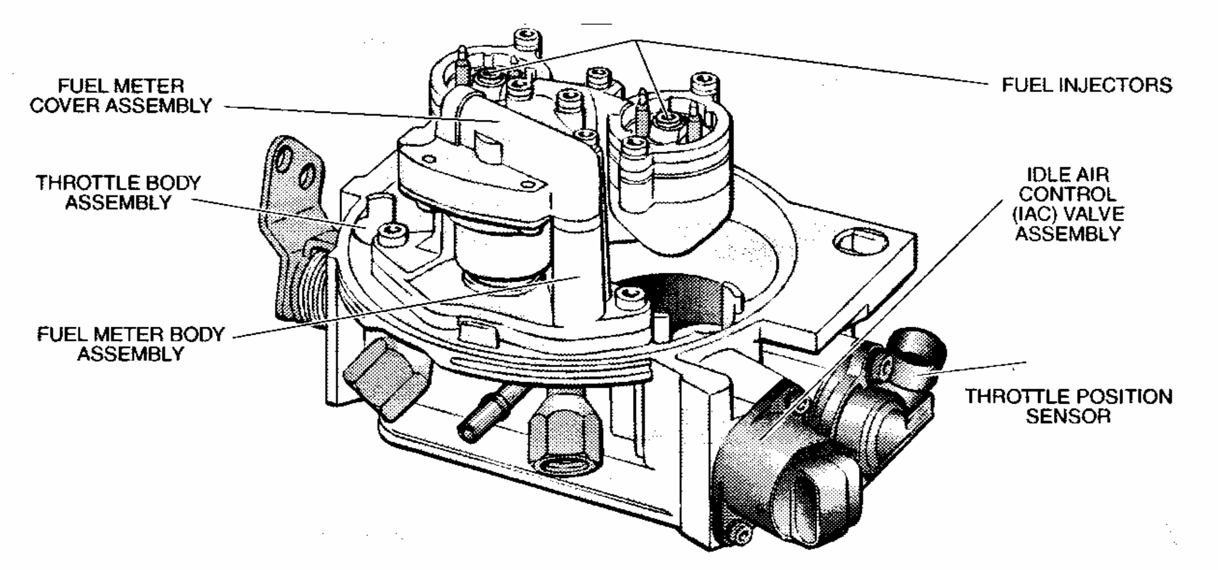
Throttle Body Injection



Throttle body injected engines use a constant pressure high pressure fuel system. The high pressure pump provides high pressure (11 psi or 29 psi depending on model) to the injectors and the pressure regulator. Because the injector tips are always open to atmospheric pressure, fuel system pressure remains constant throughout the engine operating range (idle to wide open throttle).

The throttle body assembly is mounted on a conventional carburetor type intake manifold. It is used to control air flow into the engine, thereby controlling engine power. The throttle plates within the throttle body are opened by the operator through the throttle control.

Throttle Body Assembly

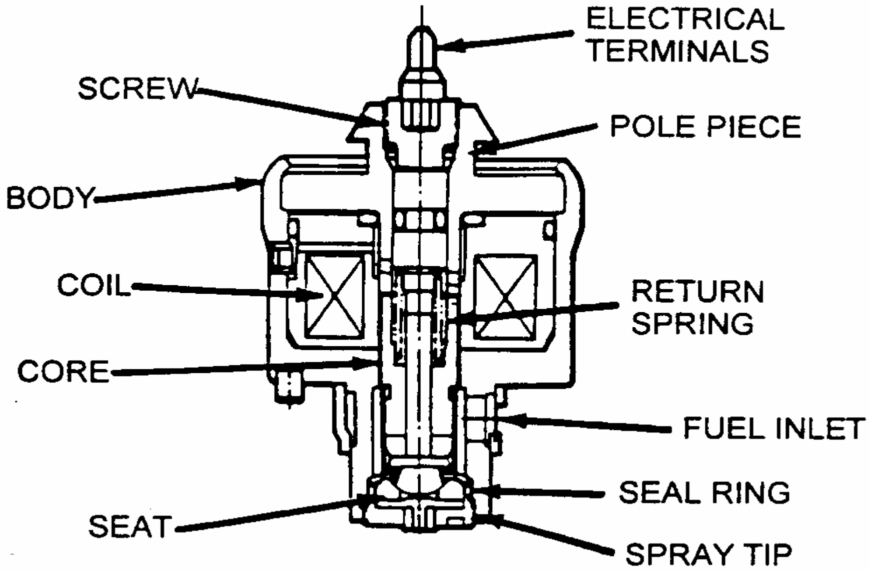


VOLVO PENTA

The Throttle Body Injection (TBI) system uses the throttle body assembly as a location for mounting the:

* Injectors.
* Fuel metering assembly.
* Pressure regulator.
* IAC motor
* TPS.

TBI Injector



Electronic fuel injectors are solenoid-operated valves controlled by the ECM. The injectors are supplied with 12 volts from the ignition relay. Drivers in the ECM supply a ground to the other terminal of the injector to actuate the solenoid.

The ECM energizes the injector solenoid, which opens a ball valve allowing pressurized fuel to flow through a flow director plate that has 6 machined holes creating a conical pattern of finely atomized fuel.

TBI systems fire one injector on one Ref Hi signal and the second injector on the next Ref Hi signal.

The amount of fuel injected is determined by the length of time that the injector is energized, this is known as Pulse Width.

The ECM calibration is based on the fact that an injector discharges a known amount of fuel per millisecond at a specified pressure at a specific voltage. Maintaining proper fuel pressure is ESSENTIAL to providing proper air/fuel ratio.

NOTE:

Do not apply a constant ground directly to the injector’s ground terminal. The internal solenoid will be damaged in a matter of a second or two.

Review the following page for TBI service kits, injector colors and system pressures by model.

GM Throttle Body Injection Service Kit Reference

Engine	Injector Color Code	Operating pressure	TBI Unit Part #	Fuel Injector Kit Part #	Pressure Regulator Part #	Metering Kit Part #
4.3Gi HU	**Black / Blue**	11 psi	3850354	3855182	3855181	N/A
4.3Gi NC	**Black / Blue**					
4.3Gi LK	**Black / Blue**					
4.3Gi BY	**Black / Blue**					
4.3Gi WT	**Purple / Pink**	29 psi	3857887	3858941	3857397	3855180
4.3Gi EF	**Purple / Pink**					
4.3GXi-A	**Purple / Pink**					
5.0Gi BY	**Black / Yellow**	29 psi	3856395	3857398	3857397	3857396
5.0Gi WT	**Black / Yellow**					
5.0Gi EF	**Black / Yellow**					
5.0GXi-A	**Black / Yellow**					
5.7Gi MD	**Black / Blue**	11 psi	3850354	3855182	3855181	N/A
5.7Gi HU	**Black / Blue**					
5.7Gi NC	**Black / Blue**					
5.7Gi LK	**Black / Blue**					
5.7GLi LK	**Black / Blue**					
5.7GSi LK	**Black / Yellow**	29 psi	3856395	3857398	3857397	3857396
5.7GSi BY	**Black / Yellow**					
5.7GSi WT	**Black / Yellow**					
5.7GSi EF	**Black / Yellow**					
5.7GXi-A,B,	**Black / Yellow**					

Please use this chart whenever servicing GM throttle body units with repair kits. In the 4.3 HU - BY and 5.7 MD - LK parts books, 3855180 fuel metering kit is currently incorrect. This kit was originally designed to service the 11 psi throttle body units but now has 29 psi components. 3855180 will be replaced by a variable replacement once the parts department corrects the kits to compensate for both high and low pressure systems.

Injector Kits include:

1 Injector
1 Fuel meter cover gasket
1 Lower O-ring
1 Upper O-ring
1 Gasket, Fuel Meter outlet

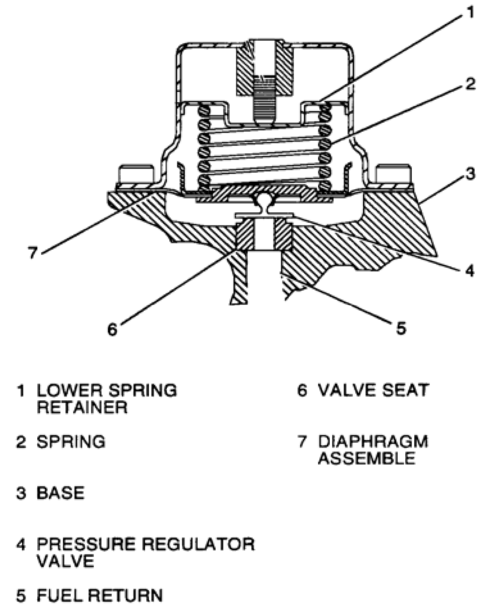
Pressure Regulator Kits include:

1 Fuel meter cover
1 Fuel meter cover gasket
1 Gasket, Fuel Meter outlet

Metering Kits include:

1 Metering assembly
1 Metering Body to TBI gasket
1 Gasket, Inlet Nut
1 Gasket, Outlet Nut

TBI Regulator



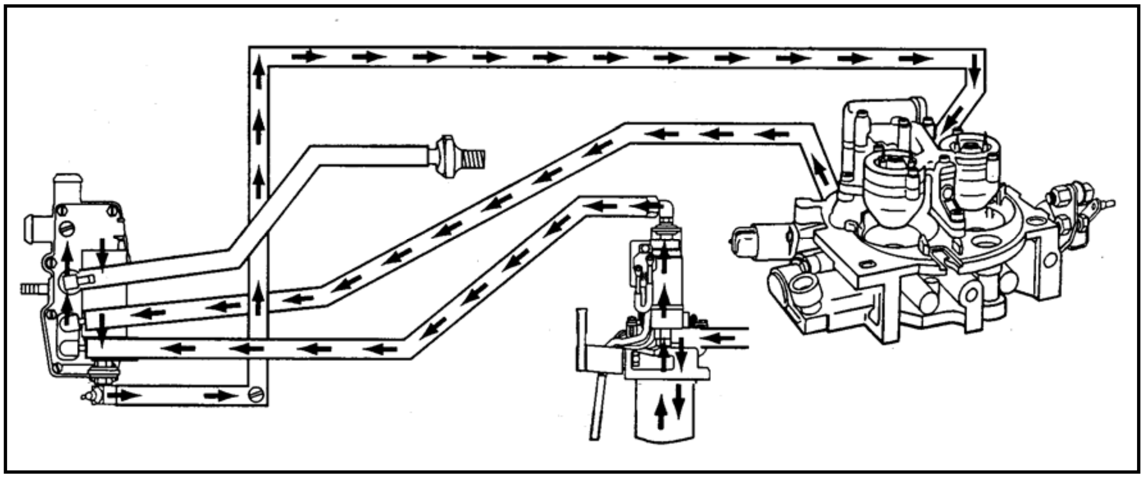
The regulator is a diaphragm operated relief valve with fuel pressure on one side of the diaphragm and opposing spring pressure on the other.

The regulator's function is to maintain a constant fuel pressure to the injectors at all times.

It is housed inside the throttle body assembly and located in the fuel flow after the injectors.

When fuel pressure exceeds spring pressure a valve will open allowing excess pressure to flow back to the reservoir. The balance between spring pressure, fuel pressure and fuel flow allows the regulator to maintain a constant pressure under all engine operating conditions.

TBI Fuel Flow



For TBI illustration purposes, this fuel flow diagram is shown using the older style vapor separating tank (VST) system.

The low pressure pump brings fuel from the tank, through the filter and fills the reservoir.

The reservoir fills from the bottom up and supplies fuel to the high pressure pump.

The high pressure pump pulls fuel from near the bottom of the reservoir and supplies the fuel rail and injectors.

If the fuel demand is less than the volume of fuel supplied by the pump, line pressure will increase until the regulator opens and allows fuel to exit the regulator and return to the reservoir.

Fuel entering the reservoir is cooled by incoming water. A small volume of water moves through a passage at the base of the reservoir.

Inside the reservoir is a float and needle mechanism that connects to a manifold vacuum line. The vapor rises to the top of the reservoir, vacuum pulls the vapor into the intake. A pulse limiter in the vacuum line prevents a backfire from igniting the fuel vapor.

As the liquid fuel level rises, the float and needle mechanism closes and prevents fuel from entering the vacuum line.

On high vacuum (18+inches Hg) small blocks, the VST needle would stick if not clipped correctly to the float tang.

Fuel Systems: Multi Port Fuel Injection

Multi-Port Fuel Injector

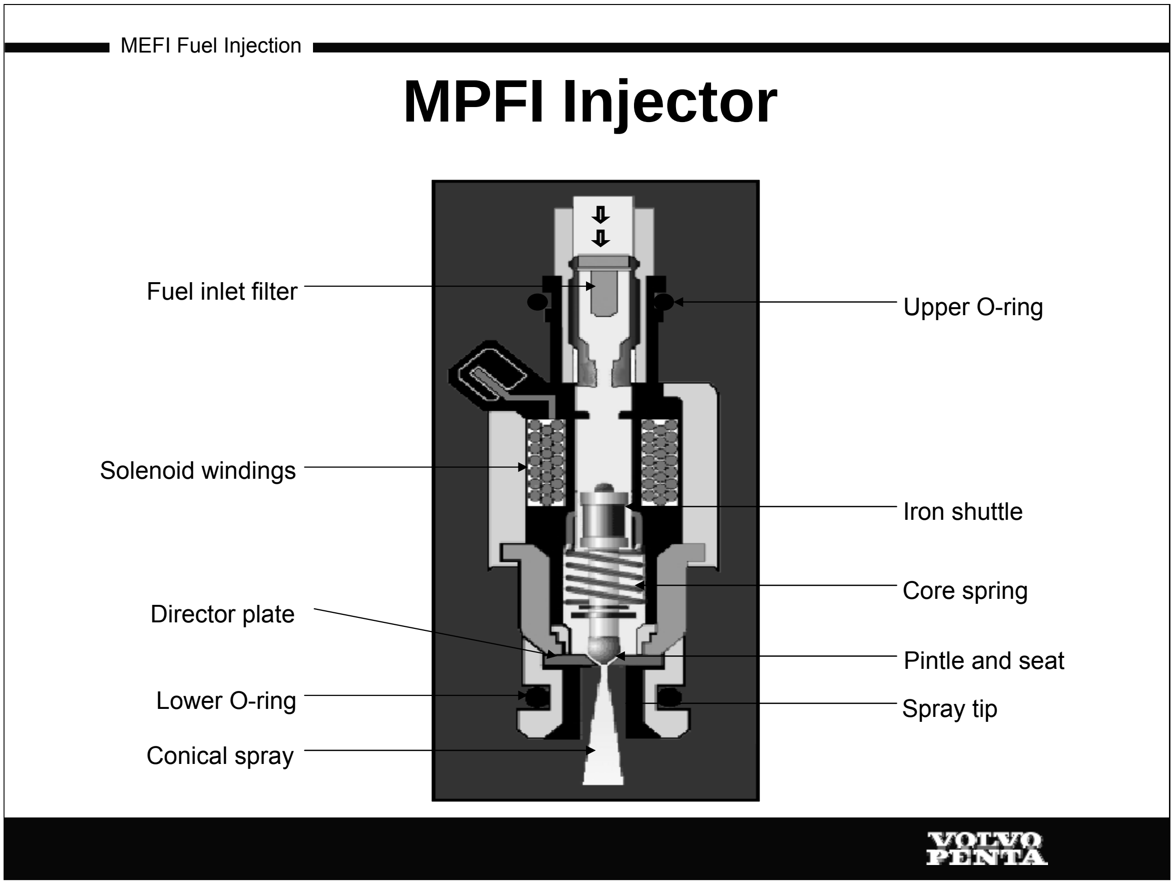
VOLVO PENTA

Multi-port fuel injectors are also solenoid operated valves controlled by the ECM.

Multi-port systems have one fuel injector per cylinder, discharging fuel directly into the intake port behind the intake valve.

Since there is no fuel in the intake manifold, the runners can be tuned for maximum air flow with out causing fuel separation.

This precise fuel distribution and the increase in volumetric efficiency are the major reasons for the power increase associated with multi-port fuel injection.



The injectors are supplied with 12 volts from the ignition/fuel relay. Drivers in the ECM supply a ground to the other terminal of the injector to actuate the solenoid.

The ECM energizes the injector solenoid, which opens a ball valve allowing pressurized fuel to flow through a flow director plate that has a number (4-8) of machined holes creating a conical pattern of finely atomized fuel.

The fuel is directed at the intake valve aiding in valve cooling and additional atomization.

The multi-port system uses 2 injector drivers.

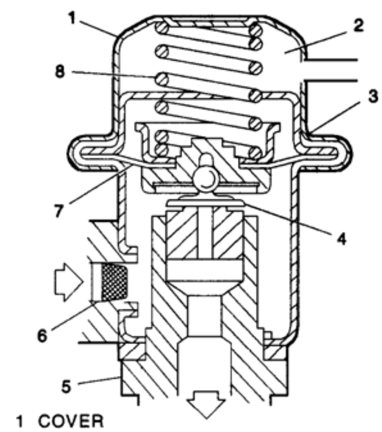
The amount of fuel injected is determined by the length of time that the injector is energized, called Pulse Width.

The unit of measure used for injector “on” time is milliseconds.

Again, as with the TBI injectors, the pulse width is based on the fact that an injector discharges a known amount of fuel per millisecond at a specific fuel pressure and at a specific supply voltage, so maintaining proper pressure is ESSENTIAL to providing proper air/fuel ratio.

When injectors stick or seize, no fault code will be set. Injector codes set for opens or shorts in the driver circuit back to the ECM.

MPFI Regulator



1 COVER
2 VACUUM CHAMBER
3 O - RING SEAL
4 FUEL PRESSURE REGULATOR VALVE
5 BASE ASSEMBLY
6 FILTER SCREEN (IF EQUIPPED)
7 DIAPHRAGM
8 SPRING

The regulator is a diaphragm operated relief valve with fuel pressure on one side of the diaphragm and opposing spring pressure and manifold vacuum on the other.

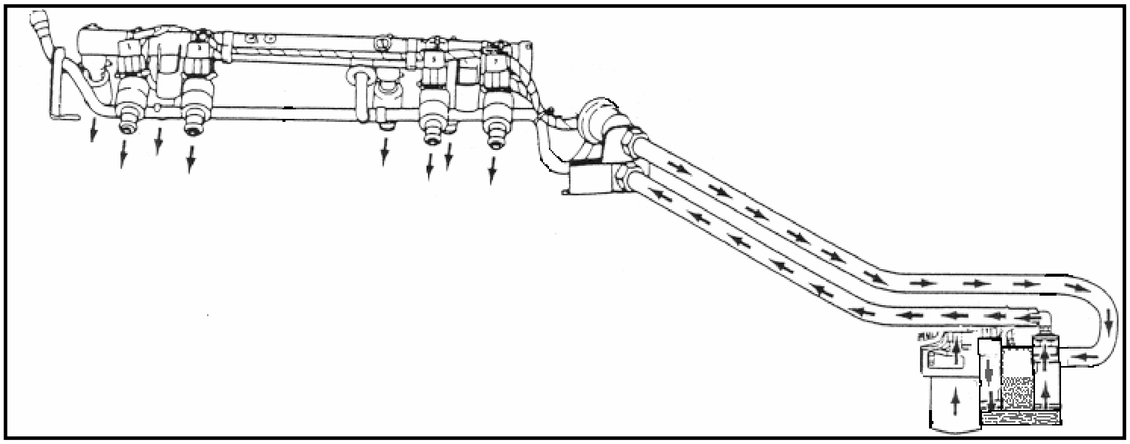
The regulator's function is to maintain a constant effective pressure at the injector tips at all times.

The addition of manifold vacuum is necessary because injector tips are located inside the manifold, this would normally cause the pressure drop at the tip to change with manifold vacuum. With manifold vacuum acting on the regulator diaphragm the effective pressure at the tip remains constant.

The regulator compensates for engine load by increasing fuel pressure as engine vacuum drops, this will cause the gauge to fluctuate with throttle opening while checking pressure.

Fuel system pressure is checked with the engine off and the fuel pumps running or with the engine running and the vacuum hose to the regulator disconnected.

MPFI Fuel Flow



The low pressure pump brings fuel from the tank, through the filter and fills the reservoir.

The reservoir fills from the bottom up and supplies fuel to the high pressure pump.

The high pressure pump pulls fuel from near the bottom of the reservoir and supplies the fuel rail and injectors.

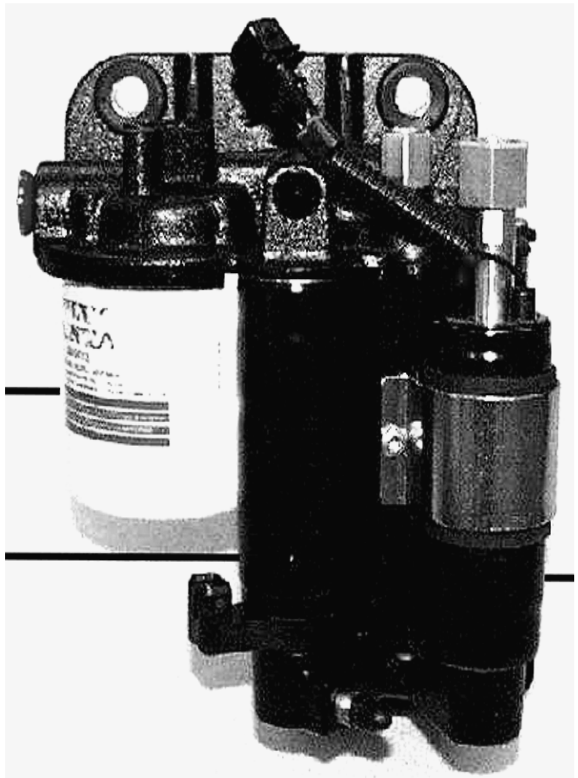
If the fuel demand is less than the volume of fuel supplied by the pump, line pressure will increase until the regulator opens and allows fuel to exit the regulator and return to the reservoir.

Fuel entering the reservoir is cooled by incoming water. A small volume of water moves through a passage around the reservoir.

Inside the reservoir is a float and needle mechanism that connects to a plenum vacuum line. The vapor rises to the top of the reservoir, vacuum pulls the vapor into the plenum. A pulse limiter in the vacuum line prevents a backfire from igniting the fuel vapor.

As the liquid fuel level rises the float and needle mechanism closes and prevents fuel from entering the vacuum line.

Fuel Pump Module



The fuel module replaces the VST system. This style of module is used in both late TBI and all MPI engines. The modules used between the TBI and MPI systems are NOT interchangeable. (see chart next page)

It contains the low pressure pump, high pressure pump and the fuel cooler-vapor separator cylinder all mounted in one compact unit.

The fuel cooling cylinder is made of anodized extruded aluminum and is sealed with double “O” rings at each end.

The cylinder is mounted in a vertical position to keep the fuel level as high as possible and separate vapors through an improved needle and float valve.

The low pressure pump fills the reservoir. The high pressure pump takes suction from the reservoir. The reservoir is raw water cooled. Raw water enters the unit at the bottom through the small hose and exits at the top of the module and is discharged to the inboard side of the exhaust riser.

The second small rubber hose at the very top of the reservoir is the vapor line to the intake manifold.

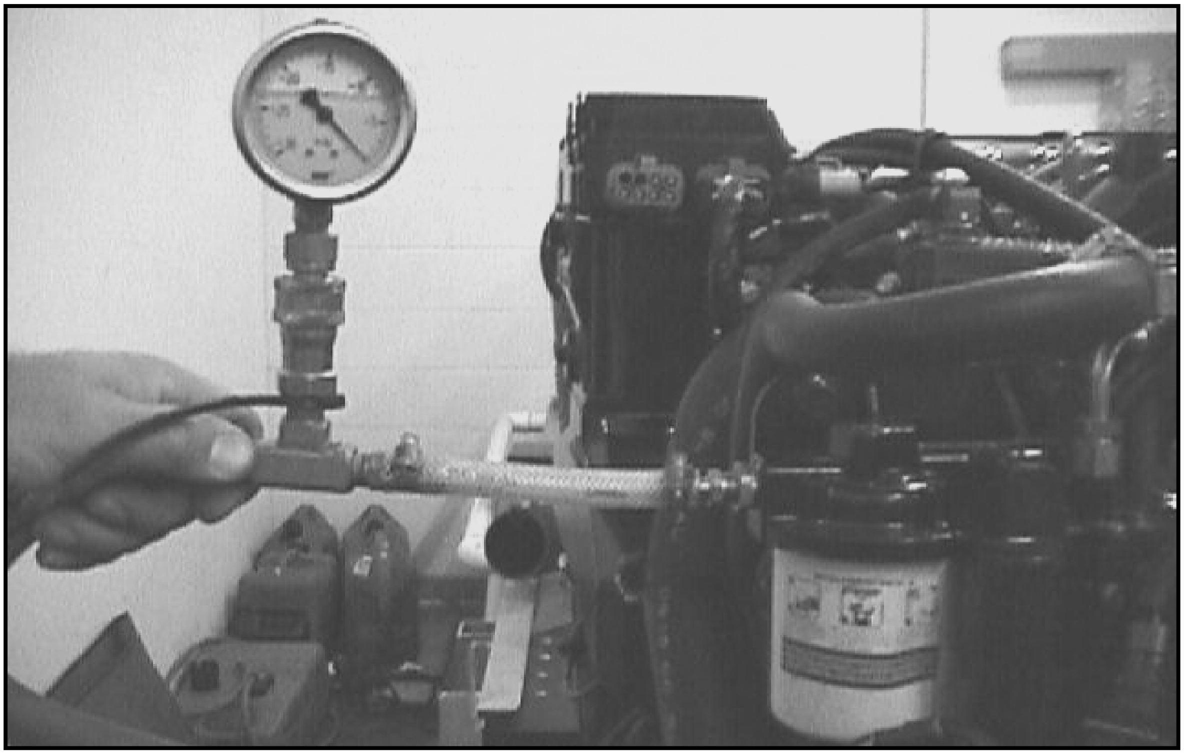
Fuel Pump Module 05 8.1L

Starting with the 8.1Gi-F, 8.1OSi-B and the 8.1GXi-E, all 8.1L engines get the new fuel pump module. The fuel pressure regulator has been moved from the fuel rail to the discharge side of the high pressure pump at the module. This requires new part numbers for all the fuel system components except the high pressure pump.

The current fuel pressure leakdown tests in Workshop Manual 7742218 do NOT cover this fuel pump module.

Fuel pressure specifications for this fuel pump module stay the same as the previous 8.1L’s.

Fuel Inlet Testing



For a **temporary** fuel flow test to check for fuel inlet air leaks or inlet restrictions, assemble a "T" with barbed fittings that will allow you to remove the hose easily. Put a clear plastic hose with nylon webbing on one side of the "T" and install on the fuel filter barb. On the other side, install the fuel hose. Install a vacuum gauge at the third fitting that reads from 0 to 30 inches Hg. The vacuum should NOT be above about 2 inches Hg when running. Also, look for air bubbles!

Electric Fuel Pump Reference Chart - Mainstream Product

Engine	Model	System	Low Pressure	High Pressure	Low Pressure Test Value	High Pressure Test Value
4.3	4.3GL/GS	Carb	3858261	N/A	4.9 - 8.5psi @ idle *	N/A
	4.3Gi HU-BY	TBI	3858261	3857650	5psi ± 3	11psi ± 2
	4.3Gi WT				4psi ± 2	29psi ± 2
	4.3Gi EF		3861355**	3588865	8psi ± 4	
	4.3GXi-A					
	4.3GXi-B,-C,-D,-E	MPI	3861355**	3588865	8psi ± 4	50 - 60psi
	4.3OSi - **ALL**					
5.0/5.8	5.0/5.8 Fi/FSi **FORD**	MPI	3858261	3857650	5psi ± 3	31 ± 3 @idle, 39 ± 3 @key on/engine off or WOT
5.0	5.0GL	Carb	3858261	N/A	4.9 - 8.5psi @ idle *	N/A
	5.0Gi BY-WT	TBI	3858261	3857650	5psi ± 3	29psi ± 2
	5.0Gi EF		3861355**	3588865	8psi ± 4	
	5.0GXi-A					
	5.0GXi-B,-C,-D,-E	MPI	3861355**	3588865	8psi ± 4	50 - 60psi
	5.0OSi - **ALL**					
5.7	5.7GL/GS	Carb	3868261	N/A	4.9 - 8.5psi @ idle *	N/A
	5.7Gi/GLi MD-LK	TBI	3868261	3857650	5psi ± 3	11psi ± 2
	5.7GSi LK-WT					29psi ± 2
	5.7GSi EF		3861355**	3588865	8psi ± 4	
	5.7Gi-A					
	5.7GXi-A, -B					
	5.7Gi-B, -C	MPI	3861355**	3588865	8psi ± 4	50 - 60psi
	5.7GXi-C,-D,-E,-F					
	5.7OSi/OSXi - **ALL**					
7.4	7.4GL/GS	Carb	3858714	N/A	4.9 - 8.5psi @ idle *	N/A
	7.4Gi/GSi HU-WT	MPI	3858714	3857650	5psi ± 3	39 ± 3psi
	7.4Gi/GSi EF		3861355**	3588865	8psi ± 4	
8.2	8.2GL/GS	Carb	3858714	N/A	4.9 - 8.5psi @ idle *	N/A
	8.2GSi NC-WT	MPI	3858714	3857650	5psi ± 3	39 ± 3psi
	8.2GSi EF		3861355**	3588865	8psi ± 4	
8.1	8.1Gi-A thru E	MPI	3861355**	3588865	8psi ± 4	40psi ± 4
	8.1GSi/Gxi-A thru D					
	8.1Gi-F		3589016**	3817328		
	8.1GXi-E					

***Please refer to appropriate Fuel System Workshop Manual for test values throughout the RPM range.**

****Complete Fuel Module assy, if low pressure pump needs to be replaced, complete pump must be ordered.**

Service Bulletin		
Group	Number	Version
23-3	7	01

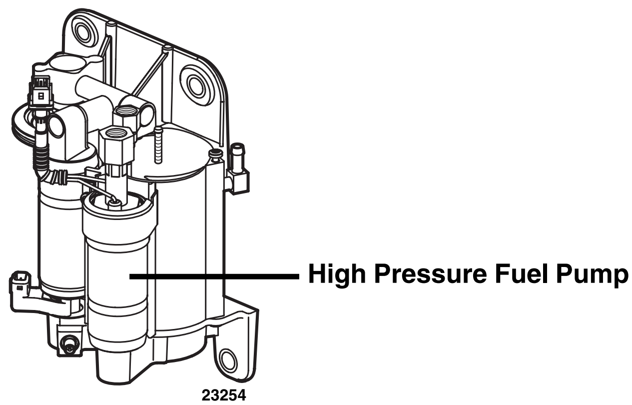
VOLVO PENTA

Volvo Penta of the Americas
1300 Volvo Penta Drive
Chesapeake, Virginia 23320-9810
USA

High pressure fuel pump

Models
All Fuel Cell equipped EFI Gasoline Engines

Distribution: M   Date: 01-2004   Binder: C   Page: 1(1)



Volvo Penta has introduced a High Pressure Fuel Pump Replacement Kit PN 3588865. Use the instructions included in the kit when servicing the fuel cell.

This kit is to be used if the high pressure fuel pump needs replacement on Fuel Cell PN 3861355 and PN 3860210. In cases where only the high pressure pump needs to be replaced, this will allow for a faster and more cost effective repair. In cases where a problem exists in the low pressure fuel pump, or the reservoir portion of the fuel cell, the entire fuel cell will still require replacement.

Testing at the low pressure test fitting at the base of the fuel cell, and the high pressure test fitting on the fuel rail, will easily isolate whether the low pressure or high pressure fuel pump has failed. Volvo Penta Fuel Pressure Test Kit P/N 3855533 includes both the low pressure fitting adapter (PN 3855354) and the high pressure fitting adapter (PN 3862357) required to perform these tests. Also, unplugging the electrical connector on each fuel pump one at a time and cycling the key to the "on" position, can assist in confirming a suspected seized fuel pump.

Note: This High Pressure Fuel Pump Kit is used only on Fuel Cell PN 3861355 and PN 3860210. It does not apply to earlier models using the Vapor Separator style system.

⚠ Warning!

Follow all related safety procedures as noted in the Workshop Manual during all fuel system testing procedures.

See the chart below for fuel pressure values:

Engines using Fuel Cell P/N 3861355 or P/N 3860210

Model	Low pressure	High Pressure
4.3 TBI	8 psi +/- 4psi	29 psi +/- 2psi
5.0 TBI	8 psi +/- 4psi	29 psi +/- 2psi
5.7 TBI	8 psi +/- 4psi	29 psi +/- 2psi
4.3 PFI	8 psi +/- 4psi	50-60 psi
5.0 PFI	8 psi +/- 4psi	50-60 psi
5.7 PFI	8 psi +/- 4psi	50-60 psi
7.4 PFI	8 psi +/- 4psi	36-44 psi
8.1 PFI	8 psi +/- 4psi	36-44 psi

VOLVO PENTA

Volvo Penta of the Americas
1300 Volvo Penta Drive
Chesapeake, Virginia 23320-9810
USA

Service Bulletin

Group	Number	Version
23-0	**2**	**02**

Component

All Gasoline Engines
Fuel Storage Mixture

Distribution: M Date: 10-2003 Binder: C

This bulletin is to clarify our recommendations with regard to gasoline fuel treatment for storage or limited use. Today's gasoline blends are not as stable as in the past and consideration must be given if the fuel will not be used within a short time or if the engine is being placed in storage. Failure to properly stabilize the fuel can damage fuel system components and is not considered as warrantable.
Boat manufacturers should follow the gasoline storage mixture section for testing prior to shipment.

Note! Volvo Penta has discontinued the fuel stabilizer #3855832 noted in our manuals and a suitable replacement can be purchased locally at most automotive supply stores.

Limited Use

If the vessels fuel within the tank(s) will not be consumed within a 30-day period from the time of filling, a gasoline fuel stabilizer must be added as per the manufacturers instructions. This will help prevent the fuel from breaking down and causing reduced engine performance or damage from uncontrolled combustion.

Storage

If the boat is being placed into storage, a gasoline fuel stabilizer must be added to the tank(s) as per the manufacturers instructions. The amount of stabilizer required is determined by the quantity of fuel and the length of time it will be placed in storage.

⚠DANGER!

Any fuel leakage should be corrected immediately to prevent possible fire and/or explosion.

⚠Caution!

Do not run engine out of fuel or run the electric fuel pumps dry more than 20 seconds. Running the electric fuel pumps dry will cause fuel pump damage.

Prepare a storage mixture

In addition to stabilization of the fuel, it is highly desirable to have the valves and cylinders coated with a light film of oil previously accomplished through "fogging". Today's multiport fuel injection manifolds are designed with a complex air channel design that will not allow the traditional fogging oils to be injected past the throttle plate while running. The oil will get stuck in the plenum and never reach the cylinders. Together with the stabilizer, two-cycle motor oil can be added to a fuel mixture for stabilization purposes.

- Using an outboard motor six-gallon fuel tank, add two-cycle motor oil at a ratio of 50:1 (one pint to 6 gallons) and stabilizer at one ounce per gallon (unless stated otherwise on the manufacturers label). Mix well.
- Disconnect boat fuel line at engine fuel pump. Attach the "storage mix" fuel tank.
- Connect a suitable engine flush device if the boat is not in the water.

- Run the engine on the "storage mixture" for approximately 5 minutes at 1500 RPM. This will ensure that all fuel system and internal engine components are thoroughly protected. Do not operate the engine above 1500 RPM as the water pump demand may exceed the supply, damaging the pump.
- Reduce the engine speed to idle and stop the engine.
- Reconnect the fuel fitting and check for fuel leaks.

Electric fuel pumps and fuel cells

Regardless of the ratio of fuel stabilizer to fuel we use, the maximum recommended storage time for gasoline, according to STA-BIL, is six months. During final assembly testing at our Lexington factory, each engine is run on a fuel mix that is stabilized. Each engine is shut off without running the fuel pumps dry and the fuel system is sealed to prevent damage. With the delay in time between the product getting installed in a boat, shipped to you, sold and finally delivered; the six-month time frame can easily be exceeded.

Since delivering a quality, dependable product is one of our highest goals; we work closely with our suppliers to identify the root cause of failure on any parts returned for warranty credit. While there are certainly legitimate failures of fuel pumps, the major portion of them are returned to us due to varnished fuel from long term storage. We would like to offer some advice on dealing with these issues.

Stuck Pumps

If a fuel pump appears stuck and will not operate, you may try briefly reversing the polarity to the pump to turn it in the opposite direction. You should disconnect the electrical plug of one pump at a time on the fuel cell to determine which pump might have a problem.

Noisy Pumps

Electric pumps will often cavitate and become noisy if they are starving for fuel. On carbureted engines or low-pressure fuel cell pumps, check the fuel supply, quality of the fuel hose, anti-siphon valve, and filter before replacing the fuel pump.
A noisy high-pressure pump on a fuel cell may indicate a low fuel level in the reservoir. Check the fuel supply and low pressure pump operation to be sure the reservoir is receiving the correct volume of fuel. The same information would apply to engines with the earlier vapor separator tank design.

This information may help prevent the needless replacement of pumps in many cases and reduce the repair time for the boat owner.

Note!

Replacement fuel modules and fuel pumps are now shipped from the parts department with testing fluid inside to extend their shelf life. The testing fluid is flammable and FAA regulations state that they cannot ship via air frieght.

Fuel Pressure/Leakdown Testing Activity

Fuel Pressure Testing and Leakdown Testing

1. With the ignition switch off, remove the fuel pump relay. Crank engine and run engine out of fuel. Do this several times to ensure fuel pressure has been reduced to 0 psi. Turn key back to off position.
2. Connect fuel pressure gauge from gauge set VP part # 3855533 with adapter VP part # 3862357 to the fuel pressure rail.
3. Using the special tool for fuel line removal, disconnect both the pressure and return lines to the fuel rail.
4. Install the fuel line shutoff adapters, (Kent Moore J 37287) between the disconnected fuel lines and the fuel rail. **Note: when installing there should be an audible click as hoses go together. After click is heard, try to pull the connection apart. It should NOT come apart. If it does come apart, then it wasn't installed properly or the connection is damaged.**

WARNING: IF THIS CONNECTION COMES APART WHILE ENGINE IS RUNNING, A LARGE FUEL LEAK WILL OCCUR WITH A POSSIBLE FIRE RESULTING.

5. Ensure the valves in the J 37287 fuel shut off adapters are in the open position (in line with the hose).
6. Reinstall fuel pump relay. Turn ignition switch on several times to run the fuel pumps and refill the lines. **Check for any fuel leaks.**
7. After fuel pressure has built up, turn key off and observe fuel pressure. Fuel pressure should hold at 40 psi + or – 4 psi for an 8.1L or 50-60 psi for the 5.0L.
8. Close both valves in the fuel shutoff adapters and record fuel pressure. ______ PSI
9. Record fuel pressure after 2 minutes. _______ PSI Fuel pressure should drop very little. If fuel pressure were to drop 10 PSI in those 2 minutes, where would the leak be and how would you fix it?
   ____
10. Open both shutoff valves and cycle the ignition switch to rebuild fuel pressure. Close the fuel shutoff valve in the supply line to the fuel rail. Observe and record the fuel pressure drop after 2 minutes. _______ PSI drop.
11. If pressure did not drop in step 9 and pressure drops in step 10, what is (are) the possible component(s) causing the pressure drop?
   ____
12. Open both shutoff valves and cycle the ignition switch to rebuild fuel pressure. Close the fuel shutoff valve in the return line from the fuel rail. Observe and record the fuel pressure drop after 2 minutes. _______ PSI drop.
13. If the pressure did not drop in steps 9 or 10 but does drop now. Where is the leak? ____

14. Remove fuel pump relay, start engine and run out of fuel. Disconnect fuel gauge and fuel shutoff adapters. Reconnect fuel lines to fuel rail.**(See the note in step 4)** Recap fuel pressure test port on the fuel rail. Reinstall fuel pump relay and start engine. Check and ensure that there are no fuel leaks.

Special Service Tools

- Tools are supplied by Volvo Penta, Kent Moore, or other suppliers
- Kent Moore tools are listed in the Workshop Manuals
- Identified by “J- “ numbers
- Order direct from Kent Moore:
  1 800 345-2233
- DIACOM and other MEFI tools are supplied by Rinda Technologies:

www.rinda.com ph 773.736.6633

Special Service Tools

•Late model fuel modules lack the Schrader valve for checking fuel pressure at the high pressure line at the fuel pump. A new service tool, VPA# 3861684 has been released so that high side fuel pressure can be checked at the pump.

•The 8.1L and IAFM fuel rails have an automotive Schrader valve configuration.

•Volvo Fuel Pressure Gauge Kit 3855533 **with adapter VPA #3862357, required for 8.1L and all IAFM**

•See EFI Diagnostic Workshop Manual for standard EFI tools.

•See Engine Mechanical Workshop Manual on new tools for engine assembly and disassembly.

VOLVO PENTA

Special Service Tools

CodeMate

VPA# 3851088

TechMate

VPA# 3851228

From Rinda Technologies.

CODE MATE:

This pocket size tester serves as both an EFI problem indicator and a spark timing service tool. This tool is less than the minimum required service tool needed to perform GM based EFI diagnostics.

The "Code Mate" allows fault codes to be read and, along with a timing light, allows base spark advance to be set on MEFI 3 and older systems.

TECH MATE

This self-contained diagnostic tool displays complete EFI systems information, allowing the tech to rapidly pinpoint engine related problems. The tool performs a complete range of EFI tests and also contains a built-in programmable fuel injector tester.

Latest update for this tool is the "version 5.0" which will read 1993 and newer GM based MEFI 1, 3 and 4 systems.

There is now (summer 2005) a later update that covers all previous engines and adds the new EGC system. This update includes new chips for the tool and a new cable end to fit the EGC system.

Special Service Tools

VP 2000 Scantool

VPA Kit# 3855947

Kit comes with new cartridge to read MEFI 4

VPA Cartridge Kit #3863486 will read Ford, and GM Mefi 1, 3 and 4

MEFI 3 Watertest Sheet

MEFI 4 Watertest Sheet

VP 2000 Scan Tool:

From OTC

The ECM can communicate a variety of information through the Data Link Connector (DLC). This data is transmitted using a serial communication interface bus which requires a scan tool for interpretation.

The new cartridge, version 6.0, has been available since late August 2003.

This tool also provides a limited “Snapshot” function.

VOLVO PENTA MEFI III EFI WATER TEST SHEET

Dealer Number :										
Contact Name :		Phone # :			Boat Model:			Owner:		
Engine Model :		**Eng S/N :**			Length:			ECM Calibration (Marked on ECM):		
Drive Ratio :		Drive S/N :			Prop Size :					
Scan Tool Data		Cal CK Sum			Trouble Codes Active:				Logged	
		Key on	Idle	1000 RPM	2000 RPM	3000 RPM	4000 RPM	WOT >>>>>	**IMPORTANT** WOT =	
Engine Speed	RPM								RPM	Engine Speed
ECT sensor	deg F								deg F	ECT sensor
IAT sensor	deg F								deg F	IAT sensor
Map sensor	Hg								Hg	Map sensor
Map sensor	V								V	Map sensor
Baro sensor	Hg								Hg	Baro sensor
Baro sensor	V								V	Baro sensor
T.P. sensor	V								V	T.P. sensor
T.P. sensor	%								%	T.P. sensor
Fuel Rate	GPH								GPH	Fuel Rate
Injection Pulse	ms								ms	Injection Pulse
Spark Advance	deg								deg	Spark Advance
Knock Signal	Y/N								Y/N	Knock Signal
Knock Retard	deg								deg	Knock Retard
IAC Position										IAC Position
Base IAC Postion										Base IAC Postion
Shift Interrupt	On/Off								On/Off	Shift Interrupt
IAC Follower										IAC Follower
Battery Voltage	V								V	Battery Voltage
Power Reduction	Y/N								Y/N	Power Reduction
Engine Hours	hrs								hrs	Engine Hours

***** All Readings Above Idle Must Be Made Under Load, On Water, With Engine Warm *****

VOLVO PENTA MEFI 4 EFI WATER TEST SHEET

Dealer Number : **Contact Name :** **Phone # :**

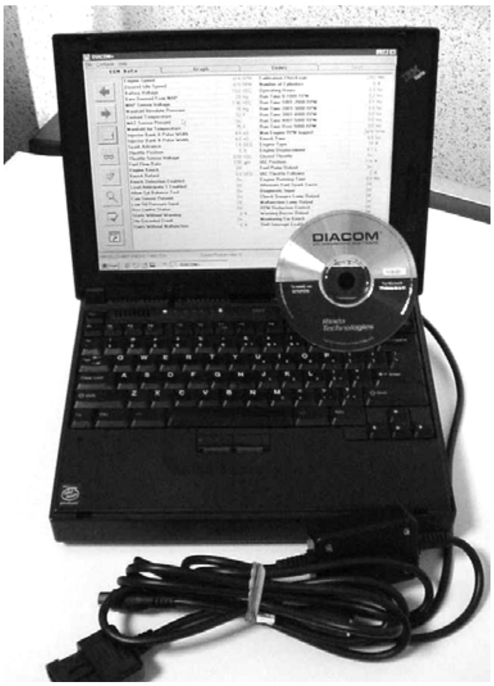
Engine Model : **Boat Model:** **Prop Size :**

Engine S/N : **Gear Ratio:** **Length:** **ECM Calibration :**

Scan Tool Data		Cal CK Sum			Trouble Codes Active:				Logged	
		Key on	**Idle**	**1000 RPM**	**2000 RPM**	**3000 RPM**	**4000 RPM**	WOT >>>>>	**IMPORTANT** WOT =	
Engine Speed	RPM								RPM	Engine Speed
ECT sensor	deg F								deg F	ECT sensor
IAT sensor	deg F								deg F	IAT sensor
Map sensor	HG								HG	Map sensor
Map sensor	V								V	Map sensor
Baro sensor	HG								HG	Baro sensor
Baro sensor	V								V	Baro sensor
T.P. sensor	V								V	T.P. sensor
T.P. sensor	%								%	T.P. sensor
Fuel Rate	GPH								GPH	Fuel Rate
Inj A Pulse	ms								ms	Inj A Pulse
Inj B Pulse	ms								ms	Inj B Pulse
Spark Adv	deg								deg	Spark Adv
Knock Signal	Y/N								Y/N	Knock Signal
Knock Retard	deg								deg	Knock Retard
IAC position	#								#	IAC position
Cam Retard	deg								deg	Cam Retard
Octane Rating	%								%	Octane Rating
Closed Throttle	Y/N								Y/N	Closed Throttle
Battery Voltage	V								V	Battery Voltage
Cause Power Red	Y/N								Y/N	Cause Power Red
Power Reduction	Y/N								Y/N	Power Reduction
Overheat Detection	Y/N								Y/N	Overheat Detection
Low Oil Switch										Low Oil Switch
Cause Power Reduction	Y/N								Y/N	Cause Power Reduction
Overheat Det	Y/N								Y/N	Overheat Det
Engine Hours	hrs								hrs	Engine Hours
Run Time	h/m/s								h/m/s	Run Time

***** All Readings Above Idle Must Be Made Under Load, On Water, With Engine Warm *****

Special Service Tools



Diacom for Windows

Newly released in Windows format

Requires Windows 98, 2000 or XP

Graphing capability

Easily captures test runs

Displays additional engine history

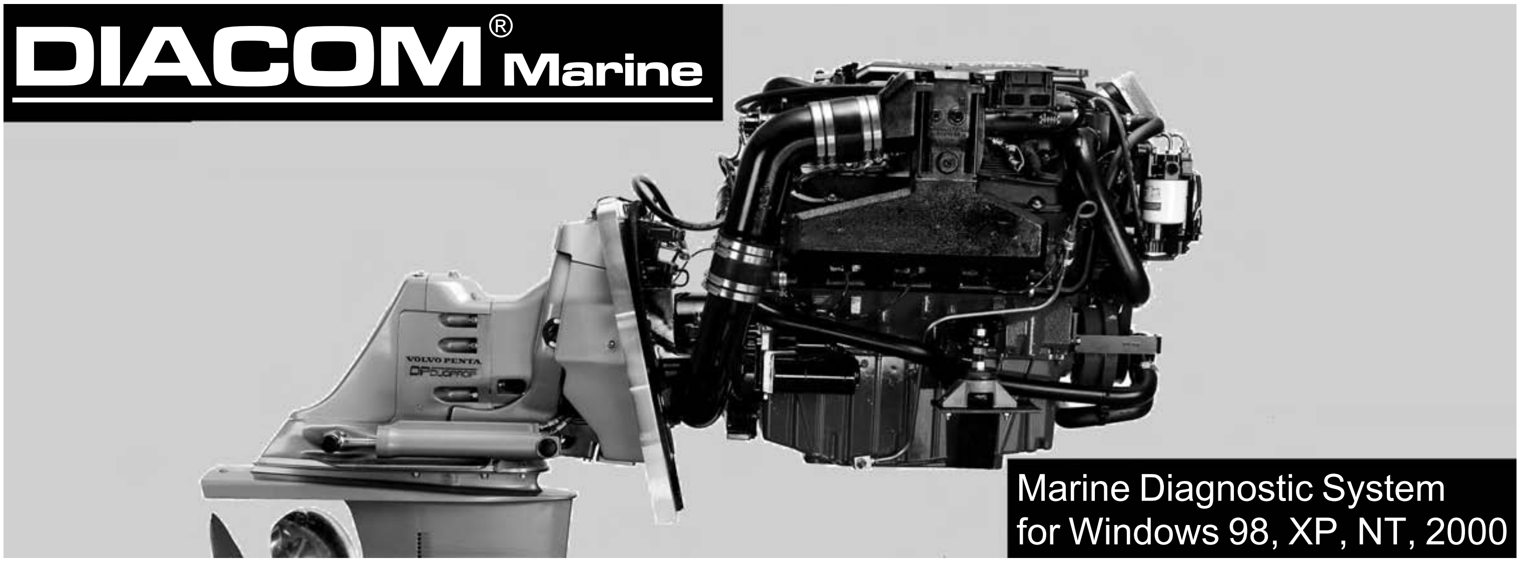
Reads MEFI 1, 3 and 4

DiacomMarine Brochure

VOLVO PENTA

EFI diagnostic software from Rinda Technologies.

This tool catches all serial data from the ECM and shows all values on one screen. It also will capture and record all serial data from the ECM for viewing back at the dock. The file created can then be viewed, graphed and sent via email or placed on storage media and mailed, to be viewed by anyone with the Diacom software.



Push the envelope. Move in a new direction.
Feel the future of technology.

The Diacom PC based diagnostic system gives you the power and flexibility you need to troubleshoot today's advanced marine EFI systems. Diacom Marine breaks down the barriers between you and your troubleshooting tasks with it's intuitive features and complete set of analysis tools. Diacom also supports today's leading operating systems including: *Windows 98, Windows XP, Windows NT and 2000.*

- **Productivity equals profitability.** Leverage the computing strength of industry standard notebook PCs to diagnose EFI faults in less time.
- **Stay compatible and competitive.** Easily access CD based service information, exchange engine data over the Internet, free yourself from dedicated diagnostic tools and take advantage of the latest notebook PC technology.

PC Diagnostic Power

Diacom Marine is a powerful Windows based diagnostic tool that is revolutionizing marine engine service. With advanced engine control systems now standard on nearly all gasoline inboard and stern drive engines, you need a service tool that pinpoints problems quickly and accurately. Diacom unlocks the computing power of your notebook PC and provides state-of-the-art features that simply leave other diagnostic tools in it's wake.

You Spoke, We Listened

We started with a blank screen and designed Diacom Marine from the ground up with your feedback and suggestions in mind. After all, who knows better than you when it comes to getting your job done? Over the past decade we've collected a wealth of knowledge from the marine service technicians and dealerships we support. This gave our engineers quite a wish list of features to consider. Thanks to your input, Diacom has been made more intuitive, more streamlined, and more discoverable, so you can complete all of your work in less time.

Internet Connectivity

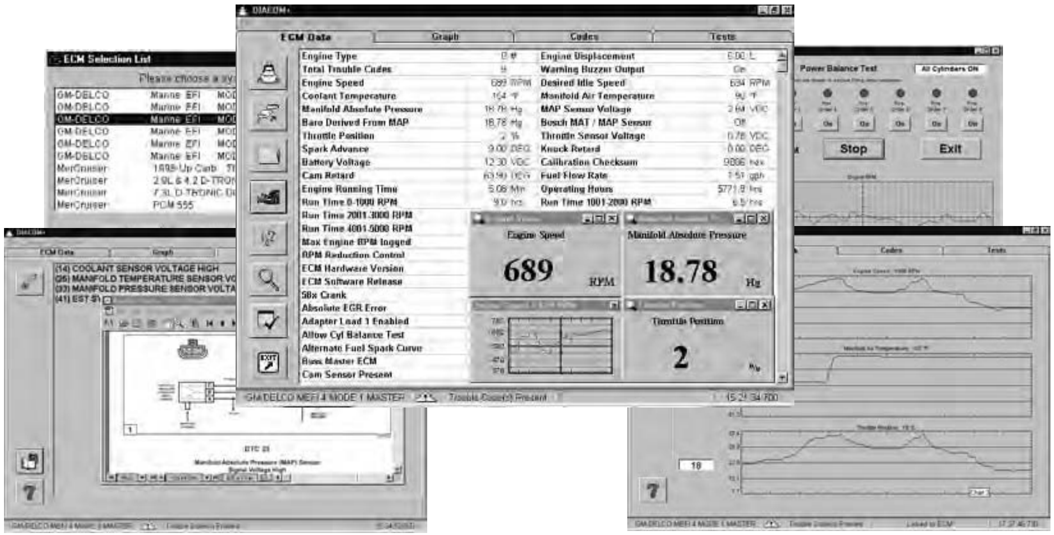
Chances are the Internet has already changed the way you interact with your customers and suppliers. Now it will change the way you troubleshoot. Diacom was

designed to be Internet "aware" and provides features that allow the easy exchange of data with other parties. Diacom can also convert engine data into formats easily read by other popular PC programs such as Microsoft Excel and Access.

Rinda Technologies Inc.

DIACOM® Marine

Speed, precision, power and flexibility. Professional features to get the job done.



Big Screen, Huge Advantage

Notebook screens have never been bigger and brighter. Diacom takes full advantage of your PC's expansive display and shows you the "Big Picture" of what's happening. Now you can spend less time pressing scanner buttons, scrolling through lists of parameters, and more time seeing what your EFI numbers mean. Diacom's data display can be easily customized allowing you to view each EFI system type in a way that best suits your taste. Throw in features such as side-by-side twin engine displays, instant pop-up graphs, enlarged parameter windows, extensive data recording capabilities, report printing, and you'll see why more marine technicians are choosing Diacom than ever before.

The Electronic Information Age

All of those years of searching through stacks of service manuals and technical bulletins are finally coming to a close. Most manufacturer's now provide engine service information on CDs which can be easily searched and updated. Diacom has been designed to seamlessly access this information, displaying it effortlessly and accurately when you need it most. Simply click on any trouble code in Diacom's display screen to launch the service information feature[1].

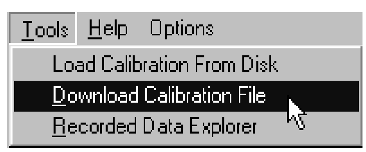
Tests Made to Order

The marine industry's ever increasing variety of EFI systems unfortunately means that tests designed for one type of engine control system probably won't apply to other systems.

Diacom's adaptable "Tests" screen is designed to automatically configure itself for the EFI system under investigation. Using Windows ActiveX programming technology, this feature simplifies your work by displaying and delivering the unique set of tests that apply to the particular system you are troubleshooting.

Special Functions

As a factory authorized dealership you know the value of having the latest service technology at your fingertips. Working closely



with marine engine manufacturers, we have incorporated specialized EFI system functions[2] into Diacom Marine. Now factory authorized service facilities can use a single integrated diagnostic program to not only troubleshoot but also perform system upgrades and memory updates electronically in just minutes. ECM exchanges can now be minimized and in most cases entirely eliminated.

For More Information

To obtain a comprehensive list of features and information about Diacom Marine as well as other Rinda Technologies products, please visit our website at www.rinda.com. Product specialists can also be reached in the USA and Canada by calling 773-736-6633.

System requirements

To use Diacom, you need:

- PC with Pentium 200 MHz or higher processor
- Microsoft Windows 98, Windows 98 Second Edition, Windows Millennium Edition, Windows XP, or Windows 2000
- For Windows 98 and Windows 98 Second Edition
  - 64 MB of RAM minimum
- For Windows Millennium Edition, Windows XP or Windows 2000
  - 128 MB of RAM minimum
- 50 Meg or greater of available hard disk space.
- CD-ROM drive
- 9 pin serial COM port or USB port.
- VGA (640 x 480) or higher resolution display screen with 256 colors or greater.
- Mouse, touchpad, or compatible pointing device.

Additional items or services required to use certain features:

- Internet connection for email and web related features.
- Appropriate document viewing utilities such as Adobe Acrobat and Microsoft Internet Explorer to view electronic service information.
- Diacom special functions require usage authorization and data files supplied by engine manufacturers.

1. Engine service manuals in electronic format must be obtained from the engine and /or vehicle manufacturers.
2. Usage restrictions apply based upon dealer type and status. Diacom special functions vary with EFI system type and engine manufacturer.

Please note all specifications are subject to change without notice. Photos and screen images shown may differ based upon product version or other factors. Information presented in this document is believed to be accurate. Responsibility for errors, omission of information or results from the use of this information cannot be assumed by Rinda Technologies, Inc.

Rinda Technologies Inc.
www.rinda.com

Special Service Tools

- **Scan tool is a bare minimum**
- **Laptop offers the best protection against early obsolescence**
  - –Easy capture of data
  - –More universal as to the brand of engine
  - –Email captured files for help
  - –Build your own “Database” of captured data
  - –Upgrades more easily produced, often only software

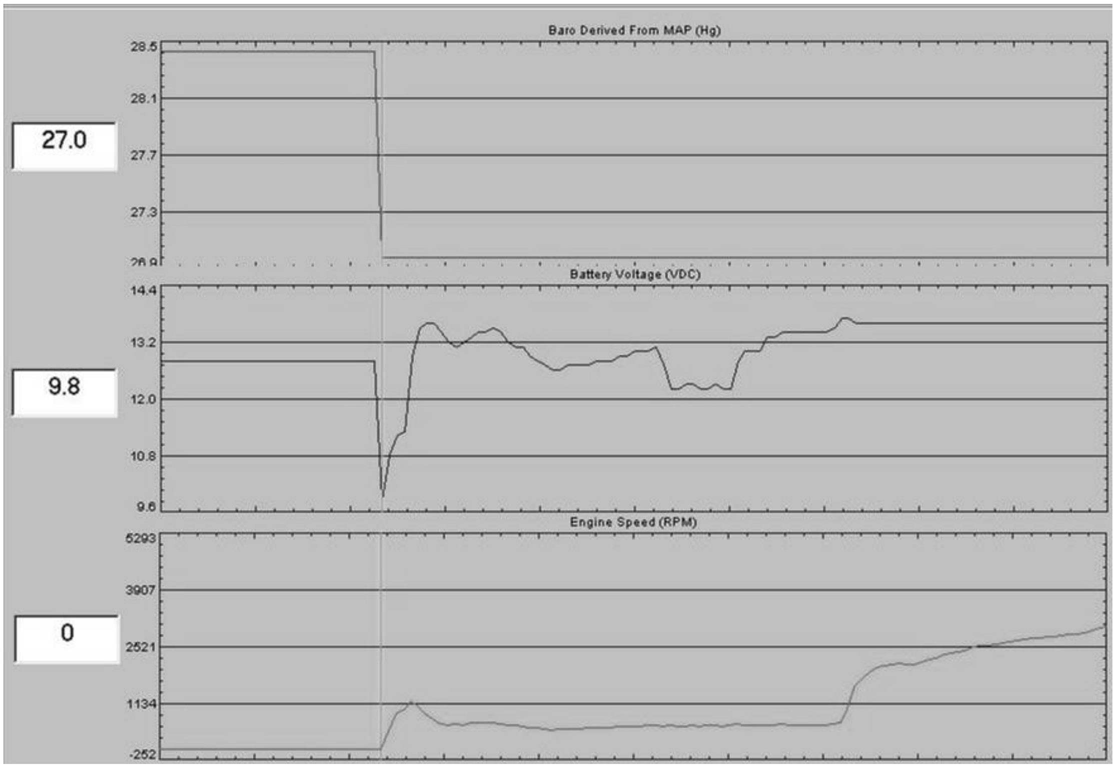
VOLVO PENTA

The long list of codes that can be set on today's MEFI 4 and 4b systems will limit the usefulness of a “winkie blinky” tool. It is almost impossible to service the engine without a scan tool. The Tech-Mate, DDT and VP2000 are durable and well suited for the typical boat environment, but all pale compared to a laptop’s capability. The VP2000 will no longer be supported with the introduction of the Electronic Gas Control (EGC) engines during the summer of 2005.

A used computer running Windows 98 or higher, can be found at a reasonable price at many computer shows around the country. With the future marine systems that will be introduced, this option allows the greatest potential for upgrade ability and flexibility.

MEFI Fuel Injection

Special Service Tools



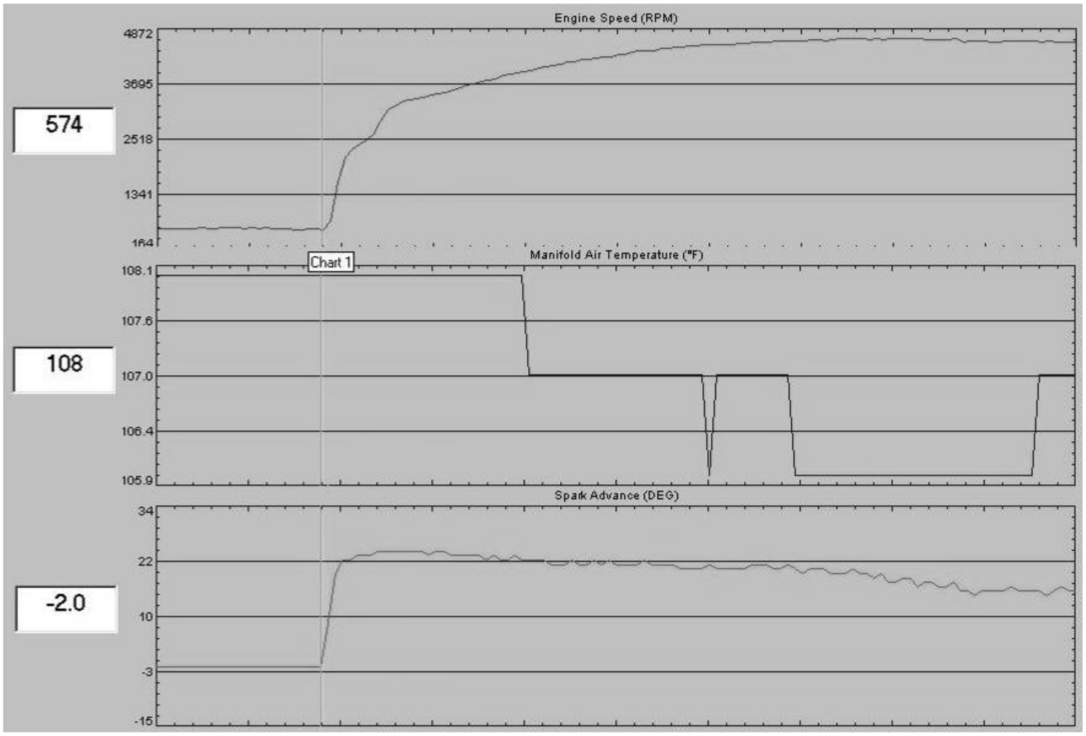
The Diacom Marine program from Rinda Technologies can be used with many of the competitors engines as well as Volvo Penta’s engines. You can view and capture data that can be emailed later to the factory. **The service manual is built right in and the codes display what they mean instead of just a code number (as with the winky-blinkie).**

The above graph shows a start cycle for an engine with a drivability complaint of hesitation on acceleration.

During starting the voltage drop to 9.8 volts (or slightly lower) due to incorrect battery capacity, type or state of charge. This low voltage causes the ECM’s processor to shut down momentarily. Once the voltage rises again, the ECM “wakes up” and rereads baro while the engine is cranking over. This causes the barometric pressure (derived from the MAP reading) to be read while there is vacuum in the intake. In this example that causes the baro to change by 2 inches of mercury. This effectively tells the engine it is at altitude and reduces the amount of fuel to be delivered accordingly. So the engine will run lean until the baro gets updated and corrected (at WOT). You can see in the bottom graph that the engine RPM dips slightly during acceleration as a result.

During a restart with a warm engine the barometric pressure remained at 29.2 inches and the hesitation was no longer present.

Special Service Tools



This is a normal reading from an 8.1Gi during a hard acceleration. The wave in the RPM graph was due to the prop ventilating slightly during the test. The center graph is the manifold air temperature declining as fresh air is pulled into the engine. The spark gets retarded slightly as the manifold pressure changes and RPM increases to prevent knock or detonation damage. The spark advance is related to RPM and MAP.

Ideally, make **multiple recordings:**

COLD: One minute cold start up. Start recording first, then crank to start, let idle for another 45 seconds.

WARM: Warm engine, turn it off, key on and begin recording, start engine and do three accelerations with

1)minimum throttle to maximum throttle as slow as reasonably done,

2)repeat with a medium-fast rate of throttle opening to maximum, and

3)once more with rapid WOT, then back to idle and now stop recording. All three in one file.

Name the file as: engine model _ serial number _ altitude _ and either word cold or hot, followed by **.rec**.

Example: 50gxi_4012053616_7000ft_cold.rec

VOLVO PENTA

Volvo Penta of the Americas
1300 Volvo Penta Drive
Chesapeake, Virginia 23320-9810
USA

Service Bulletin

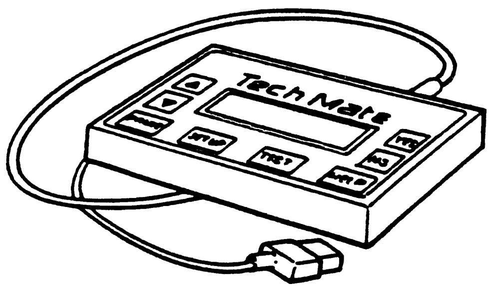
Group	Number	Version
08-2	**33**	**02**

Fuel Injection Service Tools

Models
4.3GXi-B, 5.0GXi-B, 5.7Gi-B, 5.7GXi-C, All 8.1 Liter

Distribution: M Date: 03-2003 Binder: C Page: 1(2)

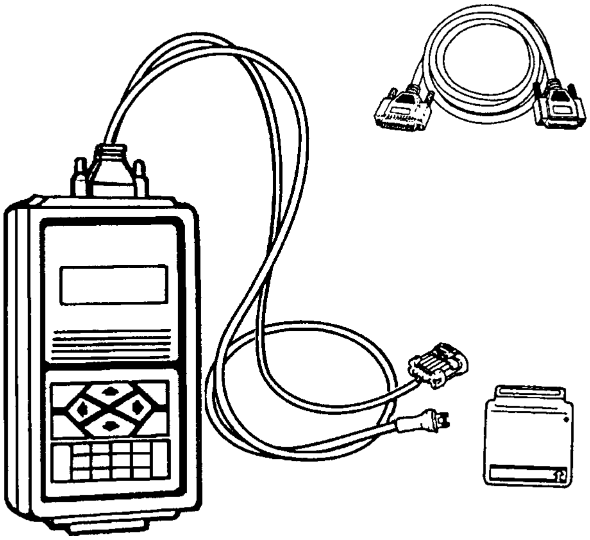
Starting with 4.3GXi-B, 5.0GXi-B, 5.7Gi-B, and 5.7GXi-C Multiport engines and all 8.1 liter engines, the Marine Electronic Fuel Injection Generation 4 (MEFI 4) Electronic Control Module (ECM) is used exclusively. The MEFI 4 system requires updated scantool hardware to be compatible with the new MEFI 4 system. Please note that the new MEFI 4 ECM looks identical to the MEFI 3 ECM externally, however the internal connections (pin locations) are different. The following equipment will assist in diagnosis of the MEFI 4 systems.



Techmate Scan tool P/N 3851228

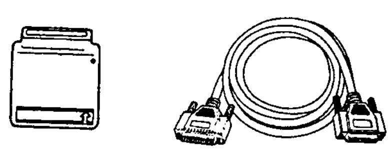
Techmate Scan tool is compatible with all Volvo Penta General Motors based EFI engines from MEFI 1 MEFI 3, and MEFI 4 systems. This full-featured tester read all parameters and diagnostic trouble codes (DTC). The unit supports all output tests including injector tests and cylinder power balance tests on MEFI 4 units.

The Techmate Scan tool is currently delivered with version 4 software and is required to read the latest engines. Techmate scan tools with earlier software versions can be updated to current standards using updated internal software. Contact Rinda Technologies, Chicago, IL, (773) 736-6633 or visit them on the web at www.rinda.com to obtain updated software.



VP - 2000 P/N 3855947

VP2000 scan tool is compatible with all Volvo Penta General Motors and Ford based engines with P/N 3861650 cartridge included. This scan tool is compatible with General Motors MEFI 1, MEFI 3, and MEFI 4 systems and Ford EEC 4 systems. The tester will read all parameters and diagnostic trouble codes (DTC) and supports all output tests including injector tests and cylinder power balance tests on MEFI 4 units.

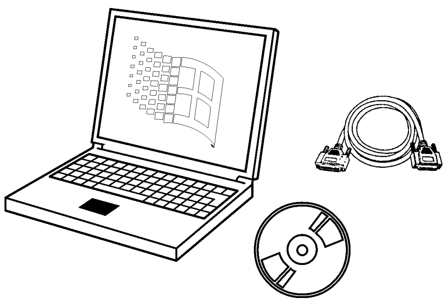


Cartridge and Cable Kit P/N 3855948

For dealers already equipped with OTC model 4000 Enhanced or compatible scan tool, this kit includes the updated cartridge P/N 3861650 and connection hardware for Volvo Penta engines.

Scan Tool Cartridge P/N 3861650

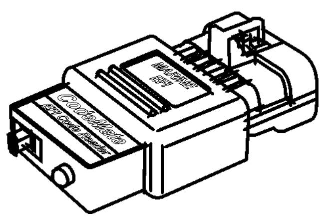
Updated cartridge package for VP2000 Scan tool compatible with MEFI 1, MEFI 3, MEFI 4 General Motors based engines and Ford based EEC 4 EFI engines.



Diacom For Windows

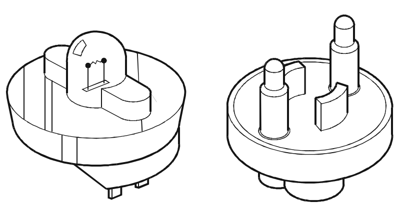
Laptop computer scan tool program capable of reading all Volvo Penta General Motors based MEFI 1, MEFI 3, and MEFI 4 systems. Displays all readings on one screen and has a variety of graphic and recording functions. Available from:

Rinda Technologies, Inc.,
4563 N. Elston Ave.
Chicago, IL 60630
Phone: (773) 736-6633
Fax: (773) 736-2950
Web: www.rinda.com



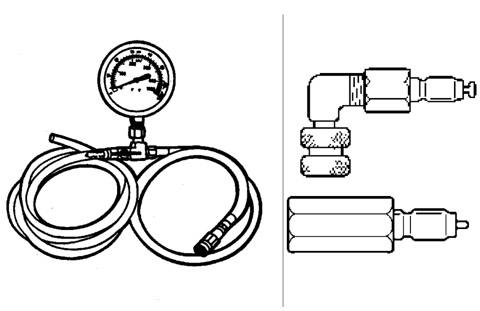
Marine Diagnostic Trouble Code Tool for GM P/N 3851088

Reads basic failure code numbers by LED for GM MEFI 1, MEFI 3, and MEFI 4 systems. Will clear codes with proper sequence. Can be used on earlier models for "Service Mode" timing settings. Should only be used as a backup for your primary scan tool.



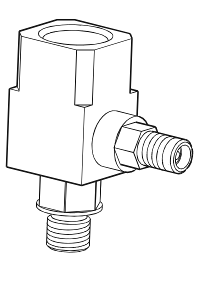
Noid Light Kit P/N 3851090

A special test light that is connected to the injector or fuel pump terminal to check for actuation signals from ECM. Can quickly verify if the ECM is actuating the injectors.



Fuel Pressure Test Kit P/N 3855533

This kit has been upgraded to include the adapter P/N 3862357 for attachment to the larger Schrader valves found on the high-pressure fuel rail on 4.3GXi-B, 5.0GXi-B, 5.7Gi-B, 5.7GXi-C Multiport engines and all 8.1 liter engines and the smaller Schrader valve adapter P/N 3855354 for low pressure test ports. Each adapter is available individually.



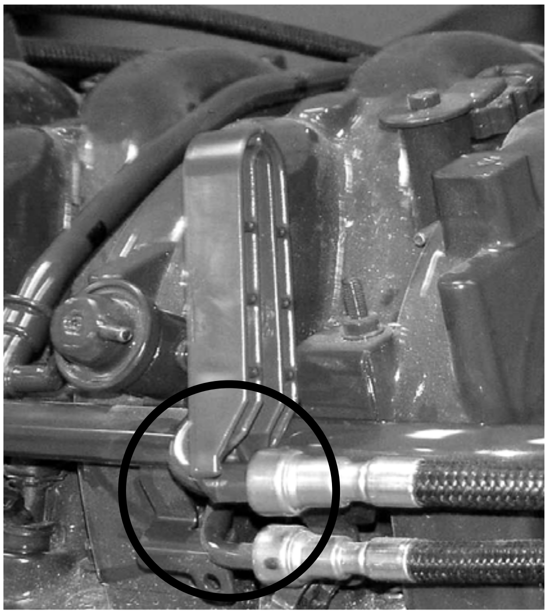
Service Tool P/N 3861684

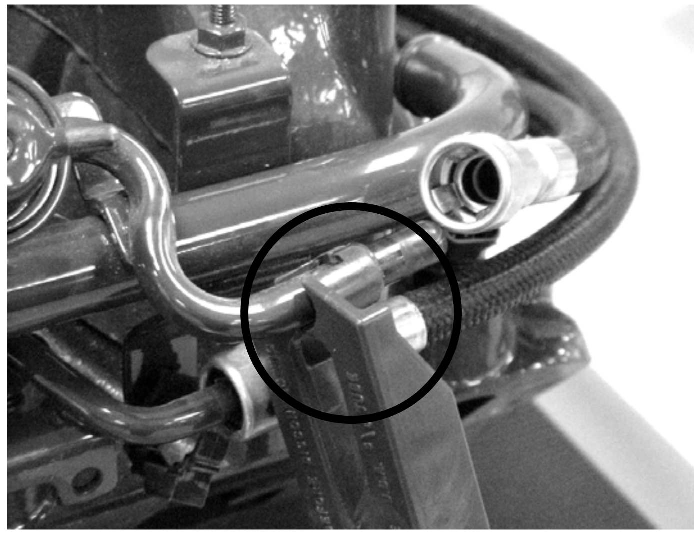
For use on engines equipped with fuel cells that did not have a high pressure test port on the fuel rail. This tool will check the high pressure side of the fuel system at the fuel pump.

Special Service Tools

Fuel Line Quick Disconnect Tool

 # J 41769





VOLVO PENTA

OTC/Kent- Moore
Demonstrate the use of theses tools

Fuel Line Quick Disconnect Tool # J 41769
This set includes a 5/16” and a 3/8” disconnect tool.

Special Service Tools

Fuel Injector Test Harness

Fuel Injector Remover

VOLVO PENTA

Fuel Injector Test Harness

VPA# J 39021-380 for 8.1L engines (pictured above) and J 44602 (not pictured) for the 4.3, 5.0 and 5.7L multiport engines.

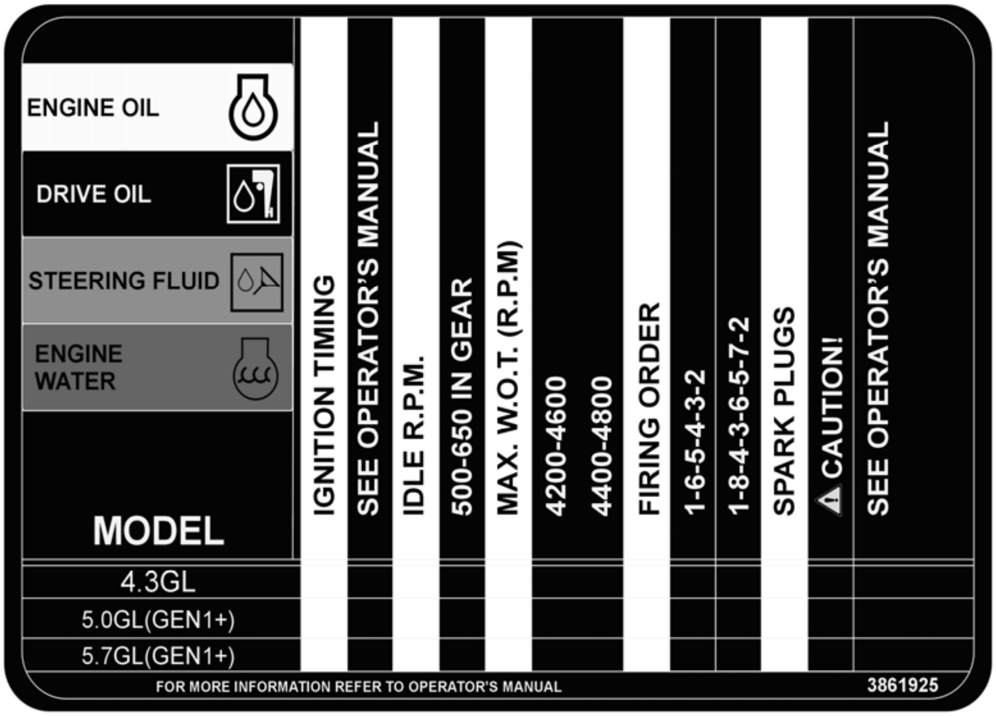
Adapts the scan tool injector test connector to the engine fuel injector.

Fuel Injector & Rail Removal Tool

VPA# J 43013

Used as a lever to pry off the o-ring seal at the fuel rail cups.

Flip it over to pry the injector from the manifold.



Oil Filter Bulletin Oil Fill Bulletin

THIS STICKER HAS THE ENGINE'S MAX RPM LISTED ON IT.

On current product, this sticker is located on the plastic engine cover.

Color coded service points. No engine is selected. The intent is to demonstrate the color coding of the service points on the engines.

VOLVO PENTA
Volvo Penta of the Americas
1300 Volvo Penta Drive
Chesapeake, Virginia 23320-9810

Parts Bulletin

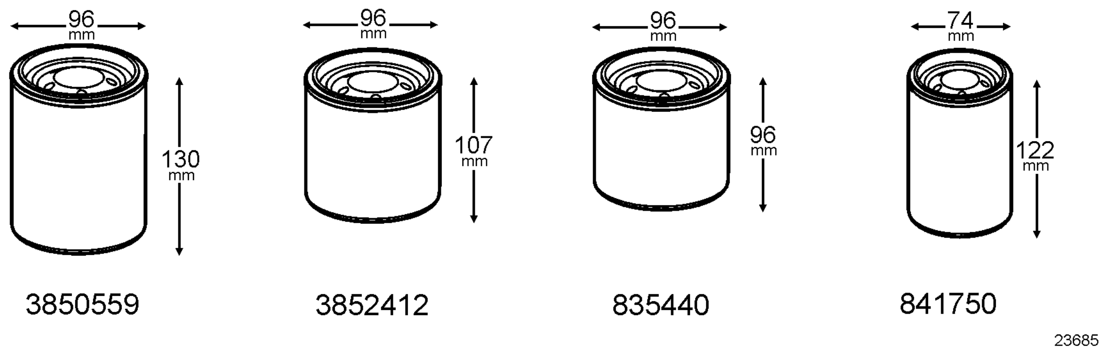
Group	Number	Version
P-21-7	**1**	**01**

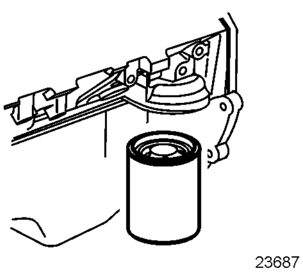
Oil Filters

Models: all GM engines

Distribution: Parts Date: March 2005 Binder: Parts Replaces: N/A

These are the oil filters for GM engines;





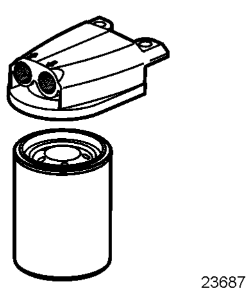
Oil filters mounted on block;

3.0L engines: 835440 and 3852412

V6 engines: 841750

V8 engines: 3850559, 835440 and 3852412

3852412 is shipped on some engines, it is replaced by 835440 in the Parts system.

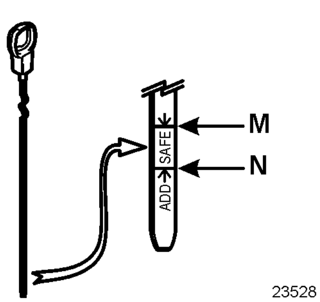


For remote oil filter kits;

Use 3850559 or 835440.

Note! for later 8.1L engines only use 835440, 3850559 will not clear the ignition coils mounted below the filter.

Note! for 7.4/8.2L only use 3850559.



⚠ **Caution!** Gas engines require a precise oil fill level to operate correctly. Overfilling results in high operating temperatures, foaming (air in oil), loss of power and reduced engine life. Underfilling causes loss of lubrication. Always check for correct oil fill on the **dipstick** when changing engine oil.

M=maximum, N=minimum

Service Bulletin

Group	Number	Version
04-2	38	01

VOLVO PENTA

Volvo Penta of the Americas
1300 Volvo Penta Drive
Chesapeake, Virginia 23320-9810
USA

Workshop Manual 7743372

Models
5.0 & 5.7 Liter

Distribution: M   Date: 11-2004   Binder: C

The Oil Capacity specification has changed: 4.5 quarts (4.2 liters) without oil filter change
5.5 quarts (5.2 liters) with oil filter change

For the following engines:

5.0 GL-A/B/C/D/E
5.0 GXi-A/B(F)/C(F)/D(F)/E(F)
5.0 OSi-B(F)/C(F)/D(F)/E(F)
5.7 GL-A/B/C/D/E
5.7 Gi-A/B(F)/C(F)/D(F)/E(F)
5.7 GXi-A/B/C(F)/D(F)/E(F)/F(F)
5.7 OSi-A(F)/B(F)/C(F)/D(F)/E(F)
5.7 OSXi-A(F)/B(F)/C(F)/D(F)/E(F)
5.7 GiI-A/B/C/D/F
5.7 GXiI-A/B/C/D/F

To insure the engine oil is filled to the correct level, the level must always be checked on the dipstick. This includes re-filling the crankcase as part of changing the engine oil.

Please place the self adhesive corrections on the following pages for your workshop manual 7743372 in the following locations:

Page 10	Table 4 Crankcase Capacities	
Page 161	Tune Up Specifications	
		Table 4 Oil Capacity
		Table 5 Oil Capacity
Page 162		Table 6 Oil Capacity

Diagnostics - Mechanical

Always start with the base engine!

- Vacuum gauge can help identify potential mechanical problems
- Manifold vacuum determines load for the system
- Read the spark plugs carefully
- Compression test with a good battery
- Leak-down test for more advanced look at cylinder and valve conditions
- Electrical connections! Low voltage or voltage drops can be extremely problematic to the system

VOLVO PENTA

The fuel injection system is limited in that it can’t help an engine that has mechanical problems. Often times the system will create a new symptom that will lead you in the wrong direction. For example, black carbon fouled plugs could be due to a stuck open thermostat that causes the system to add fuel in what is called a “multiplier”. The same symptom can also be a tuliped valve that lowers manifold pressure. This in turn tells the system it is under more load than normal and it will add fuel. Any mechanical condition that causes less vacuum to be built up in the intake is assumed by the ECM to be an increase of load on the engine.

Vacuum gauge diagnostics are located in the engine mechanical workshop manual.

Diagnostics - Mechanical

Correct propeller and drive ratio?

- Compare with other similar models
- Check ratio versus the label if a problem since first use
- Check hub for slipping

Bottom paint added or fouling present

- marine growth or barnacles?

Excessive load?

- Is this a new problem?
- Anchor chain in bow locker?
- Dingy or personal watercraft added?
- Any new weight added?

  Reduce prop size by 1 (inch or size) for every 1000 additional pounds.

One of the most common complaints we hear is poor top end performance. If the engine does not meet it's rated RPM, it will not meet it's rated horsepower. This leads to trying to troubleshoot a perfectly good engine. Left unresolved it can lead to high combustion temperatures due to engine overload that will cause valve or piston damage.

If the problem has existed since the very first day, check the weight of the boat at some local scales. Compare the prop size, drive ratio and performance with similar sized boats. Be sure to allow for addition of bottom paint and other factors relating to load.

Also be sure to check the exhaust for restrictions.

Diagnostics - Electrical

- **Battery capacity a minimum of 650CCA “starting” battery.**
- **Optional accessories added to the engine wiring? (if alternator capacity is exceeded, then a storage battery is required to supply additional current needs)**
- **Battery cabling of the correct gauge?**
- **Are the ground stud/cables tight?**
- **Remove wing nuts and use nylock nuts for a more secure connection**
- **Check battery switch connections if appropriate**
- **Battery Isolators can cause voltage drop to ECM**

Battery Isolator
Installation Bulletin

VOLVO PENTA

Fuel injected engines and the computers that run them require consistent voltage supply. A battery that has too few cold cranking amps or using a deep cycle battery for starting can lead to low voltages during cranking. If the voltage is severely low, you can have a crank, but no start condition. If it does start, it can change the “Baro derived from MAP”, which can lean the fuel mixture thinking it is now at high altitude (as talked about earlier in this book). An analog voltmeter such as the one on the dash can be very helpful here. A digital meter moves too fast and does not allow you a clear picture of the voltage drop during cranking (unless it has a record function).

Be aware also that the typical emergency stop switch interrupts the power lead from the key switch to the ECM. Test the voltage in and out of this switch if so equipped.

Service Bulletin

Group	Number	Version
32-1	13	01

VOLVO PENTA

Volvo Penta of the Americas
1300 Volvo Penta Drive
Chesapeake, Virginia 23320-9810

Battery isolators, correct installation

Models: EFI engines, see list

Distribution: M Date: Apr-2005 Binder: C

Engines affected;

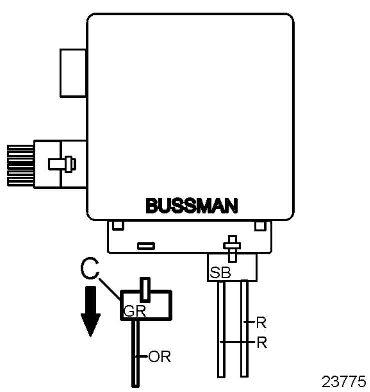
4.3GXi; -C,-CF,-D,-DF,-E,-EF
4.3OSi; -C,-CF,-D,-DF,-E,-EF
5.0GXi; -C,-CF,-D,-DF,-E,-EF
5.0OSi; -C,-CF,-D,-DF,-E,-EF
5.7Gi; -C,-CF,-D,-DF,-E,-EF
5.7GiI; -C,-D,-E,
5.7GXi; -D,-DF,-E,-EF,-F,-FF
5.7GXiI; -D,-E,-F
5.7OSi; -B,-BF,-C,-CF,-D,-DF
5.7OSXi; -B,-BF,-C,-CF,-D,-DF
8.1Gi; -C,-CF,-D,-DF,-E,-EF,-F,-FF
8.1GiI; -C,-D,-E,-F,
8.1GXi; -B,-BF,-C,-CF,-D,-DF,-E,-EF
8.1GXiI; -B,-C,-D,-E
8.1OSi-; -A,-AF,-B,-BF

EFI engines have been found in the field with incorrectly installed battery isolators. This can lead to voltage drops in the electrical system and poor battery charging. If these symptoms are present, check the installation of the isolator. The installation should comply with the guidelines below.

Correct installation of battery isolators

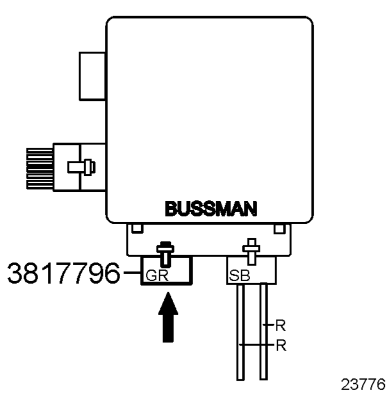
⚠ Caution! Disconnect all power to the engine before proceeding

A. Disconnect alternator from engine harness;

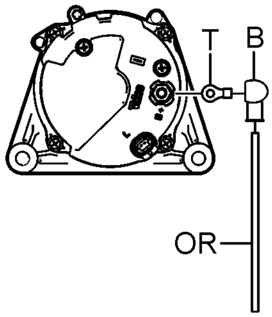


At Bussman fuse/relay box,
Remove gray connector with orange wire (C) from box.

Tape or tie strap the connector/wire to engine harness.



Install sealed connector 3817796 in box where gray connector/wire was removed.



23777

At rear of alternator,
Remove ring terminal/orange wire/ boot (OR) from the B+ terminal.

Remove ring terminal (T) and boot (B) from wire, save boot.

Seal cut end of wire with electrical tape or liquid tape. Tape or tie strap the wire (OR) to engine harness.

Alternator and wire (OR) are now disconnected from the engine harness.

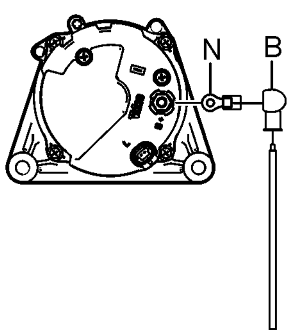
B. Connect alternator to isolator;

Note! The alternator output wire assembly, which carries alternator output to the isolator, is critical to correct operation of the charging system. The wire must meet all current ABYC specifications regarding materials, attaching terminals and routing and protecting the wire.

Note! Wire size of the output wire is critical to correct operation of the isolator and charging system.
Wire size is determined by the total length of wire. The size of the output wire used in the installation must meet these ABYC standards;

0 - 3m (0-10 ft)	6 AWG
3m to 6m (11-20 ft)	4 AWG
over 6m (over 20 ft)	2 AWG

Using the correct wire size ensures that voltage drop occurs through the isolator diodes, and not in the wire.

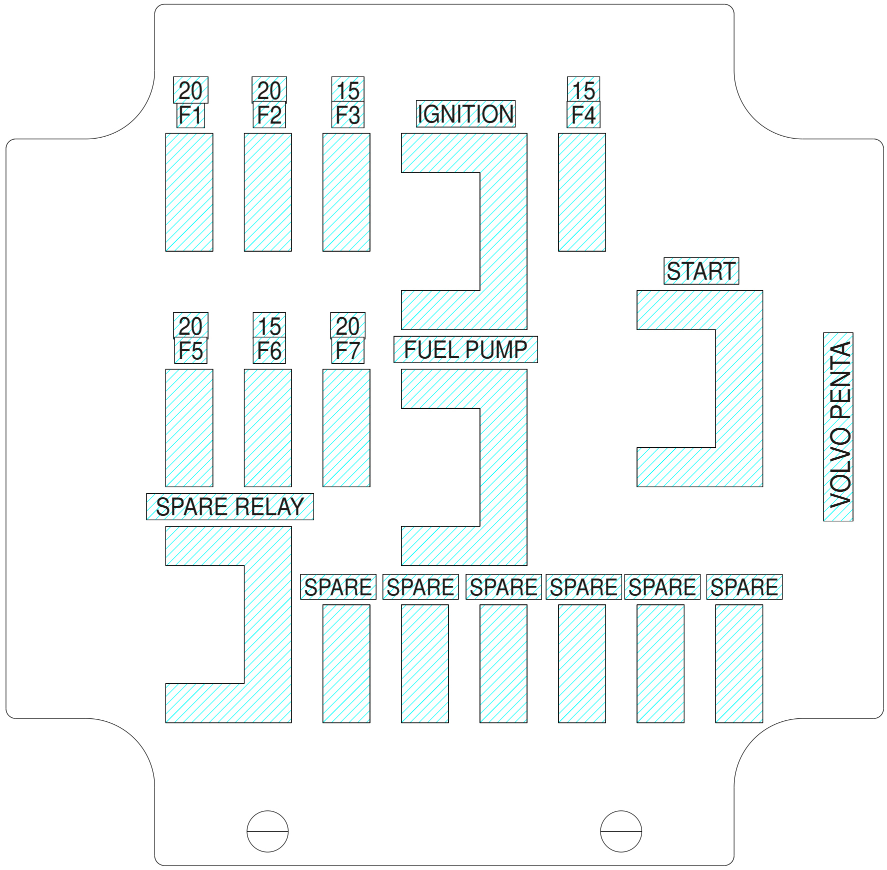


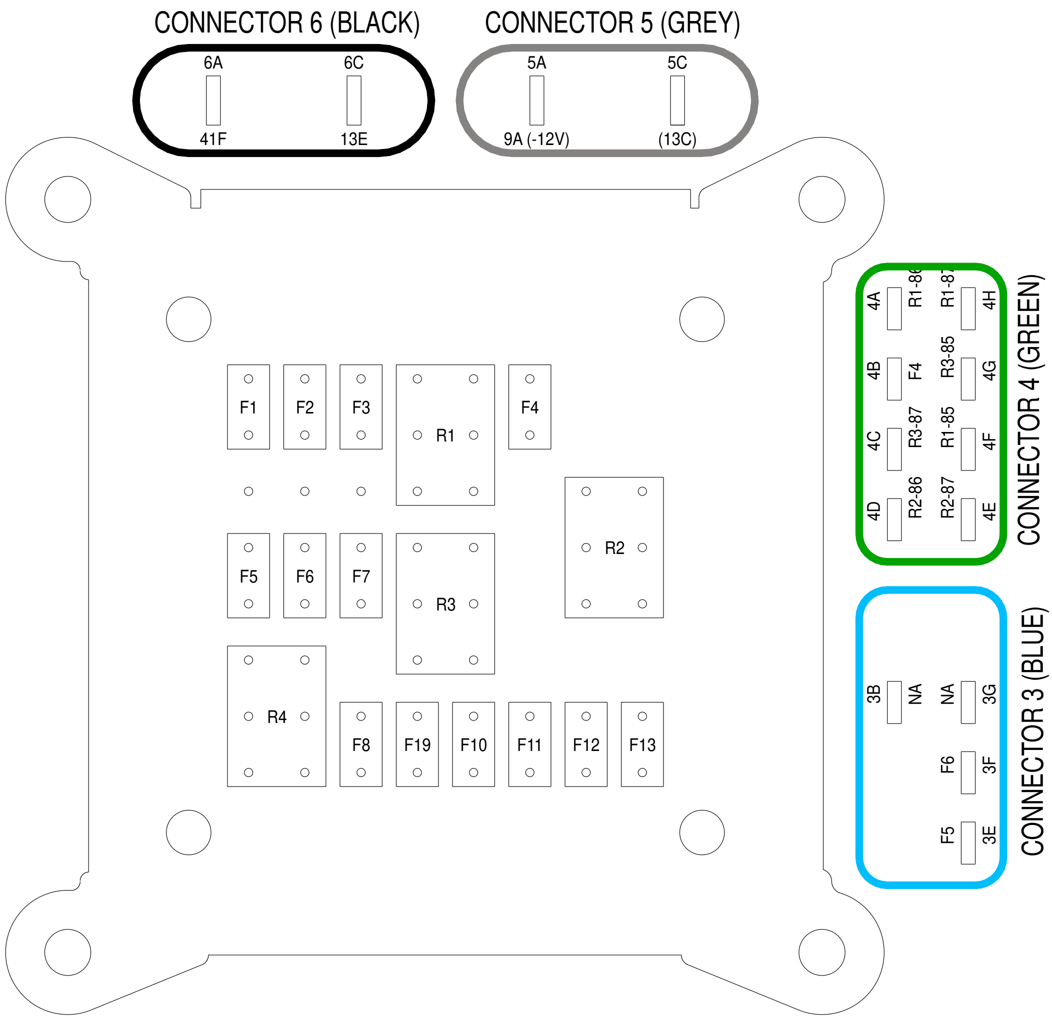
23778

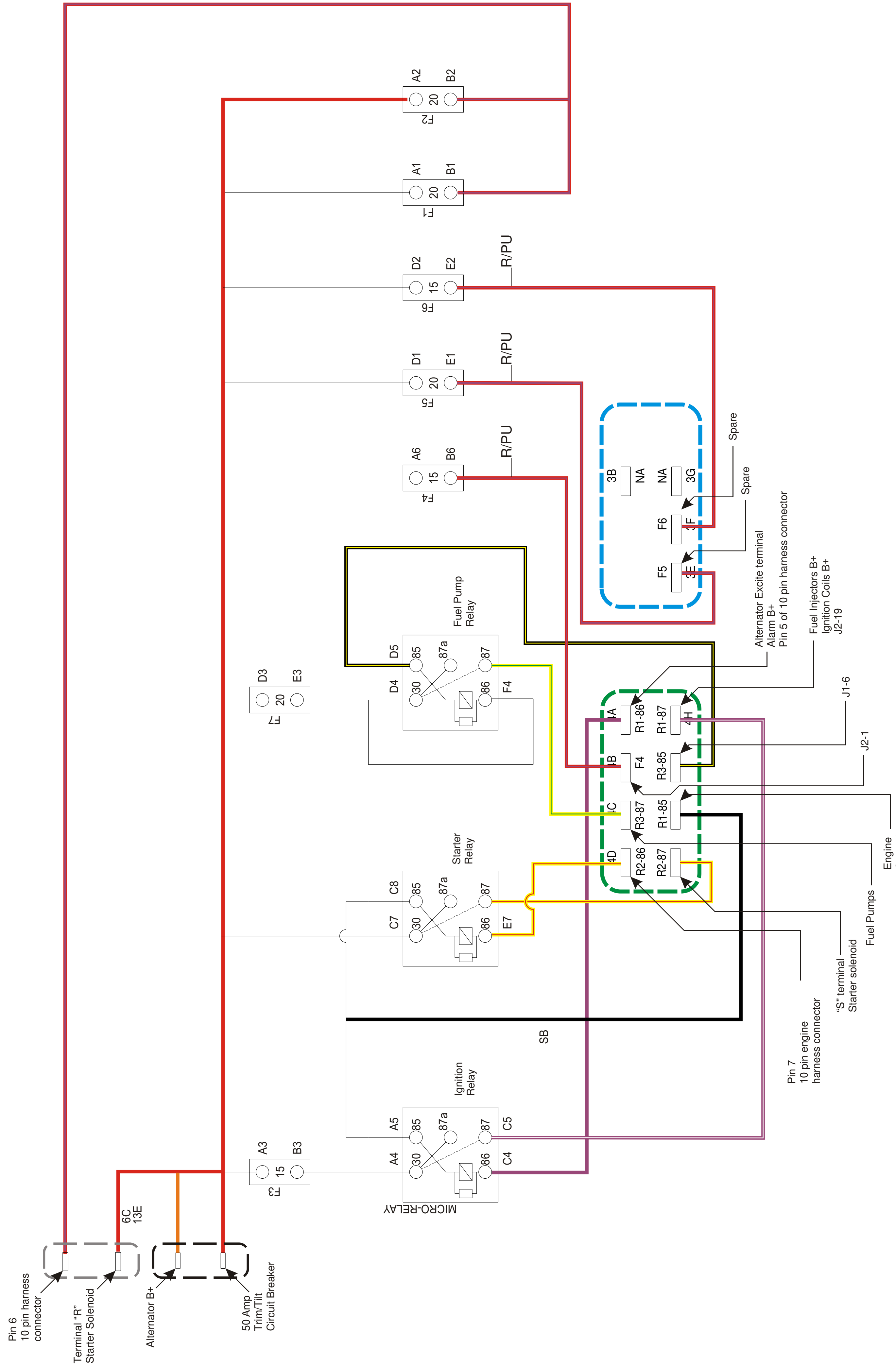
Place boot (B) over output wire.
Install a 5/16” or 8mm ring terminal (N) on output wire.
Recommended terminal has mechanical crimping of the wire’s conductor and a heat shrink seal.

Install ring terminal/boot/wire on B+ stud on alternator.
Nut torque = 10-17Nm or 7-13 ft/lbs
Route the wire to avoid sharp edges or other chafe points. Sheathing the wire is recommended.

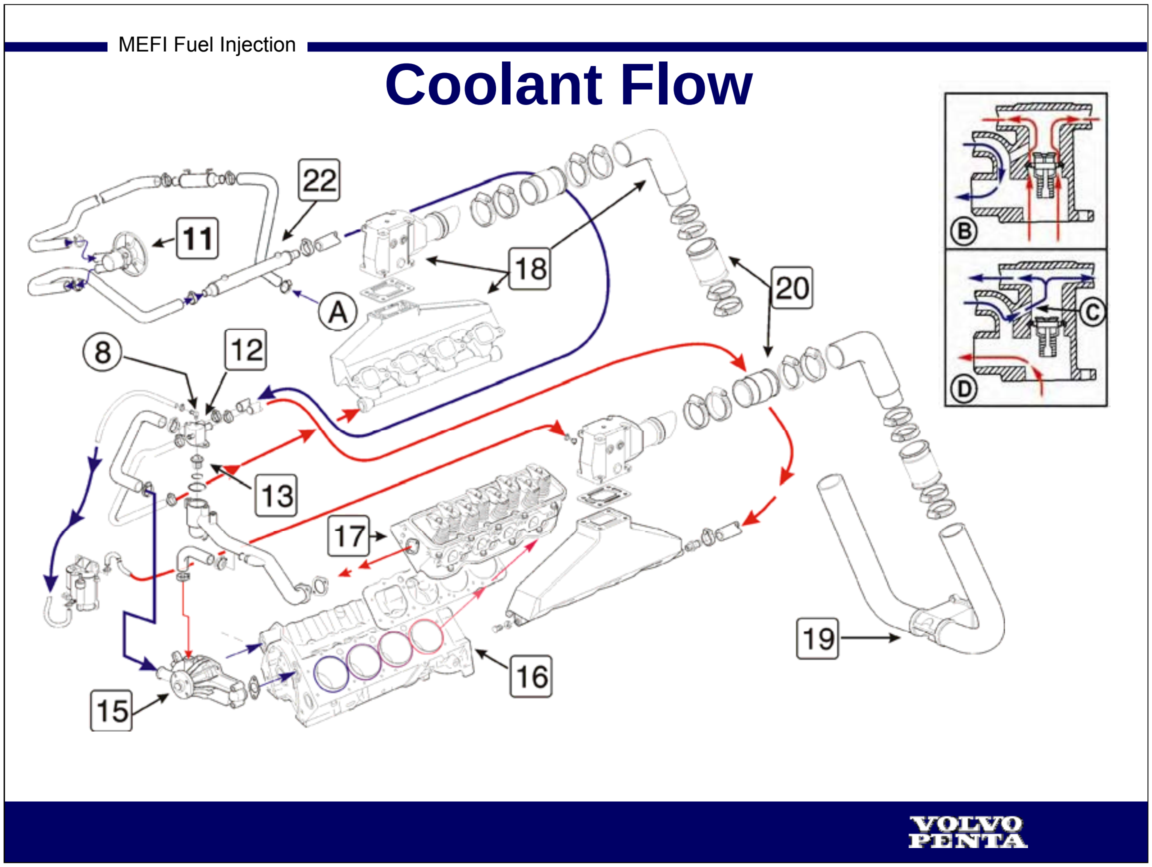
Complete the wiring of the battery isolator per manufacturer's recommended procedures.


20
F1
20
F2
15
F3
IGNITION
15
F4
START
20
F5
15
F6
20
F7
FUEL PUMP
VOLVO PENTA
SPARE RELAY
SPARE
SPARE
SPARE
SPARE
SPARE
SPARE


CONNECTOR 6 (BLACK)
6A
6C
41F
13E
CONNECTOR 5 (GREY)
5A
5C
9A (-12V)
(13C)
F1
F2
F3
R1
F4
R2
F5
F6
F7
R3
R4
F8
F19
F10
F11
F12
F13
CONNECTOR 4 (GREEN)
4A
4B
4C
4D
F4
R3-87
R2-86
R3-85
R1-85
R2-87
4H
4G
4F
4E
CONNECTOR 3 (BLUE)
3B
NA
NA
F6
F5
3G
3F
3E



MICRO-RELAY
Ignition Relay
Starter Relay
Fuel Pump Relay
85
87a
87
30
86
A5
A4
C5
C4
C8
C7
E7
D5
D4
F4
A3
B3
15
F3
D3
E3
20
F7
A6
B6
F4
D1
E1
F5
D2
E2
F6
A1
B1
F1
A2
B2
F2
R/PU
SB
6C
13E
3B
NA
NA
3G
F6
3F
F5
3E
Spare
Spare
4A
R1-86
R1-87
4H
4B
F4
R3-85
4C
R3-87
R1-85
4D
R2-86
R2-87
Alternator Excite terminal
Alarm B+
Pin 5 of 10 pin harness connector
Fuel Injectors B+
Ignition Coils B+
J2-19
J1-6
J2-1
Engine Ground
Fuel Pumps
"S" terminal Starter solenoid
Pin 7 10 pin engine harness connector
Pin 6 10 pin harness connector
Terminal "R" Starter Solenoid
Alternator B+
50 Amp Trim/Tilt Circuit Breaker



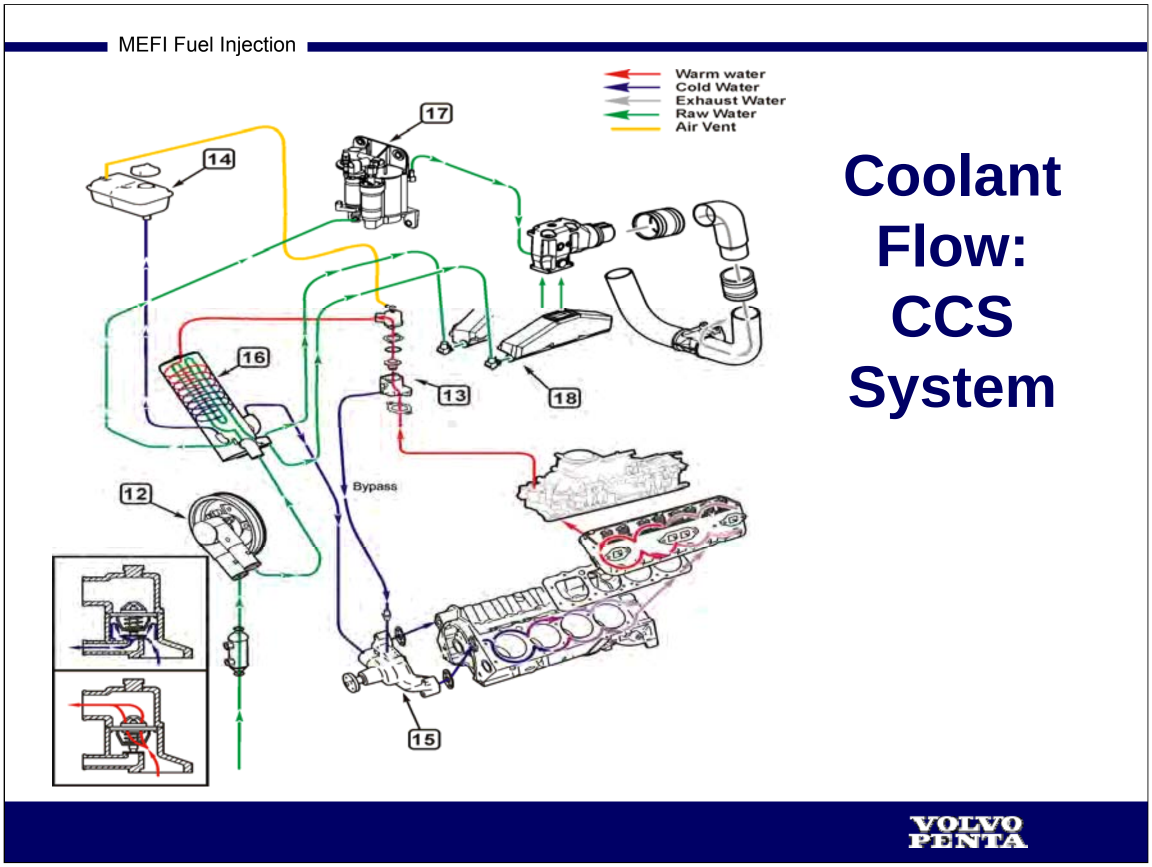
Information about coolant flow in the raw water cooled or engines with a closed cooling system is located in the “cooling system” section of the current engine mechanical workshop manuals.

The picture above shows a raw water cooled 8.1L. The other engines are similar.

Raw water is pulled into the pump (11) through the drive and the power steering cooler (22). Raw water is then discharged from the pump to the thermostat housing (12). If the thermostat is closed (as in D above), water goes through a cast bypass (C) inside the thermostat housing and is sent to the exhaust risers (18) and then overboard in the exhaust.

If the thermostat is open (as in B above), then the raw water is sent to the circulating pump (15), into the block (16), up through the heads (17) and back to the thermostat housing (12) under the thermostat. It then travels through the open thermostat, into the riser bypass hoses and then overboard.

In both the raw water cooled systems and the closed cooling systems (antifreeze), the fuel cell (MOAS) is RAW water cooled. Water flow through the fuel cell is from the thermostat housing nipple (8) to the bottom of the fuel cell, through the cell, out the top of the fuel cell and over to one of the exhaust risers and then overboard. The fuel cell has a second hose on top of the cell that goes to the intake manifold. This is the high pressure pump reservoir vent line. Engine vacuum pulls the vapors off the top of the cell and into the engine intake system to be burned. The hose connects to a pulse limiter at the intake manifold. The pulse limiter prevents a backfire of the engine from igniting the fuel vapors in the hose.



The picture above shows both raw water flow and coolant flow in a closed cooling system (CCS). In a CCS, only an antifreeze mixture flows through the engine. Raw water and antifreeze never come in contact with each other. They do meet in the heat exchanger (16), but one liquid is inside the tubes and the other is outside the tubes. As stated on the previous page the fuel cell (17) is raw water cooled even in this system. As a general rule CCS engines run at a slightly higher operating temperature than raw water cooled engines.

The raw water flow for this system is: water is pulled into the pump (12) and then discharged into the heat exchanger (16). The water leaves the heat exchanger and travels to the fuel cell and the exhaust risers (18), via separate hoses, and then is discharged overboard through the exhaust.

Fresh water and antifreeze mixture is circulated by the circulating pump (15) into the block, through the heads and to the thermostat (13). If the thermostat is closed, the water goes through the thermostat bypass and straight back to the inlet side of the circulating pump. If the thermostat is open, the water passes through the heat exchanger, is cooled and then travels back to the inlet side of the circulating pump.

Air in the system is vented from the top of the thermostat (13) housing to the coolant reservoir bottle (14).

The heat exchanger has a zinc anode screwed into the side of it that requires periodic inspection and replacement.