TABLE OF CONTENTS

PCM®

PCM PRO BOSS GT-40 EFI
Diagnostic Servicing

This manual contains information on the following FORD Power Products:

- 5.0 L Engine
- 5.8 L Engine

This manual is similar to FORD's "Powertrain Control/Emissions Diagnosis" manual for automotive applications.

The primary focus of this service manual is on diagnosis of the FORD EEC-IV Electronic Fuel Injection System. For further information on the 5.0L and 5.8L engines, refer to the following:

- Ford Power Product's; "Industrial and Marine Engines" service manual #194-209.
- FORD's; "Light Truck" service manual set #12107.

Section Description

SECTION 1 - HOW TO USE THIS MANUAL
Contains information on the manual as a whole

SECTION 2 - GENERAL INFORMATION
Contains descriptive information on the EFI, TFI-IV and EEC-IV systems. An important step in diagnosis is to understand the system you are trying to fix.

SECTION 3 - DIAGNOSIS
Contains complete step-by-step diagnosis for the EEC-IV, EFI and TFI-IV systems.

SECTION 4 - SPECIFICATIONS
Allows for quick access to fastener torque's and engine specifications.

SECTION 5 - GLOSSARY
There is extensive use of acronyms (letter abbreviations for words). Diagnostic procedures may be difficult and confusing if you are not familiar with, or know where to find, these terms.

SECTION 6 - DIAGRAMS
Provides for handy access to vacuum and electrical schematic diagrams. Also shows wire and pin identification.

SECTION 7 - SAFETY
Before performing any tests or checks, always read this section which gives safety related information.

Table of Contents

SECTION 2A
ELECTRONIC ENGINE CONTROL
(EEC-IV)

Additional Information

This service manual will alert you to certain procedures that must be done very carefully. If you ignore this information, you could:

- Injure yourself or people around you.
- Injure the boat operator, boat passengers, or people around the boat.
- Damage the FORD Power Product or it's systems.

Understand the following before proceeding:

NOTE: Gives you information that controls correct assembly and operation of the product

CAUTION: Identifies information that will help prevent damage to machinery.

WARNING: ALERTS YOU TO THE POSSIBILITY OF DANGER AND IDENTIFIES INFORMATION THAT WILL HELP PREVENT INJURIES

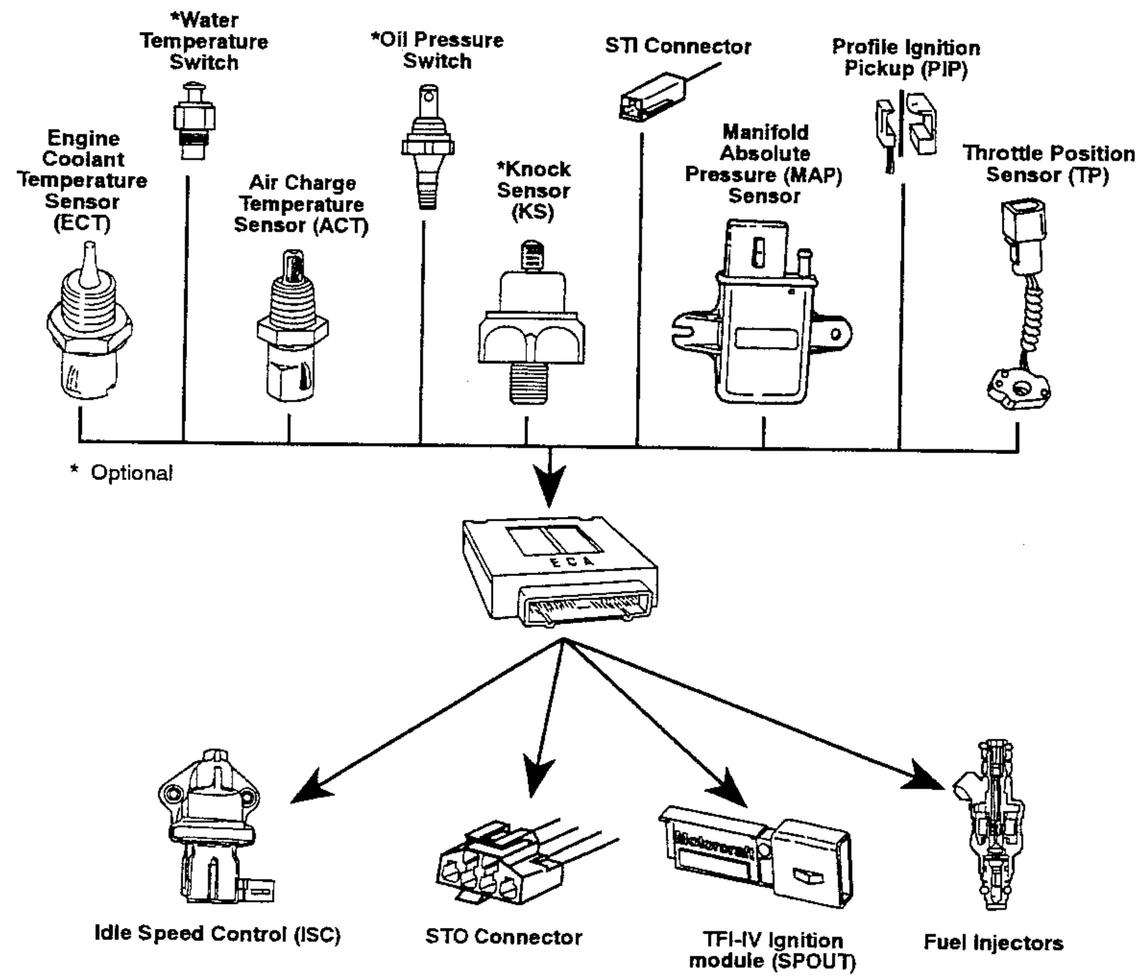
This service manual is written for qualified, factory-trained service technicians familiar with the use of FORD Service Tools. This service manual tells you how to correctly maintain and service the FORD Power Product and it's systems. When correctly serviced, the FORD Power Product will be reliable and safe to operate.

Use only FORD recommended service tools when called for in the service procedure. Use of procedures or service tools, that are not recommended in this manual, may result in personal injury and/or damage to the FORD Power Product.

SECTION 2
GENERAL INFORMATION

WARNING: BEFORE PERFORMING ANY TESTS OR CHECKS RECOMMENDED IN THIS CHAPTER, READ THE SECTION CALLED SAFETY AT THE END OF THIS MANUAL.

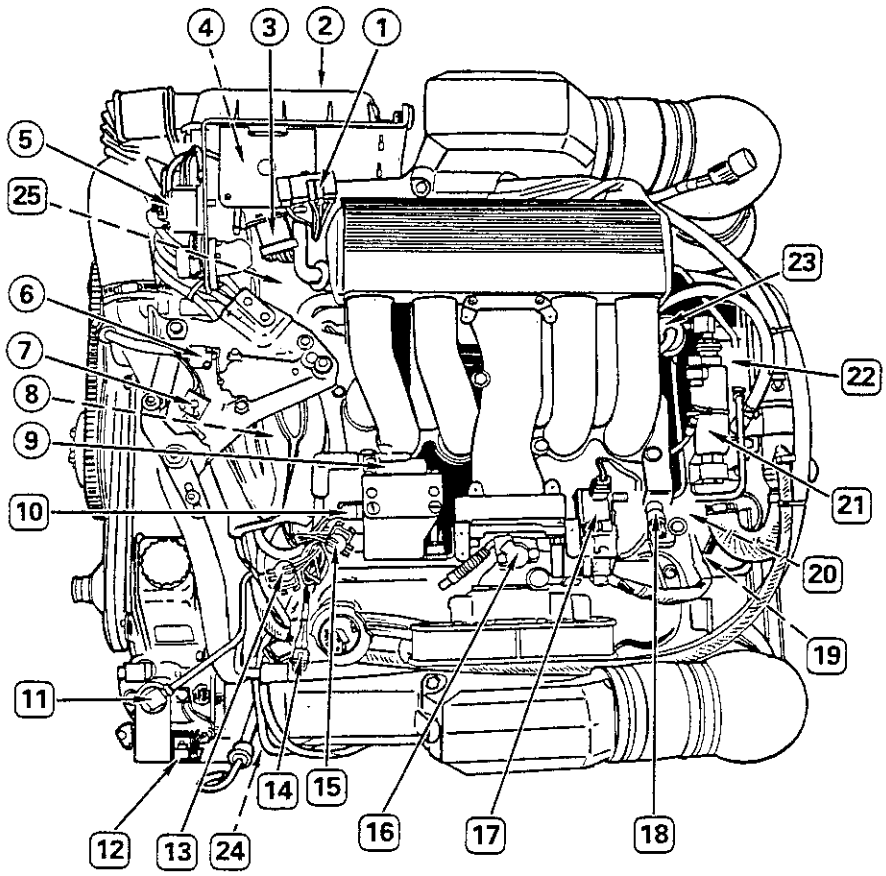
SECTION 2A - Electronic Engine Control (EEC-IV)



FORD's EEC-IV system is an electronic engine control system that consists of a network of electronic and electromechanical components. This system will continuously vary engine operation in order to meet programmed engine operating parameters.

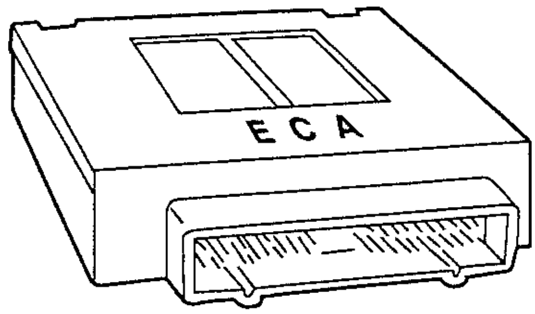
The Electronic Control Assembly (ECA) receives its information from various types of sensors such as switches, thermistors, potentiometers, Hall Effect devices, signal generators and electrical inputs.

The commands from the ECA are performed by actuators. Actuators can be electrically controlled solenoids, motors, relays or other devices. Solenoids are normally used to control fuel and idle air flow.



"Vapor Separator System" - Typical Component Location

1. STO and STI Connectors
2. Electronic Control Assembly (ECA)
3. Manifold Absolute Pressure (MAP) Sensor
4. EEC System Relay
5. ECA and Dash Panel Circuit Breakers
6. Shift Assist Switch (SAS)
7. Neutral Drive Switch (NDS)
8. Hall Effect (PIP Signal) Switch
9. E-core Coil
10. Thick Film Ignition (TFI) Module
11. Low Pressure Fuel Pump
12. Fuel Pump Circuit Breaker and Relay
13. Engine Coolant Temperature (ECT) Sensor
14. Spark Output (SPOUT) Connector
15. Air Charge Temperature (ACT) Sensor
16. Throttle Position (TP) Sensor
17. Idle Speed Control - Bypass Air (ISC-BPA) Solenoid
18. Fuel Injectors (INJ)
19. Knock Sensor (KS) and Module
20. PCV Valve
21. High Pressure Fuel Pump
22. Fuel Reservoir/Vapor Separator
23. Fuel Pressure Regulator
24. Oil Pressure Switch (S.L.O.W.)
25. Water Temperature Switch (S.L.O.W.)

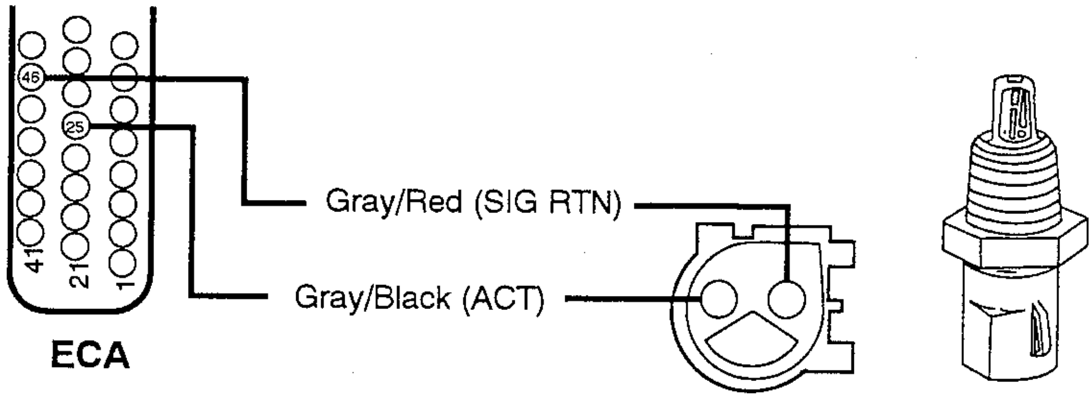


Electronic Control Assembly (ECA) -12A650-

The heart of the EEC system is the Electronic Control Assembly (ECA). The ECA is linked to all EEC-IV components by an engine wiring harness, and is sealed against dirt and moisture. The job of the ECA is to monitor and control engine operating conditions. Certain criteria is programmed into the circuitry of the ECA such as engine size, and data representing various operating conditions that could be encountered by a boater. The ECA is also known as the "Processor".

The ECA uses computer technology to "re-tune" the engine while it is operating to compensate for changes in load, speed, temperature and air density. The microprocessor contained in the ECA is capable of making the necessary computations to provide adjustment of ignition timing and air/fuel ratio.

Sensors provide the ECA with information on engine operating conditions and air density at which the boat is being operated. Potentiometers and other sensors that operate as voltage dividers require a constant source of reference voltage to provide an accurate signal. This reference voltage, abbreviated VREF, is regulated in and supplied by the ECA. The reference voltage is nominally 5 volts.



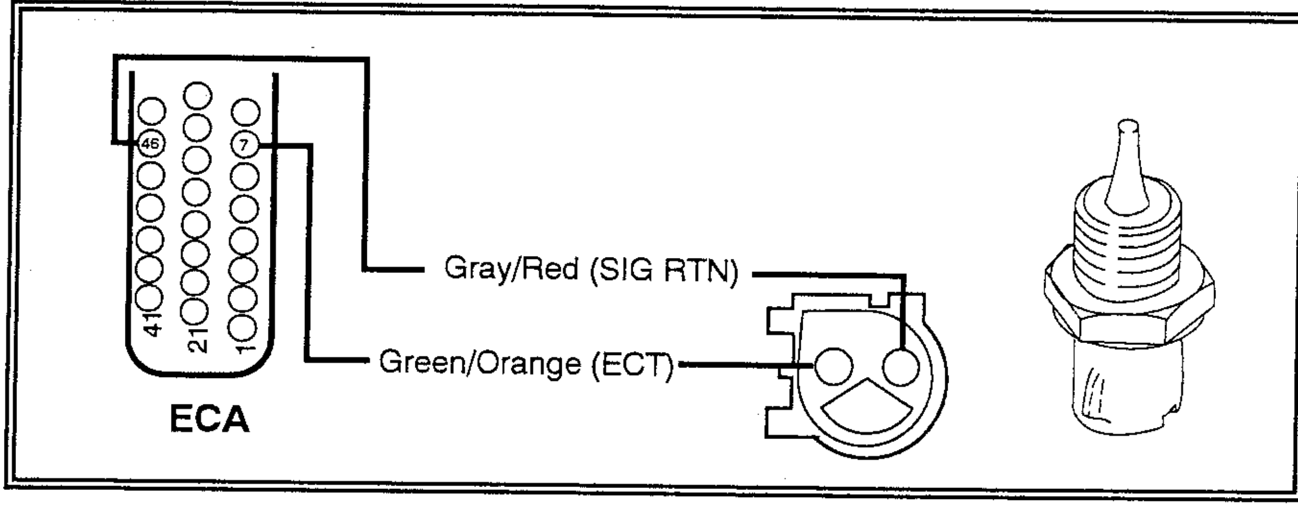
Air Charge Temperature (ACT) Sensor -12A697-

The Air Charge Temperature (ACT) sensor is a thermistor, which is a resistor with resistance changing with temperature. When resistance decreases, voltage decreases, and vice versa. The ECA will store a service code in memory if the component or circuit fails. The ACT is mounted in a brass housing that threads directly into the intake manifold air passage. It measures the temperature of the air/fuel mixture entering the engine. The ECA uses the ACT signal to adjust spark advance and air/fuel ratio in accordance with changes in incoming air temperatures.

ACT Sensor Data

Temp. °F	Temp. °C	Voltage*	Resistance
248	120	.28	1.18
212	100	.47	2.07
176	80	.80	3.84
140	60	1.35	7.60
104	40	2.16	16.15
68	20	3.06	37.30
32	0	3.87	94.98
-4	-20	4.33	271.20

*Voltage values calculated for VREF=5 volts (may vary ± 15% due to sensor and VREF variations)



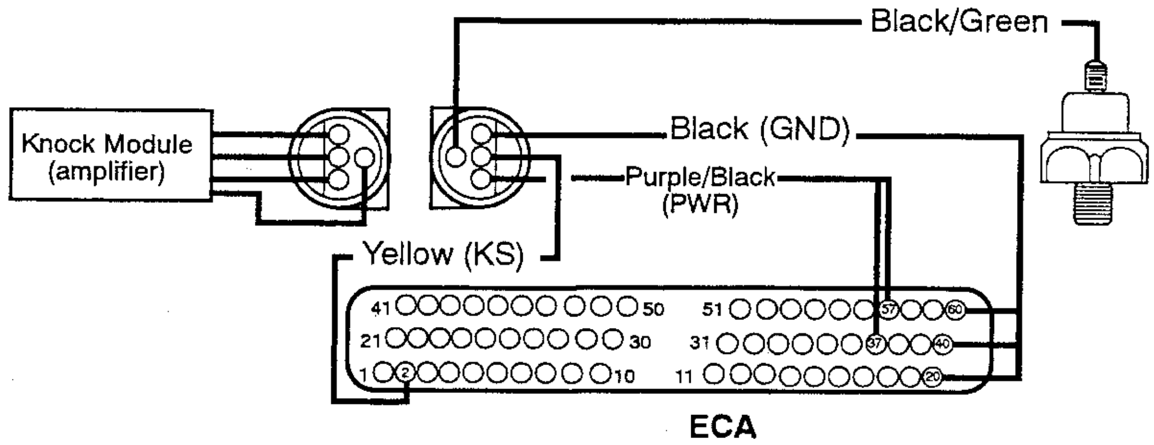
Engine Coolant Temperature (ECT) Sensor -12A648-

The ECT is a thermistor, which is a resistor that changes resistance with temperature. When resistance decreases, voltage decreases, and vice versa. The ECA will store a service code in memory if the component or circuit fails, or if a thermostat malfunction lowers water temperature below 140°F or raises it above 180°F. The ECT is mounted in a brass housing that threads directly into an intake manifold water passage, bringing the tip of the sensor in direct contact with the engine coolant. The ECA uses the ECT to modify spark advance and air/fuel ratio in accordance with changes in engine temperature.

ECT Sensor Data

Temp. °F	Temp. °C	Voltage*	Resistance
248	120	.28	1.18
212	100	.47	2.07
176	80	.80	3.84
140	60	1.35	7.60
104	40	2.16	16.15
68	20	3.06	37.30
32	0	3.87	94.98
-4	-20	4.33	271.20

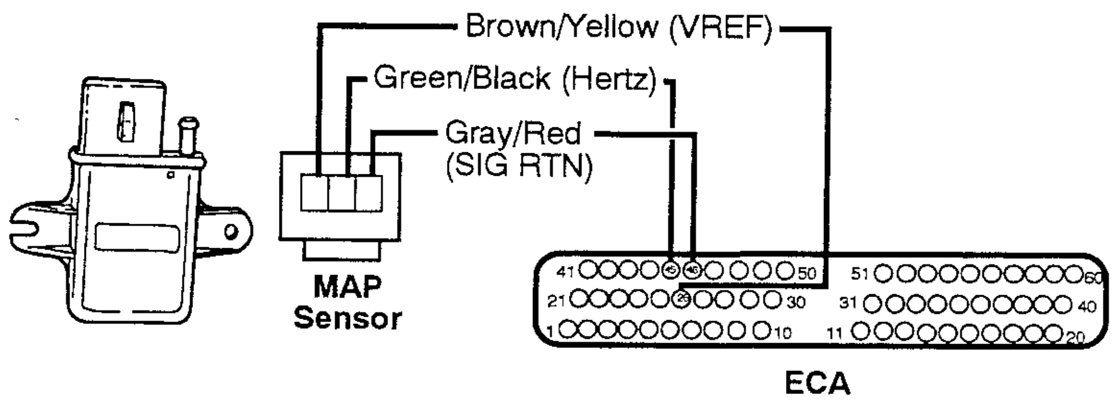
*Voltage values calculated for VREF=5 volts (may vary ± 15% due to sensor and VREF variations)



Knock Sensor (KS) -12A699- (optional)

The Knock Sensor is a signal generating device called an accelerometer. It detects engine detonation (knocking), and converts this frequency signal into a voltage. The sensor consists of a piezoelectric element mounted in a threaded metal housing. Vibrating the element generates the voltage signal. Special construction makes the element only sensitive to the particular engine vibrations associated with knocking.

When spark knock occurs, the Knock Sensor produces a pulsing electrical signal. This signal is put through an amplifier and then sent to the ECA. The ECA then immediately retards spark timing until knock is no longer sensed, or up to a maximum of 8° retard. The engine will return to normal spark advance after the MAP sensor detects a 3-4 in. Hg. change in engine vacuum.

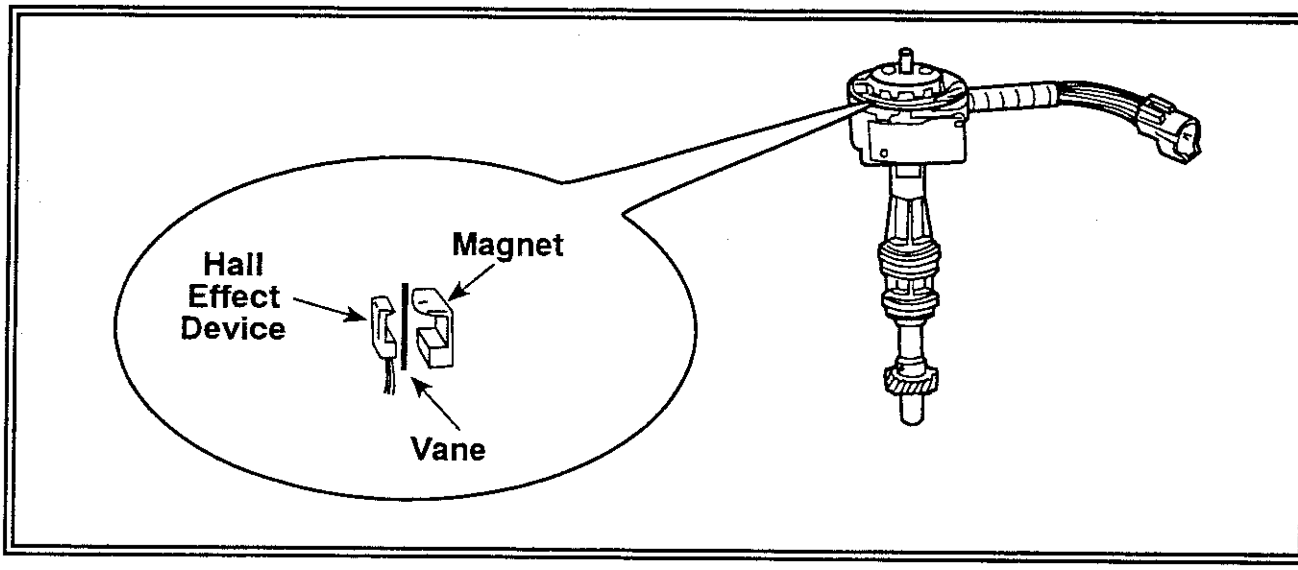


Manifold Absolute Pressure (MAP) Sensor -9F479-

The MAP sensor is used as a barometric sensor for air density compensation by updating the ECA during Key On/Engine Off, and whenever the engine is at wide-open throttle. The ECA uses MAP for spark advance and air/fuel ratio control by sensing load changes at its vacuum port. A reference voltage is supplied by the ECA to the MAP sensor. The MAP outputs a frequency signal that corresponds to manifold absolute pressure (vacuum). As vacuum increases, frequency decreases and visa versa. This gives the ECA information on engine load. A signal return wire completes the circuit back to the ECA. The ECA will store a service code in memory if the component or circuit fails.

MAP Sensor Data

Manifold Vacuum		Frequency
in. (Hg)	kPa	Hz
0	0	159
6	20.3	141
12	40.6	125
18	61.0	109
24	81.3	95
30	101.6	80

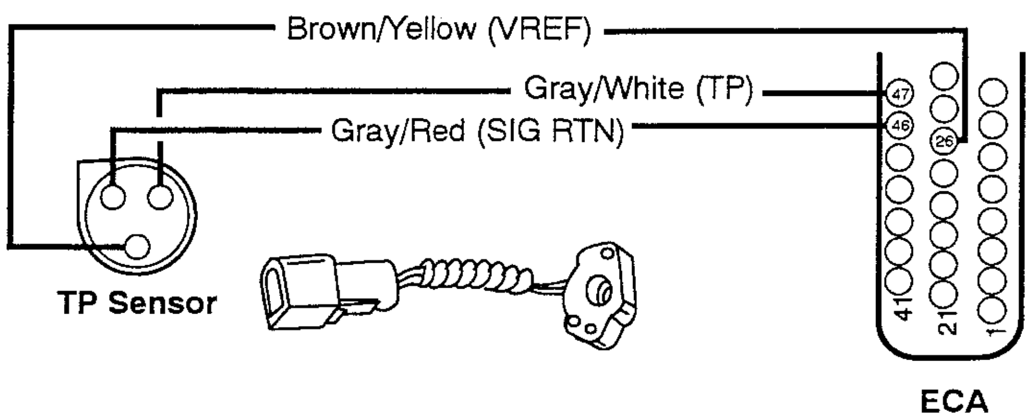


Profile Ignition Pickup (PIP)

The distributor supplies crankshaft position and RPM information to the ECA using voltage pulses (a PIP signal) sent by the Hall Effect switch. The PIP signal is used for spark and fuel injector timing.

The PIP signal is generated by a magnet, a Hall effect device and a slotted cup driven by the distributor shaft. When a window is in front of the Hall Effect device, the device is off and a low voltage signal is produced. As the slotted cup is turned and a vane passes in front of the Hall Effect device, the device is turned on and a high voltage signal is produced. One vane is narrower than the others; it provides a crankshaft position signal to the ECA called "Signature PIP". Continuous distributor rotation produces a pulsating DC wave.

The distributor has no centrifugal or vacuum advance since the ECA controls spark timing. Other than setting base timing, no distributor adjustments are required. The distributor itself has no openings since it's used with a remote mounted TFI module. Thus it's referred to as "Closed Bowl". The ECA will store a service code in memory if the component or circuit fails.



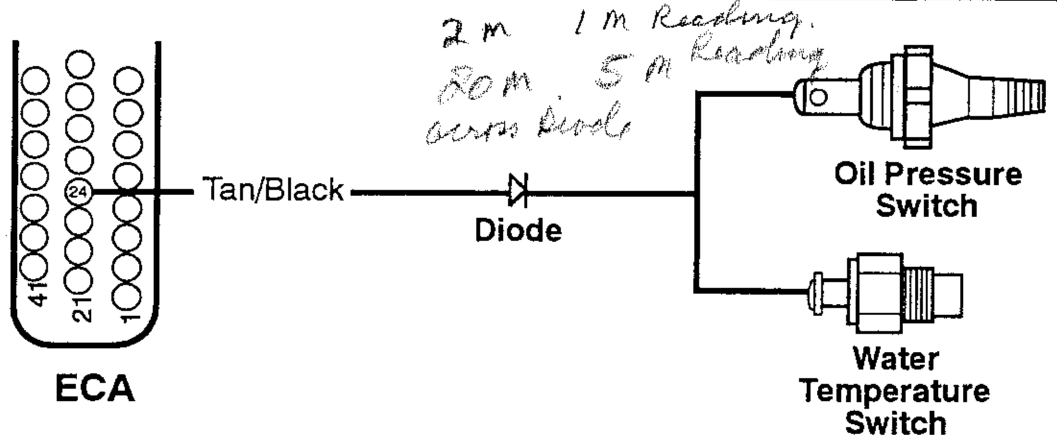
Throttle Position Sensor (TP) -9B989-

The Throttle Position sensor is a rotary type potentiometer. The sensor is located on the top of the throttle body, and is rotated by the throttle shaft. The sensor uses a five-volt reference voltage provided by the ECA. As the throttle shaft is rotated the ECA is provided with a voltage signal directly proportional to the opening angle of the throttle plate. As the opening increases, so does voltage. As the opening decreases, voltage does the same. A signal return wire completes the circuit back to the ECA. The ECA will store a service code in memory if the component or circuit fails.

TP Sensor Data

Throttle Angle °	*Voltage
0	.50
10	.97
20	1.44
30	1.90
40	2.37
50	2.84
60	3.31
70	3.78
80	4.24

*Voltage values calculated for VREF=5 volts
(These values may vary ± 15% due to sensor and VREF variations)

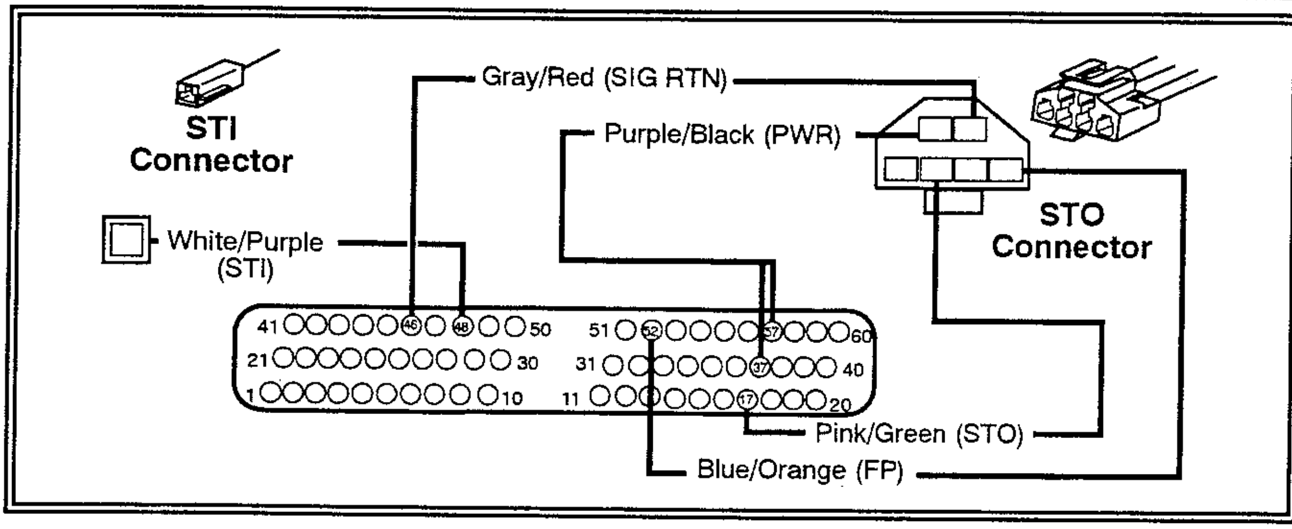


Oil Pressure and Water Temperature Switches (optional)

EFI engines are equipped with a Speed Limiting Operational Warning (S.L.O.W.) system that uses switches to monitor water temperature and oil pressure. Both switches are spliced to a common lead that connects to ECA pin 24. This circuit contains a diode that protects the ECA against damage from reverse battery polarity.

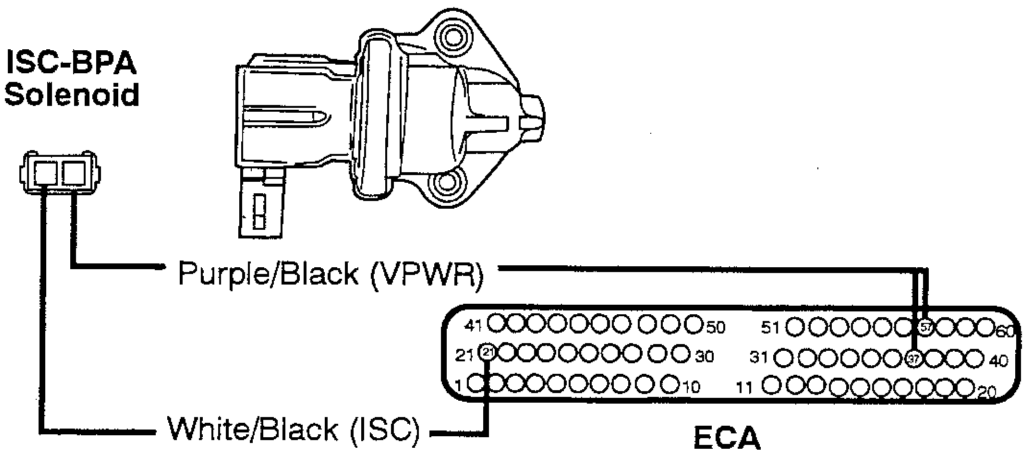
In the event of a water temperature overheat (200°F or higher) or loss of oil pressure (below 5 PSI), engine operation will noticeably change. The ECA will alter the injector firing sequence, the engine will run rough, and engine speed will drop to 2700 RPM. Below 2700 RPM the engine will run normally, but not above. The engine will remain in this S.L.O.W. operational mode as long as the cooling/oil pressure problem exists. After the problem is corrected and the water temperature or oil pressure returns to normal, the ECA will automatically allow the engine to resume proper operation. The ignition switch does not have to be turned off to reset the system.

One additional feature is provided: if the boat is equipped with an Audible Alarm kit, a warning horn will sound when the engine goes into the S.L.O.W. operational mode. If a component or the circuit fails, the ECA **WILL NOT** store a service code in memory.



Self Test Output (STO) and Input (STI) Connectors

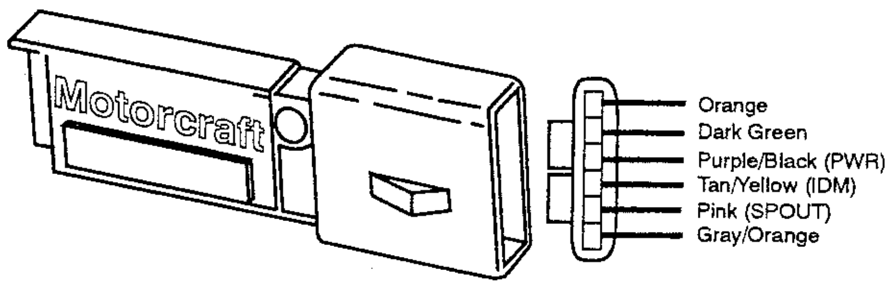
The EEC-IV system has a Self Test Input (STI) and a Self Test Output (STO) connector with the purpose of providing and receiving electrical signals from the ECA. These connectors allow use of a Star tester to access stored failure codes in the ECA memory, and to initiate the KOEO and ER Self Test modes. Both connectors are located above the MAP sensor at the starboard front of the engine. The STI connector originates at ECA pin 48 and carries a 5 volt signal. This signal is transmitted to the STO connector by the Star tester. The STO connector sends the STI signal through its SIG RTN circuit to ECA pin 46. When this circuit is grounded by the ECA, the ECA will go into self-Test and output stored service codes from pin 17 back to the STO connector and Star. Two STO leads have no relevance to ECA Self-Test functions or capabilities. The blue/orange lead to pin 52 controls operation of the fuel pumps. Grounding this lead when the ignition switch is on (but engine not running) will manually actuate the fuel pumps. It's a convenient place for the service technician to reach in order to prime a dry fuel system. The purple/black lead is powered by the EEC relay and carries switched B+ voltage. It's provided as a convenient point to check VPWR anytime the ignition switch is on. If a circuit fails, the ECA **WILL NOT** store a service code in memory.



Idle Speed Control - Bypass Air (ISC-BPA) Solenoid -9F715-

The ISC-BPA solenoid is used to control engine idle speed functions. During cold engine start-up, the ECA will go to a 100% "duty cycle" (i.e. the amount of time the ECA energizes the solenoid; 100% = on all the time). The solenoid is also used as an electronic dashpot. During deceleration, air will bypass the throttle plate, preventing engine stall. For control of warm idle speed, the ECA will duty cycle the solenoid as necessary to achieve a smooth, calibrated idle.

The ECA varies the voltage to the ISC solenoid which changes the position of the air bypass valve. Air enters the valve in front of the throttle plate, passes through a muffler and around the plate, and re-enters the intake air flow behind the plate. As voltage increases, more air is diverted (bypassed) around the throttle plate, increasing idle RPM. In this manner, additional air can be added to the engine without moving the throttle plate. If the component or circuit fails, the ECA **WILL NOT** store a service code in memory.

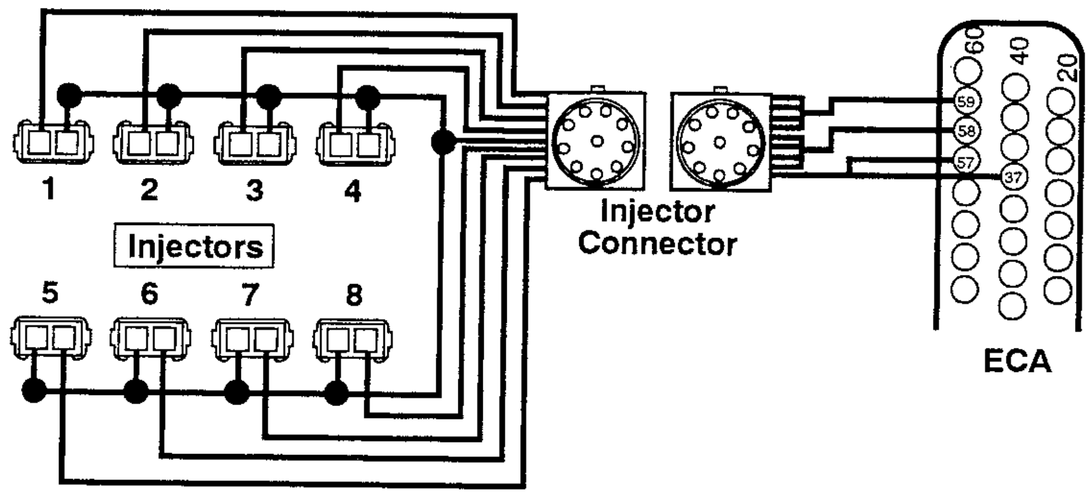


TFI Module

Thick Film Ignition Module (TFI-IV) -12A297-

The TFI-IV ignition system contains an ignition module composed of a custom integrated circuit, Darlington output device and associated thick film integrated components. The module is mounted remotely on a heat sink. When commanded by the ECA, it opens and closes the ignition coil primary circuit to produce secondary spark output. The TFI-IV module utilizes Computer Controlled Dwell (CCD) and is identified by its black color. Gray modules are called "Push Start" and are for automotive use only. The TFI-IV module is controlled by the SPOUT (spark output) signal (pink wire) from the ECA. The PIP signal (gray/orange wire) from the Hall Effect switch in the distributor will control the TFI-IV module if the SPOUT signal is absent, such as during base timing adjustment, or in the event of ECA failure. The SPOUT circuit includes a connector that's removed during base timing adjustments.

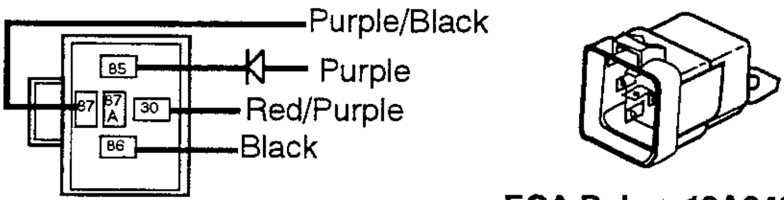
The Ignition Diagnostic Monitor (IDM) circuit (tan/yellow wire) provides the ECA with a tachometer (RPM) reference signal. 12 volt power (purple/black wire) is supplied to the TFI by the switched B+ lead at the ECA. Coil primary circuit operation is controlled by two wires: a dark green lead that attaches to the negative (-) terminal of the coil, and an orange lead that ground through the distributor. The ECA will store a service code in memory if the IDM circuit fails.



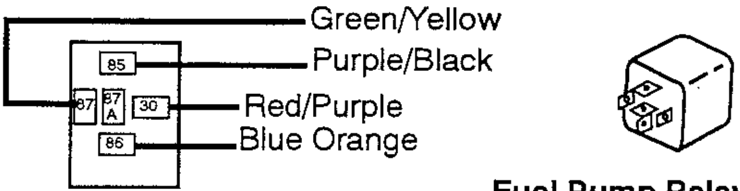
Fuel Injector (INJ) -9F593-

Fuel injector solenoids are electro-mechanical devices which meter and atomize fuel delivered to the engine. Since the injector flow orifice is fixed and fuel supply pressure is constant, fuel flow to the engine is controlled by the length of time the solenoid is energized (pulse width). Fuel atomization is attained by the contoured pintle area. The ECA controls pulse width according to the input received from various sensors, which signal the operating conditions of the engine. The injectors are mounted in the lower intake manifold just before the intake valve. These special deposit-resistant injectors can be identified by four holes in the injector tip.

FORD EFI engines use an injector firing sequence called "bank-to-bank". Four injectors operate within one crankshaft revolution, the other four operate in another crankshaft revolution. All injectors have a common 12 volt source, the purple/black lead at ECA pins 37/57. Injector firing is controlled by two ECA ground circuits. Pin 58 controls bank 1 which fires injectors 1,4,5 and 8. Pin 59 controls bank 2 which fires injectors 2,3,6 and 7. If the component or circuit fails, the ECA **WILL NOT** store a service code in memory.



ECA Relay -12A646-

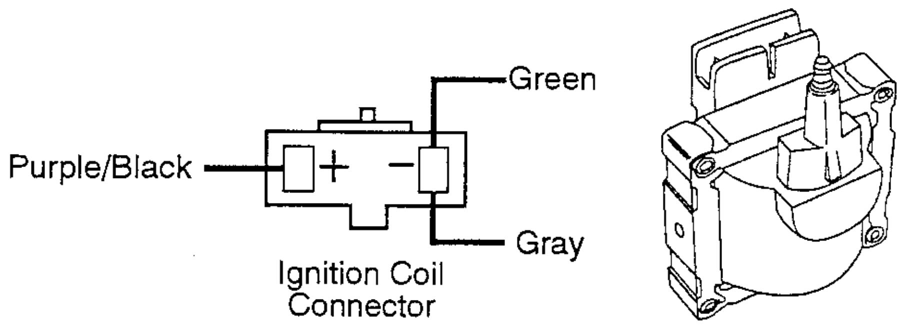


Fuel Pump Relay -9345-

ECA and Fuel Pump Relays

The EEC system utilizes two electrical relays: one to supply B+ voltage to the ECA and another to supply B+ voltage to the fuel pumps. The ECA relay receives direct battery power through a red/purple lead that's protected by a 12.5 amp circuit breaker and a 50 amp fuse. It's grounded to the engine through a black lead. The relay is actuated through a purple lead by voltage from the ignition switch. This lead contains a diode to protect the ECA against reversed battery polarity. A purple/black lead then carries B+ voltage to ECA pins 37/57. All EEC system components, including the Fuel pump relay, receive power from this lead.

The fuel pump relay receives direct battery power through a red/purple lead that's protected by a 20 amp circuit breaker. It's grounded through the ECA by a blue/orange lead. The relay is actuated by a purple/black wire that is spliced to the lead at ECA pins 37/57. A pair of green/yellow leads then carry voltage to both fuel pumps. One green/yellow lead also acts as a fuel pump monitor (FPM) and connects to ECA pin 8. It tells the ECA whether or not the pumps are operating. In the event of pump or circuit failure, it will input a service code into ECA memory.



Ignition Coil -12029-

FORD's TFI-IV ignition system features a conventional ignition coil called an "E-coil", that is remotely mounted near the TFI module. It has externally wound laminations and is epoxy filled, not oil filled. It's capable of providing approximately 38 KV minimum output.

The coil primary circuit is powered by a purple/black wire that's spliced to the lead at ECA pins 37/57, and attached to the coil positive (+) terminal. A dark green lead connects the coil negative (-) terminal to the TFI module to complete the primary circuit. The TFI module, when directed by the ECA SPOUT signal, controls operation of the coil primary circuit and thus coil secondary output. A 22,000 ohm resistor is in the gray lead that goes to the tachometer. The resistor produces a tachometer signal that's compatible with marine tachometers.

The coil primary circuit has a resistance of 0.39 - 0.42 ohms. The secondary circuit has a resistance of 7600 - 9400 ohms. Coil operating current is 6.8 amps. If the component or circuit fails, the ECA **WILL NOT** store a service code in memory.

Theory of Operation

The primary purpose of the EEC system is to maintain air/fuel ratio at or near "Stoichiometry" (being as close to a balanced 14.7:1 air/fuel mixture as possible). Fuel control adjusts for such conditions as starting, rapid acceleration or heavy load, sudden deceleration, idling, etc. Programming within the ECA determines the operating mode based on the engine conditions that exist.

Fuel Control

There are eight different engine operating modes which require fuel control:

- Engine Cranking
- Engine Warm-up
- Open Loop Control
- Hard Acceleration
- Deceleration
- Idle
- S.L.O.W. Circuit Operation
- Over-rev

The engine operating mode is determined by various sensor inputs (throttle position, manifold absolute pressure, engine RPM, inlet air and coolant temperatures). When the ignition switch is initially switched on, the ECA control mode logic automatically selects an engine-start mode which provides the low air/fuel ratio required for starting the engine. Once engine RPM rises above cranking speed, the ECA passes control to the program for the engine warm-up mode. This operating mode keeps the air/fuel ratio low to prevent engine stalling during cool weather, until the engine coolant temperature rises above a programmed value. When coolant temperature rises, the control mode logic directs the system to operate in Open Loop.

During hard acceleration or heavy engine loads, the Control Mode Logic (CML) chooses a scheme which provides a rich air/fuel mixture for the duration of the acceleration or heavy load. This provides maximum power, but poor fuel economy. After the need for enrichment has passed, control is returned to Open Loop.

During periods of deceleration, the air/fuel ratio is increased to prevent possible stalling from an overly rich mixture. When idle conditions are present, CML passes system control to the idle speed control mode. In this situation engine speed is controlled to reduce roughness and stalling which might occur because the idle load has changed due to alternator operation.

Engine Cranking

While the engine is being cranked, the fuel control system must provide an intake air/fuel ratio anywhere from 2:1 to 12:1, depending on engine temperature. Low temperatures affect the injector's ability to atomize or mix the incoming air and fuel. At low temperature, the fuel tends to form into large droplets in the air which do not burn as efficiently as tiny droplets. The larger fuel droplets tend to increase the apparent air/fuel ratio because the amount of usable fuel in the air is reduced. The system therefore must provide a decreased air/fuel ratio to provide the engine with a more combustible mixture. Operating conditions are read by the ECA through an analog-to-digital converter from a temperature sensor in the engine water coolant passage. The ECA's calibration determines what the proper air/fuel ratio must be at the temperature. The air/fuel ratio is determined and controlled as in Open Loop.

Engine Warm-up

While the engine is warming up, the fuel control system operates in an Open Loop mode. This allows an enriched air/fuel ratio to be maintained for smooth running and quicker warm-up. It also allows the air/fuel ratio to change as the engine temperature increases. The emphasis in this control mode is on rapid and smooth engine warm-up. Fuel economy is still a secondary concern. The controller determines the warm-up period based on the coolant temperature when the warm-up mode was selected. Naturally, an initially cold engine requires a longer warm-up time than a warm engine. The time allowed by the controller timer is chosen according to the calibration of the ECA.

Open Loop Control
In automobiles, engines are equipped with an oxygen sensor which provides "feedback" information to the ECA as to the oxygen level in the exhaust stream. When the ECA considers this feedback information for controlling engine operation, it is called "Closed Loop" control. When the ECA is controlling without this feedback information, it is called "Open Loop" control.

FORD marine applications operate in Open Loop. This operational mode is controlled by various sensors located in and around the engine, and includes the engine coolant temperature and air charge temperature. There is no provision for "Closed Loop" control.

The logic in the ECA's program selects the method of spark timing control. During engine startup, spark timing is controlled by the mechanical setting of the distributor. Once the engine is running, spark timing is turned over to the computer control system. This program ensures that the engine will start regardless of whether the EEC system is working or not.

Acceleration Enrichment
During periods of heavy engine load, such as wide-open throttle acceleration, fuel control is adjusted to provide an enriched ratio to maximize engine power.

The computer detects this condition by reading the Throttle Position sensor voltage or the MAP sensor. Low intake manifold vacuum or high throttle position corresponds to heavy engine loads. The ECA responds by increasing the amount of fuel to enter the intake manifold. This enrichment allows the engine to operate with a power greater than that allowed when fuel economy is controlled within specifications.

Deceleration and Idle Speed Control
During periods of light engine load and high RPM, such as closed throttle deceleration, coasting or engine idle, the engine requires a very lean air/fuel ratio. The ECA detects closed throttle deceleration by sensing a sudden increase in manifold vacuum and closed throttle position.

When these conditions are recognized by the ECA, it computes a change in the amount of fuel required and adjusts the injector "ON" time accordingly.

Idle speed control is used to prevent engine stall during idle. The goal is to allow the engine to idle at as low an RPM as possible yet keep the engine from running rough and stalling when power take-off accessories, such as the power steering pump, are operated.

Engine Idle Speed
Another system controlled by the ECA is engine idle speed. An idle Speed Control - Bypass Air (ISC-BPA) solenoid is attached to the throttle body, and controls airflow by routing it around the throttle plate. Air enters the valve in front of the throttle plate, passes through the valve and exits behind the throttle plate.

The ECA controls idle speed by varying the amount of bypass air. This is done by changing the valve opening (duty cycle). Idle speed remains constant during all load or temperature conditions.

Air Control
The ECA does not control the amount of off-idle air allowed into the engine. It does however, monitor the amount of air entering the engine. This is done so that the ECA can adjust the air/fuel ratio according to its internal calibration. The ECA monitors engine RPM and intake air temperature. The ECA is programmed with the necessary information, such as volumetric efficiency and cylinder displacement.

The air volume flow rate is computed from the Look-Up Tables in the ECA as determined by engine RPM. This value is adjusted to account for manifold absolute pressure and air density/air temperature. The resulting value is an estimate of air mass flow rate and is used to determine the appropriate air/fuel ratio.

ECA Memory Changes - Adaptive Strategy

Another feature of the EEC system is its ability to learn from past experiences. This feature enables the ECA to adjust its memory for computing Open Loop Operation.

Updated Open Loop information is stored in Keep Alive Memory which is always powered directly by the engine battery. This information is not lost when the ignition is turned off. The next time the engine is started, the new information will be used in the Open Loop mode, and will provide more accurate control of the air/fuel ratio. This feature allows the ECA to adapt to long term changes in the engine. It also allows a new ECA to adapt to an engine when it replaces one that has been damaged.

Engine Timing

Engine spark advance is controlled by the ECA. This eliminates the need for centrifugal and vacuum advance mechanisms. Base timing can be adjusted by rotating the distributor when the SPOUT connector is unplugged. The ECA monitors engine operating conditions with sensors such as TP, MAP, etc., and signals the TFI ignition module when to collapse the primary circuit to allow the secondary circuit to fire the spark plugs.

The control program for electronic spark timing is to produce maximum engine power by adjusting the advance of ignition firing in relationship to Top-Dead-Center (TDC). Spark timing can be chosen to produce the best engine power with variables of engine RPM, engine coolant temperature, initial operating manifold pressure, air charge temperature and knock module input.

Total spark advance is determined by computing information received from various engine sensors which affect spark timing. The ECA will then adjust timing according to information that has been calibrated into it. Warm-up spark advance is used when the engine is cold, since a greater amount of advance is required while the engine warms up.

The ECA receives a timing pulse (PIP signal) from the distributor which indicates crankshaft position and engine RPM. The ECA evaluates this information and sends a pulse (SPOUT signal) to the TFI module. The TFI module then opens the ignition coil primary circuit, which generates a secondary voltage pulse to fire the spark plugs. Spark distribution is performed by the distributor and rotor as in a non-electronic controlled system. Ignition timing works along with electronic fuel delivery to provide for optimum fuel economy and driveability.

Failure Mode Effects Management (FMEM)
FMEM is an alternate system strategy in the ECA designed to maintain engine operation should one or more sensor inputs fail. The sensors most likely to initiate FMEM are the ECT, ACT, TP and MAP. When a sensor input is perceived to be out-of-limits by the processor, an alternative strategy will be initiated.

The processor will substitute a fixed, in-limit sensor value and will continue to monitor the faulty sensor input. If the faulty sensor returns to within-limit operation, the processor will return to the normal engine running strategy.

NOTE: When FMEM is in effect, a service code 98 will be displayed during KOEO Self-Test along with the suspect sensor/circuit code(s).

In FMEM mode, the processor is receiving a sensor signal that is outside the limits set by the calibration strategy. In this mode the processor uses an alternate engine control strategy to maintain reasonable engine operation in spite of the fault. The error code associated with this fault is stored in Keep Alive Memory (KAM). If the fault is no longer present, the engine will return to the normal engine strategy. The error code stored is kept in Continuous Memory for the next 40 engine temperature cycles and then it is erased. This code is one of the Continuous Memory codes and it can be accessed by running the KOEO Self-Test.

When the ECT, ACT or TP sensor/circuit fails, the engine will maintain a consistent 800 RPM idle, instead of its normal 600 RPM idle. When the MAP sensor/circuit fails, the idle RPM will oscillate and the engine may stall. In addition, it may be necessary to repeatedly use the remote control warm-up lever to aid starting a hot engine.

Diagnosis

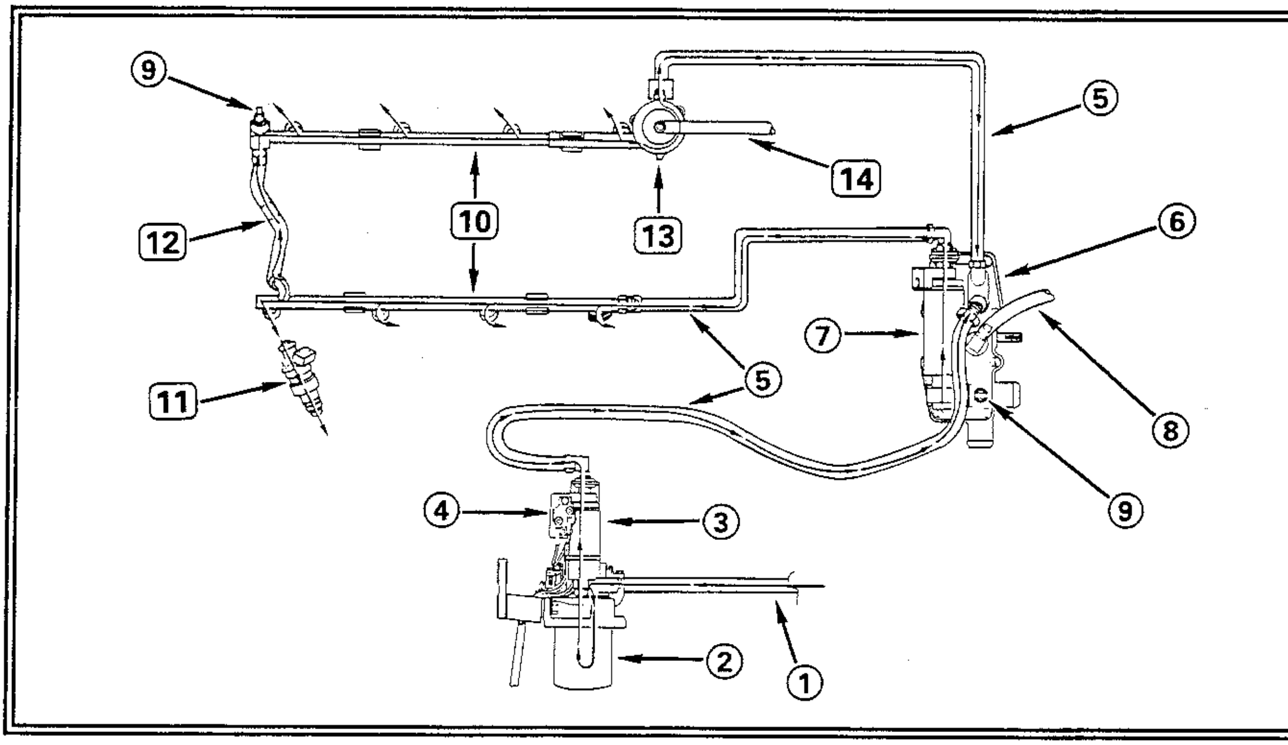
The EEC-IV system is designed to diagnose failures in the control system. Sensor and actuator failures or maladjustments can be detected by the ECA. For instance, the ECA will detect a malfunctioning MAP sensor if the sensor output goes above or below certain specified limits or fails to change for long periods of time.

The EEC-IV system has a Keep Alive Memory which stores intermittent trouble codes as they occur. The memory is not erased when the key is turned off. Trouble codes retained in the ECA are a help to the service technician when diagnosing the EEC system. After 40 engine temperature cycles, the ECA will no longer retain the intermittent codes unless the concern recurs.

Table of Contents

SECTION 2B ELECTONIC FUEL INJECTION (EFI)

Vapor Separator System



1.	Boat Fuel Line	8.	Fuel Vapor Vent Hose to Plenum
2.	Fuel Filter	9.	Relief Valve/Test Point
3.	Low Pressure Fuel Pump	10.	Fuel Rail
4.	20 Amp Circuit Breaker	11.	Fuel Injector
5.	Fuel Line	12.	Fuel Rail Crossover Hose
6.	Fuel Reservoir/Vapor Separator	13.	Fuel Pressure Regulator
7.	High Pressure Fuel Pump	14.	Regulator Vacuum Hose to Plenum

The EFI is a "Vapor Separator System" and is made up of the above components. Other systems such as the "Reservoir Cooling System" and the "Return Line System" are not covered in this manual.

Fuel is distributed to the cylinders by means of electronically controlled fuel injectors. The Electronic Fuel Injection (EFI) system is a multi-point, pulse timed, adaptive speed density system. Fuel is metered in accordance with engine demands into the intake air stream through injectors mounted on a tuned intake manifold, directly above each of the engine's intake ports. The distribution pattern is called "bank-to-bank".

The injectors, when grounded by the ECA, spray a metered quantity of fuel into the intake air stream. A constant fuel pressure drop is maintained across the injector nozzles by a pressure regulator. Fuel is supplied to the regulator by an electric high pressure fuel pump. Excess fuel supplied by the pump, but not required by the engine, passes through the regulator and returns to the fuel reservoir/vapor separator. A low pressure (LP) electric fuel pump brings fuel from the boat tank to the engine fuel filter. The LP pump transfers fuel to the fuel reservoir at the rear of the engine. When the key is turned ON, the LP pump will operate for approximately 2 seconds, then stop. Only after the ECA receives a PIP signal (indicating the engine is cranking or running) will the LP continue to operate. **This is a safety feature designed to prevent fuel pump operation should the engine quit running, or suffer a malfunction; otherwise the fuel pump could potentially feed fuel to a fire.**

The reservoir is a fuel containment/vapor purging device that eliminates the need for a fuel return line back to the boat tank. The reservoir fills from the bottom up, and supplies fuel to a high pressure (HP) pump mounted on top of the reservoir. The HP pump pulls fuel from the bottom of the reservoir, and fills the fuel rail to supply the fuel injectors. If engine fuel demand is less than the volume of fuel supplied by the pumps, line pressure will increase until an internal regulator opens inside the LP pump. This allows fuel to circulate internally. The ECA controls power for the fuel delivery system and provides correct timing for the fuel injectors.

A pressure regulator is located at the end of the fuel rail, downstream from all injectors. The regulator is a vacuum/pressure operated diaphragm valve. One side senses fuel pressure and the other side is connected to intake manifold vacuum. Its position allows the regulator to maintain equal pressure at all injectors in all fuel demand situations. Pressure regulator operation is affected by fuel pressure, an internal spring and engine vacuum. The spring holds the diaphragm closed and prevents fuel exiting back to the reservoir. Pressure at the injectors during cranking is approximately 39± 3 psi.

At idle, vacuum is high and engine fuel demand is low. Fuel pressure pushes the diaphragm off its seat and vacuum aids the opening. As the diaphragm opens, fuel is allowed to exit the rail and return to the reservoir. The amount of fuel that returns to the reservoir is determined by fuel pressure and the amount of regulator opening. This opening reduces pressure at the injectors approximately 31± 3 psi.

As RPM increases to Wide Open Throttle (WOT), vacuum drops and engine fuel demand increases. Spring pressure eventually overcomes engine vacuum, and the amount of fuel returning to the reservoir is reduced. Eventually, only fuel pressure will push on the diaphragm to open the return passage, resulting in a smaller amount of fuel returning to the reservoir. This causes pressure at the injectors to increase to approximately 39± 3 psi. At WOT, vacuum is at its lowest and the amount of fuel returned is at a minimum.

Fuel entering the reservoir may contain vapor. The reservoir has features to control this. The base of the reservoir, and the fuel inside, are cooled by incoming water. The transom bracket water hose connects to a lower corner of the reservoir, then continues to the thermostat housing. A small volume of water moves through a passage across the base of the reservoir. It connects to a small hose that attaches to the thermostat housing to complete the water circuit. The hose's small diameter also provides a restriction to prevent hot water from being pulled back into the reservoir cooling passage when the engine is shut off.

Inside the reservoir is a float and needle mechanism that connects to an air plenum vacuum line. Any vapor present separates from the fuel and rises to the top of the reservoir. As vapor quantity increases, the reservoir fuel level will drop. The float follows the fuel level and eventually opens the outlet needle.

Vacuum then pulls vapor from the reservoir into the air plenum. A pulse limiter in the vacuum line at the air plenum prevents any sudden backfire from igniting fuel vapor. After vapor is relieved, the LP pump refills the reservoir. As fuel level rises, the float shuts the outlet needle opening and the cycle repeats as conditions demand.

The fuel rail and reservoir are each equipped with a pressure relief valve. The valves are a convenient attachment point for a pressure gauge when troubleshooting, or for purging when draining for service. Use of these valves are discussed in other sections.

Note: The valve caps have a special internal viton seal to prevent fuel leakage. Do not substitute any other type of cap.

Electrical Circuit Operation

When the ignition is switched to the ON position, it turns the EEC power relay on. The EEC power relay provides power to the ECA and the control side of the fuel pump relay. Power for both fuel pumps is supplied through a 20 amp circuit breaker connected to the main engine 60 amp circuit breaker. The fuel pump relay is controlled by the ECA.

When the ignition switch is turned to the ON position, both fuel pumps will operate. If the ignition switch is not turned to the START position, the ECA will not receive a PIP signal and will shut the fuel pumps off after approximately two seconds. The ECA will operate both fuel pumps when the ignition switch is in the START position providing fuel while cranking.

After the engine starts, the ECA will continue to operate both fuel pumps unless the engine stops.

Fuel Injectors

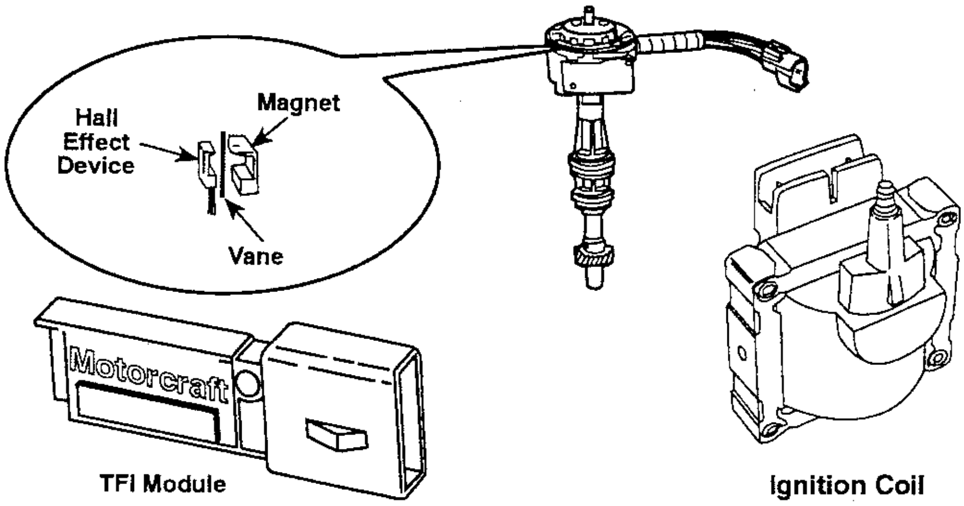
Fuel injectors are 12 volt, solenoid-operated valves that meter fuel flow to the engine. They have a special deposit-resistant tip to allow trouble free operation. The injectors are opened and closed a constant number of times per crank revolution. The amount of fuel injected is controlled by the length of time they're held open (pulse width).

The injectors are normally closed and are operated when the ECA completes a ground circuit. FORD uses an injection sequence called "bank-to-bank". Four injectors (cylinders 1,4,5 and 8) operate on one crank revolution, and the other four (cylinders 2,3,6 and 7) on another crank revolution.

CAUTION: Do not apply battery voltage directly to the injector electrical connector terminals. The internal solenoid may be damaged in a matter of seconds.

Table of Contents

SECTION 2C
THICK FILM IGNITION
(TFI-IV)



System Description

The components of the TFI-IV system consist of the TFI-IV module, distributor, Hall Effect PIP sensor, and the E-core Ignition Coil.

The ignition module and heat sink are remotely mounted to the E-core mounting bracket. This bracket is located at the front left-hand side of the engine. A sealed distributor is used with the remote mounted TFI-IV module.

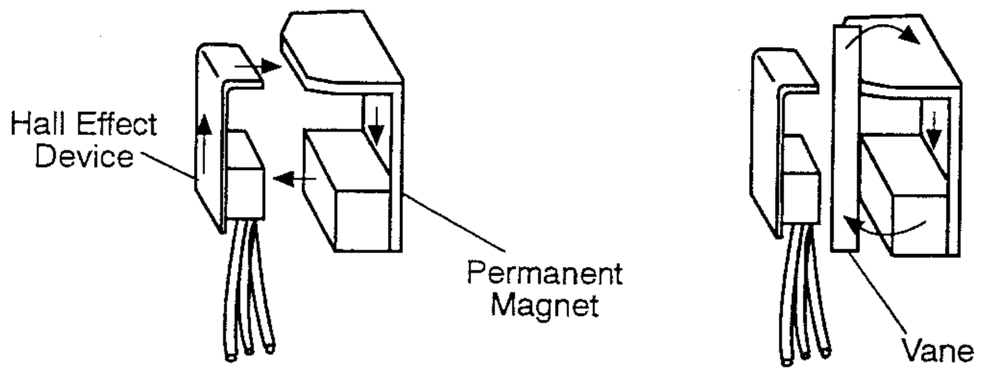
The Hall Effect PIP (Profile Ignition Pickup) sensor is located inside the distributor. Note also that there are no mechanisms on this distributor for centrifugal or vacuum advance.

The Hall Effect sensor inside the distributor responds to a rotating metallic shutter on the distributor shaft and produces a digital PIP signal. This signal provides base timing information and is an indicator of engine speed (RPM) and crankshaft position. Note that since the shutter is mounted on the distributor shaft, two revolutions of the engine crankshaft are required to fire all spark plugs once. This is because the distributor rotates at one half the crankshaft speed.

The internal circuitry of the TFI-IV module is based on Computer Controlled Dwell (CCD). The CCD system uses both edges of the SPOUT signal. The SPOUT signal, short for SPark OUTput, is a digital signal generated by the EEC-IV processor, providing spark timing information to the TFI-IV module.

The rising edge of the SPOUT signal is used to turn off or fire the coil. The falling edge controls when the coil is turned on. The coil "on time" or dwell for this system is entirely controlled by the SPOUT signal. The TFI-IV module responds directly to the SPOUT signal it receives.

In case the SPOUT signal line is open from the EEC-IV processor, the TFI-IV module will use the PIP signal to fire the coil. This results in a fixed spark angle and fixed dwell.



Magnetic Flux Field
Output = 0 volts

Hall Effect Device
Response to Vane
Output = VBAT

Sensor Description

The Hall Effect PIP sensor is a digital output device located within the distributor. A rotary vane cup, used to trigger the Hall sensor, is mounted on the shaft of the distributor and is made of a ferrous metal. When the window of a cup is in the air gap between the Hall device and the permanent magnet, a magnetic flux field is completed from the magnet through the Hall device and back to the magnet. This condition results in a low (0 volts) output signal.

As the distributor shaft turns, a tooth on the cup will move into the air gap. The magnetic field will be shunted by the tooth, preventing it from reaching the Hall device, and the output signal will change from low to high (VBAT).

One tooth on the vane cup is narrower than the rest to identify when cylinder No. 1 is at 5 degrees BTDC. The width of the PIP signal generated by this tooth is smaller than that of the other teeth and is called Signature PIP. It is required by the EEC-IV processor so that it can accurately control spark timing and firing of the fuel injectors.

SECTION 3 : DIAGNOSIS

SECTION 3A :
THE DIAGNOSTIC PROCESS

SECTION 3A - The Diagnostic Process

VERIFY COMPLAINT

Gather as much information as possible from the owner about the problem, then run the engine to verify it exists as described. If problem is said to occur at 3200 RPM with a warm engine, check it the same way. Valuable time can be wasted if you fail to verify the condition.

BEGIN WITH SYMPTOM

Always start with Diagnostic Routines. This section lists problems by symptom. Each symptom chart will offer several possibilities, and will direct you to the specific point in this manual that will most likely resolve the problem.

PERFORM QUICK TEST

If an EEC-IV problem is suspected, you will be sent to perform quick test. Quick test may in turn direct you to another point in this manual (usually a pinpoint test).

PINPOINT TESTS

Once you reach the appropriate pinpoint test, there may be special notes at the start of it. Read these before beginning any diagnostic tests or procedures. They contain important information, some safety related, pertaining to that section.

While performing the tests required, you may be further directed to another section of this manual. Continue to follow all diagnostic steps as directed.

DO NOT

- Guess
- Randomly substitute parts
- Jump from section to section

This will only waste time, and delay or prevent resolution of the problem.

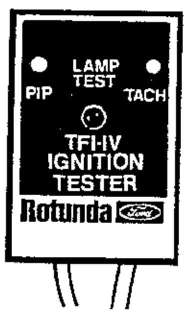
SECTION 3B: SPECIAL SERVICE TOOLS

Special Service Tools

FORD's EFI engines feature an Electronic Engine Control (EEC-IV) system. Specialized instruments are required to diagnose EEC-related fuel, electrical, and ignition problems. Without these devices, problem solving will be time consuming with little chance of successfully diagnosing problems. Use of certain diagnostic instruments, other than those recommended by FORD can damage components of the EEC system. **This damage will not be covered under FORD Warranty.**

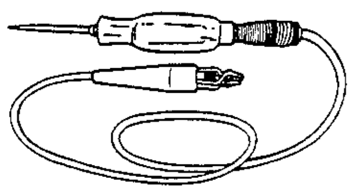
* **Rotunda** is FORD's equipment supplier. For ordering information, call their Hotline number, 800-762-6181.

105-00003
Ignition Module Tester

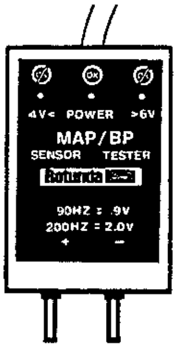


- Designed to plug directly into the TFI-IV module used in Ford EEC-IV systems to test the TFI-IV module and the hall effect sensor.

Non-powered Test Lamp

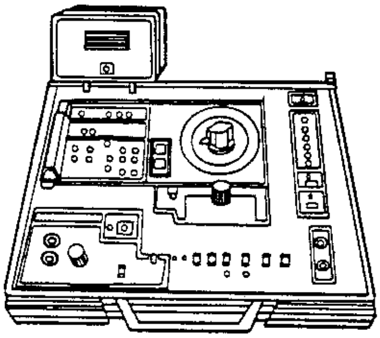


105-00001
MAP/BP Sensor Tester



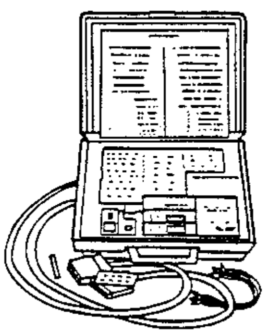
- Tests for proper input voltage and output signal of MAP/BP sensors.
- Compatible with Rotunda digital volt/ohmmeters and most other DVOM's.
- Works with all EEC-IV MAP and BP sensors.

007-0047D
EEC-IV Monitor Box



- Designed to solve driveability problems.
- Read all sensor, actuator, power and ground lines.
- Part of Test Kit 007-0048C

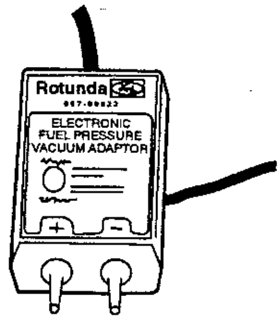
007-00021
EEC-IV Monitor Recorder



- Also known as "Flight Recorder"
- Captures the cause of driveability random intermittents in memory.
- Plugs into and works with EEC-IV monitor to help solve driveability problems.
- Part of Test Kit 007-0048C

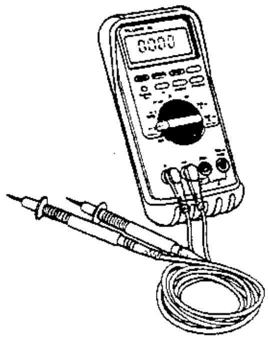
Special Service Tools

007-00022
Pressure/Vacuum Adapter



- Use anytime fuel pressure or vacuum is an issue in a driveability complaint.
- Plugs into EEC-IV monitor, Recorder or a DVOM.
- Adapts directly to FORD Schrader fuel tap.
- Part of Test Kit 007-0048C

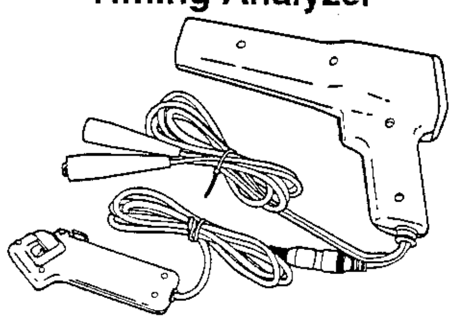
014-00407 or 007-00001
Digital Volt/Ohmmeter



- Essential for gathering EEC system operating data during diagnosis, testing and engine servicing procedures.
- Designed to work in conjunction with the EEC-IV Breakout Box Testers

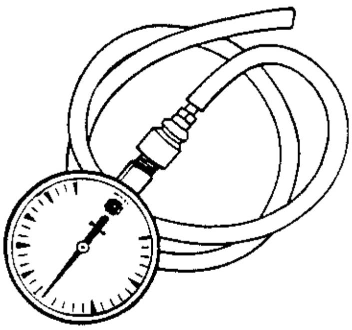
NOTE: Any digital volt/ohmmeter used to test the EEC system must have a minimum impedance rating of 10 Megohms per Volt. Any other type DVOM will damage the ECA.

059-00014
Timing Analyzer



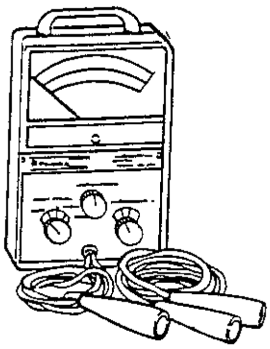
- Variable sensitivity control allow timing light to function on a wide variety of ignition systems.
- Required to perform EEC timing control test.

059-0008
Vacuum/pressure Tester



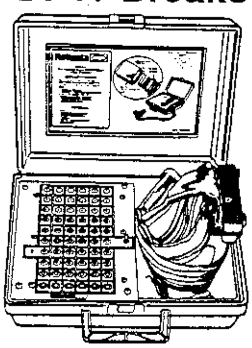
Assists in diagnosing:
- Sticky valves
- Ignition problems
- Valve maladjustment
- Leaking intake manifold
- Uneven compression
- Worn Rings/cylinder walls
- Spark plug miss.

059-00010
Tachometer



- Measures engine RPM.
- Range 0-6,000 RPM.
- Accuracy ±40 RPM.
- Resolution 20 RPM.

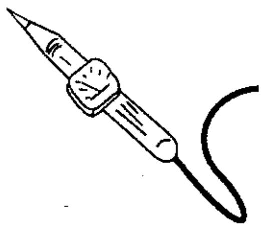
007-00033 or 014-00322
EEC-IV Breakout Box



- Recommended for use in the pinpoint test routines of the EEC-IV self test procedures.
- Access all the information from the 60 pins of the processor through the pin jacks on the front panel of the Breakout Box.

Special Service Tools

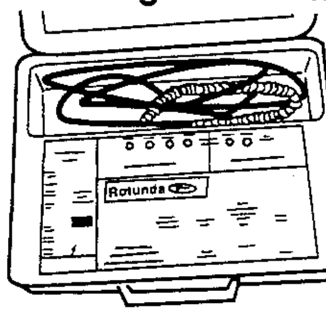
Kilovolt Tester



- Required to check spark output of the TFI-IV ignition system in both open and closed circuit situations.
- Available from Merc-o-tronic Instruments and other quality manufacturers.

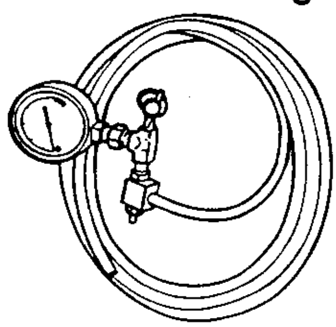
WARNING: ANY DEVICE USED TO CHECK IGNITION SYSTEM SPARK OUTPUT MUST NOT ALLOW AN OPEN SPARK. USE OF SUCH A DEVICE WILL CREATE A HAZARDOUS CONDITION DUE TO THE POSSIBLE PRESENCE OF FUEL VAPORS IN A BOAT'S ENGINE COMPARTMENT.

007-0035A TFI-IV
Intermittent Ignition Analyzer



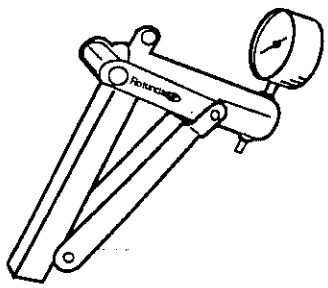
- Identifies primary ignition system faults in the EEC-IV TFI-IV system.
- Indicates problems caused by a malfunctioning coil, TFI-IV system signals or faulty wiring.

014-00748
Fuel Pressure Testing Kit



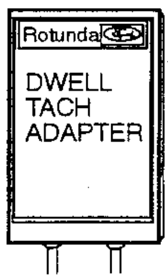
- Enables technician to quickly determine if the fuel pump and pressure regulator are operating within specifications.
- 0-60 psi 1% accuracy (60-150 psi retard).

021-00037 or D83L-7059A
Vacuum Tester



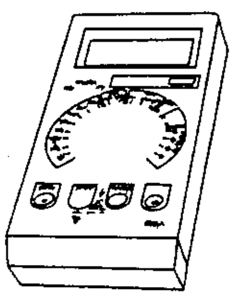
- Checks all vacuum operated components.
- Hand operated pump evacuates the diaphragm chamber and the unit is verified either by checking the vacuum gauge or actual observation of the part.

007-00003
Dwell Tach Adapter



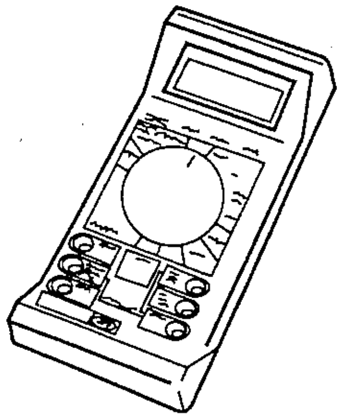
- Compatible with most DVOM's.
- 0-5000 RPM tach range.
- 90° dwell range.

014-00575
Multimeter Plus



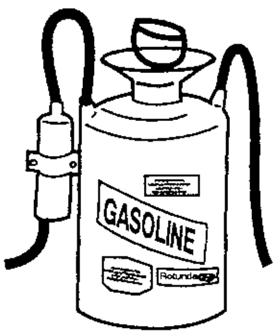
- Secondary tachometer to run RPM tests.
- Audible circuit that beeps when you have continuity.
- 10 megohm impedance.
- AC. volt ranges.
- DC. amp scale.
- Separate diode test.

014-00768 Megameter



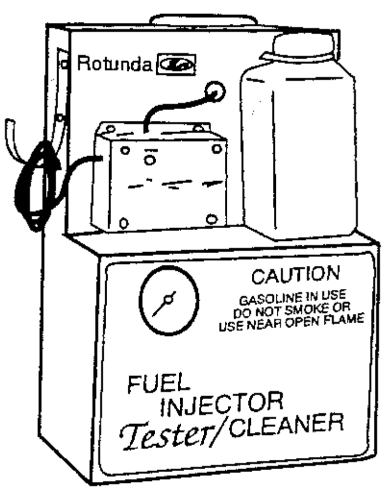
- Percentage of dwell for reading solenoid duty cycle and computer pulse testing.
- Temperature readings to help verify sensor output.
- Secondary tachometer.
- Digital frequency readings.

021-00041
Injector Cleaner



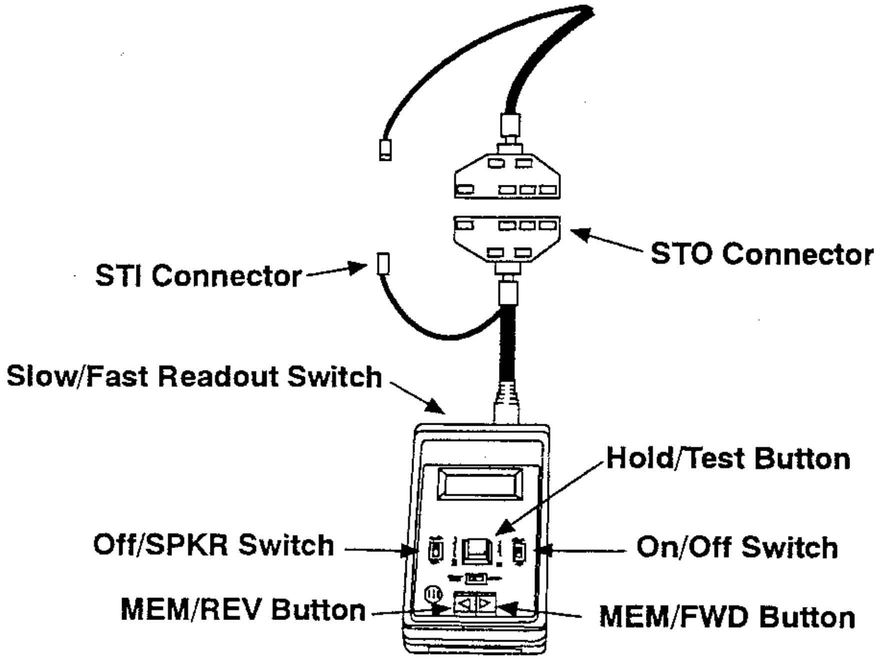
- Ideal for FORD EFI systems.
- Cleans fuel injectors without having to remove them.

113-00001
Fuel Injector Tester/Cleaner



- Individual injectors can be quickly tested for designated rate of flow.
- Clean and accurately test the electronic fuel injectors, without removing them from the engine.

007-0041B Star Tester



The Star tester is an electrical instrument used to diagnose EEC system problems on EFI engines. It's the preferred means to put the ECA into a Self-Test mode, and to access service codes stored in the ECA. It can also be used in a variety of Self-Test procedures that are described elsewhere in this section.

Tester Features

The tester utilizes a LCD screen to visually display information. It will show both "prompts" (grammatical data) and service codes (numerical data).

Service codes will be represented by 2-digit numbers, and can be interpreted by referring to information in the KOEO Code Display and ER Code Display charts in this section. A Star tester can retrieve service codes in two modes, store them in its memory, and allow repetitive code review. It also has a loud beeper that can be used in conjunction with various tests to aid problem diagnosis, and to alert you to important tester information displayed on the LCD screen.

Tester Switches

The MODE switch is located on top of the tester. All other switches are on the face of the tester.

MODE Can be set in either "FAST" of SLOW" position.

HOLD/TEST When depressed ("TEST" position), it puts the ECA in a Self-Test mode and allows reception of service codes. When raised ("HOLD" position), it locks service codes into tester memory and drops the ECA out of Self-Test mode. It's also used to clear codes from the ECA memory after service has been completed.

SPKR Short for speaker, turns beeper on and off. Primarily is used when conducting "Wiggle" tests. Also alerts technician to important tester information displayed on LCD screen.

PWR Short for POWER, turns tester on and off. Tester will beep once when switch is turned on. Turning tester off will clear service codes from tester memory.

MEM REV/MEM FWD Short for Memory Reverse/Memory Forward, used after service codes have been received and stored in tester memory. Codes "wrap around", that is they are stored in tester memory in the order they are received, and are always displayed in this sequence. Codes can be reviewed both forward and backward for your convenience. They can be reviewed as many times as you wish, until tester is turned off.

Tester Prompts

The LCD screen presents service information in an abbreviated grammatical form called "Prompts". They help interpret data received by a Star tester during self-test.

STI LO Short for Self-Test Input Low. This prompt means the ignition key is ON and the ECA is in Self-Test, or engine STI connector has not been attached to the Star tester, or STI circuit is open.

LO BAT Short for Low Battery. Change 9V battery in back of Star tester before conducting a Self-Test.

STO LO Short for Self-Test Output Low. The ignition key is ON and the ECA has sensed an open circuit in the system. May also mean the large engine STO connector is not attached to the tester or the ECA is outputting Self-Test information.

NOTE: Prompt will blink while outputting data; if prompt quits blinking, and stays off for 15-20 seconds, all codes have been received and test is complete).

DYN RSP Short for Dynamic Response. The ECA is requesting that you perform an action on the engine. The throttle must quickly be opened to WOT and then quickly returned to idle. This action is required only during Engine Running Self-Test.

WARNING: SHIFT REMOTE CONTROL HANDLE INTO THE SHIFT-DISENGAGE POSITION; ONLY THE THROTTLE MUST OPERATE. IF THIS PRECAUTION IS NOT TAKEN, THERE WILL BE SUDDEN, UNEXPECTED BOAT MOVEMENT THAT MAY PUT ALL BOAT OCCUPANTS AT RISK.

CD RCVD Short for Codes Received. Service codes have been received and stored in the Star tester memory.

1 ST CD Short for First Code Received. Code displayed on screen was the first code received during Self-Test. Tester will also beep when this prompt appears.

Table of Contents

SECTION 3C: DIAGNOSTIC ROUTINES

SECTION 3C - Diagnostic Routines

The Diagnostic Routines list the components and systems that can contribute to a particular operational problem in the order of probability, ease of accomplishment, and accessibility. These Routines can be used as check lists for reference in the event of unusual or infrequent causes of malfunction.

It's not necessary that any given order be followed, but it makes good sense for the technician to visually inspect everything that his experience tells him could be the source of the condition before beginning a more involved diagnosis. The effectiveness of every service procedure must be validated.

All references, under the REFERENCE column in each Diagnostic Routine chart, are as follows:

- Section numbers refer to sections in this Diagnostic Manual.
- "Appropriate Service Manual" refers to those listed in Section 1 of this manual.

If a particular system/component is determined to be operating normally, return to the Diagnostic Routine Chart in this section for other possible causes of the symptom.

NOTE: Whenever diagnostic procedures refer you to Pinpoint Tests, always read the Special Notes and Test Equipment information found at the start of each Pinpoint Test section. This data will aid diagnosing problems outlined in that Test.

WARNING: BEFORE PERFORMING ANY TESTS OR CHECKS RECOMMENDED IN THIS CHAPTER, READ THE SECTION CALLED SAFETY AT THE END OF THIS MANUAL.

SYMPTOM INDEX

Symptom		Go to Chart:
Starting	No Crank	1
	Hard Start/Long Crank	2
	Stalls After Start	3
	No Start/Normal Crank	4
Idle	Slow Return To Idle	5
	Rolling Idle/Runs Rough/Misses	6
	Fast Idle	7
	Low/Slow Idle	8
	Stalls/Quits	3
	Backfires	12
Stalls/Quits	Acceleration	9
	Cruise	8
	Deceleration	8
Runs Rough	Acceleration	10
	Cruise	10
Misses	Acceleration	10
	Cruise	10
Buck/Jerk	Acceleration	9
	Cruise	9
	Deceleration	9
Hesitation/Stumble on Acceleration		9
Surge	Acceleration	9
	Cruise	11
Backfires	Acceleration	12
	Deceleration	12
Lack/Loss of Power	Acceleration	13
	Cruise	13
Spark Knock	Acceleration	14
	Cruise	14
Diesels/Runs on		7
Poor Fuel Economy		15
Fuel System Odor		16

Chart 1 - No Crank

System	Component	Reference
Starting	Battery, Starter Motor, Assist Solenoid, Neutral Safety Switch, Ignition Switch or Fuse, Circuit Breaker	Cranking System - Appropriate Service Manual
Engine	Flywheel, Engine Seized	Appropriate Service Manual
Fuel	Injectors (hydro-lock)	Section 3H

NOTE: It is good practice to confirm that the correct starting procedure was used by the operator before proceeding with diagnosis.

Chart 2 - Hard Start/Long Crank

System	Component	Reference
Ignition	Spark Plugs, Coil, Secondary Ignition Wires, Distributor Cap and Rotor, Hall Sensor, TFI-IV Module	Section 3F - Visual Check Appropriate Service Manual
EEC	EEC-IV Quick Test	Section 3D
Fuel/Throttle Body	Fuel Filter, Fuel Pumps, Contamination in Fuel, Fuel Lines, Fuel Pressure Regulator, Injectors, Improper Fuel, Idle Airflow, PCV Valve	Section 3H - Visual Check Appropriate Service Manual
Exhaust	Component (restricted)	Appropriate Service Manual
Air Intake and Vacuum Distribution	Vacuum Leaks, Flame Arrestor Restricted	Visual Check; Audible Check

Chart 3 - Stalls After Starting, Stalls at Idle

System	Component	Reference
EEC	EEC-IV Quick Test	Section 3D
Fuel/Throttle Body	Idle Airflow, Electrical Connections, Vacuum Connections, Fuel Filter, Fuel Pumps or Relay, Contamination in Fuel, Fuel Lines, Tank (Fuel Supply), Fuel Pressure Regulator, Injectors, Improper Fuel, Fuel Reservoir	Section 3H - Visual Check
Vacuum Distributor	Vacuum Leaks	Visual Check; Audible Check
Ignition	Electrical Connections, Secondary Ignition Wires, Ignition Switch or Fuse, Ignition Coil, TFI-IV module, Distributor Cap, Rotor, Circuit Breaker, Hall Sensor	Section 3F
Exhaust	Component (restricted)	Appropriate Service Manual
Air Intake	Intake Manifold, Throttle Body, Flame Arrestor, Plenum	Appropriate Service Manual
Engine	Camshaft and Valve Train	Appropriate Service Manual

WARNING: EXTENDED CRANKING, BECAUSE OF A "NO START" CONDITION, CAN LOAD THE ENGINE CYLINDERS WITH RAW FUEL. AFTER THE CONDITION HAS BEEN CORRECTED, VERIFY CYLINDERS ARE NOT HYDRAULICALLY LOCKED BEFORE ATTEMPTING TO START ENGINE.

Chart 4 - No Start/Normal Crank

System	Component	Reference
EEC	EEC-IV Quick Test	Section 3D
Ignition	Electrical Connections, Secondary Wires, Spark Plugs, Ignition Switch, Ignition Coil, TFI-IV Module, Distributor Cap, Loss of ECA Ground, Rotor, Circuit Breaker, Hall Sensor, EEC Power Relay, Loss of ECA VPWR	Section 3F
Fuel/Throttle Body	Fuel Filter, Fuel Pumps or Relay, Contamination in Fuel, Fuel Lines, Tank (fuel supply), Fuel Pressure Regulator, Injectors, Fuel Reservoir	Section 3H - Visual Check Appropriate Service Manual
Engine	Compression, Timing	Appropriate Service Manual
Exhaust	Component (Restriction)	Appropriate Service Manual
Air Intake	Intake Manifold, Plenum, Flame Arrestor, Throttle Body	Appropriate Service Manual

Chart 5 - Slow Return to Idle

System	Component	Reference
EEC	EEC-IV Quick Test	Section 3D
Fuel/Throttle Body	Contamination, Throttle Plate and Linkage	Section 3H
Vacuum Distribution	Vacuum Leaks	Visual Check Audible Check
Air Intake	Air Leak	Appropriate Service Manual
Remote Control	Throttle Cable Adjustment	Appropriate Service Manual

Chart 6 - Rolling Idle/Runs Rough/Misses

System	Component	Reference
Ignition	Secondary Wires, Spark Plugs, Coil, Distributor Cap, Rotor, Timing	Section 3F
EEC	EEC-IV Quick Test	Section 3D
Fuel/Throttle Body	Idle Airflow, Electrical Connections, Vacuum Connections, Fuel Pressure Regulator, Fuel Reservoir, Injectors, Fuel Rail, Fuel Lines, Fuel Pumps	Section 3H
Vacuum Distribution	Vacuum Leaks	Visual Check; Audible Check
Engine	Compression, Valve Train, Camshaft, Intake Manifold Gaskets	Appropriate Service Manual
Air Intake	Intake Manifold, Throttle Body, Plenum	Appropriate Service Manual
Charging	Components	Appropriate Service Manual
Exhaust	Components	Appropriate Service Manual

Chart 7 - Fast Idle - Diesels/Runs On

System	Component	Reference
Fuel/Throttle Body	Idle Airflow, Electrical Connections	Section 3H - Visual Check
Vacuum Distribution	Vacuum Leaks	Visual Check; Audible Check
EEC	EEC-IV Quick Test	Section 3D

Chart 8 - Slow Idle - Stalls at Cruise or Deceleration

System	Component	Reference
Fuel/Throttle Body	Idle Airflow, Throttle Plate and Linkage	Section 3H - Visual Check
Vacuum Distribution	Vacuum Leaks	Visual Check; Audible Check
EEC	EEC-IV Quick Test	Section 3D
Air Intake	Intake Manifold Gasket, Plenum Gasket	Appropriate Service Manual
Cooling	Overheating	Appropriate Service Manual

Chart 9 - Stalls/Hesitation/Surge on Acceleration Buck/Jerk on Acceleration, Cruise or Deceleration

System	Component	Reference
EEC	EEC-IV Quick Test	Section 3D
Ignition	Secondary Wires, Spark Plugs, Coil, Distributor Cap, Rotor, Crossed Wires, Timing	Section 3F
Fuel/Throttle Body	Idle Airflow, Fuel Filter, Fuel Pumps, Contamination in Fuel, Fuel Lines, Fuel Pressure Regulator, Fuel Reservoir, Injectors	Section 3H - Visual Check
Vacuum Distribution	Vacuum Leaks	Visual Check; Audible Check
Air Intake	Flame Arrestor	Appropriate Service Manual
Exhaust	Restriction	Appropriate Service Manual

Chart 10 - Runs Rough/Misses on Acceleration or Cruise

System	Component	Reference
Ignition	Secondary Wires, Spark Plugs, Coil, Distributor Cap, Rotor, Timing, Crossed Wires	Section 3F
EEC	EEC-IV Quick Test	Section 3D
Fuel/Throttle Body	Fuel Filter, Fuel Pumps, Fuel Lines, Fuel Pressure Regulator, Injectors	Section 3H - Visual Check
Vacuum Distribution	Vacuum Leaks	Visual Check; Audible Check
Engine	Components	Appropriate Service Manual

Chart 11 - Surge at Cruise

System	Component	Reference
EEC	EEC-IV Quick Test	Section 3D
Fuel/Throttle Body	Fuel Filter, Fuel Pumps, Fuel Lines, Fuel Pressure Regulator, Fuel Octane, Idle Airflow, Fuel Reservoir	Section 3H - Visual Check Appropriate Service Manual
Ignition	Spark Plugs, Secondary Wires, Coil, Timing	Section 3F
Vacuum Distribution	Vacuum Leaks	Visual Check; Audible Check
Air Intake	Air Intake Components	Visual Check Appropriate Service manual
Engine	Valve Train and Camshaft, Intake manifold and Gaskets	Appropriate Service manual

Chart 12 - Backfires at idle, Acceleration or Deceleration

System	Component	Reference
Ignition	Spark Plugs, Secondary Wires, Coil, Crossed Wires, Timing	Section 3F
Vacuum Distribution	Vacuum Hoses, Connections	Visual Check; Audible Check
EEC	EEC-IV Quick Test	Section 3D
Engine	Intake Manifold Gaskets, Compression Checks, Camshaft, Valves	Appropriate Service Manual
Exhaust	Components (restricted)	Appropriate Service Manual
Fuel/Throttle Body	Fuel Filter, Fuel Pumps, Contamination in Fuel, Fuel Lines, Fuel Pressure Regulator, Injectors, Fuel Octane	Section 3H - Visual Check Appropriate Service Manual

Chart 13 - Loss of Power on Acceleration or Cruise

System	Component	Reference
Ignition	Spark Plugs, Secondary Wires, Coil, Timing	Section 3F Appropriate Service Manual
EEC	EEC-IV Quick Test	Section 3D
Fuel/Throttle Body	Fuel Filter, Fuel Pumps, Fuel Lines, Fuel Pressure Regulator, Injectors, Idle Airflow, Fuel Reservoir	Section 3H - Visual Check Appropriate Service Manual
Exhaust	Component (restricted)	Appropriate Service Manual
Cooling	Thermostat	Visual Check; Audible Check
Vacuum Distribution	Vacuum Leaks	Appropriate Service Manual
Air Intake	Flame Arrestor	Appropriate Service Manual
Engine	Compression Check, Camshaft, Valves	Appropriate Service Manual

Chart 14 - Spark Knock on Acceleration or Cruise

System	Component	Reference
Ignition	Timing, Knock Sensor	Section 3F
EEC	EEC-IV Quick Test	Section 3D
Cooling	Overheat	Appropriate Service Manual
Engine	Oil Level, Compression Check, Intake Manifold Gasket	Appropriate Service Manual
Fuel/Throttle Body	Fuel Octane, Fuel Pumps and Filter, Fuel Lines, Fuel Pressure Regulator, Injectors	Section 3H - Visual Check Appropriate Service Manual
Air Intake	Flame Arrestor	Appropriate Service Manual

NOTE: Since fuel consumption is drastically increased for short-run operation, stop and go operation, etc., as opposed to normal cruising, an attempt should be made to determine these factors when confronted with "poor fuel economy" conditions. However, since the operator is not always at fault, consider the following:

Chart 15 - Poor Fuel Economy

System	Component	Reference
Fuel/Throttle Body	Fuel Pressure Regulator	Section 3H Appropriate Service Manual
Air Intake	Flame Arrestor	Visual Check Appropriate Service Manual
Ignition	Spark Plugs, Coil, Secondary Wires, Distributor Cap, Rotor, Timing	Section 3F Appropriate Service Manual
EEC	EEC-IV Quick Test	Section 3D
Cooling	Thermostat	Appropriate Service Manual
Factors External to the Engine	Condition of Boat Bottom, Vertical Drive, Propeller	Visual Check

Chart 16 - Fuel System Odor

System	Component	Reference
Fuel/Throttle Body	Fuel Filter Leaks, Injector Leak, Fuel Pumps Leak, Fuel Lines, Fuel Pressure Regulator Leaks, Fuel Tank Leaks, Fuel Tank Filler Neck Leaks, Fuel Tank Sender Leaks, Fuel Reservoir	Section 3H - Visual Check Appropriate Service Manual
EEC	EEC-IV Quick Test	Section 3D

The following charts provide voltage reference values for use when performing pinpoint tests to check circuit operation. The numbers under the "Black Lead" and "Red Lead" columns refer to DVOM test points on a Breakout Box. Engine must be at operating temperature to ensure accurate voltage values.

SENSOR	DVOM SETTING	BLACK LEAD	RED LEAD	VALUE	NOTES
VREF	DCV	46	26	4.74 - 5.25	
TP	DCV	46	47	.8 - 1.15 4.65 - 5.0	Closed Throttle WOT
ECT	DCV	46	7	.87 - 1.17	A
ACT	DCV	46	25	1.13 - 1.53	A
MAP	HZ	46	45	159	B
PIP	DCV	46	56	0 -.3 VBAT	C D
KS	DCV	46	2	.3	
SAS	DCV	40	10	0 VBAT	Not Actuated Actuated
NDS	DCV	40	30	0 5.0	In Neutral FWD & REV

A. Measure temperature with a pyrometer at base of sensor.
B. Based on 30.0 in. Hg. barometric pressure. As barometric pressure increases, Hertz signal increases.
C. When distributor cup **opening** is in alignment with Hall Effect device.
D. When distributor cup **vane** is in alignment with Hall Effect device.

ACTUATOR	DVOM SETTING	BLACK LEAD	RED LEAD	VALUE	NOTES
INJ BANK 1	DCV	40	58	VBAT	
INJ BANK 2	DCV	40	59	VBAT	
ISC-BPA	DCV	40	21	VBAT	
FP	DCV	40	52	VBAT	

POWER SUPPLY	DVOM SETTING	BLACK LEAD	RED LEAD	VALUE	NOTES
KAPWR	DCV	40/60	1	VBAT	Key on and off
VPWR	DCV	40/60	37/57	VBAT	Key on only

GROUND	DVOM SETTING	BLACK LEAD	RED LEAD	VALUE	NOTES
IGN GND	DCV	40/60	16	0	
CSE GND	DCV	40/60	20	0	
PWR GND	DCV	40/60	20	0	

Table of Contents

SECTION 3D : QUICK TEST

WARNING: BEFORE PERFORMING ANY TESTS OR CHECKS RECOMMENDED IN THIS CHAPTER, READ THE SECTION CALLED SAFETY AT THE END OF THIS MANUAL.

NOTES:

- The Quick Test procedure should be used **ONLY** when the Diagnostic Routines section directs you here.
- The Key On Engine Off and Engine Running Self-Tests detect faults that are present at time of testing. Faults that occur only when the engine is operating, or intermittent faults that have occurred in the last 40 engine temperature cycles are detected during Continuous Self-Test, stored in the ECA memory and displayed in the Continuous Memory portion of the Key On, Engine Off Self-Test.
- If all phases of Quick Test, including EEC-IV Diagnosis by Symptom Step 8, result in a PASS, it is likely that the problem is non-EEC-IV related and will be found elsewhere. You should return to the Diagnostic Routines in Section 3C for other possible areas of concern.
- When directed to a Pinpoint Test, always read the beginning page(s) of the test for special notes and wiring schematics.
- After service, rerun Quick Test to ensure that service was effective.

CAUTION:

- **Do Not go to Pinpoint Test Section unless directed by the Quick Test procedures. (Not following Quick Test procedures may produce incorrect results and replacement of non-defective components).**
- **Do Not replace any parts unless directed by a test procedure.**
- **Do Not measure voltage or resistance directly at the processor connector.**
- **Do Not perform any diagnostic procedure with the engine connected to a battery charger.**

Test Description

Quick-Test is an operational mode in which the ECA checks the engine for EEC-related faults. Self-Test is divided into four specialized checks:

- Key On Engine Off (KOEO)
- Timing Control
- Engine Running (ER)
- Continuous

Self-Test is not a conclusive test by itself (other non EEC related causes may have similar symptoms), but is part of the Quick-Test diagnostic procedure. The ECA stores the Self-Test program in its permanent memory. When activated by a Star tester, it checks the EEC-IV system by testing its memory integrity and processing capability, and verifies that various sensors and actuators are connected and operating properly.

The Key On Engine Off, Timing Control and Engine Running Self-Tests are functional checks which only detect faults present at time of Self-Test. Continuous Self-Test detects faults that occur anytime during normal engine operation.

Key On Engine Off (KOEO) Self-Test

As it implies, this test of the EEC-IV system is conducted with the ignition on, but with the engine off. It requires use of a Star tester, and will provide three types of numerical data:

On-Demand Codes

These are 2 digit service codes that are the first to appear on the Star tester LCD screen. Each code represents a Hard Fault, i.e. a defective component or circuit that is **present at time of test.** They only appear **before** the Separator Code. For interpretation of these codes, see **KOEO Code Display** in this section.

Separator Code
This is a single 2 digit code that appears on the Star tester LCD screen after the last Hard Fault code. As its name implies, it "separates" the Hard Fault codes from the Continuous Codes that follow. The separator code is always the number 10.

Continuous codes
These are also 2 digit service codes, and they only appear **after** the Separator Code. They are an ECA memory readout, and represent an Intermittent Fault. Continuous Codes are a result of fault information stored during Continuous Self-Test while the engine was in normal operation. **These codes are displayed only during Key On Engine Off Self-Test.** Intermittent faults that have not occurred in the last 40 warm engine temperature cycles are erased from ECA memory and will not produce a Continuous Code.

Engine Running (ER) Self-Test

This test of the EEC-IV system is conducted with the engine running at idle. Sensors and actuators are checked under actual operating conditions and temperatures. The actuators are exercised and checked for expected results.

On Demand Codes
Like the first part of the KOEO Self-Test, this test looks for Hard Faults that **are present at time of testing.** They're represented by 2 digit service codes. ER Self-Test does not provide continuous Codes. In addition, this test requires you to perform an action on the engine called a "Dynamic Response".

Dynamic Response (not used on all applications)
The dynamic response action is to quickly open the throttle to WOT and immediately return it to idle. It's used to verify operation of the TP and MAP sensors. The signal for the technician to perform the brief WOT is the appearance of the DYN RSP prompt on the Star tester LCD screen ("FAST" mode), or a Code 10 ("SLOW" mode).

Timing Control Self-Test

This test requires use of a variable advance timing light in addition to a Star tester. It's comprised of a Base Timing Check and followed by a Computed Timing Check. In the Computed Timing Check, an additional 15° ± 2° is added to the base timing figure (20°±2° total spark advance) to determine whether the ECA is properly controlling spark advance.

It's usually performed during the first high idle cycle of the ER Self-Test, but can be conducted independently at any time if the intent is just to verify correct ECA spark management.

Continuous Self-Test

Continuous Self-Test occurs throughout normal engine operation. During this mode of testing, the EEC-IV processor (ECA) continuously monitors inputs for intermittent opens and shorts, and stores fault information in Keep Alive Memory (KAM) in the form of service codes. These Continuous Codes must be retrieved within 40 warm engine temperature cycles. On the 41st engine temperature cycle, the service code will be automatically erased. These codes will be re-acquired if the faults continue to occur. Faults recognized during Continuous Self-Test can be retrieved only during Key On Engine Off Self-Test.

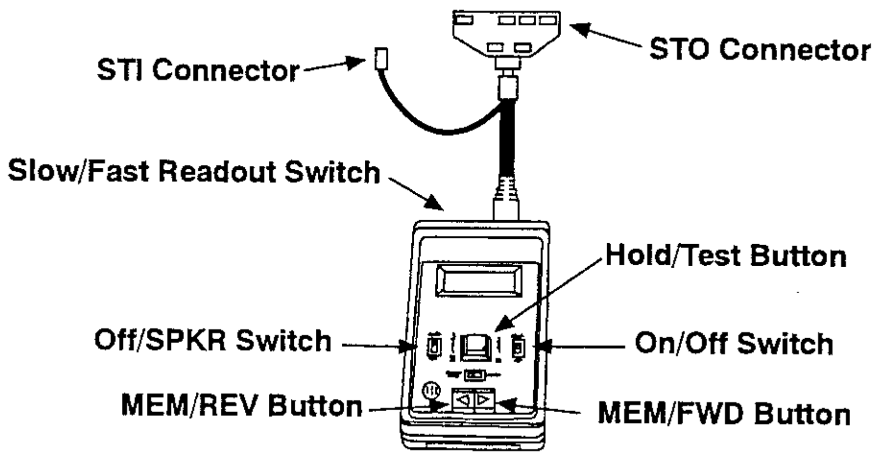
Code Output Format

The EEC-IV system communicates service information through the Self-Test service codes. These service codes are two-digit numbers representing the results of Self-Test. Service codes are transmitted on the Self-Test Output (STO) line found in the engine Self-Test connector. They are in the form of timed pulses, and are read on a Star tester. See **KOEO Code Display** and **ER Code Display** elsewhere in this section.

Correct results of Quick Test are dependent on the proper operation of NON EEC-IV related components. It may be necessary to disconnect or disassemble harness connector assemblies to do some of the inspections. Pin locations should be noted before disassembly.

Use of The Star Tester

The Star tester was designed to retrieve data from the ECA, which is the heart of the EEC-IV system. It will conduct the tests and display the information previously described. The following pages are the instructions for performing each of the Self-Tests. Note that the "STO LO" prompt will flash at random times throughout these tests. This is normal and indicates that the ECA is imparting information to the Star tester. Begin Quick Test with step 1.



STEP 1 - Quick Test Preparation

Visual Check

Proper preparation is essential for accurate test results. Perform the following inspections:

1. Check flame arrestor integrity and installation.
2. Check all engine vacuum hoses for damage, leaks, cracks, blockage, proper routing, etc.
3. Check EEC-IV system wiring harness for proper connections, bent or broken pins, corrosion, loose wires, proper routing, etc.
4. Check the ECA, sensors and actuators for physical damage.
5. Check engine cooling system for proper operation.
6. Check engine crankcase and vertical drive oil levels.
7. Make all necessary repairs before performing Quick Test Step 2.

Engine Preparation and Equipment Hookup

- Connect Star tester as shown.
- Perform all safety steps required to start and run engine tests. **Place remote control shift lever in neutral position.**
- Run engine until it reaches normal operating temperature.
- Turn off all electrical accessories.

STEP 2 - Key On Engine Off (KOEO) Self-Test

NOTE: Engine must be at normal operating temperature before performing this test. All visual checks must be satisfactorily completed.

1. Connect a Star tester to engine STO and STI connectors.
2. Set **MODE** switch on top of tester to : FAST or SLOW
3. Set **SPKR** switch to "OFF" position.
4. Put **HOLD/TEST** button in "HOLD" (raised) position.
5. Move **PWR** switch up to turn on the Star tester; it will beep once. It will briefly display "888", light all prompts on left side of screen, and finally show "000". If "LO BAT" prompt stays on, turn tester off and replace tester battery before proceeding.
6. Turn ignition key on; **DO NOT** start engine.
7. This portion of KOEO Self-Test will take approximately 1 minute. To put the EEC processor (ECA) into Self-Test, push **HOLD/TEST** button down into "TEST" position (button will stay depressed). The following will occur:
   - Engine will make various noises as the ECA checks the EEC system for problems that are on engine at that moment (Hard Faults), and retrieves from ECA memory stored service codes (Intermittent Faults).
   - Numbers (service codes) will begin to appear on the Star tester readout screen.

NOTE: **DO NOT** raise test button while the tester is displaying test codes. This will erase all Continuous (memory) codes. Engine would have to be returned to service to re-acquire lost Continuous codes.

8. The KOEO Self-Test is complete when the "CD RCVD" prompt appears (in "FAST" mode), or when the STO LO prompt stops blinking and stays off for 15-20 seconds (in "SLOW" mode). Push **HOLD/TEST** button again to release it to the raised position. This will lock all service codes into the Tester memory, and release ECA from Self-Test mode.
9. Turn ignition key OFF.

10. Use **MEM FWD** and **MEM REV** buttons to review service codes. The first code received will be identified by a beep, and the "1 ST CD" prompt will appear. Codes can be reviewed as often as desired. Write down all service codes, **in the exact order they are displayed,** so you can refer to them later.

NOTE: Turning **PWR** switch OFF will erase all codes in the tester memory. Also, the sequence of the service codes is extremely important. Codes must be acted upon in a specific order, starting with the first code received and continuing on in the exact sequence displayed by the tester. "Up-stream" codes (first received) can create "down-stream" codes (later received) codes. As a problem is corrected, retest KOEO; some down stream codes may no longer appear. Follow the code order to ensure effective trouble shooting.

11. Refer to **KOEO Code Display** for interpretation of codes received.

STEP 2 - KOEO (cont.)

Hard Fault Codes	Separator code	Continuous memory Codes	Action to Take
11	10	11	Both tests indicate a PASS: • If engine idles rough or runs rough, Go to EEC-IV Pinpoint Test 3E16. • If symptom is not present, Go to Quick Test Step 4. • If engine is a no start, Go to EEC-IV Pinpoint Test 3E1.
Any Code(s)	10	11	HARD FAULT: • Go to Quick Test Step 7 for reference under KOEO. • Write down codes, in order they appeared, for later reference. Resolve all Hard Faults before continuing. Always start with the first code displayed.
11	10	Any Code(s) Except: 15,19,28,45,46,48,49,50,56,62,66,67,69, 88 or 99	INTERMITTENT FAULT: • Do not service codes at this time. • If engine idles rough or runs rough, Go to EEC-IV Pinpoint Test P. • If symptom is not present, Go to Quick Test Step 4. • Write codes down, in order they appeared for later reference.

STEP 2 - KOEO (cont.)

Any code(s)	10	Any Code(s)	Both tests indicate a FAULT: • Go to Quick Test Step 7 for reference under KOEO. Do not service continuous codes at this time. • Write down codes, in order they appeared, for later reference. Always start with the first code displayed.
11	10	15	Go to EEC-IV Pinpoint Test 3E15.
11	10	67	Go to EEC-IV Pinpoint Test 3E17.

No Codes Displayed or Codes Not Listed	Self Test did not activate or unlisted codes displayed: • Repeat KOEO Self-Test to verify the above condition. • If condition still exists, Go to EEC-IV Pinpoint Test 3E14. • If engine is a no start, Go to EEC-IV Pinpoint Test 3E1.

STEP 3 - Output Cycling Test

NOTE: This test will check the operation of EEC controlled engine actuators, and can be performed, if so desired, at the conclusion of the KOEO Self-Test. Engine must be at normal operating temperature before performing this test. All visual checks must be satisfactorily completed.

1. Perform Steps 1 through 7 of **Quick Test Step 2 - KOEO**
2. When KOEO Quick Test is complete, the "CD RCVD" prompt will appear, (in "FAST" mode), or when the STO LO prompt stops blinking and stays off for 15-20 seconds (in "SLOW" mode). Display screen prompts will cease movement. **Leave HOLD/TEST button in its depressed position.**
3. When all prompt movement has stopped, quickly move throttle to WOT position and quickly return it to idle. This will energize all EEC-controlled actuators. You'll be able to hear and feel (by touching an actuator) this occur. Doing this a second time will deactivate all actuators. This cycle can be repeated as many times as desired. If an actuator does not respond as expected, additional tests may be necessary to confirm its failure. Defective actuators should be repaired or replaced.
4. When test is complete, release **HOLD/TEST** button. Turn tester off, then turn engine off.

STEP 4 - Timing Control Test

Base Timing Check

This test does not require use of a Star tester, but is usually performed in conjunction with Quick Test procedures. **Perform this test before conducting the Computed Timing Test. If Base Timing is incorrect, Computed Timing will also be wrong.** Engine must be at normal operating temperature. If engine is below operating temperature, the ECA will add additional timing advance and Base Timing Test will be inaccurate. All visual checks must be satisfactorily completed.

1. Connect a timing light to the engine.
2. Start and run engine at idle.
3. Unplug SPOUT connector (remove shorting bar), then read engine timing. Base timing must be **5°.** If base timing is incorrect, loosen distributor clamp and rotate distributor to reset base timing.
4. Re-attach SPOUT connector and turn off engine. Leave timing light attached if continuing with Computed Timing Check, otherwise remove timing light.
5. Push **HOLD/TEST** button to return button to "HOLD" position. This will disengage Self-Test mode, and engine RPM should return to normal idle.
6. Turn engine off, and remove timing light and Star tester.

Computed Timing Check

1. Connect a timing light to the engine. Make sure SPOUT connector is installed.
2. Perform Steps 1 through 6 of Engine Running Self-Test (STEP 5).
3. Press **HOLD/TEST** button down to "TEST" position to initiate ER Self-Test mode. Engine RPM will increase and stay elevated for several seconds. Ignore any codes at this time.
4. Read engine timing; it should be over base timing. (if computed timing is not correct, but base timing was, replace the ECA).

STEP 5 - Engine Running (ER) Self-Test

NOTE: Engine must be at normal operating temperature before performing this test. All visual checks must be satisfactorily completed.

WARNING: REMOTE CONTROL HANDLE MUST BE MOVED TO THE SHIFT-DISENGAGED POSITION. THIS WILL PREVENT UNEXPECTED AND POSSIBLY HAZARDOUS BOAT MOVEMENT DURING THE DYNAMIC RESPONSE PART OF THIS TEST.

1. Connect a Star tester to engine STO and STI connectors.
2. Set **MODE** switch on top of tester to either "SLOW" or "FAST".
3. Set **SPKR** switch on face of Tester to "OFF" position.
4. Put **HOLD/TEST** button in "HOLD" (raised) position.
5. Move **PWR** switch up to turn on the Star tester; it will beep once. It will briefly display "888", light all prompts on left side of screen, and finally show "000". If the "LO BAT" prompt stays on, turn Tester off and replace tester battery before proceeding.
6. Start engine and let idle 10 seconds to stabilize RPM.
7. This portion of the ER Self-Test will take approximately 2 minutes. **Be prepared to perform a Dynamic Response (quickly move throttle to WOT then quickly return it to idle position) when the appropriate indicator is displayed:**
   - "FAST" mode: the "DYN RSP" prompt appears
   - "SLOW" mode: a code 10 appears.
8. To put the EEC processor (ECA) into Self-Test, push **HOLD/TEST** button down into TEST" position (button will stay depressed). The following will occur:
   - Engine will make various noses and twice cycle RPM up and down as the ECA looks for Hard Faults
   - STO LO prompt will flash 1/2 the number of engine cylinders (i.e. 4 flashes mean 8 cylinders), and the number 40 (8 cyl. engine) will appear on the readout screen.

STEP 5 - Engine Running (ER) Self-Test (cont.)

9. The first "high idle" Self-Test cycle will last approximately one minute. This is so you can check the EEC system's control of computed timing. Perform this check if you wish to do so, or if the Quick Test procedure directs you to.
10. The Dynamic Response indicator (DYN RSP or a code 10) will appear shortly after a final, brief (approximately 5 seconds) up/down RPM cycle. When it does, quickly move throttle to the wide open position and quickly return it to idle.

NOTE: If this action is delayed (not done immediately after indicator appears), Self-Test may not recognize it as being performed, and a failure code 77 will appear. The entire ER Self-Test will have to be repeated because the test conclusions will be invalid and incomplete.

11. The ER Self-Test is complete when the "CD RCVD" prompt appears along with the last service code (in "FAST" mode), or when STO LO prompt stops blinking and remains off for 15-20 seconds (in "SLOW" mode). Push **HOLD/TEST** button again to release it to the raised position. This will lock all service codes into the Star tester memory, and release ECA from Self-Test mode.
12. Turn engine "OFF".
13. Use **MEM FWD** and **MEM REV** buttons to review service codes. The first code received will be identified by a beep, and the "1ST CD" prompt will appear. Codes can be reviewed as often as desired. Write down all service codes, **in the exact order they are displayed,** so you can refer to them later.

NOTE:
- Turning the **PWR** switch OFF will erase all codes in the Star tester memory.
- The sequence of the service codes is extremely important. Codes must be acted upon in a specific order, starting with the first code received and continuing on in the exact sequence displayed by the Star tester.

14. Refer to the ER code display on the next page for interpretation of codes received.

STEP 5 - ER Code Display

Engine Code	Dynamic Response	Engine Running	Action to Take
40	10 or DYN RSP	11	ER test indicates a PASS: • If Continuous Codes were present, Go to Quick Test Step 7 for CONT reference. • If Continuous Memory is a PASS Code 11 and a symptom is present, Go to Quick Test Step 8.
40	10 or DYN RSP	Any Code(s)	HARD FAULT: • Go to Quick Test Step 7 for reference under ER. • Write down codes, in order they appeared, for later reference. Always start with the first code displayed.
98	No Display	Any Code(s)	Engine is in FMEM mode: • Engine Running Self-Test will not initiate until a PASS Code 11 is obtained in KOEO Self-Test. • Run KOEO Self-Test and address all codes displayed.

No Codes Displayed or Codes Not Listed	Self Test did not activate: • Repeat ER Self-Test to verify the above condition. • If condition still exists, Go to EEC-IV Pinpoint Test 3E14.

STEP 6 - Continuous Monitor DTM (Wiggle Test)

In Diagnostic Test Mode (DTM), the technician can ATTEMPT to re-create and detect an intermittent fault using this test. This will aid in locating loose wires and poor connections. It will only check sensors (not actuators) that use a VREF signal and interface with the ECA. It can be performed either with engine off or with engine running.

1. Hook up a STAR tester.
2. Start engine or turn key to ON position.
3. Activate, deactivate and reactivate Self-Test.:
   a. Move **PWR** switch up.
   b. Press **HOLD/TEST** button three times (down-pause-up-pause-down)

   You are now in Continuous Monitor DTM.
4. Tap, move and wiggle the suspect sensor and/or harness or drive the boat.
5. When a fault is detected, a Continuous Memory Fault Code will be stored in memory. This will be indicated by Red LED lights and/or continuous tone (move **SPKR** switch to "SPKR" position).

NOTE: A fault can be simulated by disconnecting any sensor wire that interfaces with the ECA. When wire is removed, a tone will sound continuously until wire is re-connected. This tone represents an open circuit.

STEP 7 - Service Code Chart

Service Code	Description	KOEO	ER	CONT
No Code	Loss of VREF	3E14	3E14	3E14
10	Separator Code	-	-	-
11	System Pass Code	Pass	Pass	Pass
12	RPM Not within Upper Band Limit	-	3E10	-
13	RPM Not within Lower Band Limit	-	3E10-13	-
14	PIP Circuit Fault	-	-	3E12
15	ROM Test Failed/KAM in Continuous	Replace ECA		3E15
18	Loss of Tach Input to ECA/ SPOUT Circuit Grounded	-	3E13	3E12-2
19	Failure in EEC Reference Voltage	Replace ECA		-
21	ECTout of range	3E4	3E4	-
22	MAP out of range	3E5	3E5-6	3E5-9
23	TP out of range	3E7-2	3E7	-
24	ACT out of range	3E4	3E4	-
28	Loss of primary tach	Future Application		
48	Loss of secondary tach	Future Application		
51	-40°F indicated - ECT sensor circuit open	3E4-5	-	3E4-10
53	TPS circuit above max. voltage	3E7-3	-	3E7-10
54	-40°F indicated - ACT sensor circuit open	3E4-5	-	3E4-10
61	254°F indicated - ECT circuit grounded	3E4-7	-	3E4-10
63	TPS circuit below minimum voltage	3E7-6	-	3E7-14
64	254°F indicated - ACT circuit grounded	3E4-7	-	3E4-10
67	NDS circuit open during self test	3E17	-	3E17
95	Fuel pump circuit open - ECA to motor ground	3E9-11	-	3E9-18
96	Fuel pump circuit open - BAT to relay	3E9-6	-	3E9-21
98	FMEM failure	Quick Test Step 2		
Codes Not Listed	All	3E14	3E14	3E14

STEP 8 - Diagnosis By Symptom

NOTES:
- Verify that a Pass code 11 was received in KOEO, for both Hard Faults and Intermittent Faults, and also ER Self-Tests before continuing with this test.
- If a symptom is present and the EEC system is suspected, Go to Symptom Chart Index. The chart will refer you to an EEC-IV Pinpoint Test.
- If the EEC system is not suspected or if symptom or application is not contained in the Symptom Chart Index, Go to Section 3 - Diagnostic Routines.

Symptom Chart Index

Symptom	Go to:
Engine runs rough at idle, acceleration, or cruise	3E16-2
Engine misses at idle, acceleration or cruise	3E16-2
Engine lacks/loses power	3E16-2
Engine surges at acceleration or cruise	3E16-2
Erratic RPM	3E16-2
Engine hesitates	3E16-2
Engine Spark knocks	3E6-1
Engine stalls/stalls during Self-Test	3E16-1

STEP 9 - Erasing Continuous Codes

NOTE: Continuous memory codes should only be erased after all service procedures related to solution of their problems have been satisfactorily completed. If codes are accidentally erased, engine will have to be put back into service so the codes can be re-acquired.

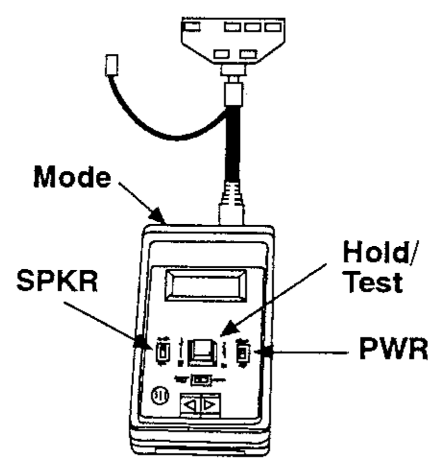
1. Attach a STAR tester to the engine STI and STO connectors.

2. Set **MODE** switch on top of tester to either mode.

3. Set **SPKR** switch to "OFF" position.

4. Put **HOLD/TEST** button in "HOLD" (raised) position.

5. Move **PWR** switch up to turn on the tester; it will beep once. It will briefly display "888", light all prompts on left side of screen, and finally show "000". If "LO BAT" prompt stays on, turn tester off and replace tester battery before proceeding.



6. Turn ignition key ON. Do not start engine.

7. Push **HOLD/TEST** button down into "TEST" position. As soon as the first service code appears, push **HOLD/TEST** button again to raise it to the "HOLD" position. All memory codes will be erased.

SECTION 3E : EEC-IV PINPOINT TESTS

Special Notes

- Pinpoint tests are used to check EEC circuits for volt, ohm or Hertz values as specified in the individual tests. Read the special notes at the start of each test before conducting the required procedures.
- Turn key off and isolate both ends of a circuit whenever checking for shorts or continuity unless directed otherwise.
- Disconnect solenoids and switches from harness before measuring for continuity, resistance or energizing by way of a 12 volt source.
- When unplugging connectors, inspect for damaged or pushed-out pins, corrosion, loose wires, etc. Service as necessary.
- An EEC-IV Monitor can be used as a substitute for the EEC-IV Breakout Box during Pinpoint Testing. The EEC-IV Breakout Box and Monitor are pin for pin compatible when referencing the 60 pin connector. For Monitor operation, refer to instructions supplied with test equipment.

WARNING: BEFORE PERFORMING ANY TESTS OR CHECKS RECOMMENDED IN THIS CHAPTER, READ THE SECTION CALLED SAFETY AT THE END OF THIS MANUAL.

TEST 3E-1 : EEC-IV TFI NO-START

Note: You should enter this Pinpoint Test only when Quick Test has been successfully completed and the engine is still a no start, or when directed here.

Remember: To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Fuel quantity and quality
- Ignition: general condition, moisture, cracks, damage, etc.
- Engine: internal, valves, timing belt, camshaft
- Starter and Battery Circuit
- TFI module
- Distributor
- Ignition coil

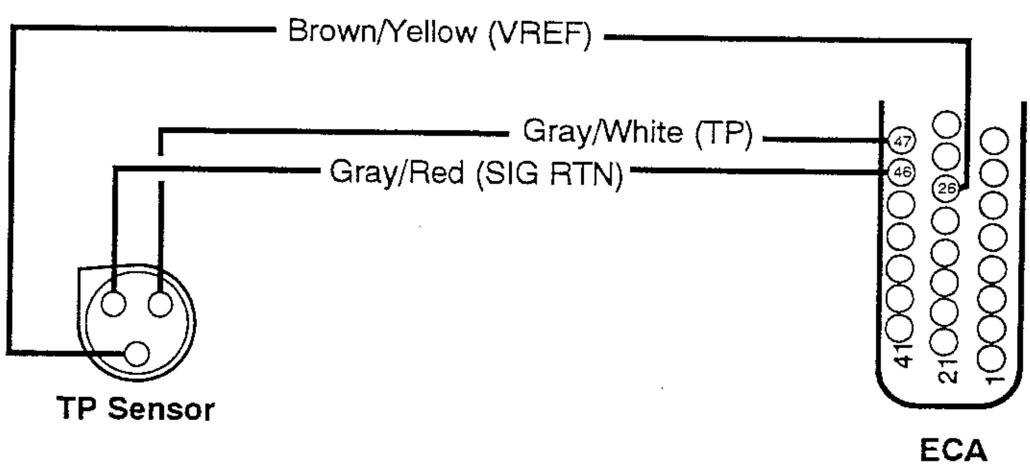
This Pinpoint Test is intended to diagnose only the following:

- Spark (as related to EEC-IV)
- Harness circuits: PIP, SPOUT, IGN, GND, VPWR
- Processor assembly (ECA)

WARNING: STOP THIS TEST AT THE FIRST SIGN OF A FUEL LEAK AND SERVICE AS REQUIRED. NO OPEN FLAME - NO SMOKING DURING FUEL DELIVERY CHECKS.

TEST 3E1 : EEC-IV TFI NO-START

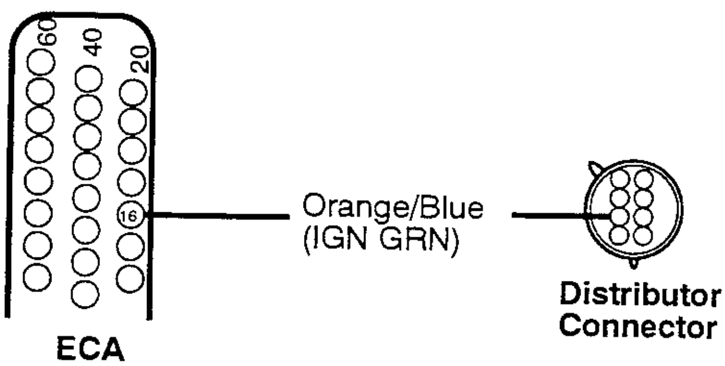
Test Step		Result	Action to Take
3E1-1	ATTEMPT TO CRANK ENGINE		
• Does engine crank?		Yes	Go to **3E1-2.**
		No	Refer to cranking system diagnosis in appropriate service manual.
3E1-2	CHECK FOR VREF AT THROTTLE POSITION SENSOR		
• Key off. • Disconnect TP sensor. • Key on, engine off. • Measure voltage between VREF circuit and SIG RTN circuit at the TP sensor engine harness connector. • Is voltage between 4.0 and 6.0 volts?		Yes No	Reconnect TP sensor. Go to **3E1-3.** Go to Pinpoint Test Step **3E3-1.**



Test Step		Result	Action to Take
3E1-3	CHECK FOR SPARK AT PLUGS		
• Crank engine and check for spark with Kilovolt Meter.		Yes	Go to **3E1-13.**
• Was spark present and consistent?		No	Go to **3E1-4.**

TEST 3E1 : EEC-IV TFI NO-START

Test Step		Result	Action to Take
3E1-4	CHECK FOR SPARK AT COIL		
• Check for spark with Kilovolt Meter while cranking engine. • Was Spark present during crank?		Yes No	Refer to **Section 3F** for TFI cap, rotor and wires diagnosis. Go to **3E1-5.**
3E1-5	CHECK CONTINUITY OF IGN GND CIRCUIT		
• Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Disconnect distributor. • Measure resistance between Test Pin 16 and distributor connector IGN GND circuit. • Is resistance less than 5.0 ohms?		Yes No	Go to **3E1-6.** Service open circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.



Test Step		Result	Action to Take
3E1-6	ISOLATION OF PROBLEM TO SPOUT CIRCUIT		
• Reconnect distributor. • Install Breakout Box, connect processor. • Timing switch to "DIST" position on Breakout Box. • Attempt to start engine. • Does the engine start?		Yes No	Timing switch to "Computed" position on Breakout Box. Go to **3E1-11.** Go to **3E1-7.**

TEST 3E1 : EEC-IV TFI NO-START

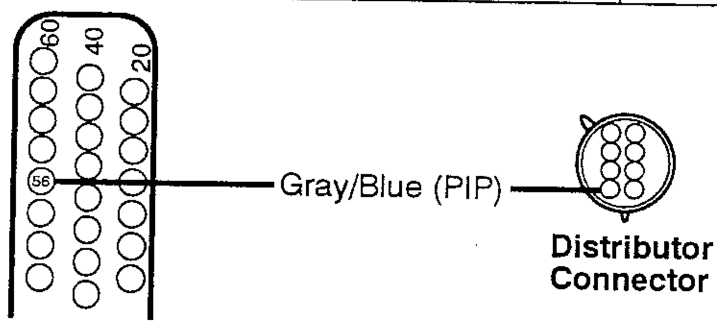
Test Step	Result	Action to Take
3E1-7 CHECK SPOUT SIGNAL		
• Key on, engine off. • Install Breakout Box, connect processor. • Timing switch to "DIST" position on Breakout Box. • Measure voltage between Test Pin 36 and battery negative post during cranking. • Is voltage between 3.0 and 6.0 volts?	Yes No	EEC system OK. Remove Breakout Box. Reconnect all components. Refer to **Section 3F** Place timing switch to "Computed" position and Go to **3E1-8.**
3E1-8 CHECK SPOUT AND PIP CIRCUITS FOR SHORT TO POWER		
• Key off. • Install Breakout Box. • Disconnect processor. • Disconnect distributor and TFI module. • Key on. • Measure voltage between Test Pin 36 (SPOUT) and battery negative post. • Measure voltage between Test Pin 56 (PIP) and battery negative post. • Is voltage greater than 10.5 volts?	Yes No	Service short circuit to the START circuit or to VPWR circuit in harness. Remove Breakout Box. Reconnect all components. Rerun Quick Test. Go to **3E1-9.**
3E1-9 CHECK SPOUT AND PIP CIRCUITS FOR SHORT TO GROUND		
• Key off. • Install Breakout Box. • Disconnect processor. • Disconnect distributor and TFI module. • Measure resistance between Test Pin 36 (SPOUT) and Test Pins 16, 20, 40, 46, 60 (short to GROUND) and 56 (short to PIP). • Measure resistance between Test Pin 56 (PIP) and Test Pins 16, 20, 40, 46, 60 (short to GROUND). • Is each resistance greater than 10,000 ohms?	Yes No	Go to **3E1-10.** Service short circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test. If engine does not start, Go to **3E1-10.**

TEST 3E1 : EEC-IV TFI NO-START

Test Step	Result	Action to Take
3E1-10 ISOLATE SHORT(S) IN PROCESSOR		
• Key off. • Install Breakout Box. • Reconnect processor to Breakout Box. • Disconnect distributor and TFI module. • Measure resistance between Test Pin 36 (SPOUT) and Test Pins 37 and 57 (short to POWER). Also Test Pins 40 and 60 (short to GROUND). • Measure resistance between Test Pin 56 (PIP) and Test Pins 37 and 57 (short to POWER). Also Test Pins 40 and 60 (short to GROUND). • Is each resistance greater than 500 ohms?	Yes No	Reconnect all components. Go to **3E1-11.** Replace processor. Remove Breakout Box. Reconnect all components. Rerun Quick Test.
3E1-11 CHECK PIP SIGNAL		
• Key off. • Install Breakout Box, connect processor. • Measure voltage between Test Pin 56 and Test Pins 40 and 60. • Crank engine, record reading. • Is voltage between 3.0 and 7.0 volts?	Yes No	Replace processor. Remove Breakout Box. Reconnect all components. Rerun Quick Test. Go to **3E1-12.**

TEST 3E1 : EEC-IV TFI NO-START

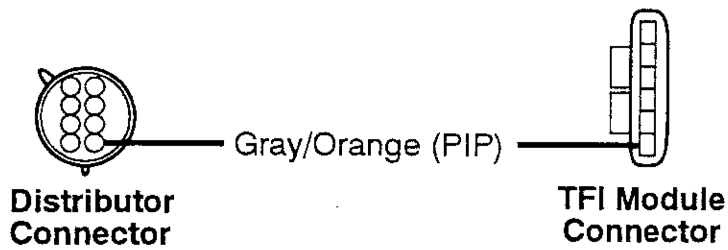
Test Step	Result	Action to Take
3E1-12 CHECK CONTINUITY OF PIP CIRCUIT		
• Key off. • Install Breakout Box. • Disconnect processor. • Disconnect distributor. • Measure resistance between Test Pin 56 and PIP circuit at the distributor connector. • Is resistance less than 5.0 ohms?	Yes No	Go to **3E1-14.** Service open circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.



Test Step	Result	Action to Take
3E1-13 SPOUT SIGNAL VERIFICATION		
• Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, connect processor. • Ensure timing switch is in "Computed" position on Breakout Box. • Measure voltage between Test Pin 56 and Test Pins 40 and 60. • Crank engine, record reading. • Is voltage between 3.0 and 6.0 volts?	Yes No	Go to **3E1-18.** Go to **3E1-8.**

TEST 3E1 : EEC-IV TFI NO-START

Test Step	Result	Action to Take
3E1-14 CHECK CONTINUITY OF PIP CIRCUIT		
• Key off. • Disconnect TFI module. • Disconnect distributor. • Measure resistance through PIP circuit from distributor connector TFI connector. • Is resistance less than 5.0 ohms?	Yes No	Go to **3E1-15.** Service open circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.



Test Step	Result	Action to Take
3E1-15 CHECK PIP CIRCUIT FOR SHORT TO POWER AND GROUND		
• Key off. • Install Breakout Box. • Disconnect processor. • Disconnect distributor. • Measure resistance between Test Pin 56 and Test Pins 16, 20, 40, 46, 60 (short to ground) and 26, 37, 57 (short to power). • Is each resistance greater than 10,000 ohms?	Yes No	Go to **3E1-16**. Service short circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.

TEST 3E1 : EEC-IV TFI NO-START

Test Step	Result	Action to Take
3E1-16 ISOLATE SHORTS IN PROCESSOR		
• Key off. • Install Breakout Box. • Reconnect processor to Breakout Box. • Measure resistance between Test Pin 56 and Test Pins 16, 20, 40, 46, 60 (short to ground) and 26, 37, 57 (short to power). • Is each resistance greater than 10,000 ohms?	Yes No	Go to **3E1-17**. Replace processor. Remove Breakout Box. Reconnect all components. Rerun Quick Test.
3E1-17 CHECK PIP SIGNAL		
• Key off. • Install Breakout Box, connect processor. • Reconnect distributor. • Measure voltage between Test Pin 56 and Test Pin 16. • Is voltage between 3.0 and 7.0 volts?	Yes No	Replace processor. Remove Breakout Box. Reconnect all components. Rerun Quick Test. Go to **3E1-5.**
3E1-18 CHECK FUEL PRESSURE		
WARNING: IF FUEL STARTS LEAKING, TURN KEY OFF IMMEDIATELY. NO SMOKING. • Connect fuel pressure gauge. • Note initial pressure reading. • Observe pressure gauge as you pressurize fuel system. (Turn key to RUN for on second, then turn key to OFF. Wait 10 seconds. Repeat five times.) • Does fuel pressure increase?	Yes No	Go to Pinpoint Test Step **3E16-1.** Go to Pinpoint Test Step **3E8-2.**

TEST 3E2 : CRANKING BATTERY

Note: You should enter this Pinpoint Test only when directed here from Pinpoint Tests **3E3, 3E9 OR 3E13**.

Remember: To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

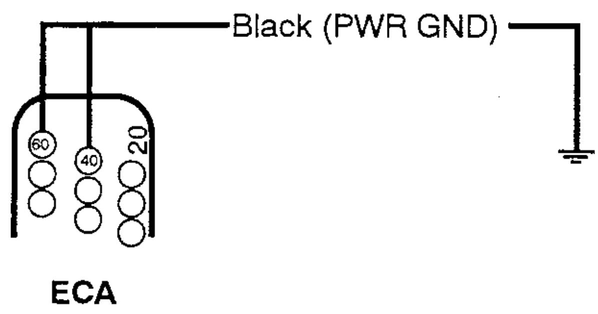
- Ignition Switch
- Battery Cables
- Alternator
- Voltage Regulator
- Ground Straps

This Pinpoint Test is intended to diagnose only the following:

- Processor
- Harness circuits:
  SIG RTN, PWR GND, VPWR, KAPWR, IGNITION SWITCH
- Battery Voltage
- Power Relay

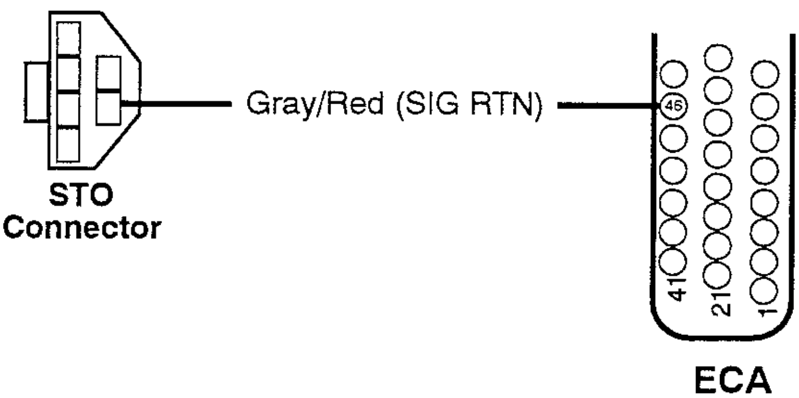
TEST 3E2 : CRANKING BATTERY

Test Step	Result	Action to Take
3E2-1 CHECK BATTERY VOLTAGE		
• Key on, engine off. • Measure voltage across battery terminals. • Is voltage greater than 10.5 volts?	Yes No	Go to **3E2-2.** Service discharged battery. Refer to cranking system diagnosis in appropriate service manual.
3E2-2 CHECK PWR GND CIRCUIT CONTINUITY		
• Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, connect processor. • Measure resistance between battery negative post and Test Pins 40 and 60. • Is each resistance less than 5.0 ohms?	Yes No	Go to **3E2-3**. Service open in PWR GND circuit. Remove Breakout Box. Reconnect processor. Rerun Quick Test.



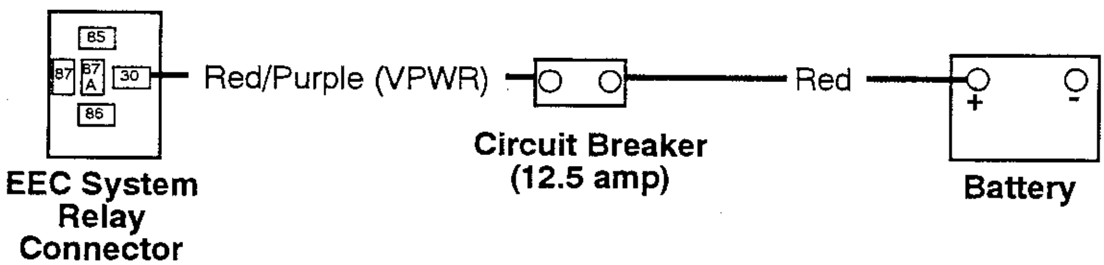
TEST 3E2 : CRANKING BATTERY

Test Step	Result	Action to Take
3E2-3 CHECK FOR OPEN BETWEEN SIG RTN AND PWR GND CIRCUITS AT PROCESSOR		
• Key off. • Install Breakout Box, connect processor. • Measure resistance between Test Pin 46 and Test Pin 40 and 60. • Is each resistance less than 5.0 ohms?	Yes No	Go to **3E2-4**. Replace processor. Remove Breakout Box. Rerun Quick Test.
3E2-4 CHECK SIG RTN CIRCUIT CONTINUITY		
• Key off. • Install Breakout Box, connect processor. • DVOM on 200 ohm scale. • Measure resistance between Test Pin 46 and Gray/Red SIG RTN lead of Self-Test connector. • Is resistance less than 5.0 ohms?	Yes No	Go to **3E2-5.** Service open in SIG RTN circuit. Remove Breakout Box. Reconnect processor. Rerun Quick Test.

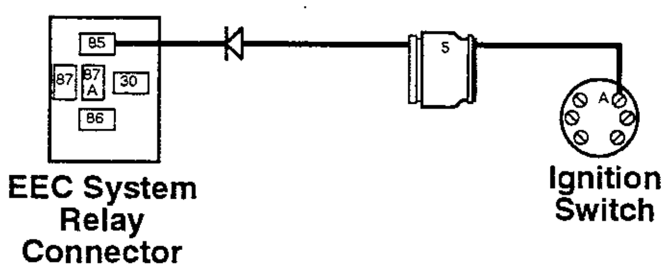


TEST 3E2 : CRANKING BATTERY

Test Step	Result	Action to Take
3E2-5 CHECK KAPWR CIRCUIT VOLTAGE AT EEC POWER RELAY		
• Key off. • Disconnect EEC power relay. • Key on, engine off. • Measure voltage between VPWR wire at the EEC power relay and battery negative post. • Is voltage greater than 10.5 volts?	Yes No	Go to **3E2-6.** Service open in VPWR circuit between EEC power relay and battery positive post. Remove Breakout Box. Reconnect all components. Rerun Quick Test.

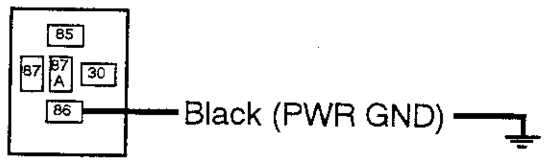


Test Step	Result	Action to Take
3E2-6 CHECK IGNITION CIRCUIT VOLTAGE AT EEC POWER RELAY		
• Key on, engine off. • Disconnect EEC power relay. • Measure voltage between the battery negative post and IGNITION switch circuit at the EEC power relay connector. • Is voltage greater than 10.5 volts?	Yes No	Go to **3E2-7.** Service open in ignition switch circuits. Remove Breakout Box. Reconnect all components. Rerun Quick Test.



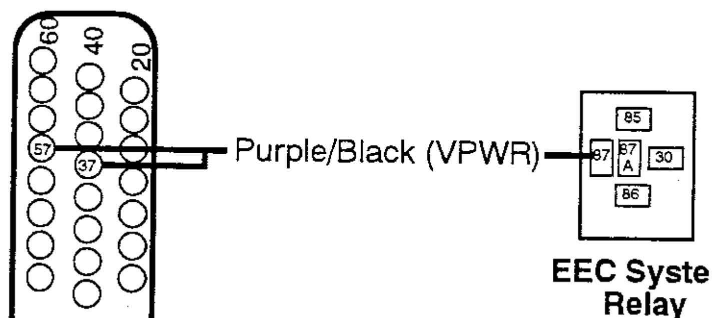
TEST 3E2 : CRANKING BATTERY

Test Step		Result	Action to Take
3E2-7	CHECK PWR GND CIRCUIT CONTINUITY		
• Key off. • Measure resistance between PWR GND circuit at EEC power relay engine harness connector and battery negative post. • Is resistance less than 10 ohms?		Yes No	Go to **3E2-8.** Service open circuit. Remove Breakout Box. Reconnect processor. Rerun Quick Test.



EEC System Relay Connector

Test Step		Result	Action to Take
3E2-8	CHECK VPWR CIRCUIT CONTINUITY		
• Key off. • Install Breakout Box, connect processor. • Measure resistance between Test Pins 37 and 57 and the VPWR terminal of the EEC power relay connector. • Is resistance less than 5.0 ohms?		Yes No	Go to **3E2-9.** Service open in VPWR circuit between the EEC power relay connector and processor. Remove Breakout Box. Reconnect all components. Rerun Quick Test.



ECA

EEC System Relay Connector

TEST 3E2 : CRANKING BATTERY

Test Step		Result	Action to Take
3E2-9	CHECK VPWR CIRCUIT VOLTAGE		
• Key off. • Install Breakout Box, connect processor. • Install EEC power relay. • Key on, engine off. • Measure voltage between Test Pins 37 and 57, and Test Pins 40, 60 and 46. • Is voltage greater than 10.5 volts?		Yes	Service open or short to ground in VPWR circuit between processor and EEC power relay. Remove Breakout Box. Reconnect processor. Rerun Quick Test.
		No	Replace EEC power relay. Remove Breakout Box. Reconnect processor. Rerun Quick Test.

TEST 3E3 : REFERENCE VOLTAGE

Note: You should enter this Pinpoint Test only when a check for VREF has failed in the sensor Pinpoint Tests or Pinpoint Tests **3E4, 3E7, 3E14.**

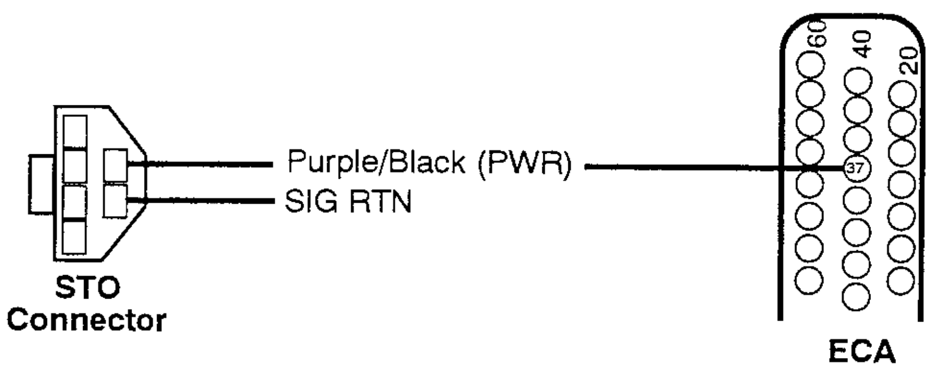
Remember: This Pinpoint Test is intended to diagnose only the following:

- Sensor harness circuits: SIG RTN, VREF
- 3-wire sensors: TP, MAP
- Processor assembly

Description: Reference Voltage (VREF) is a positive voltage (about 5.0 volts) that is output by the processor. This consistent voltage is used by all 3-wire sensors. Signal Return (SIG RTN) is a dedicated ground used by most EEC-IV sensors and some other inputs.

TEST 3E3 : REFERENCE VOLTAGE

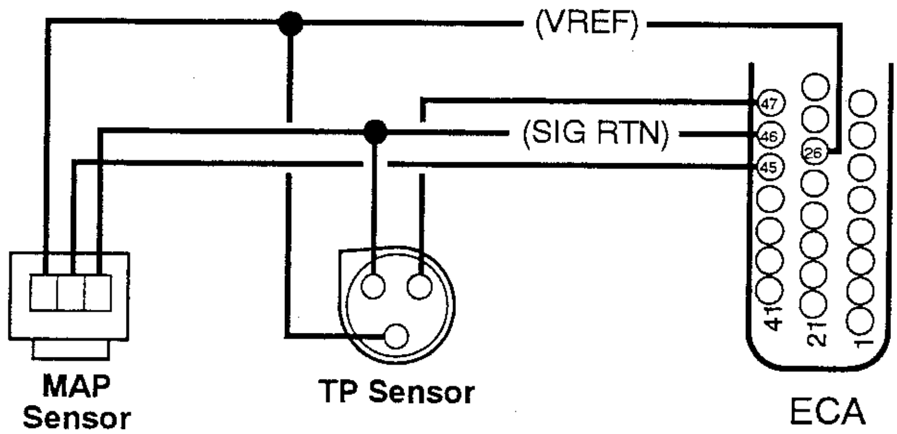
Test Step		Result	Action to Take
3E3-1	CHECK ENGINE BATTERY POWER CIRCUIT		
• Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, connect processor. • Key on, engine off. • Measure voltage between Test Pin 37 and SIG RTN (pin 46) circuit in the Self-Test connector. Note voltage. • Measure voltage across battery terminals. Note voltage. • Are both voltages greater than 10.5 volts, are both voltages within 1.0 volt of each other?		Yes No	Go to **3E3-2.** Key off, reconnect sensor. Go to Pinpoint Test Step **3E2-1.**



Test Step		Result	Action to Take
3E3-2	CHECK VREF VOLTAGE		
• Key on, engine off. • Install Breakout Box, connect processor. • Measure voltage between Test Pin 26 and Test Pin 46. • What is the voltage?		More than 6.0 volts Less than 4.0 volts Between 4 and 6 volts	Go to **3E3-4.** Go to **3E3-5.** Go to **3E3-3.**

TEST 3E3 : REFERENCE VOLTAGE

Test Step		Result	Action to Take
3E3-3	CHECK VREF AND SIG RTN CIRCUITS FOR CONTINUITY		
• Key off. • Disconnect sensor that sent you here. • Install Breakout Box. • Disconnect processor. • Measure resistance between Test Pin 26 and VREF circuit at engine harness connector of the sensor that sent you here. • Measure resistance between Test Pin 46 and SIG RTN circuit at engine harness connector of the sensor that sent you here. • Is each resistance less than 5.0 ohms?		Yes No	Reference voltage OK. Remove Breakout Box. Reconnect sensor. Rerun Quick Test. Service open in VREF or SIG RTN circuits. Remove Breakout Box. Reconnect all components. Rerun Quick Test.



TEST 3E3 : REFERENCE VOLTAGE

Test Step	Result	Action to Take
3E3-4 CHECK FOR EXCESS VOLTAGE ON VREF CIRCUIT		
• Key off. • Install Breakout Box. • Disconnect processor. • Disconnect Star Tester (if applicable). NOTE: For proper results of this test, the Tester must be disconnected. Due to the circuitry of the Tester and the engine, voltage can be fed to the VREF circuit giving the false indication of a short to power. • Key on, engine off. • Measure voltage between Test Pin 26 and the battery ground. • Is voltage less than 0.5 volts?	Yes No	Replace processor. Remove Breakout Box. Reconnect sensor. Rerun Quick Test. Service short to battery power in engine harness. Remove Breakout Box. Reconnect processor and sensor. Rerun Quick Test. If condition persists, replace processor.
3E3-5 CHECK FOR SHORTED THROTTLE POSITION SENSOR		
• Key off. • Install Breakout Box, connect processor. • Disconnect Throttle Position (TP) sensor from engine harness. • Key on, engine off. • Measure voltage between Test Pin 26 and Test Pin 46. • Is voltage less than 4.0 volts?	Yes No	Key off, reconnect TP sensor: Go to **3E3-6.** Replace TP sensor. Remove Breakout Box. Reconnect all components. Rerun Quick Test.
3E3-6 CHECK FOR SHORTED MAP SENSOR		
• Key off. • Install Breakout Box, connect processor. • Disconnect MAP sensor. • Key on, engine off. • Measure voltage between Test Pin 26 and Test Pin 46. • Is voltage less than 4.0 volts?	Yes No	Key off, reconnect MAP sensor. Go to **3E3-7.** Replace MAP sensor. Remove Breakout Box. Reconnect processor and sensor(s). Rerun Quick Test.

TEST 3E3 : REFERENCE VOLTAGE

Test Step		Result	Action to Take
3E3-7	CHECK VREF CIRCUIT FOR SHORT TO GROUND		
• Key off. • Install Breakout Box. • Disconnect processor. • Disconnect TP sensor. • Disconnect MAP sensor. • Measure resistance between Test Pin 26 and Test Pins 20, 40, 46 and 60. • Is any resistance less than 5.0 ohms?		Yes	Service short to ground. Remove Breakout Box. Reconnect all components. Connect all sensors. Rerun Quick Test. If condition persists, replace processor.
		No	Replace processor. Remove Breakout Box. Reconnect all components. Rerun Quick Test.

TEST 3E4 : ACT AND ECT SENSORS

Note: You should enter this Pinpoint Test only when you have been directed here from Quick Test.

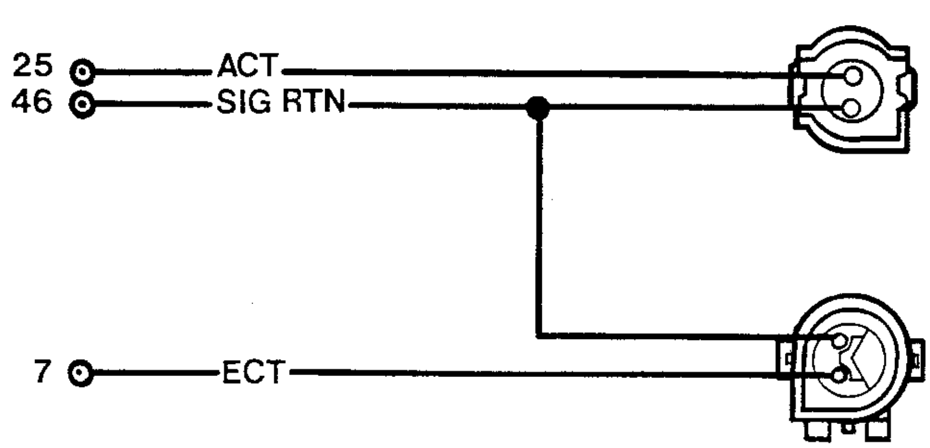
Remember: To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Cooling system
- Water pump drive belt
- Engine operating temperature
- Engine oil level
- Thermostat
- Flame Arrestor
- Ambient temperature

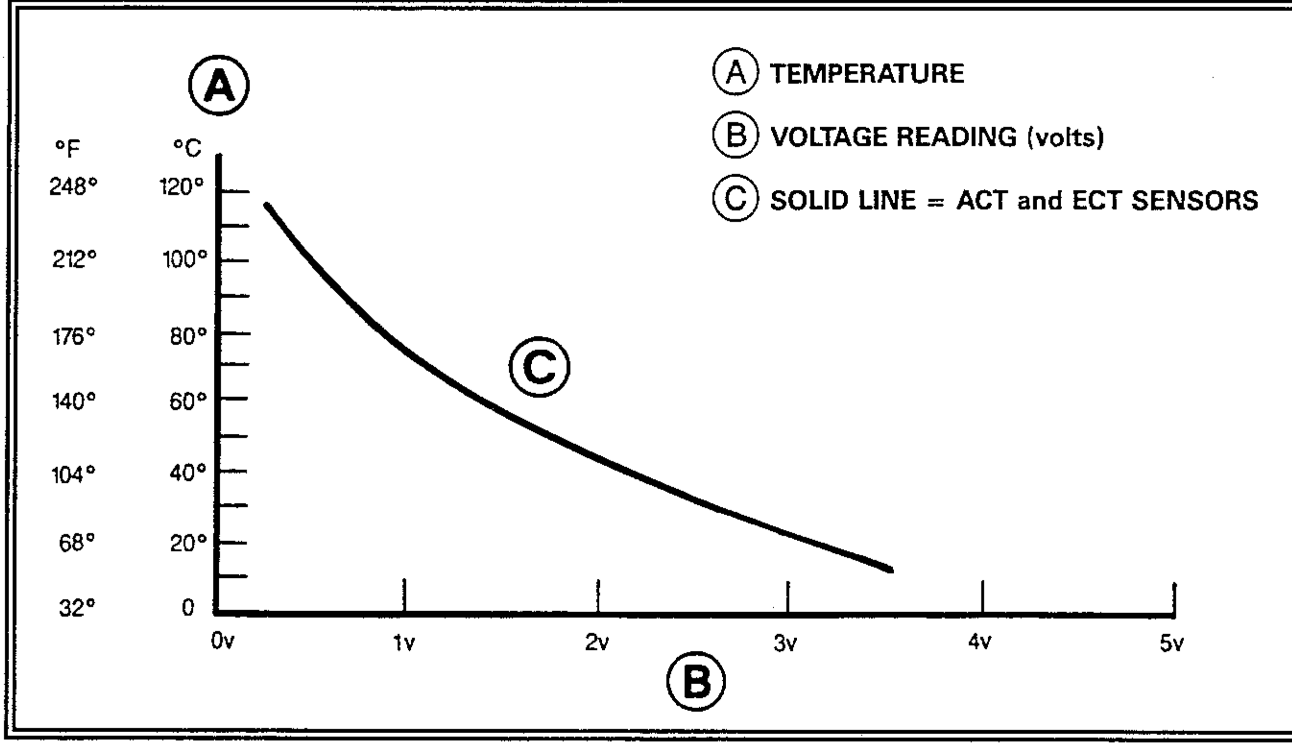
This Pinpoint Test is intended to diagnose only the following:

- ACT sensor
- ECT sensor
- Harness circuits: ACT, ECT, and SIG RTN
- Processor assembly

Description: The Air Charge Temperature (ACT) and Engine Coolant Temperature (ECT) sensor change resistance in response to temperature. ACT and ECT sensor resistance decreases as the surrounding temperature increases providing a signal to the processor that indicates the temperature of either the incoming air charge or engine coolant temperature.



TEST 3E4 : ACT AND ECT SENSORS



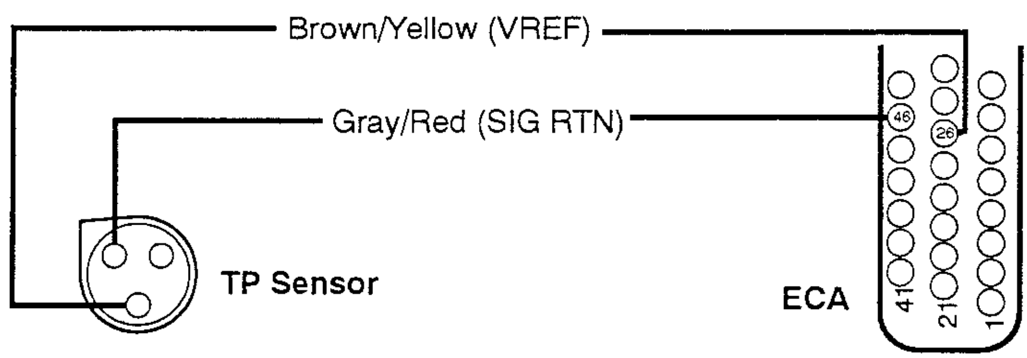
NOTES:

- Engine coolant temperature must be greater than 10°C (50°F) to pass KOEO test and greater than 71°C (160°F) to pass the KOER test. To accomplish this, the engine should be at normal operating temperature.
- Ambient temperature should be above 10°C (50°F) to receive acceptable input from the Air Charge Temperature sensor.
- Voltage values were calculated for VREF=5.0 volts. These values may vary 15 percent due to sensor and VREF variations.

Temperature		Engine Cooling/Air charge Temperature Sensor Values	
°F	°C	Voltage (volts)	Resistance (K ohms)
248	120	.27	1.18
230	110	.35	1.55
212	100	.46	2.07
194	90	.60	2.80
176	80	.78	3.84
158	70	1.02	5.37
140	60	1.33	7.70
122	50	1.70	10.97
104	40	2.13	16.15
86	30	2.60	24.27
68	20	3.07	27.30
50	10	3.51	58.75

TEST 3E4 : ACT AND ECT SENSORS

Test Step		Result	Action to Take
3E4-1	SERVICE CODE 21 OR 24: CHECK OPERATION, INSTALLATION OF TEMPERATURE SENSOR		
Service Code 21 (ECT) or 24 (ACT) indicates that the corresponding sensor is out of Self-Test range. Refer to the chart on the preceding page for the correct voltage range. Possible causes: 1. Ambient temperature below 10°C (50°F) (ACT) 2. Faulty harness connector 3. Faulty sensor • Run engine for two minutes at 2000 RPM. **For NO STARTS**: Go to **3E4-3.** **For ENGINE STALLS**: Go to Pinpoint Test Step **3E16-1**. • Check that the thermostat housing-to-water pump recirculating hose is hot and pressurized. • Rerun Quick Test. • Are codes 21 or 24 present?		Yes No	Go to **3E4-2.** Service other codes as necessary.
3E4-2	CHECK VREF CIRCUIT VOLTAGE AT THROTTLE POSITION SENSOR		
• Key off. • Disconnect TP sensor. • Key on, engine off. • Measure voltage between VREF circuit and SIG RTN circuit at the TP sensor engine harness connector. • Is voltage between 4.0 volts and 6.0 volts?		Yes No	Reconnect TP sensor. Go to **3E4-3.** Go to Pinpoint Test Step **3E3-1**.



TEST 3E4 : ACT AND ECT SENSORS

Test Step		Result	Action to Take
3E4-3	CHECK RESISTANCE OF TEMPERATURE SENSOR WITH ENGINE OFF		
• Key off. • Disconnect suspect temperature sensor. • Measure resistance between sensor signal circuit and SIG RTN circuit at the temperature sensor. Refer to the chart at the beginning of this Pinpoint Test for resistance specifications. • Is resistance within specifications?		Yes No	For ECT sensor with a NO START: Do not service code 21 at this time, Go to Pinpoint Test Step **3E1-1.** Replace suspect sensor. Reconnect engine harness. Rerun Quick Test.
3E4-4	CHECK RESISTANCE OF TEMPERATURE SENSOR WITH ENGINE RUNNING		
NOTE: Engine may have cooled down. Always warm engine before taking ECT sensor resistance measurements. Check for open thermostat. • Key off. • Disconnect suspect temperature sensor. • Run engine for two minutes at 2000 RPM. • Measure resistance between sensor signal circuit and SIG RTN circuit at the temperature sensor. Refer to the chart at the beginning of this Pinpoint Test for resistance specifications. • Is resistance within specifications?		Yes No	Replace processor. Reconnect engine harness. Rerun Quick Test. Replace suspect sensor. Reconnect engine harness. Rerun Quick Test.

TEST 3E4 : ACT AND ECT SENSORS

Test Step		Result	Action to Take
3E4-5	SERVICE CODE 51 OR 54: INDUCE OPPOSITE CODE 61 OR 64		
Service Code 51 (ECT) or 54 (ACT) indicates that the corresponding sensor's signal is greater than the Self-Test maximum. The maximum for ECT and ACT sensors is 4.6 volts. Possible causes: 1. Open in harness (ACT) or (ECT) 2. Faulty harness connection 3. Faulty sensor 4. Faulty processor • Key off. • Disconnect suspect temperature sensor. • Connect a jumper wire between the sensor signal circuit and SIG RTN circuit at the temperature sensor engine harness connector. • Run Key On Engine Off Self-Test. • Is code 61 or 64 present?		Yes No	Replace suspect sensor. Remove jumper wire. Reconnect engine harness. Rerun Quick Test. Remove jumper wire. Go to **3E4-6.**
3E4-6	CHECK CONTINUITY OF SENSOR AND SIG RTN CIRCUIT		
• Key off. • Disconnect suspect temperature sensor. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Measure resistance between sensor signal circuit at the temperature sensor engine harness connector and Test Pin 7 (ECT) or 25 (ACT). • Measure resistance between SIG RTN circuit at the temperature sensor engine harness connector and Test Pin 46. • Is each resistance less than 5.0 ohms?		Yes No	Replace processor. Remove Breakout Box. Reconnect all components. Rerun Quick Test. Service open circuits. Remove Breakout Box. Reconnect all components. Rerun Quick Test.

TEST 3E4 : ACT AND ECT SENSORS

Test Step		Result	Action to Take
3E4-7	SERVICE CODE 61 OR 64: INDUCE OPPOSITE CODE 51 OR 54		
Service Code 61 (ECT) or 64 (ACT) indicates that the corresponding sensor's signal is less than the Self-Test minimum. The ACT and ECT sensor minimum is 0.2 volts. Possible causes: 1. Grounded circuit in harness 2. Faulty sensor 3. Faulty processor 4. Faulty harness connection • Key off. • Disconnect engine harness from suspect sensor. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Run Key On Engine Off Self-Test. • Is code 51 or 54 present?		Yes No	Replace sensor. Reconnect engine harness. Rerun Quick Test. Go to **3E4-8.**
3E4-8	CHECK VREF CIRCUIT VOLTAGE AT THROTTLE POSITION SENSOR		
• Refer to **3E4-2** schematic. • Key off. • Disconnect suspect temperature sensor. • Disconnect TP sensor. • Key on, engine off. • Measure voltage between VREF circuit and SIG RTN circuit at the TP sensor engine harness connector. • Is voltage between 4.0 volts and 6.0 volts?		Yes No	Reconnect TP sensor. Go to **3E4-9.** Go to Pinpoint Test Step **3E3-1.**

TEST 3E4 : ACT AND ECT SENSORS

Test Step	Result	Action to Take
3E4-9 CHECK TEMPERATURE SENSOR SIGNAL CIRCUIT FOR SHORT TO GROUND		
• Key off. • Disconnect suspect temperature sensor. • Disconnect processor 60 Pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Measure resistance between Test Pin 7 (ECT) or 25 (ACT) and Test Pins 40, 46 and 60. • Is each resistance greater than 10,000 ohms?	Yes No	Replace processor. Remove Breakout Box. Reconnect all components. Rerun Quick Test. Service short circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.
3E4-10 CONTINUOUS MEMORY CODE 51, 54, 61 OR 68: CHECK SENSOR		
Continuous Memory codes 51 and 54 indicate that the sensor signal was greater than the Self-Test maximum of 4.6 volts. The code was generated under normal operating conditions. Continuous Memory codes 61 and 64 indicate that the sensor signal was less than the Self-Test minimum of 0.2 volts. The code was generated under normal operating conditions. • ACT Sensor: 54 and 64 Continuous Memory Codes • ECT Sensor: 51 and 61 Continuous Memory Codes Possible cause: 1. Faulty sensor 2. Open circuit in harness 3. Grounded circuit in harness 4. Faulty processor • Perform Key On Engine Off "Wiggle" Test. Refer to Quick Test Section. • Observe DVOM or Star Tester for indication of a fault while performing the following: -Tap on the sensor to simulate rough water -Wiggle the sensor connector • Is fault indicated?	Yes No	Disconnect and inspect connectors. If OK, replace the sensor. Clear Continuous Memory (refer to Quick Test section). Rerun Quick Test. Go to **3E4-11.**

TEST 3E4 : ACT AND ECT SENSORS

Test Step		Result	Action to Take
3E4-11	CHECK EEC-IV ENGINE HARNESS		
• Still in Key On Engine Off "Wiggle" Test mode. • Observe DVOM or Star Tester for fault indication while performing the following: Grasp the engine harness close to the sensor connector. Wiggle, shake or bend a small section of the EEC-IV system engine harness while working your way to the 60 Pin connector. • Is a fault indicated?		Yes No	Isolate fault and service as necessary. Clear Continuous Memory (Refer to Quick Test Section 3D). Rerun Quick Test. Go to **3E4-12.**
3E4-12	CHECK PROCESSOR AND ENGINE HARNESS CONNECTORS		
• Key off. • Disconnect processor 60-Pin connector. Disconnect sensor connector. Inspect for damage, loose or pushed out pins, loose or poorly crimped wires. • Are connectors and terminals OK?		Yes No	Unable to duplicate and/or identify fault at this time. For further diagnosis, contact your marine manufacturer. Service as necessary. Clear Continuous Memory (refer to Quick Test -step 9) Rerun Quick Test.

TEST 3E5 : MANIFOLD ABSOLUTE PRESSURE (MAP)

Note: You should enter this Pinpoint Test only when you have been directed here from Quick Test or Test **3E13.** Map Sensor Tester, *Rotunda* No. 105-00001, is required for some checks.

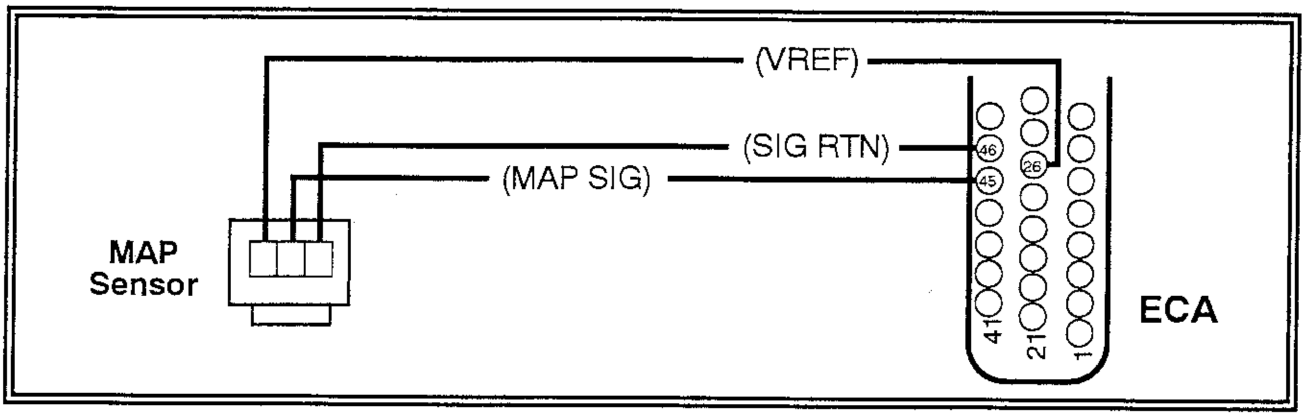
Remember: To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Unusually high/low barometric pressure
- Kinked or obstructed vacuum lines (MAP)
- Basic engine (valves, vacuum leaks, timing, etc.)

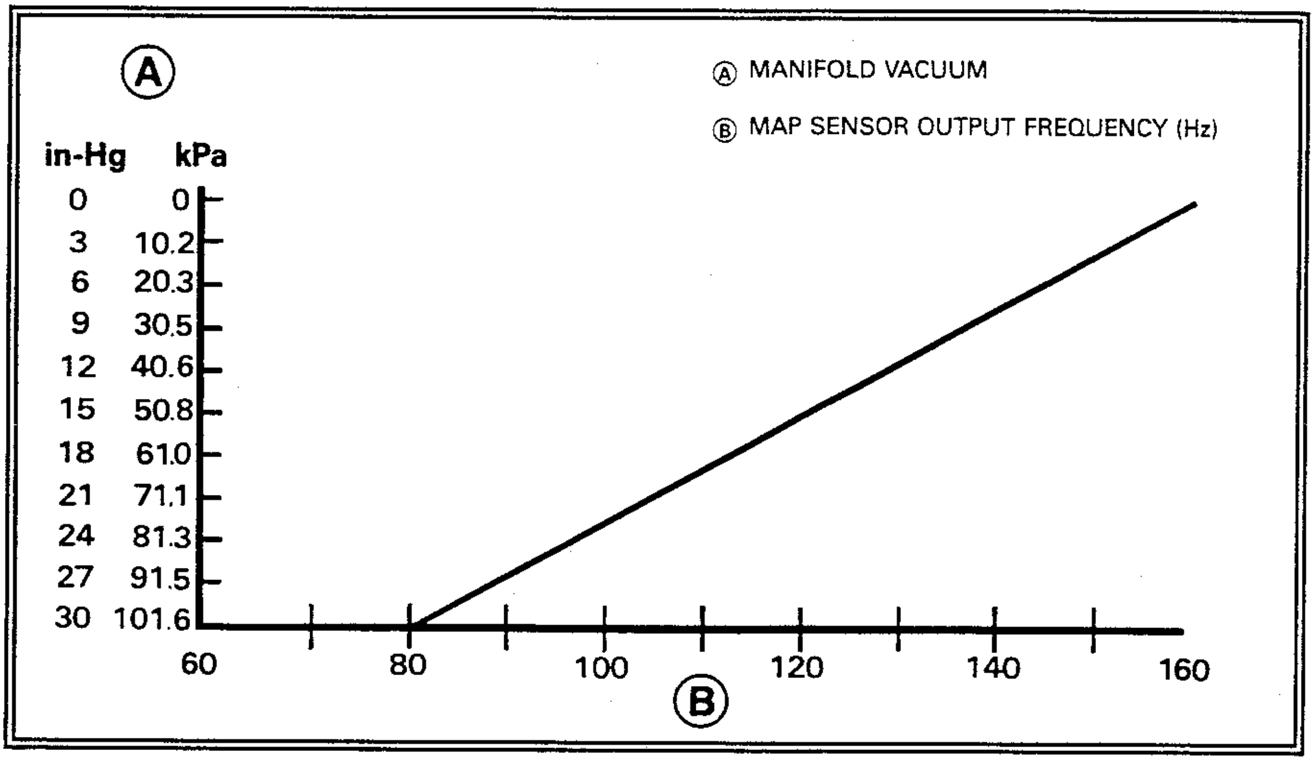
This Pinpoint Test is intended to diagnose only the following:

- MAP sensor
- Harness circuits: VREF, MAP, SIG, and SIG RTN
- Processor assembly
- MAP vacuum line

Description: The Manifold Absolute Pressure (MAP) sensor operates as a piezoelectric (pressure-sensing) disc. However, rather than generating a voltage, its output is a frequency change. The sensor changes frequency relative to intake manifold vacuum. The sensor frequency increases as vacuum increases. The MAP sensor allows the EEC processor to determine what the engine load is. Its signal affects air/fuel ratio, ignition timing and altitude compensation.



TEST 3E5 : MANIFOLD ABSOLUTE PRESSURE



NOTES: MAP sensor output frequency versus manifold data is based on 30.0 in-Hg barometric pressure.

MAP Sensor Data

Manifold Vacuum		Frequency
in-Hg	kPa	Hz
0	0	159
3	10.2	150
6	20.3	141
9	30.5	133
12	40.6	125
15	50.8	117
18	61.0	109
21	71.1	102
24	81.3	95
27	91.5	88
30	101.6	80

TEST 3E5 : MANIFOLD ABSOLUTE PRESSURE

Test Step	Result	Action to Take
3E5-1 SERVICE CODE 22: CHECK FOR POWER TO MAP SENSOR		
Service Code 22 indicates that the Manifold Absolute Pressure (MAP) sensor is out of Self-Test range. Correct MAP tester range of measurement is typically from 1.4 to 1.6 volts. Possible causes: 1. MAP SIG circuit open between sensor engine harness connector and processor. 2. MAP SIG circuit shorted to VREF, SIG RTN, or GND 3. Damaged MAP sensor 4. Vacuum trapped at MAP sensor 5. High atmospheric pressure 6. Damaged processor 7. VREF circuit open at MAP sensor 8. SIG RTN circuit open at MAP sensor • Key off. • Disconnect the MAP sensor from the engine harness. • Connect the MAP tester between the engine harness connector and the MAP sensor. • Insert MAP tester banana plugs into DVOM. NOTE: Green light on tester indicates VREF is OK (4-6 volts). Red light or no light indicates VREF is either too low or too high. • Is green light on?	Yes No	Go to **3E5-3**. Go to **3E5-2**.
3E5-2 CHECK FOR POWER AT SENSOR ENGINE HARNESS CONNECTOR		
NOTE: Green light reaffirms that VREF is OK (4-6 volts). Red light or no light indicates VREF is either too low or too high. • Key on. • MAP tester connected. • DVOM connected to MAP tester. • Disconnect MAP sensor. • Is green light on?	Yes No	Replace MAP sensor. Rerun Quick Test. Remove MAP tester. Reconnect MAP sensor. Go to Pinpoint Test Step **3E3-1**.

TEST 3E5 : MANIFOLD ABSOLUTE PRESSURE

Test Step	Result	Action to Take
3E5-3 CHECK MAP SENSOR OUTPUT		
NOTE: Measure several known good MAP sensors on available engines. The measured voltage will be typical for your location on the day of testing. • Key on. • Connect MAP tester. • Connect the DVOM to the MAP tester. • Measure MAP sensor voltage on customer engine. • Is DVOM voltage in range for your altitude?	Yes	Remove MAP tester. Go to **3E5-4.**
	No	Remove MAP tester. Go to **3E5-5.**

Approximate Altitude (Ft.)	Voltage Output (±.04 Volts)
0	1.59
1000	1.56
2000	1.53
3000	1.50
4000	1.47
5000	1.44
6000	1.41
7000	1.39

Test Step	Result	Action to Take
3E5-4 CHECK MAP SIG CIRCUIT CONTINUITY		
• Key off. • Disconnect MAP tester. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Measure resistance between MAP SIG circuit at the MAP sensor engine harness connector and Test Pin 45. • Is resistance less than 5.0 ohms?	Yes	Replace processor. Remove Breakout Box. Reconnect MAP sensor. Rerun Quick Test.
	No	Service open circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.

TEST 3E5 : MANIFOLD ABSOLUTE PRESSURE

Test Step	Result	Action to Take
3E5-5 CHECK MAP SIG CIRCUIT FOR SHORTS TO VREF, SIG RTN AND GROUND		
• Key off. • Disconnect MAP sensor. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Measure resistance between Test Pin 45 and Test Pins 26, 46, 40 and 60. • Is each resistance greater than 10,000 ohms?	Yes No	Replace MAP sensor. Remove Breakout Box. Reconnect processor. Rerun Quick Test. Service short circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.
3E5-6 ENGINE RUNNING SERVICE CODE 22		
Service Code 22 (KOER) indicates the MAP signal is out of range for Engine Running Self-Test. Possible causes: 1. Damaged MAP sensor 2. Damaged vacuum hoses • Are there any unusual service codes?	Yes No	Go to Pinpoint Test Step **3E14-1**. Go to **3E5-7**.
3E5-7 CHECK MAP SENSOR INTEGRITY		
• Key off. • Disconnect vacuum supply hose from MAP sensor. • Install vacuum pump to MAP sensor. • Apply 18 in-Hg (61 kPa) vacuum to MAP sensor. • Does MAP sensor hold vacuum?	Yes No	Release vacuum. Go to **3E5-8**. Replace MAP sensor. Connect vacuum supply hose to MAP sensor. Rerun Quick Test.

TEST 3E5 : MANIFOLD ABSOLUTE PRESSURE

Test Step	Result	Action to Take
3E5-8 ATTEMPT TO ELIMINATE ENGINE RUNNING SERVICE CODE 22		
• Key off. • Plug MAP sensor vacuum supply hose. • Start engine and maintain 1500±100 engine RPM. • Slowly apply 15 in-Hg (51 kPa) vacuum to MAP sensor. • While maintaining RPM, perform Engine Running Self-Test. • Is Engine Running Service Code 22 still present? NOTE: Disregard any other Service Codes at this time.	Yes No	Go to **3E5-12.** Inspect vacuum supply hose to MAP sensor. Service as necessary. If OK, service other Engine Running Service Codes. If none, Go to Diagnostic Routines, Section 3C, to address any other concerns.
3E5-9 CHECK FOR CONTINUOUS MEMORY CODE 22: EXERCISE MAP SENSOR		
Continuous Memory Service Code 22 indicates the Manifold Absolute Pressure (MAP) sensor was out of Self-Test range. The code was set during normal operating conditions. Correct range of measurement is typically from 1.4 to 1.6 volts. Possible causes: 1. Damaged MAP sensor. 2. Damaged EEC-IV engine harness. 3. Damaged MAP sensor engine harness connectors and/or terminals. 4. Unusually high/low barometric pressure. • Using Key On, Engine Off "Wiggle" Test Mode, observe DVOM or Star Tester for indication of a fault while performing the following: 1. Connect a vacuum pump to the MAP sensor. 2. Slowly apply 25 in-Hg (84 kPa) vacuum to the MAP sensor. 3. Slowly bleed vacuum off the MAP sensor. 4. Lightly tap on MAP sensor (simulate rough water). 5. Wiggle MAP connector. • Is fault indicated?	Yes No	Disconnect and inspect connectors. If connector and terminals are good, replace MAP sensor. Rerun Quick Test. Go to **3E5-10.**

TEST 3E5 : MANIFOLD ABSOLUTE PRESSURE

Test Step		Result	Action to Take
3E5-10	CHECK EEC-IV ENGINE HARNESS		
• Remain in Key On, "Wiggle" Test Mode. • Observe DVOM or Star Tester for a fault indication while performing the following: Grasp the engine harness closest to the sensor connector. Wiggle, shake or bend a small section of the EEC-IV system engine harness while working your way to the processor. • Is a fault indicated?		Yes No	Isolate fault and service as necessary. Clear continuous Memory Code (refer to Quick Test Section 3D). Rerun Quick Test. Go to **3E5-11.**
3E5-11	CHECK PROCESSOR AND ENGINE HARNESS CONNECTORS		
• Key off. • Disconnect processor 60 pin connector. • Inspect connectors and connector terminals for obvious damage or faults. • Are connectors and terminals OK?		Yes No	Go to **3E5-12.** Service as necessary. Rerun Quick Test.
3E5-12	PERFORM KEY ON MAP SENSOR CHECK		
• Key off. • Disconnect 60 pin connector at processor. • Connect Breakout Box to processor. Attach 60 pin connector to Breakout Box. • Connect a vacuum gauge to intake manifold. • Attach DVOM red lead to Pin 45, and black lead to Pin 46. Set DVOM to Hertz (Hz) scale. • Refer to MAP sensor data chart at beginning of test. Turn key switch to **ON** position. • Does meter show approximately 159 Hertz? NOTE: Reading may vary slightly depending on barometric pressure.		Yes No	Go to **3E5-13.** Check all electrical connections for proper contact, corrosion, etc. Service as necessary. Rerun Quick Test.

TEST 3E5 : MANIFOLD ABSOLUTE PRESSURE

Test Step		Result	Action to Take
3E5-13	PERFORM ENGINE RUNNING MAP SENSOR CHECK		
• Key off. • Disconnect 60 pin connector at processor. • Connect Breakout Box to processor. Attach 60 pin connector to Breakout Box. • Connect a vacuum gauge to intake manifold. • Attach DVOM red lead to Pin 45, and black lead to Pin 46. Set DVOM to Hertz (Hz) scale. • Refer to MAP sensor data chart at the beginning of this test. NOTE: It will be necessary to "load" engine to create changes in vacuum/Hertz signal readings. If boat is operated on water, have an experienced driver handle boat while you observe meter readings • Start and run engine in gear. Vary RPM throughout range and check Hertz signal readings. • Does meter show Hertz signal/vacuum readings that approximate those on chart? NOTE: Readings may vary slightly depending on barometric pressure.		Yes No	Unable to duplicate and/or identify fault at this time. For further diagnosis contact your marine manufacturer. Replace MAP sensor. Rerun Quick Test.

TEST 3E6 : KNOCK SENSOR

NOTE: You should enter this Pinpoint Test only when you have been directed here.

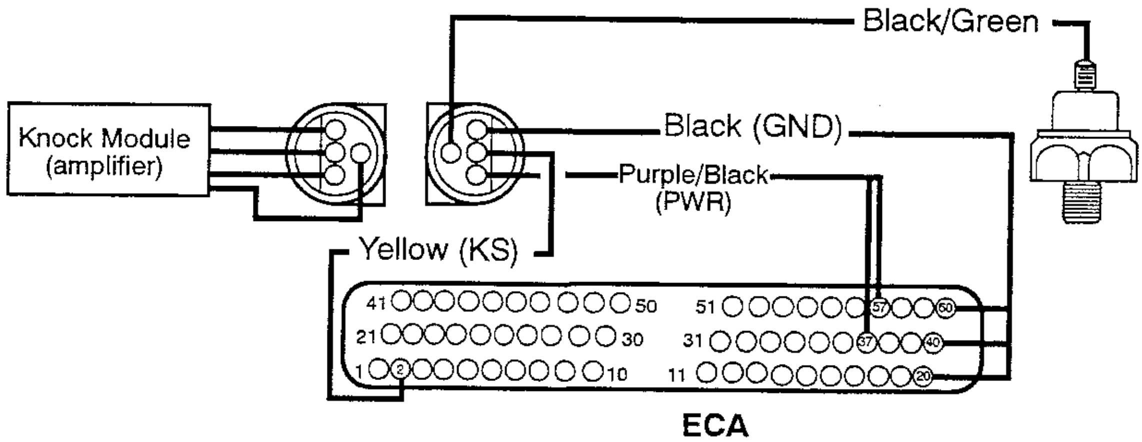
Remember: To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Fuel quality
- Basic engine
- Spark timing

This Pinpoint Test is intended to diagnose only the following:

- Knock sensor
- Harness circuits: KS and SIG RTN
- Processor assembly

Description: The Knock Sensor is used to detect detonation (spark knock). As a result, a voltage sent to the processor will lead to retarded spark timing.



TEST 3E6 : KNOCK SENSOR

Test Step	Result	Action to Take
3E6-1 CIRCUIT OPERATION VERIFICATION: GENERATE KNOCK MANUALLY		
This test will check operation of the knock sensor and its circuit, and locate failures. Possible causes are: 1. Failed amplifier 2. Damaged knock sensor 3. Open or shorted engine harness 4. Damaged processor NOTE: Since knock conditions are sensitive to fuel, altitude and weather in addition to ignition timing, perform Step **3E6-1** before servicing any components. • Warm engine up to operating temperature. Install a variable advance timing light, and bring engine up to 2800 RPM. • Tap the engine block close to the knock sensor with a small steel hammer. • While tapping, does spark advance begin to retard? If tapping continues, does spark continue to retard to a maximum of 10° below starting point?	Yes No	Knock sensor system OK. Run Engine Running Self Test and service any codes. Go to **3E6-2.**
3E6-2 CHECK KS CIRCUIT VOLTAGE		
• Key off. • Disconnect the 60 pin connector. Connect a Breakout Box to the ECA, then attach the 60 pin connector to the Breakout Box. • Key on, engine off. • Measure voltage between Test Pin 2 and Test Pins 20, 40 and 60.	.28 - .32 volts Less than .27 volts More than 4 volts	Go to **3E6-6.** Go to **3E6-4.** Go to **3E6-5.**

TEST 3E6 : KNOCK SENSOR

Test Step	Result	Action to Take
3E6-3 CHECK CONTINUITY OF KS CIRCUIT		
• Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Disconnect knock sensor. • Measure resistance between knock sensor engine harness connector and Test Pin 2. • Is resistance less than 5.0 ohms?	Yes No	Go to **3E6-4.** Service open circuit. Remove Breakout Box. Reconnect all components. Rerun **3E6-1.**
3E6-4 CHECK KS CIRCUIT FOR SHORT TO GROUND		
• Key off. • Install Breakout box, disconnect processor. • Disconnect Knock sensor. • Measure resistance between Test Pin 2 and Test Pins 20, 40 and 60. • Is each resistance greater than 10,000 ohms?	Yes No	Remove Breakout Box. Reconnect processor. Go to **3E6-6.** Service short circuit. Remove Breakout Box. Reconnect all components. Rerun **3E6-1.**
3E6-5 CHECK KS CIRCUIT FOR SHORT TO POWER		
• Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Disconnect knock sensor. • Key on, engine off. • Measure voltage between Test Pin 2 and Test Pins 20, 40 and 60. • Is voltage less than 0.5 volts?	Yes No	Remove Breakout Box. Reconnect processor. Go to **3E6-6.** Service short circuit. Remove Breakout Box. Reconnect all components. Rerun **3E6-1.**

TEST 3E6 : KNOCK SENSOR

Test Step		Result	Action to Take
3E6-6	TEST PROCESSOR WITH SUBSTITUTE KNOCK SENSOR		
• Key off. • Install a known good knock sensor on the engine. Connect knock sensor wire. • Warm engine up to operating temperature. Bring engine up to 2800 RPM. • Tap engine block near substitute knock sensor with a small steel hammer. • While tapping, does spark advance begin to retard? If tapping continues, does spark continue to retard to a maximum of 10° below starting point?		Yes No	Replace original knock sensor. Go to **3E6-7.**
3E7-7	TEST PROCESSOR WITH SUBSTITUTE KNOCK MODULE		
• Key off. • Install a known good knock module on the engine. Connect to knock sensor. • Warm engine up to operating temperature. Bring engine up to 2800 RPM. • Tap engine block near knock sensor with a small steel hammer. • While tapping, does spark advance begin to retard? If tapping continues, does spark continue to retard to a maximum of 10° below starting point?		Yes No	Replace original knock module. Replace processor. Rerun **3E6-1.**

TEST 3E7 : THROTTLE POSITION (TP)

NOTE: You should enter this Pinpoint Test only when you have been directed here from Quick Test.

Remember: To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

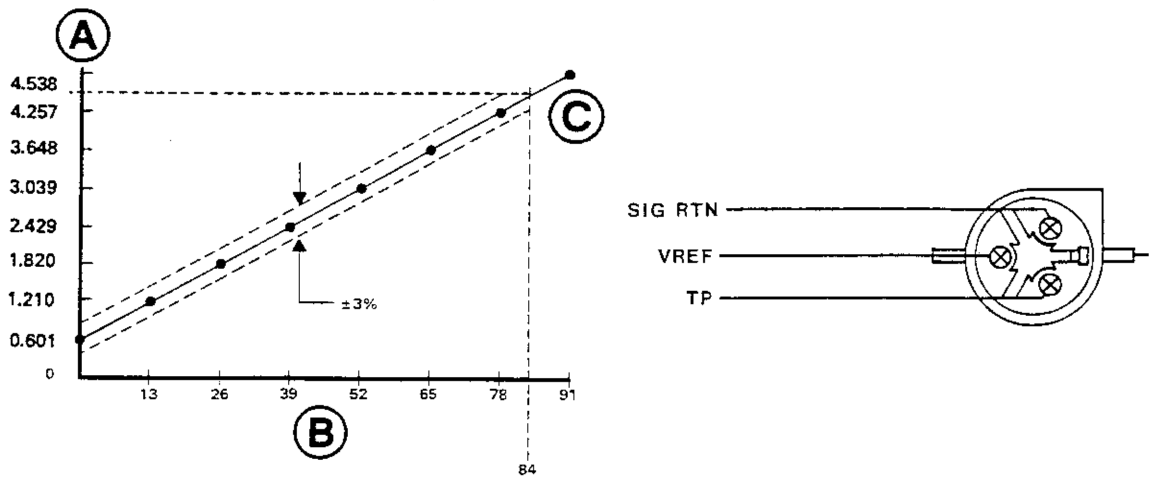
- Binding throttle shaft/linkage
- TP sensor may not be seated properly (tightened down)

This Pinpoint Test is intended to diagnose only the following:

- Throttle Position (TP) sensor
- Sensor harness circuits: VREF, TP, and SIG RTN
- Processor assembly

Description: The Throttle Position (TP) Sensor is a potentiometer that provides a signal to the EEC processor that is directly proportional to throttle plate position.

NOTE: **The normal range of the throttle angle measurement for the Throttle Position (TP) sensor is from 0 to 85 degrees.**



Ⓐ **Signal (volts)**

Ⓑ **Throttle Shaft Rotation (Degrees – TP Rotational Angle)**

Ⓒ **Over Travel Permissible**

TEST 3E7 : THROTTLE POSITION (TP)

Test Step		Result	Action to Take
3E7-1	ENGINE RUNNING SERVICE CODE 23: CHECK FOR OTHER SERVICE CODES		
Service Code 23 indicates that the Throttle Position (TP) sensor's rotational setting may be out of Self-Test range. Possible causes: 1. Binding throttle linkage 2. TP sensor may not be seated properly (tightened down) 3. Damaged TP sensor 4. Damaged processor • Are any unusual codes present with Code 23?		Yes No	Go to Pinpoint Test Step **3E14-1.** Go to **3E7-2.**
3E7-2	SERVICE CODE 23: CHECK FOR STUCK THROTTLE PLATE		
Service Code 23 indicates that the Throttle Position (TP) sensor's rotational setting may be out of Self-Test range. Possible causes: 1. Binding throttle linkage 2. TP sensor may not be seated properly (tightened down) 3. Damaged TP sensor 4. Damaged processor • Visually inspect throttle body and throttle linkage for binding or sticking. • Verify the throttle linkage is at mechanical/closed throttle. Check for: binding throttle linkage, vacuum line/ electrical harness interference, etc. • Does throttle move freely and return to closed throttle position?		Yes No	Go to **3E7-3.** Service as necessary. Rerun Quick Test.

TEST 3E7 : THROTTLE POSITION (TP)

Test Step	Result	Action to Take
3E7-3 SERVICE CODE 53: ATTEMPT TO GENERATE CODE 63		
Service Code 53 indicates that the Throttle Position (TP) sensor signal is greater than the Self-Test maximum value. Possible causes are: 1. TP sensor may not be seated properly (tightened down) 2. Damaged TP sensor 3. Short to power in engine harness 4. Damaged processor • Key off. • Disconnect TP sensor. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Rerun Quick Test Step 2. • Is code 63 present (ignore all other codes)?	Yes No	Go to **3E7-4.** Go to **3E7-5.**
3E7-4 CHECK VREF CIRCUIT VOLTAGE		
• Key off. • Disconnect TP sensor. • Key on, engine off. • Measure voltage between VREF circuit and SIG RTN circuit at the TP sensor engine harness connector. • Is voltage between 4.0 and 6.0 volts?	Yes No	Replace TP sensor. Rerun Quick Test. Reconnect all components. Go to Pinpoint Test Step **3E3-1.**
3E7-5 CHECK TP CIRCUIT FOR SHORTS TO POWER		
• Key off. • Disconnect TP sensor • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Measure resistance between Test Pin 47 and Test Pins 26 and 57. • Is each resistance greater than 10,000 ohms?	Yes No	Replace processor. Remove Breakout Box. Reconnect TP sensor. Rerun Quick Test. Service short circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.

TEST 3E7 : THROTTLE POSITION (TP)

Test Step	Result	Action to Take
3E7-6 SERVICE CODE 63: ATTEMPT TO GENERATE CODE 53 OR 23		
Service Code 63 indicates that the Throttle Position (TP) sensor signal is less than the Self-Test minimum value. Possible causes: 1. TP sensor may not be seated properly (tightened down) 2. Damaged TP sensor 3. Open engine harness 4. Grounded engine harness 5. Damaged processor • Key off. • Disconnect TP sensor. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Jumper VREF circuit to TP circuit at TP sensor engine harness connector. • Perform Key On Engine Off Self-Test. NOTE: If no codes are generated, immediately remove jumper and go directly to **3E7-9.** • Is Code 53 or 23 present (ignore all other codes)?	Yes No	Replace TP sensor. Remove jumper. Rerun Quick Test. Remove jumper. Go to **3E7-7.**
3E7-7 CHECK VREF CIRCUIT VOLTAGE		
• Key off. • Disconnect TP sensor. • Key on engine off. • Measure voltage between VREF circuit and SIG RTN circuit at the TP sensor engine harness connector. • Is voltage between 4.0 and 6.0 volts?	Yes No	Go to **3E7-8.** Reconnect all components. Go to Pinpoint Test Step **3E3-1.**

TEST 3E7 : THROTTLE POSITION (TP)

Test Step	Result	Action to Take
3E7-8 CHECK TP CIRCUIT CONTINUITY		
• Key off. • Disconnect TP sensor. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Measure resistance between TP circuit at the TP sensor engine harness connector and Test Pin 47. • Is the resistance less than 5.0 ohms?	Yes No	Go to **3E7-9**. Service open circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.
3E7-9 CHECK TP CIRCUIT FOR SHORTS TO GROUND		
• Key off. • Disconnect TP sensor. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Measure resistance between Test Pin 47 and Test Pins 40, 46 and 60. • Is each resistance greater than 10,000 ohms?	Yes No	Replace processor. Remove Breakout Box. Reconnect all components. Rerun Quick Test. Service short circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.
3E7-10 CONTINUOUS MEMORY CODE 53: MONITOR TP CIRCUIT UNDER SIMULATED ROUGH WATER CONDITION		
• Enter Key On Engine Off "Wiggle" Test mode. Refer to Quick Test Section. • Observe DVOM or Star Tester for indication of a fault while performing the following: 1. Move throttle slowly to WOT position 2. Release throttle slowly to closed position and lightly tap on TP sensor (simulate rough water) 3. Wiggle TP harness connector • Does DVOM or Star Tester indicate a fault?	Yes No	Go to **3E7-11**. Go to **3E7-12**.

TEST 3E7 : THROTTLE POSITION (TP)

Test Step		Result	Action to Take
3E7-11	MEASURE THROTTLE POSITION SIGNAL VOLTAGE WHILE EXERCISING TP SENSOR		
• Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box and connect processor to Breakout Box. • DVOM or Star Tester still connected to STO as in previous step. • Connect a DVOM from Test Pin 47 to Test Pin 46. • Key on, engine off. • While observing DVOM, repeat Step **3E7-10.** • Does the fault occur below 4.25 volts?		Yes No	Disconnect and inspect connectors. If connector and terminals are good, replace TP sensor. Clear Continuous Memory (refer to Quick Test Section 3D). Rerun Quick Test. Throttle position sensor over-travel may have caused the Continuous Memory Code 53. Verify engine harness integrity, Go to **3E7-12.**
3E7-12	CHECK EEC-IV ENGINE HARNESS		
• Still in Key On Engine Off "Wiggle" Test mode. • Observe DVOM or Star Tester for a fault indication while performing the following: Grasp the engine harness close to the sensor connector. Wiggle, shake or bend a small section of the EEC-IV system engine harness while working your way to the processor. • Does DVOM or Star Tester indicate a fault?		Yes No	Isolate fault. Service as necessary. Refer to appropriate figure. Clear Continuous Memory (refer to Quick Test Section 3D). Rerun Quick Test. Go to **3E7-13.**
3E7-13	CHECK PROCESSOR AND HARNESS CONNECTORS		
• Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Are connectors and terminals OK?		Yes No	Service as necessary. Clear Continuous Memory (Refer to Quick Test Section 3D). Rerun Quick Test. Unable to duplicate and/or identify fault at this time. For further diagnosis call your marine manufacturer. All others, clear Continuous Memory (refer to Quick Test Section 3D). Rerun Quick Test.

TEST 3E7 : THROTTLE POSITION (TP)

Test Step	Result	Action to Take
3E7-14 CONTINUOUS MEMORY CODE 63: MONITOR TP CIRCUIT UNDER SIMULATED ROUGH WATER CONDITION		
• Enter Key On Engine Off Wiggle" Test mode. Refer to Quick Test Section. • Observe DVOM or Star Tester for indication of a fault while performing the following: 1. Move throttle slowly to WOT position 2. Release throttle slowly to closed position 3. Lightly tap on TP sensor (simulate rough water) 4. Wiggle TP harness connector • Does DVOM or Star Tester indicate a fault?	Yes No	Inspect connectors. If connectors and terminals are good, replace TP sensor. Clear Continuous Memory (refer to Quick Test Section 3D. Rerun Quick Test. Go to **3E7-15.**
3E7-15 CHECK EEC-IV ENGINE HARNESS		
• Still in Key On Engine Off "Wiggle" Test mode. • Observe DVOM or Star Tester for a fault indication while performing the following: Grasp the engine harness close to the sensor connector. Wiggle, shake or bend a small section of the EEC-IV system engine harness while working your way to the processor. • Does DVOM or Star Tester indicate a fault?	Yes No	Isolate fault. Service as necessary. Clear Continuous Memory (refer to Quick Test Section). Rerun Quick Test. Go to **3E7-16.**
3E7-16 CHECK PROCESSOR AND HARNESS CONNECTORS		
• Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. • Are connectors and terminals OK?	Yes No	Unable to duplicate and/or identify fault at this time. For further diagnosis call your marine manufacturer. Service as necessary. Clear Continuous Memory. Refer to Quick Test Section. Rerun Quick Test.

TEST 3E8 : FUEL CONTROL

NOTE: You should enter this Pinpoint Test only when you have been directed here from Pinpoint Test **3E16.**

Remember: To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Ignition System
- Positive Crankcase Ventilation System
- Air Intake system
- Fuel/Engine Oil Contamination
- Electrical System
- Fuel System
- Intake Manifold
- Exhaust Manifold System Leak/Plugged
- Engine Cooling System

This Pinpoint Test is intended to diagnose only the following:

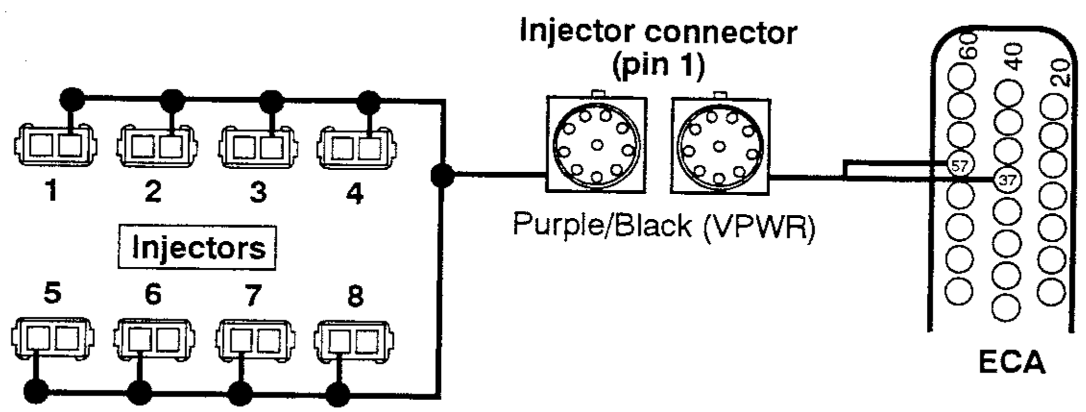
- Vacuum Systems
- Fuel Injector
- Fuel Injector Electrical Circuits
- Processor Assembly
- Harness Circuits: INJ, 1-8, VPWR and SIG RTN

TEST 3E8 : FUEL CONTROL

Test Step	Result	Action to Take
3E8-1 CHECK FUEL PRESSURE		
WARNING: THE FUEL SYSTEM WILL REMAIN PRESSURIZED WHEN ENGINE IS NOT RUNNING. TO PREVENT INJURY OR FIRE, USE CAUTION WHEN WORKING ON THE FUEL SYSTEM. • Key off. • Install fuel pressure gauge. • Verify that manifold vacuum is connected to the fuel pressure regulator if applicable. If engine will start: • Start and run engine at idle. Note fuel pressure. If engine will not start: • Cycle the key off and on several times. Note fuel pressure. • Is fuel pressure within specification for the engine being tested?	Yes No	Go to **3E8-2**. Refer to Section 3H: EFI Diagnosis.
3E8-2 CHECK SYSTEM'S ABILITY TO HOLD FUEL PRESSURE		
• Pressurize fuel system per step **3E8-1**. • Visually look for fuel leaking at the injector O-ring, fuel pressure regulator, and the fuel lines to the fuel reservoir. Service as necessary. • Key on, engine off. • With a stethoscope listen for leaking fuel injectors. • Does fuel pressure remain at specification for 60 seconds?	Yes No	For No Starts: Go to **3E8-3.** For Service Codes or other Symptoms: Go to **3E8-4.** Refer to Section 3H: EFI Diagnosis.
3E8-3 FUEL DELIVERY TEST		
• Key off. • Install fuel pressure gauge. • Pressurize fuel system per step **3E8-1**. • Crank engine for five seconds. • Does pressure drop greater than 5 psi (34 kPa) by the end of the five second crank cycle?	Yes No	The EEC-IV system is not the cause of the No Start. Remove the fuel pressure gauge. Refer to Section 3C: Diagnostic Routines, for other No Start routines. Remove fuel pressure gauge. Go to **3E8-5.**

TEST 3E8 : FUEL CONTROL

Test Step		Result	Action to Take
3E8-4	CYLINDER BALANCE TEST		
• Connect tachometer to engine. Run engine at idle. • Disconnect and reconnect the injectors one at a time: Note RPM drop for each injector. • Does each injector produce a momentary drop in RPM? NOTE: ISC will attempt to re-establish RPM.		Yes No	Go to **3E8-6.** Go to **3E8-5.**
3E8-5	CHECK RESISTANCE OF INJECTOR(S) AND HARNESS EFI ENGINES		
• Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Measure resistance of Injector Bank 1 between Test Pin 37 and Test Pin 58. Record resistance. • Measure resistance of Injector Bank 2 between Test Pin 37 and Test Pin 59. Record resistance. • Is each resistance within 3.0 - 5.5 ohms?		Yes No	Go to **3E8-9**. For No Start: Service open in VPWR circuit. For others: Go to **3E8-6.**

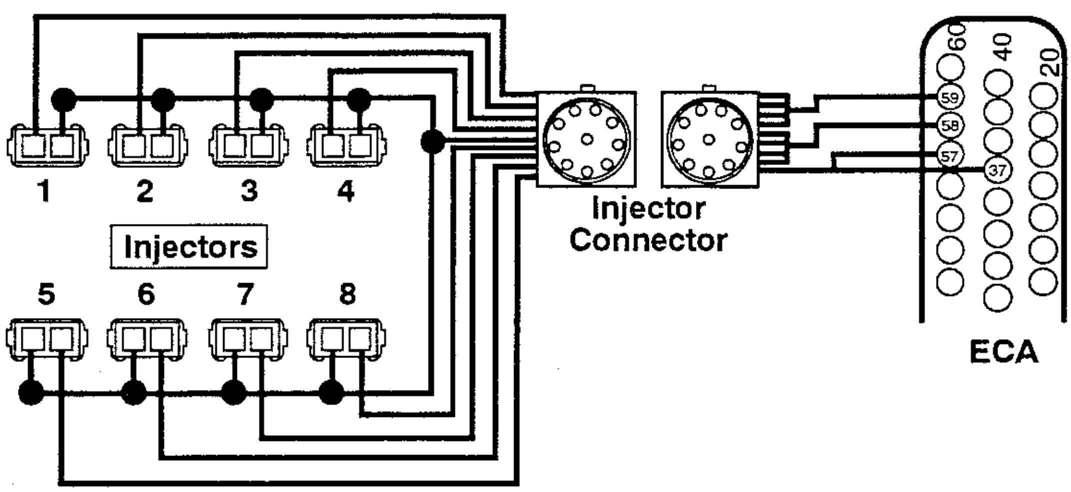


TEST 3E8 : FUEL CONTROL

Test Step		Result	Action to Take
3E8-6	CHECK CONTINUITY OF FUEL INJECTOR HARNESS		
• Key off. • Install Breakout Box, disconnect processor. • Disconnect injector engine harness connector at the suspect injector. • Refer to the **3E8-5.** Schematic for the appropriate injector pin identification. • Measure resistance between Test Pin 37 and 57, and the VPWR pin at the injector engine harness connector. • Measure resistance between the injector test pin(s) at the Breakout Box and the same injector circuit signal pin at each injector engine harness connector. • In each resistance less than 5.0 ohms?		Yes	Go to **3E8-7.**
		No	Service open circuit. Remove Breakout Box. Reconnect processor and injectors. Run engine under load above 3000 RPM for 5 minutes. Rerun Quick Test.

TEST 3E8 : FUEL CONTROL

Test Step		Result	Action to Take
3E8-7	CHECK INJECTOR HARNESS CIRCUIT FOR SHORT TO POWER OR GROUND		
• Key off. • Install Breakout Box, disconnect processor. • Disconnect suspect fuel injector engine harness. • Measure resistance between the injector test pin(s) and Test Pin 37/57, 40, 46 and 60. • Measure resistance between the injector test pin(s) at the Breakout Box and engine ground. • Is each resistance greater than 10,000 ohms?		Yes No	Go to **3E8-8**. Service short circuit. Remove Breakout Box. Reconnect processor and injectors. Run engine under load above 3000 RPM for 5 minutes. Rerun Quick Test.



TEST 3E8 : FUEL CONTROL

Test Step	Result	Action to Take
3E8-8 ISOLATE FAULTY INJECTOR CIRCUIT		
• Key off. • Install Breakout Box, disconnect processor. • Disconnect all injectors on suspect bank. • DVOM on 200 ohm scale. • Connect one injector and measure resistance between Test Pin 37 and either Test Pin 58 or 59 as appropriate. • Disconnect the injector and repeat processor for each of the remaining injectors. • Is each resistance within 13.0 - 17.0 ohms?	Yes	Go to **3E8-9.**
	No	Replace injector. Remove Breakout Box. Reconnect processor and injectors. Run engine under load above 3000 RPM for 5 minutes. Rerun Quick Test.
3E8-9 CHECK INJECTOR DRIVER SIGNAL		
Requires standard non-powered 12 volt test lamp. • Key off. • Install Breakout Box. • Connect processor to Breakout Box. • Connect test lamp between Test Pin 37 and Test Pin 58. • Connect test lamp between Test Pin 37 and 59. • Crank or start engine. NOTE: Properly operating systems will show a dim glow on the lamp. • Is glow on lamp dim?	Yes	Remove Breakout Box. Reconnect processor. Follow instructions of the injector test equipment. Also refer to TFI Diagnosis for other possible causes. After any servicing, run engine under load above 3000 RPM for 5 minutes. Rerun Quick Test and Cylinder Balance Test.
	No	No light/Bright light: Replace processor. Remove Breakout Box. Run engine under load above 3000 RPM for 5 minutes. Rerun Quick Test.

TEST 3E9 : FUEL PUMP CIRCUIT

NOTE: You should enter this Pinpoint Test only when you have been directed here from Quick Test.

Remember: This Pinpoint Test is intended to diagnose only the following:

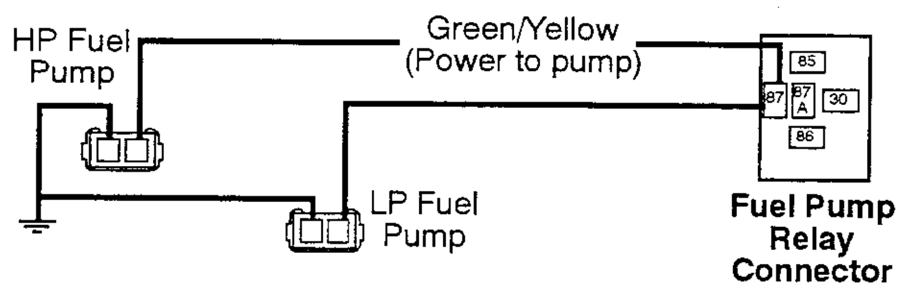
- Fuel Pump Relay
- Harness circuits: BATT(+), VPWR, FP, GND and Power-to-Pumps
- Processor assembly

Description: The Fuel Pump Relay is a normally open relay that is used to supply voltage to the electric fuel pumps. When the ignition key is turned to START or RUN position, the processor grounds Pin 52 (FP), which activates the relay (closes the contacts) and sends voltage to the fuel pump. If, within 1-2 seconds, the processor does not receive an ignition PIP signal (indicating the engine is running), PIN 52 will be ungrounded and the fuel pump will turn off.

The fuel pump monitor circuit is wired into the Power-to-Pumps circuit and is used by the processor to monitor the fuel pump secondary circuit.

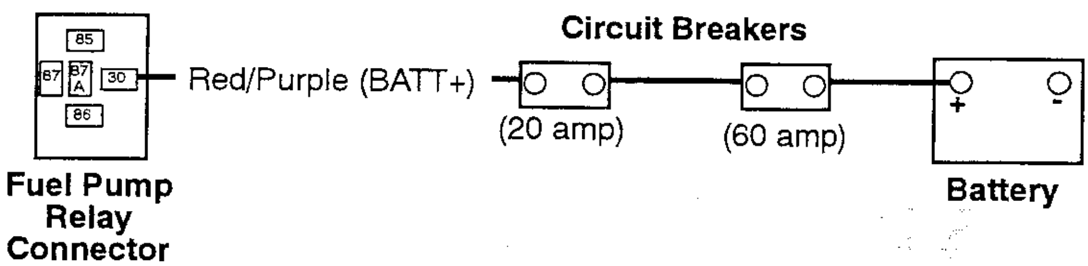
TEST 3E9 : FUEL PUMP CIRCUIT

Test Step		Result	Action to Take
3E9-1	NO FUEL PUMP PRESSURE: CHECK FOR FUEL PUMP ELECTRICAL OPERATION		
• To check if fuel pump runs, turn key from OFF to RUN position, repeat several times. (Do not turn to start position.)		Yes	Go to Section 3H: EFI Diagnosis.
• Does fuel pump run briefly each time the key is turned to RUN position?		No	Go to **3E9-2.**
3E9-2	CHECK FOR VPWR TO PROCESSOR		
• Key Off. • Install Breakout Box, connect processor.		Yes	Go to **3E9-3.**
• Key on, engine off. • Measure voltage between Test Pin 37 and Test Pin 40, and between Test Pin 57 and Test Pin 60. • Are both voltages greater than 10.5 volts?		No	Go to Pinpoint Test Step **3E2-1.**
3E9-3	CHECK FOR VOLTAGE TO POWER-TO-PUMPS CIRCUIT		
• Key on, engine off. • Install Breakout Box, connect processor. • Measure voltage between engine ground and Power-to-Pumps circuit at fuel pump relay while cranking engine.		Yes	Go to Section 3H: EFI Diagnosis for open in Power-to Pumps circuit, fuel pump GND, open in pump, etc.
• Is voltage greater than 8.0 volts during crank?		No	Go to **3E9-4.**



TEST 3E9 : FUEL PUMP CIRCUIT

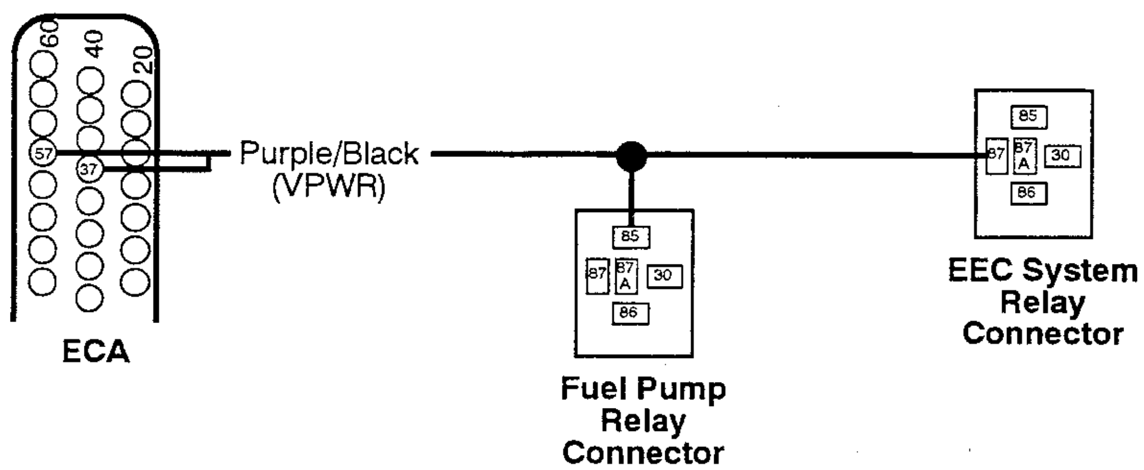
Test Step	Result	Action to Take
3E9-4 CHECK FOR BATT(+) TO FUEL PUMP RELAY		
• Key on, engine off. • Install Breakout Box, connect processor. • Measure voltage between engine ground and BATT(+) at fuel pump relay. • Is voltage greater that 10.5 volts?	Yes	Go to **3E9-5**.
	No	Verify integrity of circuit breaker for BATT(+) supply to fuel pump relay. If OK, service open in BATT(+) between fuel pump relay and battery positive post. Remove Breakout Box. Reconnect processor. Rerun Quick Test.



Test Step	Result	Action to Take
3E9-5 CHECK FOR VOLTAGE AT POWER-TO-PUMPS CIRCUIT		
• Key off. • Install Breakout Box. • Disconnect processor. • Connect jumper wire from Test Pin 52 to Test Pin 40 or 60. • Key on, engine off. • Measure voltage between engine ground and Power-to-Pumps circuit at fuel pump relay (see **3E9-3**). • Is voltage greater than 10.5 volts?	Yes	Replace processor. Remove Breakout Box. Rerun Quick Test.
	No	Replace fuel pump relay. Remove Breakout Box. Reconnect processor. Rerun Quick Test.

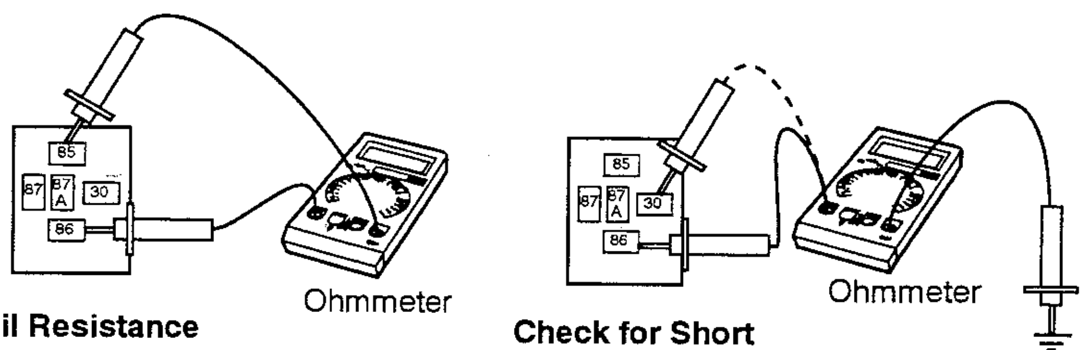
TEST 3E9 : FUEL PUMP CIRCUIT

Test Step		Result	Action to Take
3E9-6	SERVICE CODE 96: CHECK FOR VPWR TO FUEL PUMP RELAY		
Service Code 96 indicates a fuel pump primary circuit failure. Possible causes: 1. Open or shorted circuit 2. Damaged fuel pump relay 3. Damaged processor • Disconnect fuel pump relay. • Key on, engine off. • Measure voltage between VPWR circuit at the fuel pump relay engine harness connector and ground. • Is voltage greater than 10.5 volts?		Yes No	Go to **3E9-7**. Service open in VPWR circuit between the EEC power relay and the fuel pump relay. Reconnect fuel pump relay. Rerun Quick Test.



TEST 3E9 : FUEL PUMP CIRCUIT

Test Step	Result	Action to Take
3E9-7 CHECK FUEL PUMP RELAY		
• Key off. • Disconnect fuel pump relay. • DVOM on 200 ohm scale. • Check fuel pump relay coil resistance: -Resistance should be between 40 and 85 ohms • DVOM on 10,000 ohm scale. • Check fuel pump relay for internal shorts. -Both resistances should be greater than 10,000 ohms • Are all resistance checks OK?	Yes No	Go to **3E9-8**. Replace fuel pump relay. Rerun Quick Test.



Coil Resistance **Check for Short**

Test Step	Result	Action to Take
3E9-8 CHECK FUEL PUMP CIRCUIT FOR SHORT TO POWER		
• Key off. • Disconnect fuel pump relay. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Key on, engine off. • Measure voltage between Test Pin 52 and battery negative post. • Is voltage less than 1.0 volt?	Yes No	Go to **3E9-9.** Service short circuit. Reconnect all components. Attempt to start engine. If engine fails to start, replace processor. Rerun Quick Test.

TEST 3E9 : FUEL PUMP CIRCUIT

Test Step	Result	Action to Take
3E9-9 CHECK FUEL PUMP CIRCUIT FOR SHORT TO GROUND		
• Key off. • Install Breakout Box, disconnect processor. • Disconnect fuel pump relay. • Measure resistance between Test Pin 52, and Test Pins 40 and 60. • Is resistance greater than 10,000 ohms?	Yes No	Go to **3E9-10**. Service short circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.
3E9-10 CHECK FUEL PUMP CIRCUIT CONTINUITY		
• Key off. • Install Breakout Box, disconnect processor. • Disconnect fuel pump relay. • Measure resistance between fuel pump circuit at the fuel pump relay engine harness connector and Test Pin 52 (see **3E9-3**). • Is resistance less than 5.0 ohms?	Yes No	Replace processor. Reconnect fuel pump relay. Rerun Quick Test. Service open circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.
3E9-11 SERVICE CODE 95: DOES ENGINE START		
Service Code 95 indicates that one of the following has occurred: **No Start:** 1. Open circuit in or between the fuel pump and FPM circuit connection to the Power-to Pumps circuit 2. Poor fuel pump ground **Engine Starts:** 1. Fuel pump secondary circuit short to power 2. Fuel pump relay contacts always closed 3. Open in FPM circuit between processor and connection to the Power-to-Pumps circuit 4. Damaged processor • Does the engine start?	Yes No	Go to **3E9-12.** Check fuel pump ground circuit. If okay, Go to **3E9-10.**
3E9-12 VERIFY THAT FUEL PUMP IS OFF		
• Key on, wait five seconds. • Listen for motor noise from fuel pump. • Is fuel pump off?	Yes No	Go to **3E9-14.** Go to **3E9-13.**

TEST 3E9 : FUEL PUMP CIRCUIT

Test Step	Result	Action to Take
3E9-13 CHECK FOR FUEL PUMP RELAY ALWAYS CLOSED		
• Key off. • Locate and disconnect fuel pump relay. • Key on. • Is fuel pump off with relay disconnected?	Yes No	Replace fuel pump relay. Rerun Quick Test. Service short to power in power-to-pumps/FPM circuit. Reconnect fuel pump relay. Rerun Quick Test.
3E9-14 CHECK FPM CIRCUIT FOR CONTINUITY		
• Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Disconnect fuel pump relay. • Measure resistance between Test Pin 8 and Power-to Pumps circuit at the fuel pump relay engine harness connector (see **3E9-3**). • Is resistance less than 5.0 ohms?	Yes No	Replace processor. Remove Breakout Box. Reconnect fuel pump relay. Rerun Quick Test. Service open circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.
3E9-15 SERVICE CODE 96: DOES ENGINE START		
Service Code 96 indicates a fuel pump secondary circuit failure between the BATT(+) supply and the FPM connection to the Power-to-Pumps circuit. Possible causes: **No Start:** 1. Open circuit between the BATT(+) supply and the FPM connection to the Power-to-Pumps circuit 2. Fuel pump relay contacts always open **Engine Starts:** - Damaged processor • Does the engine start?	Yes No	Replace processor. Rerun Quick Test. Go to **3E9-16**.

TEST 3E9 : FUEL PUMP CIRCUIT

Test Step	Result	Action to Take
3E9-16 CHECK FOR BATT(+) TO FUEL PUMP RELAY		
• Key off. • Disconnect fuel pump relay. • Measure voltage between BATT(+) circuit at the fuel pump relay engine harness connector and battery negative post (see **3E9-4**). • Is voltage greater than 10.5 volts.	Yes	Go to **3E9-17.**
	No	Verify integrity of circuit breaker for BATT(+) supply to fuel pump relay. If OK, service open in BATT(+) circuit. Reconnect fuel pump relay. Rerun Quick Test.
3E9-17 CHECK POWER-TO-PUMPS CIRCUIT CONTINUITY		
• Key off. • Disconnect fuel pump relay. • Measure resistance between Power-to-Pumps circuit at the fuel pump relay engine harness connector and the battery negative post (see **3E9-3**). • Is resistance less than 10.0 ohms?	Yes	Replace fuel pump relay. Rerun Quick Test.
	No	Service open in Power-to-Pumps circuit between FPM splice and fuel pump relay. Refer to schematic. Reconnect fuel pump relay. Rerun Quick Test.

TEST 3E9 : FUEL PUMP CIRCUIT

Test Step	Result	Action to Take
3E9-18 CONTINUOUS MEMORY CODE 95: CHECK EEC-IV HARNESS		
A Continuous Memory Code 95 indicates that one of the following intermittent conditions has occurred: 1. Fuel pump circuit activated when processor expected circuit to be off (i.e. fuel system test or prime procedure) 2. Open circuit in or between the fuel pump and FPM circuit at the processor 3. Poor fuel pump ground 4. FPM or Power-to-Pumps circuit short to power 5. Fuel pump relay contacts stuck closed • Start engine. • Check for engine stall/stumble while performing the following (also, if possible, listen for fuel pump turning off.) 1. Shake, wiggle, bend the Power-to-Pumps circuit between the Power-to-Pumps pin at the fuel pump relay and the fuel pump 2. Shake, wiggle, bend the fuel pump ground circuit from the fuel pump to ground 3. Lightly tap the fuel pump to simulate rough water • Key off. • Inspect the fuel pump engine harness connector and the fuel pump ground for corrosion, damaged pins, etc. • Is fault indicated/found?	Yes No	Isolate fault and service as necessary. Clear Continuous Memory (refer to Quick Test Section 3D). Rerun Quick Test. Go to **3E9-19**.

TEST 3E9 : FUEL PUMP CIRCUIT

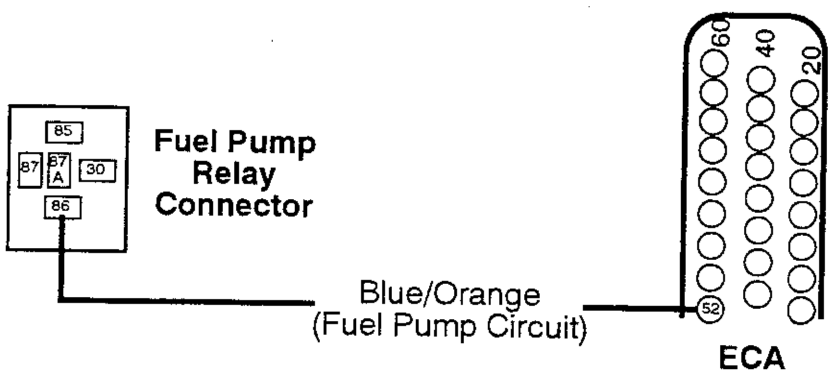
Test Step	Result	Action to Take
3E9-19 CHECK FPM CIRCUIT		
• Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Key on, engine off. • Connect a Test Lamp between Test Pin 8 and Test Pin 37. • Observe Test Lamp for an indication of a fault while performing the following. (The light will go out when a fault is found, indicating an open): Shake, wiggle, bend the fuel pump monitor circuit between the fuel pump relay (or splice if applicable) and the processor • Is fault indicated?	Yes No	Isolate fault and service as necessary. Remove Breakout Box. Clear Continuous Memory (Section 3D: Quick Test - Step 9). Rerun Quick Test. Go to **3E9-20.**
3E9-20 CHECK FOR SHORTS TO POWER		
• Key on, engine off. • Install Breakout Box, disconnect processor. • Connect a Test Lamp between Test Pin 8 and Test Pin 40. • Observe Test Lamp for an indication of a fault while performing the following. (The light will turn on when a fault is detected, indicating a short to power. Also, if possible, listen for fuel pump turning on.): Shake, wiggle, bend the fuel pump monitor circuit and Power-to-Pumps circuit, especially where they may be in the vicinity of a power circuit • Lightly tap the fuel pump relay (to simulate rough water). • Is fault indicated?	Yes No	Isolate fault and service as necessary. Remove Breakout Box. Reconnect processor. Clear Continuous Memory (section 3D: Quick Test - Step 9). Rerun Quick Test. Go to **3E9-24.**

TEST 3E9 : FUEL PUMP CIRCUIT

Test Step		Result	Action to Take
3E9-21	CONTINUOUS MEMORY CODE 96: CHECK FOR CONTINUOUS MEMORY CODE 87		
• Is continuous memory Code 87 also present?		Yes No	Go to **3E9-23**. Go to **3E9-22**.
3E9-22	CHECK EEC-IV HARNESS		
A Continuous Memory Code 96, without the presence of a Continuous Memory Code 87, indicates that during engine operation, one of the following has occurred: 1. Open in the BATT(+) circuit between BATT(+) and the fuel pump relay (see **3E9-4**). 2. Open fuel pump relay contacts 3. Open in the Power-to-Pumps circuit from the fuel pump relay to the FPM splice (see **3E9-3**). • Start engine. • Check for engine stall/stumble while performing the following (also, if possible, listen for fuel pump turning off): 1. Shake, wiggle, bend the BATT(+) circuit from BATT(+) to the fuel pump relay 2. Lightly tap the fuel pump relay (to simulate rough water) 3. Shake, wiggle, bend the Power-to-Pumps circuit from the fuel pump relay to the FPM splice • Key off. • Inspect the fuel pump relay connectors and BATT(+) connector terminal for corrosion, damaged pins, etc. • Is fault indicated/found?		Yes No	Isolate fault and service as necessary. Clear Continuous Memory (section 3D Quick Test - Step 9). Rerun Quick Test. Under certain conditions, a continuous Memory Code 96 may have been set without a Continuous Memory Code 87, even though a fault has occurred in the fuel pump primary circuit. Go to **3E9-23** to check the fuel pump primary circuit.

TEST 3E9 : FUEL PUMP CIRCUIT

Test Step		Result	Action to Take
3E9-23	CONTINUOUS MEMORY CODE 87: CHECK EEC-IV HARNESS		
A Continuous Memory Code 87 indicates that a fuel pump primary circuit failure has occurred during engine operation. Possible causes are: 1. Open in VPWR circuit between the EEC power relay and the fuel pump relay (**3E9-6**). 2. Open coil in fuel pump relay 3. Open in fuel pump circuit (Pin 52) • Start engine. • Check for engine stall/stumble while performing the following (also, if possible, listen for fuel pump turning off): 1. Shake, wiggle, bend the VPWR circuit between the EEC power relay and the fuel pump relay 2. Shake, wiggle, bend the EEC-IV engine harness fuel pump circuit (Test Pin 52) between the processor and the fuel pump relay 3. Lightly tap the fuel pump relay to simulate rough water • Key off. • Inspect the processor 60 pin connector and the fuel pump relay connectors for corrosion, damaged pins, etc. • Is fault indicated/found?		Yes No	Isolate fault and service as necessary. Clear Continuous Memory (section 3D: Quick Test - Step 9). Rerun Quick Test. Go to **3E9-24**.



TEST 3E9 : FUEL PUMP CIRCUIT

3E9-24	ON THE WATER TEST

The purpose of the on the water test is to identify an area of concern by monitoring certain controlled parameters while trying to recreate an operational symptom.

NOTE: A basic working knowledge of the EEC-IV system is critical to effectively analyze on the water test data.

WARNING: THIS ON THE WATER TEST IS A SUGGESTED BUT OPTIONAL PROCEDURE. ALL APPLICABLE SAFETY PROCEDURES MUST BE FOLLOWED. IN ORDER FOR AN ON THE WATER TEST TO BE PERFORMED, IT IS REQUIRED THAT ANOTHER PERSON ACCOMPANY THE DRIVER. THE ACCOMPANYING PERSON CAN MAKE MEASUREMENTS, OBSERVE CHANGES AND RECORD NOTES. IF FOR SOME REASON THIS TEST IS NOT PERFORMED, RETURN TO DIAGNOSTIC ROUTINES FOR OTHER POSSIBLE CAUSES.

Prepare Engine For An On The Water Test.

- Install Breakout Box. Connect processor.
- Install fuel pressure gauge and MAP tester (optional).
- Other materials needed: DVOM, pencil, paper, appropriate schematic/ pin usage sheet.

Preliminary Power/Ground Checks.

- With the key ON and a DVOM referenced to the battery negative post, check the following signals for correct values.

POWERS: KAPWR>10.5V (Pin 1), VPWR>10.5V (Pins 37/57), VREF 5± 1V (Pin 26).
GROUNDS: (all = 0± .5V) PWR GND (Pins 20/40/60), SIG RTN (Pin 46), IGN GND (Pin 16).

Obtaining Other Needed Information And Materials Before The On The Water Test.

- Refer to the Symptom Charts in Diagnostic Routine Section. Looking at the charts that most resemble the engine's driveability symptom. Before the on the water test, perform the Visual/Mechanical Checks that are listed. Next, list the EEC-IV sensors and actuators. These circuits, along with the FP/FPM signals, are the main signals that will be monitored.
- Refer to the Diagnostic Reference Value Sheet in Diagnostic Routine Section. With a DVOM referenced as indicated, all values in DCV units can be used; other values may also be helpful, i.e. MAP Hz using the MAP tester.

TEST 3E9 : FUEL PUMP CIRCUIT

3E9-24	ON THE WATER TEST

- The use of test lamp(s) and a DVOM may also aid diagnosis. For example, with a Continuous Memory 87 (fuel pump primary circuit failure) and a surge/stall symptom, a test lamp could be connected at the fuel pump relay between the VPWR circuit and ground. A DVOM would be connected between the Fuel Pump (FP) circuit at the relay and Test Pin 1 (KAPWR) at the Breakout Box. Under normal operating conditions, the lamp would be on and the DVOM would read battery voltage (if the engine stalled, the processor would "unground" the FP circuit and DVOM voltage would be low. If the problem was in the fuel pump wiring, the lamp/voltage would change just before the symptom occurred). If the VPWR lamp goes out, the problem is in the VPWR supply to the relay. If the lamp stayed on, the DVOM voltage remained high and a Continuous Memory 87 was set again, replace the fuel pump relay. If only the FP voltage went low, the problem is either in the FP circuit or the processor. The DVOM could now be connected between Test Pin 52 (FP) and Test Pin 1 (KAPWR) at the Breakout Box. If, just before the symptom occurs, the voltage goes low, replace the processor; if the voltage stays high, the problem is in the FP circuit wiring. For the fuel pump secondary circuit codes (95,96), the BATT(+), Power to Pumps and FPM circuits could be similarly monitored.

NOTE: Due to the low resistance of some test lamps, it is recommended that a DVOM or equivalent high resistance testing device be used when monitoring processor output circuits.

- After starting the engine for the on the water test, the processor will enter Engine Running Continuous Memory mode (section 3D: Quick Test).
- Operate the boat to create the conditions so that the symptom will occur. Use any customer information to recreate the symptom.
- When the symptom occurs, the accompanying passenger should observe changes in listed EEC-IV signals. Information about the symptom, operating condition value of the EEC-IV signal or other notes should be recorded onto paper.
- If you are unable to duplicate the symptom, it may still be helpful to verify that the EEC-IV values are in the expected range.

Analyzing The Data

- Once the on the water test is completed, the results need to be analyzed to locate and service the exact fault which caused the symptom.
- If no problem is identified, return to Section 3C: Diagnostic Routines for other possible causes of the symptom.

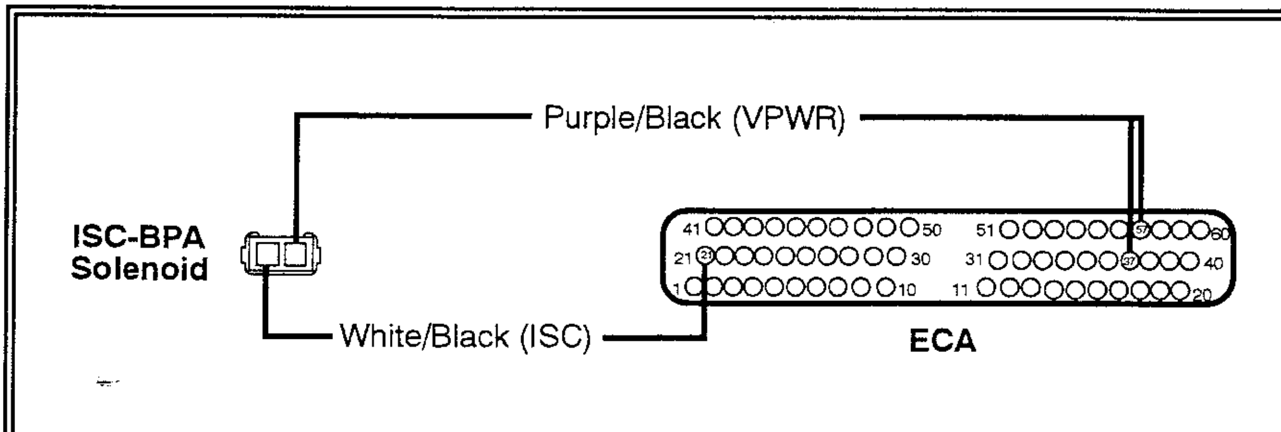
TEST 3E10 :
IDLE SPEED CONTROL (BYPASS AIR)

NOTE: You should enter this Pinpoint Test only when you have been directed here from Quick Test or Pinpoint Test **3E16.**

Remember: To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:
- Engine not up to operating temperature
- Engine over operating temperature
- Throttle sticking or linkage binding

This Pinpoint Test is intended to diagnose only the following:
- RPM in Self-Test only
- ISC solenoid
- Harness circuits: ISC and VPWR
- Processor assembly

Description: The Idle Speed Control (ISC) solenoid is used to control engine idle speed and dashpot functions. The ISC solenoid is mounted on the throttle body and allows air to bypass the throttle plate. The amount of air allowed to bypass is determined by the processor and controlled by a duty cycle signal.



TEST 3E10 : IDLE SPEED CONTROL (BYPASS AIR)

Test Step	Result	Action to Take
3E10-1 SERVICE CODE 12: CHECK FOR RPM DROP		
Service Code 12 indicates that during Engine Running Self-Test, engine RPM could not be controlled within the Self-Test upper limit band. Possible causes: 1. Open or shorted circuit 2. Throttle linkage binding 3. Improper idle airflow set 4. Throttle body/ISC solenoid contamination 5. Items external to Idle Speed Control system that could affect engine RPM 6. Damaged ISC solenoid 7. Damaged processor • Key off. • Connect engine tachometer. • Start engine. • Disconnect ISC harness connector. • Does RPM drop or stall?	Yes No	Go to **3E10-2**. Go to **3E10-3**.
3E10-2 CHECK FOR UNUSUAL CODES		
• Are any unusual Service Codes present?	Yes No	Reconnect ISC solenoid. Go to Quick Test Step 6/7 for appropriate Pinpoint Test.. Go to **3E10-3**.
3E10-3 CHECK FOR EEC CODES		
• Is Service Code 22 present?	Yes No	Reconnect ISC solenoid. Go to Quick Test Step 6/7 for appropriate Pinpoint Test Go to **3E10-4**.

TEST 3E10 : IDLE SPEED CONTROL (BYPASS AIR)

Test Step	Result	Action to Take
3E10-4 MEASURE ISC SOLENOID RESISTANCE		
• Key off. • Disconnect ISC solenoid. • Measure solenoid resistance. • Is resistance between 6.0 and 13.0 ohms?	Yes No	Go to **3E10-5**. Replace ISC solenoid. Rerun Quick Test.
3E10-5 CHECK FOR INTERNAL SHORT TO ISC SOLENOID CASE		
• Key off. • Disconnect ISC solenoid. • Measure resistance from either ISC solenoid pin to metal ISC frame. • Is resistance greater than 10,000 ohms?	Yes No	Go to **3E10-6**. Replace ISC solenoid. Rerun Quick Test.
3E10-6 CHECK VPWR CIRCUIT VOLTAGE		
• Key on, engine off. • Disconnect ISC solenoid. • Measure voltage between VPWR circuit (purple/black wire) at the ISC solenoid engine harness connector and battery ground. • Is voltage greater than 10.5 volts?	Yes No	Go to **3E10-7**. Service defective circuit. Rerun Quick Test.
3E10-7 CHECK ISC CIRCUIT CONTINUITY		
• Key off. • Disconnect ISC solenoid • Disconnect processor and inspect both 60 pin connectors for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • measure resistance between Test Pin 21 at the Breakout Box and ISC circuit (white/black wire) at ISC solenoid engine harness connector. • Is resistance greater than 5.0 ohms?	Yes No	Go to **3E10-8**. Service defective circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.

TEST 3E10 : IDLE SPEED CONTROL (BYPASS AIR)

Test Step		Result	Action to Take
3E10-8	CHECK ISC CIRCUIT FOR SHORT TO GROUND		
• Key off. • Install Breakout Box, disconnect processor. • Disconnect ISC solenoid. • Measure resistance between Test Pin 21 and Test Pins 40, 46 and 60. • Is each resistance greater than 10,000 ohms?		Yes No	Go to **3E10-9**. Service grounded circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.
3E10-9	CHECK ISC CIRCUIT FOR SHORT TO POWER		
• Key off. • Install Breakout Box, disconnect processor. • Disconnect ISC solenoid. • Key on. • Measure voltage between Test Pin 21 and engine ground. • Is voltage less than 1 volt?		Yes No	Go to **3E10-10**. Service short circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test. If code or symptom is still present, replace ECA.
3E10-10	CHECK FOR ISC SIGNAL FROM THE PROCESSOR		
• Key off. • Install Breakout Box. • Reconnect processor to Breakout Box. • Reconnect ISC solenoid. • Connect DVOM between Test Pin 21 and Test Pin 40. • Start engine. • Slowly increase RPM to 3000 RPM. • Is voltage between 3.0 and 11.5 volts?		Yes No	Go to **3E10-11**. Remove ISC solenoid and verify that it is not stuck open. If OK, replace processor. Remove Breakout Box. Rerun Quick Test.

TEST 3E10 : IDLE SPEED CONTROL (BYPASS AIR)

Test Step	Result	Action to Take
3E10-11 CHECK IDLE		
• Does engine idle speed appear normal?	Yes	Remove ISC solenoid and inspect for contamination. **If contamination is present:** Clean solenoid. Rerun Quick Test. If code/symptom is still present, replace ISC solenoid. **No contamination present:** Replace ISC solenoid. Rerun Quick Test.
	No	Go to **3E10-12**.
3E10-12 CHECK FOR PROBLEMS AFFECTING PROPER ENGINE SPEED		
• Check throttle linkage for binding. • Inspect throttle body for contamination. • Check engine vacuum hoses. • Check for leaks around ISC solenoid (i.e. mounting gasket, etc.). • Are all the above checks OK?	Yes	Remove ISC solenoid and inspect for contamination. If contamination is present, clean ISC solenoid. Rerun Quick Test. Replace ISC solenoid if test fails.
	No	Service as necessary. Remove Breakout Box. Reconnect processor. Rerun Quick Test.
3E10-13 SERVICE CODE 13		
Service Code 13 indicates that during Engine Running Self-Test, engine RPM could not be controlled within the Self-Test lower limit band. Possible causes: 1. Improper throttle cable adjustment 2. Vacuum leaks 3. Throttle linkage binding 4. Throttle plates open 5. Improper ignition timing 6. Throttle body ISC solenoid contamination 7. ISC circuit short to ground 8. Damaged ISC solenoid • Does engine idle speed appear normal?	Yes	Remove ISC solenoid and inspect for contamination. If contamination is present, clean ISC solenoid. Rerun Quick Test. Replace ISC solenoid if test fails.
	No	Adjust throttle cable to specification. Refer to appropriate Engine manual for adjustment procedure. If idle is still not to specification, Go to **3E10-14**.

TEST 3E10 : IDLE SPEED CONTROL (BYPASS AIR)

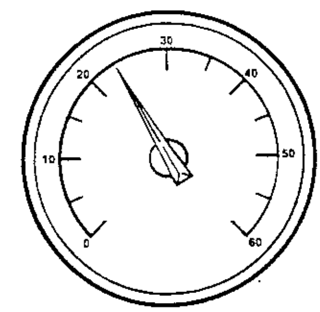
Test Step		Result	Action to Take
3E10-14	CHECK FOR CONDITIONS AFFECTING IDLE		
• Check engine vacuum hoses for leaks. • Check throttle linkage for binding. • Check that throttle plates are closed. • Check for induction system leaks. (i.e. ISC solenoid to throttle body gasket, loose ISC, PCV, etc.) • Check throttle body for contamination. • Verify base timing is to specification. • Are all the above checks OK?		Yes No	Go to **3E10-15.** Service as necessary. Rerun Quick Test.
3E10-15	CHECK FOR INTERNAL SHORT TO ISC SOLENOID CASE		
• Key off. • Disconnect ISC solenoid. • Measure resistance from either ISC solenoid pin to metal ISC frame. • Is resistance greater than 10,000 ohms?		Yes No	Go to **3E10-16.** Replace ISC solenoid. Rerun Quick Test.
3E10-16	CHECK ISC CIRCUIT FOR SHORT TO GROUND		
• Key off. • Disconnect ISC solenoid. • Disconnect the processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Measure resistance between Test Pin 21 and Test Pins 40, 46 and 60. • Are all resistances greater than 10,000 ohms?		Yes No	Go to **3E10-17.** Service grounded circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.

TEST 3E10 : IDLE SPEED CONTROL (BYPASS AIR)

Test Step	Result	Action to Take
3E10-17 CHECK PROCESSOR OUTPUT		
• Key off. • Install Breakout Box. • Reconnect processor to Breakout Box. • Reconnect ISC solenoid. • Connect DVOM between Test Pin 21 and Test Pin 40. • Start engine. • Slowly increase RPM to 3000 RPM. • Is voltage between 3.0 and 11.5 volts?	Yes	Remove ISC solenoid and inspect for contamination. **If contamination is present:** Clean solenoid. Rerun Quick Test. If code/symptom is still present, replace ISC solenoid. **No contamination present:** Replace ISC solenoid. Rerun Quick Test.
	No	Replace processor. Remove Breakout Box. Rerun Quick Test.

TEST 3E11 : DYNAMIC RESPONSE

NOTE: You should enter this Pinpoint Test only when you have been directed here.



Remember: This Pinpoint Test is intended to diagnose only the following:

- Throttle movement (greater than 3/4 throttle)
- RPM increase (greater than 2000 RPM)

WARNING: MUST BE IN "SHIFT DISENGAGED" POSITION TO PREVENT UNEXPECTED AND HAZARDOUS BOAT MOVEMENT

Test Step	Result	Action to Take
3E11-1 SERVICE CODE 77: SYSTEM FAILED TO RECOGNIZE BRIEF WOT		
NOTE: A brief snap of the throttle may not be sufficient to pass this test. Be sure to go to WOT and return.	Yes	Go to **3E11-2**.
• Rerun Engine Running Self-Test. Be sure operator is familiar with the Engine Running format which proceeds as follows: 1. Activate Self-Test 2. Start engine 3. Start of test 4. Dynamic Response code: perform brief WOT 5. Testing over 6. Service code output begins • Is Code 77 still present?	No	Dynamic Response Test passed. Service any other service code(s) received as necessary.
3E11-2 DID ENGINE ACHIEVE GREATER THAN 2000 RPM		
During the WOT in the Dynamic Response Test, did the engine achieve greater than 2000 RPM?	Yes	Replace processor. Rerun Quick Test.
	No	Check for conditions that would prevent engine from achieving greater than 2000 RPM (binding throttle linkage, etc.). Refer to Diagnostic Routines for other possible causes of the engine's operating symptoms.

TEST 3E12 :
TFI IGNITION DIAGNOSTIC MONITOR (IDM)

NOTE: You should enter this Pinpoint Test only when you have been directed here from Quick Test.

Remember: To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- TFI
- Ignition coil
- Spark plugs and high tension cables
- Distributor
- Arcing of secondary ignition components

This Pinpoint Test is intended to diagnose only the following:

- Harness circuit: IDM
- Processor assembly

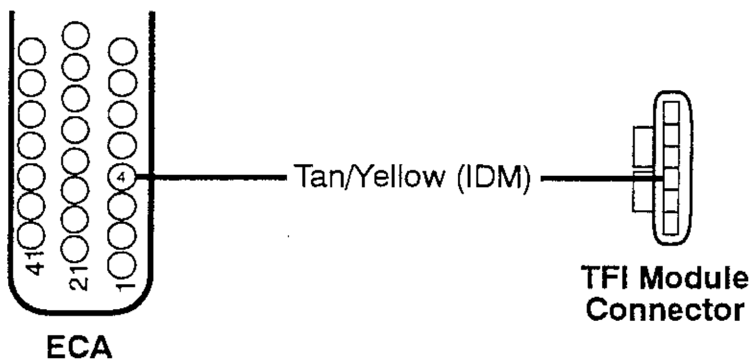
Description: The Ignition Diagnostic Monitor is an input signal to the processor that verifies spark function based on the flyback voltage created by the ignition coil primary discharge, otherwise known as TACH. This signal is transmitted from the TFI module to the processor. The IDM signal consists of a single pulse for each successful ignition event. Lack of an IDM pulse is used as an indication of intermittent and/or missing spark events.

TEST 3E12 :
TFI IGNITION DIAGNOSTIC MONITOR (IDM)

Test Step		Result	Action to Take
3E12-1	CONTINUOUS MEMORY CODE 14: ERRATIC IGNITION		
Code 14 indicates two successive erratic Profile Ignition Pickup (PIP) pulses occurred, resulting in a possible engine miss or stall. Possible causes: 1. Loose wires/connectors 2. Arcing secondary ignition components (coil, cap, rotor, wires, plugs, etc.) 3. On board transmitter (2 way radio)* • Are any of the above present? *Verify all radio and condenser installations. Carefully follow manufacturer's installation instructions regarding the routing of antenna and power leads		Yes No	Service as necessary. Clear continuous Memory Code 14 (section 3D Quick Test - Step 9). Rerun Quick Test. Go to **3E12-2.**

TEST 3E12 : TFI IGNITION DIAGNOSTIC MONITOR (IDM)

Test Step		Result	Action to Take
3E12-2	CONTINUOUS MEMORY CODE 18: CHECK IDM CIRCUIT CONTINUITY		
Continuous Memory Code 18 indicates a loss of IDM input to the Processor. Possible causes: 1. Open engine harness 2. Shorted engine harness 3. TFI module 4. Processor • Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Disconnect TFI module. • Measure resistance between Test Pin 4 at the Breakout Box and IDM circuit (tan/yellow wire) at the TFI engine harness connector. • Is each resistance less than 5.0 ohms?		Yes No	Go to **3E12-3.** Service open circuit. Remove Breakout Box. Reconnect processor. Clear Continuous Memory Codes. Reconnect all components. Rerun Quick Test.



TEST 3E12 : TFI IGNITION DIAGNOSTIC MONITOR (IDM)

Test Step	Result	Action to Take
3E12-3 CHECK IDM CIRCUIT FOR SHORTS TO POWER (EXCLUDING VREF)		
• Key off. • Install Breakout Box. • Disconnect processor and TFI module. • Measure voltage between Test Pin 4 at the Breakout Box and battery negative post. • Key on, engine off. • Measure voltage between Test Pin 4 and Test Pins 40 and 60. • Is any voltage reading greater than 10.5 volts?	Yes No	Service short circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test. Go to **3E12-4.**
3E12-4 CHECK IDM CIRCUIT FOR SHORTS TO VREF AND PIP		
• Key off. • Install Breakout Box, disconnect processor. • Disconnect TFI module. **For Shorts to VREF:** Measure resistance between Test Pin 4 and Test Pin 26. **For Shorts to PIP circuit:** Measure resistance between Test Pin 4 and Test Pin 56. • Is each resistance greater than 10,000 ohms?	Yes No	Go to **3E12-5.** Service short circuits. Remove Breakout Box. Reconnect all components. Rerun Quick Test.
3E12-5 CHECK IDM CIRCUIT FOR SHORT TO GROUND		
• Key off. • Install Breakout Box, disconnect processor. • Disconnect TFI module. • Measure resistance between Test Pin 4 and Test Pins 40, 46 and 60. • Is each resistance above 10,000 ohms?	Yes No	Go to **3E12-6.** Remove Breakout Box. Service short to ground in IDM circuit. Reconnect all components. Clear Continuous Memory Code. Rerun Quick Test.

TEST 3E12 :
TFI IGNITION DIAGNOSTIC MONITOR (IDM)

Test Step	Result	Action to Take
3E12-6 CHECK TFI MODULE		
• Key off. • Install Breakout Box. • Connect processor and TFI module to Breakout Box. • Connect DVOM between Test Pin 4 and Test Pin 16. • Start engine. • Observe DVOM when voltage is allowed to stabilize. • Lightly tap on TFI ignition module to simulate rough water. • Wiggle TFI module and distributor HALL connectors. • A sudden change in voltage indicates a fault. • Is a fault indicated?	Yes No	Disconnect and inspect connectors. If connector and terminals are good, remove Breakout Box, reconnect all components. Refer to Section 3F: TFI-IV Diagnosis. Go to **3E12-7**.
3E12-7 CHECK EEC-IV HARNESS		
• DVOM still connected between Test Pin 4 and Test Pin 16. • Key on, engine running. • While observing a voltage change like in **3E12-6**, perform the following: Wiggle TFI module and distributor HALL connectors. Shake and bend a small section of the EEC-IV harness while working your way to the processor. • Is a fault indicated?	Yes No	Isolate fault and service as necessary. Remove Breakout Box. Reconnect all components. Clear Continuous Memory Code. Rerun Quick Test. Go to **3E12-8**.
3E12-8 CHECK PROCESSOR AND HARNESS CONNECTORS		
• Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. • Are connectors and terminals OK?	Yes No	Go to **3E12-9**. Service as necessary. Remove Breakout Box. Reconnect all components. Clear Continuous Memory Codes (section 3D: Quick Test - Step 9). Rerun Quick Test.

TEST 3E12 : TFI IGNITION DIAGNOSTIC MONITOR (IDM)

Test Step		Result	Action to Take
3E12-9	CHECK PROCESSOR FOR SHORT TO POWER		
• Key off. • Install Breakout Box. • Connect processor to Breakout Box. • Disconnect distributor HALL and TFI module. • Measure voltage between Test Pin 4 and engine ground. • Key on, engine off. • Measure voltage between Test Pin 4 and Test Pins 40 and 60. • Is any voltage reading greater than 10.5 volts?		Yes No	Replace processor. Remove Breakout Box. Reconnect all components. Rerun Quick Test. Go to **3E12-10**.
3E12-10	CHECK PROCESSOR FOR SHORT TO GROUND		
• Key off. • Install Breakout Box. • Connect processor to Breakout Box. • Disconnect TFI module. • Measure resistance between Test Pin 4 and Test Pins 40, 46 and 60. • Is each resistance greater than 10,000 ohms?		Yes No	Remove Breakout Box. Reconnect all components. For further diagnosis, refer to Section 3F: TFI-IV Diagnosis. Replace processor. Remove Breakout Box. Reconnect all components. Rerun Quick Test.

TEST 3E13 : SPARK TIMING CHECK

NOTE: You should enter this Pinpoint Test only when checking computed timing, or you have been directed here from Quick Test.

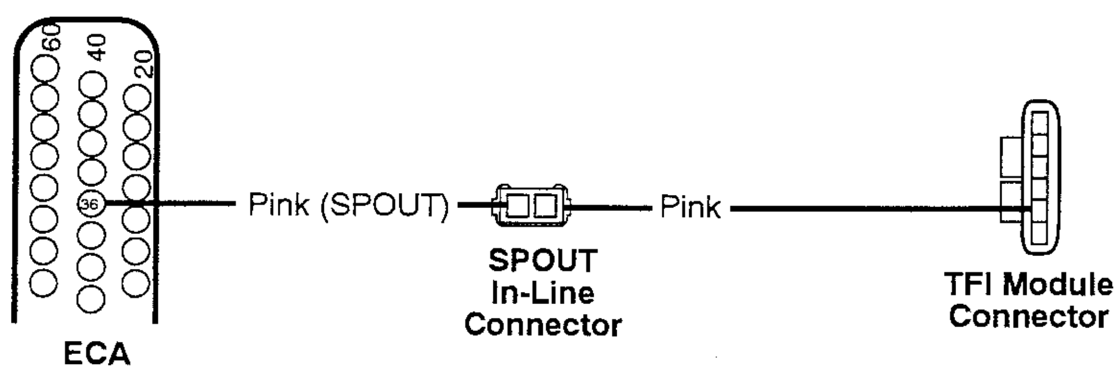
Remember: To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Base engine
- Distributor
- TFI module

This Pinpoint Test is intended to diagnose only the following:

- Harness circuit: SPOUT
- Base timing
- Processor assembly

Description: The Spark Output (SPOUT) is a digital signal generated by the EEC-IV module which supplies desired spark timing and, in some instances dwell information to the TFI module. Normally there will be one and only one SPOUT pulse for each PIP period.



TEST 3E13 : SPARK TIMING CHECK

Test Step		Result	Action to Take
3E13-1	SPARK TIMING CHECK		
NOTE: Before proceeding with this Pinpoint Test, verify that the base timing check in Quick Test - Step 4 has been performed. • Key off. • Disconnect processor 60 pin connector. Inspect for damaged of pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box. Leave processor disconnected. • Key on, engine off. • Measure voltage between Test Pin 37 and Test Pin 40. • Measure voltage between Test Pin 57 and Test Pin 60. • Is each voltage greater than 10.5 volts?		Yes No	Go to **3E13-2.** Go to Pinpoint Test **3E2-1**.
3E13-2	CHECK SPOUT CIRCUIT CONTINUITY		
• Key off. • Install Breakout Box, disconnect processor. • Disconnect TFI module. • Measure resistance between Test Pin 36 at the Breakout Box and SPOUT circuit (pink wire) at the TFI module engine harness connector. • Is resistance less than 5.0 ohms?		Yes No	Go to **3E13-3**. Service open circuit. Remove Breakout Box. Reconnect all components. Check timing as in Quick Test : Section 3D - Step 4.

TEST 3E13 : SPARK TIMING CHECK

Test Step	Result	Action to Take
3E13-3 CHECK SPOUT VOLTAGE AT PROCESSOR		
• Key off. • Install Breakout Box. • Connect processor Breakout Box. • Reconnect TFI module. • Timing switch to "DIST" position on Breakout Box. • DVOM on 20 volt AC scale. • Start engine. • Measure voltage between Test Pin 36 at the Breakout Box and battery negative post. • Is AC voltage between 3.0 and 10.0 volts?	Yes	EEC system OK. Remove Breakout Box. Reconnect processors, Go to Section 3F: TFI-IV Diagnosis.
	No	Replace processor. Remove Breakout Box. Rerun Quick Test.

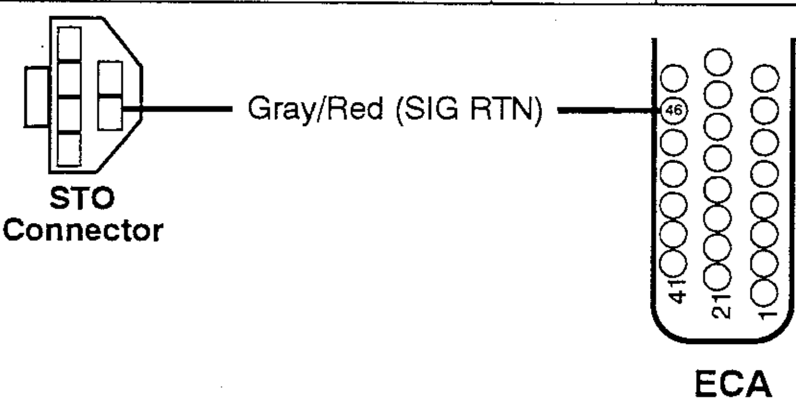
TEST 3E14 : NO CODES OR CODES NOT LISTED

NOTE: You should enter this Pinpoint Test only when you have been directed here from Quick Test.

This Pinpoint Test is intended to diagnose only the following:

- Processor
- EEC Power Relay
- Harness Circuits: SIG RTN, STO, STI, VPWR, VREF

Test Step		Result	Action to Take
3E14-1	CHECK VREF VOLTAGE AT SELF-TEST CONNECTOR		
If using a Star Tester to run Self-Test, verify that correct procedure is used for your application. Refer to Quick Test Section 3. • Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box and connect processor to Breakout Box. • Key on, engine off. • Measure voltage between Test Pin 26 at the Breakout Box and SIG RTN circuit (gray/red wire) in the Self-Test connector. • Is voltage between 4.0 and 6.0 volts?		Yes No	Go to **3E14-3**. Go to **3E14-2**.

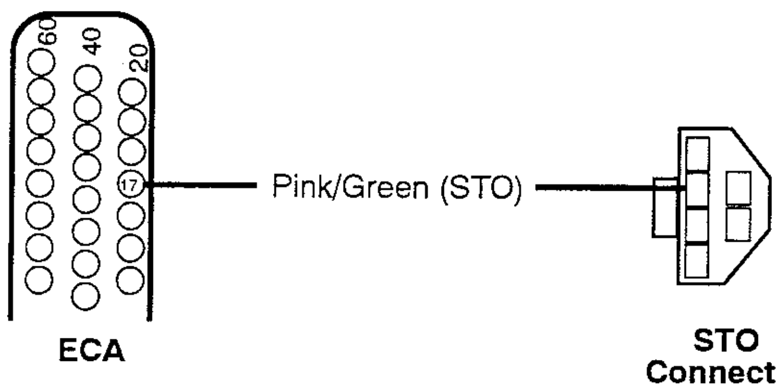


TEST 3E14 : NO CODES OR CODES NOT LISTED

Test Step		Result	Action to Take
3E14-2	CHECK SIG RTN CIRCUIT CONTINUITY		
• Key off. • Install Breakout Box, disconnect processor. • Measure resistance between SIG RTN circuit (gray/red wire) in the Self-Test connector and Test Pin 46. • Is resistance less than 5.0 ohms?		Yes No	Go to Pinpoint Test **3E3-1**. Service defective circuit. Reconnect processor. Rerun Quick Test.
3E14-3	CHECK STI CIRCUIT CONTINUITY		
• Key off. • Install Breakout Box. • Disconnect processor. • Measure resistance between STI circuit in the Self-Test single pin connector and Test Pin 48. • Is resistance less than 5.0 ohms?		Yes No	Go to **3E14-4**. Service open circuit. Remove Breakout Box. Reconnect processor. Rerun Quick Test.

TEST 3E14 : NO CODES OR CODES NOT LISTED

Test Step		Result	Action to Take
3E14-4	CHECK STO CIRCUIT CONTINUITY		
• Key off. • Install Breakout Box, disconnect processor. • Measure resistance between STO circuit (pink/green wire) in the Self-Test connector and Test Pin 17. • Is resistance less than 5.0 ohms?		Yes No	Go to **3E14-5.** Service open circuit. Remove Breakout Box. Reconnect processor. Rerun Quick Test.



Test Step		Result	Action to Take
3E14-5	CHECK STO CIRCUIT FOR SHORT TO GROUND		
• Key off. • Install Breakout Box, disconnect processor. • Measure resistance between STO circuit (pink/green wire) in the Self-Test connector and engine block ground (see **3E14-4**). • Is resistance less than 5.0 ohms?		Yes No	Service STO circuit for short to ground. Remove Breakout Box. Reconnect processor. Rerun Quick Test. Go to **3E14-6.**

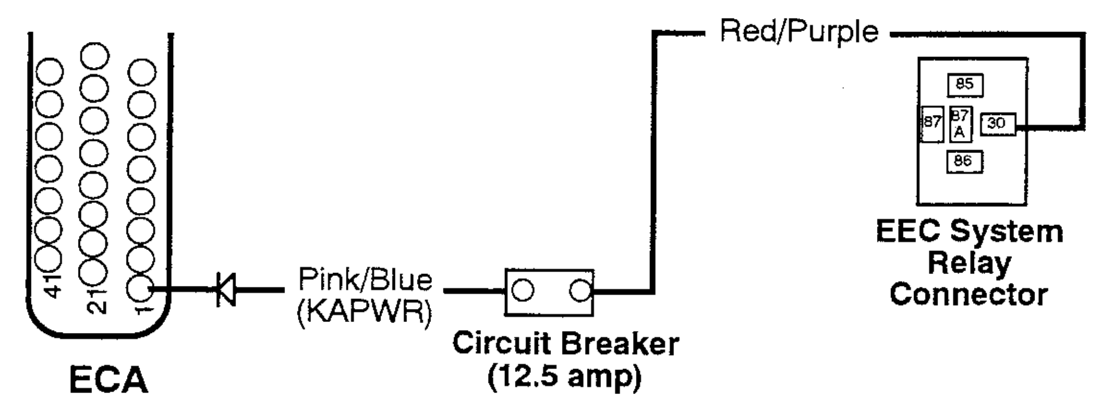
TEST 3E14 : NO CODES OR CODES NOT LISTED

Test Step	Result	Action to Take
3E14-6 CHECK IF POWER RELAY IS ALWAYS ON		
• Key off. • Install Breakout Box, disconnect processor. • Connect DVOM to Test Pin 37 or 57 and to Test Pin 40 or 60. • DVOM on 20 volt scale • Turn key on and then off. Wait 10 seconds. • Does voltage change from greater than 10.5 volts to less than 1.0 volt?	Yes No	Replace the processor. Go to **3E14-7**.
3E14-7 CHECK VPWR CIRCUIT FOR SHORT TO POWER		
• Key off. • Install Breakout Box, disconnect processor. • Disconnect EEC Power Relay. • Measure voltage between Test Pin 37 or 57 and Test Pin 40 and 60. • Is voltage greater than 1.0 volts?	Yes No	Service VPWR circuit short to power. Remove Breakout Box. Reconnect all components. Rerun Quick Test. Replace EEC Power Relay. Remove Breakout Box. Reconnect processor. Rerun Quick Test.

TEST 3E15 :
CONTINUOUS MEMORY SERVICE CODE

NOTE: You should enter this Pinpoint Test only when you have been directed here from Quick Test.

Remember: This Pinpoint Test is intended to diagnose only the following:
- Processor
- Harness Circuit KAPWR



TEST 3E15 : CONTINUOUS MEMORY SERVICE CODE

Test Step		Result	Action to Take
3E15-1	CHECK KAPWR TO PROCESSOR		
Continuous Memory Code 15 indicates that the processor has experienced a power interrupt in its Keep Alive Memory (KAM) circuit. NOTE: If KAPWR is interrupted to the processor, for example when installing a Breakout Box, or when battery is disconnected, Code 15 may be stored in continuous memory. • Key off. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor disconnected. • Measure voltage between Test Pin 1 and Test Pin 40 or 60 at the Breakout Box. • While observing DVOM, grasp the EEC-IV harness and wiggle, shake or bend a small section while working your way from the processor to the dash panel. • Does DVOM indicate less than 10.5 volt?		Yes No	Service open circuit. Remove Breakout Box. Reconnect processor. Rerun Quick Test. Reconnect processor. Go to **3E15-2.**
3E15-2	INSPECT ENGINE COMPARTMENT WIRING FOR PROPER ROUTING		
• Inspect EEC wiring for closeness to ignition components or wires. If EEC wiring is close, reroute as necessary. • Clear Continuous Memory Codes (section 3: Quick Test - Step 9). • Wait five minutes to allow Code 15 to reset. • Rerun Key On Engine Off Self-Test. • Is Code 15 still present on re-test?		Yes No	Replace processor. Remove Breakout Box. Rerun Quick Test. Remove Breakout Box. Reconnect processor. Service other codes as necessary. If none, testing is complete.

TEST 3E16 : SYSTEM CHECK

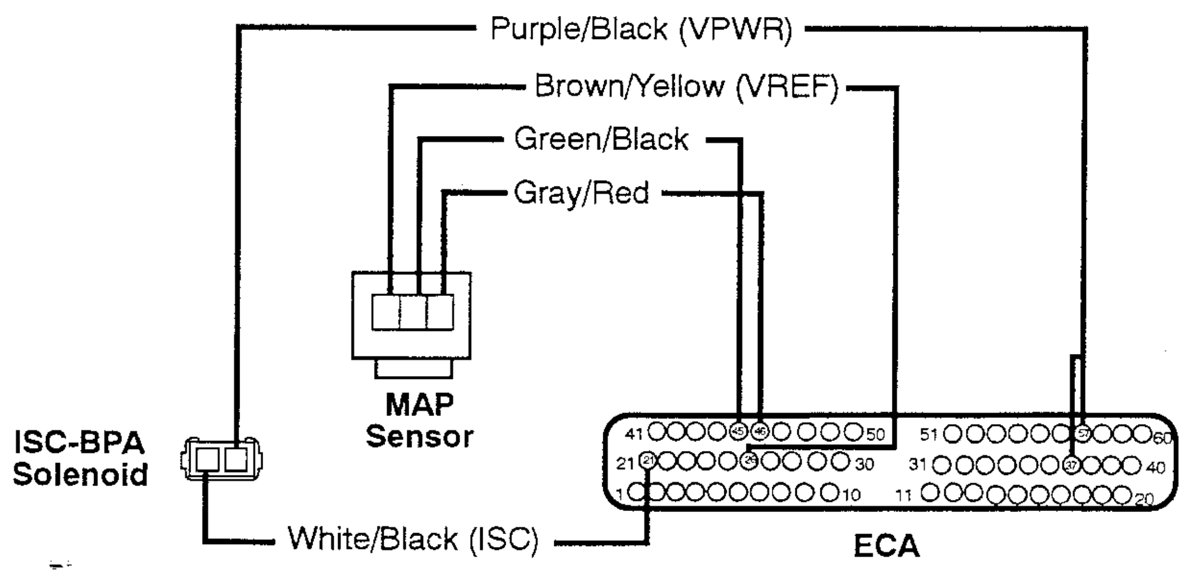
NOTE: You should enter this Pinpoint Test only when you have been directed here from Quick Test or Pinpoint Test **3E1-1**. MAP Sensor Tester, *Rotunda* No. 105-00001, is required for some checks.

Remember: To prevent the replacement of good components, be aware that the following non-EEC areas may be at fault:

- Poor power/ground connections
- Ignition system distributor cap, rotor, wires, coil, plugs
- Engine valves, cam timing, compression, etc.

This Pinpoint Test is intended only as a Quick Check for the basic functioning of the following:

- ISC Bypass Air system
- MAP system



TEST 3E16 : SYSTEM CHECK

Test Step		Result	Action to Take
3E16-1	ISC-BPA CHECK		
• Attempt to start engine at part throttle. • Will engine run smooth at part throttle?		Yes No	Go to Pinpoint Test **3E10-4**. Go to **3E16-3**.
3E16-2	CHECK FOR RPM DROP		
• Key off. • Connect engine tachometer. • Start engine. • Disconnect ISC solenoid. • Does RPM drop or stall?		Yes No	Reconnect ISC solenoid. Go to **3E16-3**. Go to Pinpoint Test **3E10-4**.
3E16-3	POWER TO MAP SENSOR TEST		
• Key off. • Disconnect the MAP sensor from the engine harness. • Connect the MAP tester between the engine harness and the MAP sensor. • Insert MAP tester banana plugs into DVOM. • Key on, engine off. • Is green light on?		Yes No	Go to **3E16-4**. Service open VREF circuit. Remove MAP tester. Reconnect MAP. Re-evaluate symptom.

TEST 3E16 : SYSTEM CHECK

Test Step		Result	Action to Take
3E16-4	CHECK MAP SENSOR OUTPUT		
NOTE: Measure several known good MAP sensors on available engines. The measured voltage will be typical for your location on the day of testing. • MAP Tester and DVOM connected. • Key on. • Is voltage in range for your altitude?		Yes No (sensor output is out of range.)	Go to **3E16-5**. Replace MAP sensor.

Approximate Altitude (Ft.)	Voltage Output (±.04 volts)
0	1.59
1000	1.56
2000	1.53
3000	1.50
4000	1.47
5000	1.44
6000	1.41
7000	1.39

Test Step		Result	Action to Take
3E16-5	CHECK VACUUM LINES		
• Check vacuum lines for proper routing. Check MAP sensor vacuum line for holes, disconnection's, kinks or blockage. • Are vacuum lines OK?		Yes No	Go to **3E16-6**. Service vacuum lines as necessary. Rerun Quick Test.
3E16-6	CHECK MAP SENSOR		
• Key off. • Disconnect MAP vacuum hose at sensor. • Connect a vacuum pump to MAP sensor. • Apply 18 in-Hg (61 kPa) vacuum to MAP sensor. • Does MAP sensor hold vacuum?		Yes No	Release vacuum. Remove vacuum pump. Go to **3E16-7**. Replace MAP sensor. Reconnect vacuum hose to MAP sensor. Rerun Quick Test.

TEST 3E16 : SYSTEM CHECK

Test Step		Result	Action to Take
3E16-7	CHECK VACUUM MANIFOLD SOURCE		
• Key off. • Disconnect MAP vacuum hose at sensor. • Connect a vacuum gauge to vacuum hose. • Start/crank engine. • Is manifold vacuum present at vacuum hose?		Yes	Remove vacuum gauge. Reconnect vacuum line to MAP sensor. Go to Pinpoint Test **3E8-1**.
		No	Remove obstruction in vacuum hose, or replace damaged hose. Rerun Quick Test.

TEST 3E17 : NEUTRAL DRIVE INPUT (if equipped)

NOTE: You should enter this Pinpoint Test only when you have been directed here from Quick Test .

Remember: This Pinpoint Test is intended to diagnose only the following:

- Neutral Drive switch
- Processor
- Harness circuits: NDS, and SIG RTN

Description: The Neutral Drive Input gives an indication of the "in gear" load to the processor. This information is required for adjusting fuel/air ratio and idle speed. If the Neutral Drive Switch (NDS) is closed, the circuit from Test Pin 30 will be grounded.

Test Step	Result	Action to Take
3E17-1 CODE 67: SYSTEM IDENTIFICATION		
A Code 67 resulted from the voltage being high at Pin 30 (Neutral Drive) while cranking the engine or during KOEO test. Possible causes: 1. Neutral Drive Switch open 2. Damaged processor • Is code 67 present?	Yes	Go to **3E17-2.**
3E17-2 CHECK NEUTRAL DRIVE INPUT		
• Key off. • Verify vertical drive is in Neutral. • Disconnect processor 60 pin connector. Inspect for damaged or pushed out pins, corrosion, loose wires, etc. Service as necessary. • Install Breakout Box, leave processor connected. • Key on, engine off. • Measure voltage between Test Pin 30 at the Breakout Box and engine ground. • Is voltage less than 1.0 volt?	Yes No	Replace processor. Go to **3E17-3.**

TEST 3E17 : NEUTRAL DRIVE INPUT

Test Step		Result	Action to Take
3E17-3	CHECK NEUTRAL DRIVE SWITCH		
• Key off. • Install Breakout Box, disconnect processor. • Disconnect engine harness from the Neutral Drive Switch and measure resistance across the switch. • Is resistance less than 5.0 ohms?		Yes	Service open in engine harness Neutral Drive circuit. Remove Breakout Box. Reconnect all components. Rerun Quick Test.
		No	Replace Neutral Drive Switch. Remove Breakout Box. Reconnect all components. Rerun Quick Test.

SECTION 3F : TFI-IV PINPOINT TESTS

NOTES:

- If a remote starter is used, the ignition key must be in the ON position during cranking when using the pinpoint diagnostics.
- Pinpoint Tests 3F1, 3F2 and 3F3 are written to catch "Hard Faults"; intermittent failures will be difficult or impossible to diagnose using these procedures.
- The A/C voltage readings in the following test steps are all based upon readings taken with a Digital Volt/Ohm Meter. Do not use a "true" RMS type meter such as the Fluke 8060a because the A/C voltage readings obtained may be significantly different, leading to incorrect answers to the questions asked in the Pinpoint Tests.
- When making measurements on a wiring harness, both a visual inspection and a continuity test should be performed. Inspect the connector pins for damage (corrosion, bent or spread pins, etc.) when directed to remove a connector.
- When making voltage checks, a GROUND reading means any value within a range of 0 to 1 volt. Also BAT+ readings mean any value that falls within a range of 10 to 14 volts.
- When making voltage checks and a reference to ground is made, use either the negative battery lead or cast iron on the engine. BAT+ means the positive battery cable at the battery.

Symptom Index

Symptom	Action to Take
• Engine No Start and Clear Codes.	Go to **3F1.**
• Engine No Start and Code 14.	Go to **3F1.**
• Code 18 - IDM missing.	Go to **3F2.**
• Timing off, Code 18 - SPOUT open, Lack of Power, Poor Fuel Economy.	Go to **3F3.**
• Clear Codes, Code 14, intermittent miss or stall.	Go to **3F4.**
• Clear Codes and Misfire under load - secondary short to ground.	Go to Secondary System Diagnostic Procedures.
• Engine continues to run after Key is turned off.	Check TFI PWR for short to battery power.

Preliminary Checkout, Equipment and Notes

Checkout

- Visually inspect engine compartment to ensure all vacuum hoses and spark plug wires are properly routed and securely connected.
- Examine all wiring harnesses and connectors for damaged insulation; burned, overheated, damaged pins; loose or broken connections.
- Be certain battery is fully charged.
- All accessories should be **OFF** during diagnosis.

Equipment (Required)

Obtain the following test equipment or an equivalent:

- Marine Kilovolt Tester
- Digital Volt/Ohm Meter
- 12 Volt Incandescent Test Lamp
- Remote Starter Switch
- EEC-IV Breakout Box
- Variable Advance Inductive Timing Light

Equipment (Optional)

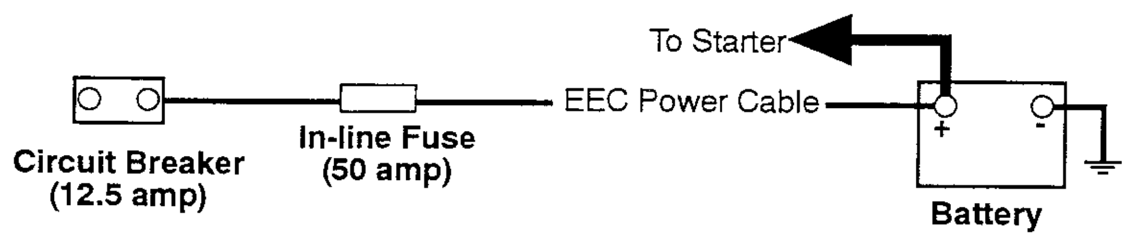
TFI-IV Intermittent Analyzer (Rotunda 007-00035). Necessary for diagnosis of intermittent TFI-IV ignition system faults. This analyzer must have a CCD update added to it in order to test FORDs TFI modules.

WARNING:

- **BEFORE PERFORMING ANY TESTS OR CHECKS RECOMMENDED IN THIS CHAPTER, READ THE SECTION CALLED SAFETY AT THE END OF THIS MANUAL.**
- **DO NOT CHECK IGNITION SYSTEM OUTPUT WITH ANY DEVICE THAT PRODUCES AN OPEN SPARK. THIS COULD IGNITE FUEL VAPORS THAT MAY BE PRESENT DURING TEST.**

TEST 3F1 : TFI-IV NO START

Test Step	Result	Action to Take
3F1-1 WERE TESTS IN EEC-IV QUICK TEST COMPLETED		
• Were all tests accomplished according to EEC-IV Quick Test procedures?	Yes	Go to **3F1-2**.
	No	Refer to Section 3C: Diagnostic Routines.
3F1-2 CHECK FOR GOOD BATTERY		
• Is battery voltage greater than 12 volts DC with the key on?	Yes	Go to **3F1-3.**
	No	Service battery.
3F1-3 CHECK FOR 9 VOLTS MINIMUM AT BATTERY WHILE CRANKING		
• Connect a voltmeter between the positive and negative battery terminals. • Crank engine. • Does meter show a minimum of 9 volts while cranking?	Yes	Go to **3F1-4.**
	No	Replace defective battery. Test engine for start-up capability. If it still fails to start, Go to **3F1-4.**
3F1-4 CHECK EEC POWER CABLE ATTACHMENT		
• Is EEC power cable attached to battery B+ terminal?	Yes	Go to **3F1-5.**
	No	Attach EEC power cable to battery B+ terminal. Test engine for start-up capability. If it still fails to start, Go to **3F1-5.**



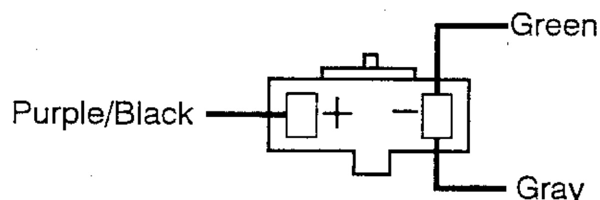
Test Step	Result	Action to Take
3F1-5 CHECK 12.5 AMP CIRCUIT BREAKER		
• Is 12.5 amp circuit breaker tripped? (see **3F1-4**).	Yes	Reset circuit breaker. Test engine start-up capability. If engine still fails to start, Go to **3F1-6.**
	No	Go to **3F1-6.**

TEST 3F1 : TFI-IV NO START

Test Step		Result	Action to Take
3F1-6	CHECK 50 AMP FUSE		
• Is 50 amp fuse in good operating condition? (see **3F1-4**).		Yes No	Go to **3F1-7**. Replace 50 amp fuse. Test engine for start-up capability. If it still fails to start, Go to **3F1-7**.
3F1-7	CHECK FOR SPARK AT COIL DURING CRANKING		
• Using a Marine Kilovolt Tester, check for spark at coil wire during cranking. • Was a minimum of 20 Kilovolts present during cranking?		Yes No	Go to **3F1-16.** Go to **3F1-8.**
3F1-8	CHECK FOR ECA GROUNDS		
• Unplug 60 pin connector at ECA. • Attach a Breakout Box to 60 pin connector. Do not attach Breakout Box to ECA. • Use an ohmmeter to check ground continuity between pins 20/40/60 and an engine ground. • Was there a zero (0) ohmmeter reading on all three checks?		Yes No	Go to **3F1-9**. Repair faulty ground circuit(s). Test engine start-up capability. If engine still fails to start, Go to **3F1-9**.

TEST 3F1 : TFI-IV NO START

Test Step	Result	Action to Take
3F1-9 CHECK FOR SWITCHED B+ AT COIL		
• Unplug 2-wire connector at ignition coil. • Connect a voltmeter between connector purple/black wire terminal and an engine ground. • Turn key switch on (do not crank engine) and check for battery voltage. • Was battery voltage present with key switch on?	Yes No	Go to **3F1-10**. Go to **3F1-14.**



Ignition Coil Connector

Test Step	Result	Action to Take
3F1-10 CHECK COIL PRIMARY AND SECONDARY CIRCUIT RESISTANCE		
• Unplug 2 wire connector at ignition coil. • Use an ohmmeter to check primary and secondary circuit resistance. • Was primary circuit resistance 0.39 - 0.42 ohms? Was secondary circuit resistance 7600 - 9400 ohms?	Yes No	Go to **3F1-11.** Replace coil if either resistance value is not correct. Test engine start-up capability. If engine still fails to start, Go to **3F1-11.**
3F1-11 CHECK FOR GROUNDED TACHOMETER LEAD		
• Unplug 2 wire connector at ignition coil. • Connect an ohmmeter between the connector gray lead and an engine ground. (see **3F1-9**). • Does ohmmeter show an infinity (Ω) reading?	Yes No	Go to **3F1-12.** Repair grounded tachometer lead. Test engine start-up capability. If engine still fails to start, Go to **3F1-12**.

TEST 3F1 : TFI-IV NO START

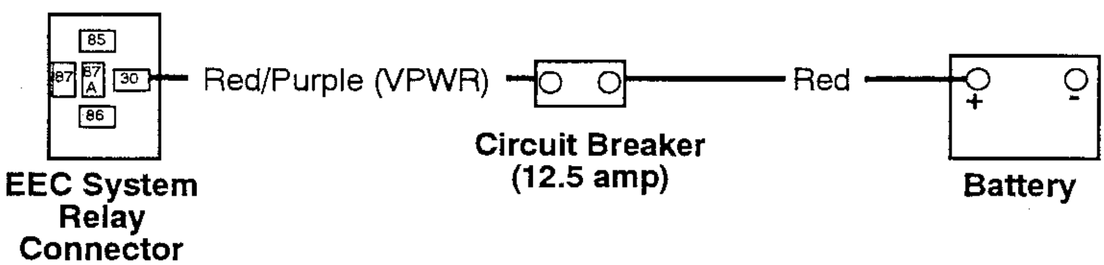
Test Step	Result	Action to Take
3F1-12 CHECK CONTINUITY OF TFI PRIMARY CIRCUIT CONTROL LEAD		
• Unplug connector at TFI module. • Unplug connector at ignition coil. • Use an ohmmeter to check continuity of dark green lead between coil connector and TFI connector. • Does meter show zero (0) continuity?	Yes No	Go to **3F1-13.** Repair lead. Test engine start up capability. If engine still fails to start, Go to **3F1-13.**
3F1-13 CHECK TFI MODULE/PIP SENSOR OPERATION		
• Attach 2 wire connector to ignition coil. • Unplug connector at TFI module. • Install *Rotunda* TFI Tester between connector and TFI module. Operate Tester according to instructions supplied with Tester. If test light does not come on when test button is pressed, check and repair faulty distributor ground circuit before conducting test. • Were both Tester lights blinking while engine was cranking?	Yes No	Problem is not ignition related. Check fuel system. If PIP light blinks, but tachometer light doesn't, replace TFI module. If PIP light doesn't blink (tachometer light function is not important), replace Hall Effect switch inside distributor. Test engine start-up capability. If engine still fails to start, check fuel system.
3F1-14 CHECK FOR SWITCHED B+ AT ECA.		
• Disconnect 60 pin connector at ECA. • Attach a Breakout Box to 60 pin connector. Do not connect Breakout Box to ECA. • Use a voltmeter to check between pins 37/57 and pins 20/40/60 for battery voltage when key switch is turned on (do not crank engine). • Is battery voltage present at both pins 37 and 57 with key switch on?	Yes No	Repair defective purple/black wire circuit between ECA and coil. Test engine start-up capability. If engine still fails to start, Go to **3F1-10.** Go to **3F1-15.**
3F1-15 CHECK EEC POWER RELAY		
• Remove EEC power relay and substitute a new one. • Is battery voltage now present at both pins 37/57 with key switch on?	Yes No	Discard defective relay. Test engine start-up capability. If engine still fails to start, Go to **3F1-10.** Go to **3F1-20.**

TEST 3F1 : TFI-IV NO START

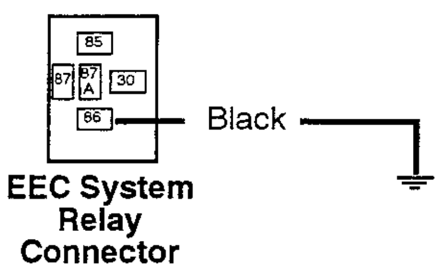
Test Step	Result	Action to Take
3F1-16 CHECK FOR SPARK AT SPARK PLUGS		
• Connect a marine Kilovolt meter to each spark plug lead at the plug. Leave lead attached to spark plug. • Operate KV Tester in accordance with manufacturer's instructions. • Is a minimum of 5 - 7 Kilovolts available at each spark plug?	Yes No	Go to **3F1-17.** Go to **3F1-18.**
3F1-17 CHECK FIRING ORDER AND PLUG WIRE ROUTING		
• Is firing order and spark plug wire routing correct for engine being tested?	Yes No	Problem is not ignition related, Check fuel system. Correct firing order/wire routing problem. Test engine start-up capability. If engine still fails to start, problem is not ignition related, check fuel system.
3F1-18 CHECK ROTOR AND DISTRIBUTOR CAP CONDITION		
• Disable ignition system to prevent electrical arcing by disconnecting 2 wire connector at ignition coil. • Remove distributor cap. Check condition of rotor. NOTE: The cap and rotor may have a white, crusty residue of dielectric silicone grease. This is normal. • Check condition of center button and all terminals inside distributor cap. • Momentarily crank engine. Watch rotor movement. • Does rotor turn when engine is cranked? Is rotor and distributor cap in good condition?	Yes No	Go to **3F1-19.** Replace defective rotor and/or distributor cap. Test engine start-up capability. If engine still fails to start, Go to **3F1-19.** If rotor fails to turn when engine is cranked, determine cause and repair it. Test engine start-up capability. If engine still fails to start, Go to **3F1-19.**
3F1-19 CHECK SPARK PLUG LEADS AND SPARK PLUGS		
• Remove spark plug leads and check resistance of each lead. • Remove spark plugs and check each plug for gap, heat range and condition. • Are spark plugs in good operating condition? Does each spark plug lead have a resistance of 3000 - 7000 ohms per foot?	Yes No	Check engine compression. If engine still fails to start, contact your marine manufacturer. Replace defective parts. If engine still fails to start, check engine compression.

TEST 3F1 : TFI-IV NO START

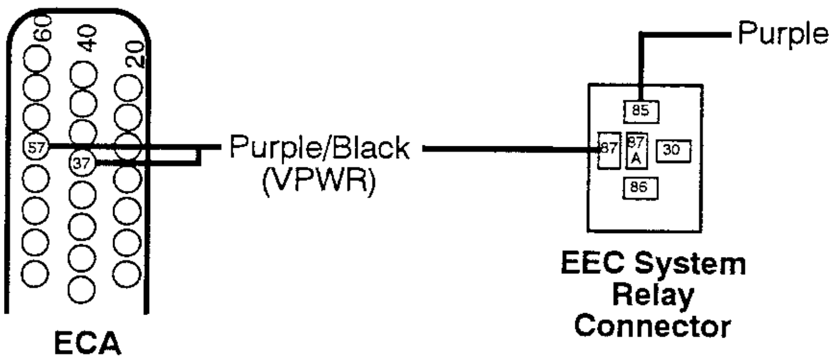
Test Step		Result	Action to Take
3F1-20	CHECK FOR BATTERY VOLTAGE AT EEC POWER RELAY CONNECTOR		
• Separate EEC relay from connector. • Connect a voltmeter to red/purple wire at EEC relay connector, and to an engine ground. • Is battery voltage present at EEC relay connector?		Yes No	Go to **3F1-21**. Go to **3F1-22**.



Test Step		Result	Action to Take
3F1-21	CHECK RELAY CONNECTOR GROUND CIRCUIT		
• Separate EEC relay from connector. • Connect an ohmmeter between the relay connector black lead and an engine ground. • Does meter show zero (0) continuity?		Yes No	Go to **3F1-23**. Repair defective relay ground circuit. Test engine for start-up capability. If it still fails to start, Go to **3F1-22**.

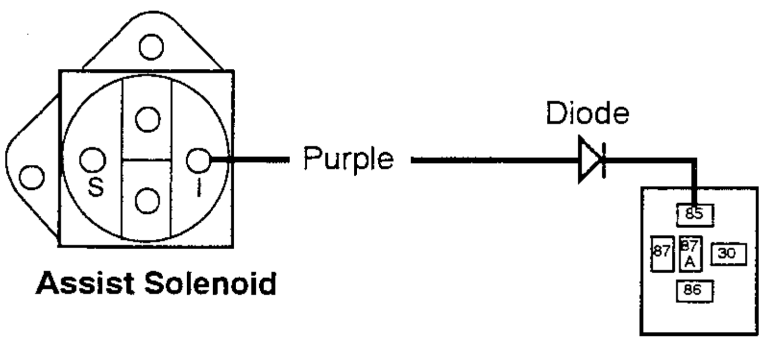


TEST 3F1 : TFI-IV NO START

Test Step		Result	Action to Take
3F1-22	CHECK FOR BATTERY VOLTAGE FROM 12.5 AMP CIRCUIT BREAKER		
• Connect a voltmeter to the red/purple wire terminal of the 12.5 amp circuit breaker, and to an engine ground (see **3F1-20**). • Is battery voltage present at 12.5 amp circuit breaker?		Yes	Repair defective red/purple wire circuit between circuit breaker and relay connector. Test engine for start-up capability. If it still fails to start, Go to **3F1-23**.
		No	Go to **3F1-24**.
3F1-23	CHECK FOR SWITCHED B+ AT EEC POWER RELAY CONNECTOR		
• Separate EEC relay from connector. • Connect a voltmeter to the purple wire at the EEC relay connector, and to an engine ground. • Turn key switch on, **do not crank engine.** • Is battery voltage present at EEC relay connector purple wire with key switch on?		Yes	Repair defective purple/black wire between relay connector and 60 pin connector. Test engine for start-up capability. If it still fails to start, check fuel system.
		No	Go to **3F1-26**.
 			
3F1-24	CHECK FOR BATTERY VOLTAGE TO 12.5 AMP CIRCUIT BREAKER		
• Connect a voltmeter to the red wire at the 12.5 amp circuit breaker, and to an engine ground (see **3F1-20**). • Is battery voltage present?		Yes	Replace defective circuit breaker. Test engine for start-up capability. If it still fails to start, Go to **3F1-23.**
		No	Go to **3F1-25**.

TEST 3F1 : TFI-IV NO START

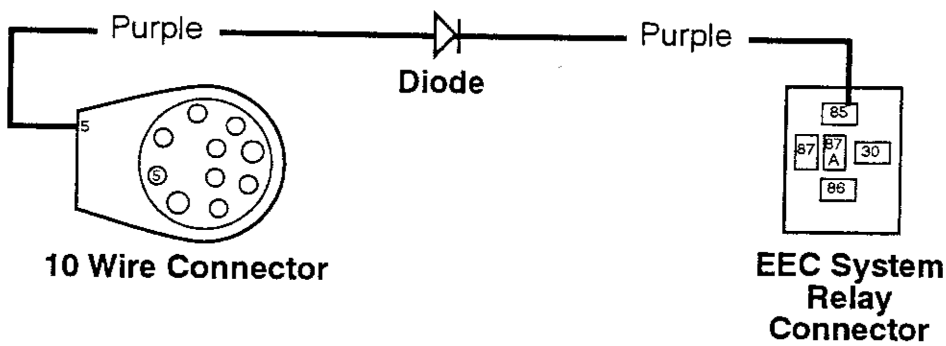
Test Step	Result	Action to Take
3F1-25 CHECK FOR 12 VOLTS MINIMUM AT BATTERY		
• Connect a voltmeter between the positive and negative battery terminals. • Does meter show a minimum of 12 volts?	Yes	Replace defective 50 amp fuse, fuse holder or wire to 12.5 amp circuit breaker. Test engine for start-up capability. If it still fails to start, Go to **3F1-23**.
	No	Replace battery. Test engine for start-up capability.
3F1-26 CHECK FOR SWITCHED B+ AT ASSIST SOLENOID		
• Attach a voltmeter to the solenoid's small "I" terminal (purple lead), and to an engine ground.	Yes	Go to **3F1-27**.
• Turn key switch on, **do not crank engine.** • Does meter show a minimum of 12 volts with key switch on?	No	Go to **3F1-28**.



Test Step	Result	Action to Take
3F1-27 CHECK FOR SWITCHED B+ AT ASSIST SOLENOID WHILE CRANKING		
• Key switch off. • Remove purple lead from solenoid's small "I" terminal. • Attach a voltmeter to the solenoid's small "I" terminal, and to an engine ground. • Crank engine.	Yes	Service defective purple wire circuit or diode between assist solenoid and EEC relay connector. Test engine for start-up capability. If it still fails to start, check fuel system.
• Does meter show a minimum of 12 volts while cranking?	No	Replace defective solenoid. Test engine for start-up capability. If it still fails to start, check fuel system.

TEST 3F1 : TFI-IV NO START

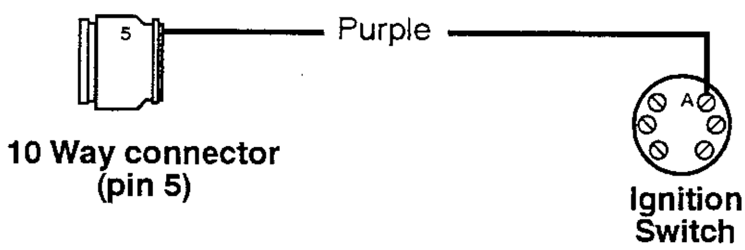
Test Step	Result	Action to Take
3F1-28 CHECK SOLENOID TO 10 WIRE CONNECTOR CIRCUIT FOR CONTINUITY		
• Key switch off. • Remove purple lead from solenoid's small "I" terminal. • Disconnect boat wire harness from engine 10 wire connector. • Connect an ohmmeter between the purple lead at the solenoid, and terminal 5 (purple wire) at the engine 10 wire connector. • Does meter show zero (0) continuity?	Yes No	Go to **3F1-29**. Service defective purple wire circuit between 10 wire connector and solenoid. Test engine for start-up capability. If it still fails to start, check fuel system.



Test Step	Result	Action to Take
3F1-29 CHECK SOLENOID TO 10 WIRE CONNECTOR CIRCUIT FOR A GROUND		
• Key switch off. • Remove purple lead from solenoid's small "I" terminal. • Disconnect boat wire harness from engine 10 wire connector. • Connect an ohmmeter between the purple lead at the solenoid or 10 wire connector, and to an engine ground. • Does meter show infinity (Ω)?	Yes No	Go to **3F1-30**. Service defective purple wire circuit between 10 wire connector and solenoid. Test engine for start-up capability. If it still fails to start, check fuel system.

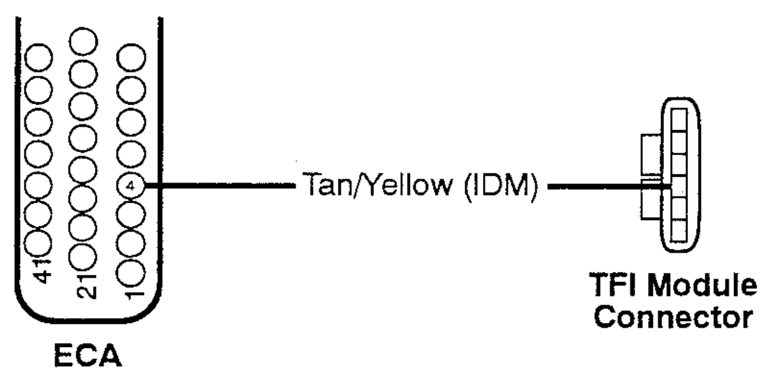
TEST 3F1 : TFI-IV NO START

Test Step		Result	Action to Take
3F1-30	CHECK FOR BATTERY VOLTAGE AT KEY SWITCH "A" TERMINAL		
• Attach a voltmeter to the key switch "A" terminal, and to a good ground. • Turn key switch to the "ON" position. • Does meter show battery voltage?		Yes	Service defective boat harness circuit (purple wire) between key switch and engine 10 wire connector. Test engine for start-up capability. If it still fails to start, check fuel system.
		No	Replace defective key switch. Test engine for start-up capability. If it still fails to start, check fuel system.



TEST 3F2 : TFI-IV IDM MISSING, CODE 18

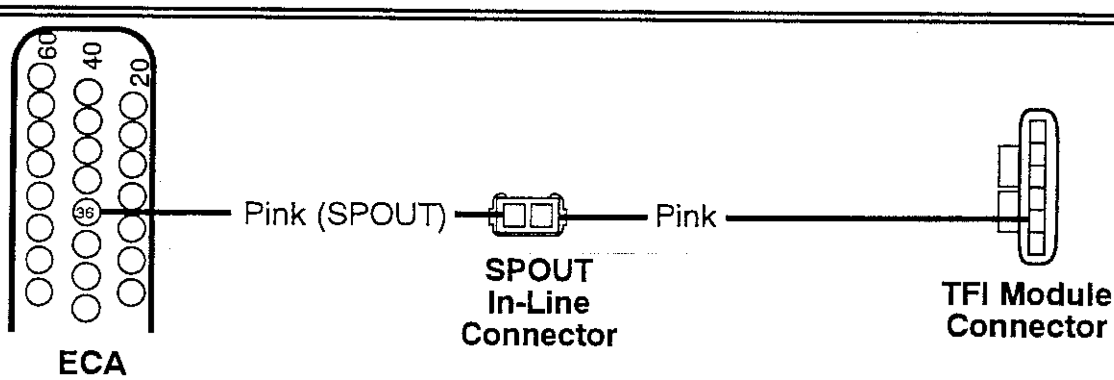
Test Step	Result	Action to Take
3F2-1 VISUAL CHECK FOR CCD TFI MODULE		
• Check for CCD TFI module. CCD modules are colored black. • Is TFI module black?	Yes No	Go to **3F2-2**. Replace TFI module with correct CCD type/color module. Rerun engine, repeat Self-Test procedures.
3F2-2 CHECK IDM SIGNAL AT 60 PIN CONNECTOR		
• Key off. • Disconnect 60 pin connector at processor. Attach Breakout Box to 60 pin connector. Leave processor disconnected. • Set DVOM on 20 volt AC scale. • Crank engine and measure voltage between Pin 4 (IDM) and Pins 20/40/60 (engine ground). • Is voltage greater than 1.0 volt AC?	Yes No	Replace EEC processor. Remove all test equipment. Reconnect all components. Clear Continuous Memory. Rerun Quick Test. Go to **3F2-3**.
3F2-3 CHECK FOR IDM SHORT HIGH IN HARNESS		
• Key off. • Remove TFI connector from TFI module. • Set DVOM on 20 volt DC scale. • Key on, **do not crank engine**. • Measure voltage between TFI connector tan/yellow lead (IDM) and Pins 20/40/60 (engine ground). • Is voltage less than 0.5 volt DC?	Yes No	Go to **3F2-4**. Service IDM circuit shorted high between 60 pin connector and TFI connector. Remove all test equipment. Reconnect all components. Clear Continuous Memory. Rerun Quick Test.



TEST 3F2 : TFI-IV IDM MISSING, CODE 18

Test Step	Result	Action to Take
3F2-4 CHECK FOR IDM CIRCUIT GROUND		
• Key off. • Set DVOM on 20K ohm scale. • Measure resistance between TFI connector tan/yellow lead (IDM) and Pins 20/40/60 (engine ground). • Is resistance greater than 10K ohms?	Yes	Go to **3F2-5**.
	No	Service grounded IDM circuit between 60 pin connector and TFI connector. Remove all test equipment. Reconnect all components. Clear Continuous Memory. Rerun Quick Test.
3F2-5 CHECK IDM CIRCUIT CONTINUITY		
• Key off. • Measure resistance between TFI connector tan/yellow lead (IDM) and Pin 4. • Is resistance less than 5.0 ohms?	Yes	Replace TFI module. Remove all test equipment. Reconnect all components. Clear Continuous Memory. Rerun Quick Test.
	No	Service open IDM circuit between TFI module and 60 pin connector. Remove all test equipment. Reconnect all components. Clear Continuous Memory. Rerun Quick Test.

TEST 3F3 : TFI-IV TIMING OFF, CODE 18 - SPOUT OPEN, POOR FUEL ECONOMY, POOR DRIVEABILITY



Test Step		Result	Action to Take
3F3-1	VISUAL CHECK FOR CCD TFI MODULE		
• Check for CCD TFI module. CCD modules are colored black. • Is TFI module black?		Yes	Go to **3F3-2**.
		No	Replace TFI module with correct CCD type/color module. Rerun engine, repeat Self Test Procedures.
3F3-2	CHECK BASE TIMING		
CAUTION: Do not use a remove starter while doing timing check. • Key off. • Install timing light. • Idle engine at normal operating temperature. • Remove SPOUT in-line connector. • Is base timing correct?		Yes	Go to **3F3-3**.
		No	Reset timing (section 3D: Quick Test - Step 4).
3F3-3	CHECK FOR SPARK ADVANCE		
• Key off. • Reconnect SPOUT in-line connector. • Idle engine at normal operating temperature. • Is timing greater than 5 degrees, does spark advance?		Yes	Not an ignition problem. Refer to Section 3C, Diagnostic Routines.
		No	Go to **3F3-4**.

TEST 3F3 : TFI-IV TIMING OFF, CODE 18 - SPOUT OPEN, POOR FUEL ECONOMY, POOR DRIVEABILITY

Test Step	Result	Action to Take
3F3-4 CHECK SPOUT VOLTAGE TO TFI MODULE		
• Disconnect 60 pin connector. Attach a Breakout Box to 60 pin connector. Connect Breakout Box to processor. • Remove SPOUT in-line connector. • Set DVOM on 20 volt AC scale. • Run engine and measure voltage between Pin 36 (SPOUT) and Pin 20/40/60 (engine ground). • Is voltage between 3.0 and 8.5 volts AC?	Yes No	Replace TFI module. Remove all test equipment. Reconnect all components. Clear Continuous Memory. Rerun Quick Test. Go to **3F3-5**.
3F3-5 CHECK SPOUT CIRCUIT CONTINUITY		
• Key off. • Disconnect EEC processor from Breakout Box. • Remove TFI connector from TFI module. • Set DVOM on 200 ohm scale. • Measure resistance between Pin 36 (SPOUT) and TFI connector pink lead. • Is resistance less than 5.0 ohms?	Yes No	Go to **3F3-7**. Go to **3F3-6**.
3F3-6 CHECK SPOUT IN-LINE CONNECTOR CONTINUITY		
• Key off. • Remove SPOUT in-line connector. • Set DVOM on 200 ohm scale. • Measure resistance between both terminals of SPOUT in-line connector. • Is resistance less than 5.0 ohms?	Yes No	Check terminals for proper contact with harness, and reinstall. Repeat **3F3-5**. Replace defective SPOUT in-line connector. Repeat **3F3-5**.

TEST 3F3 : TFI-IV TIMING OFF, CODE 18 - SPOUT OPEN, POOR FUEL ECONOMY, POOR DRIVEABILITY

Test Step	Result	Action to Take
3F3-7 CHECK FOR GROUNDED SPOUT HARNESS CIRCUIT		
• Key off. • Set DVOM on 200 ohm scale. • Measure resistance between TFI connector pink lead and an engine ground. • Does meter show infinity Ω?	Yes No	Go to **3F3-8**. Service defective pink wire (SPOUT) circuit.
3F3-8 CHECK FOR GROUNDED SPOUT TFI CIRCUIT		
• Key off. • Set DVOM on 20 volt DC scale. • Attach TFI connector to TFI module. • Key switch on. • Measure voltage between Pin 36 and an engine ground. • Does meter show a voltage reading?	Yes No	Replace defective TFI module. Replace EEC processor. Remove all test equipment. Reconnect all components. Clear Continuous Memory. Rerun Quick Test.

TEST 3F4 : TFI-IV INTERMITTENT DIAGNOSIS

NOTES:

- This procedure begins with a complaint that the engine stops at unexpected times but can be restarted. In situations like this there are two things that are very important. The technician must obtain as much information directly from the customer about the conditions under which the problem occurs, and the service history of the engine must be thoroughly reviewed to avoid repeat replacement of good components.

- Two testers are available for assistance with intermittent diagnosis. The ***Rotunda* TFI/EEC-IV Intermittent Ignition Analyzer 007-00035** is available for diagnosing intermittent problems. It provides a quick connection to the TFI-IV ignition system and records intermittent failures. The TFI-IV Intermittent Analyzer cannot be used with TFI-IV modules with Computer Controlled Dwell (CCD) unless a CCD update is added to the analyzer. The ***Rotunda* Ignition System Tester 007-00008** provides a quick means of separating primary ignition system problems from fuel or other system problems causing similar symptoms. It will detect any primary ignition system problem, but it is particularly useful in detection of intermittent problems.

CHECKOUT:

- Visually inspect the engine compartment to ensure all vacuum hoses and spark plug wires are properly routed and securely connected.

- Examine all wiring harnesses and connectors for insulation damage, burned, overheated, loose or broken conditions.

Test Step		Result	Action to Take
3F4-1	FIND SYMPTOMS		
• Talk to customer.			Record symptoms. Go to **3F4-2.**
3F4-2	REVIEW ENGINE HISTORY		
• Review engine service history.			Note number of previous repairs and components replaced. Go to **3F4-3**.
3F4-3	TEST EQUIPMENT		
• Is a Rotunda TFI/EEC-IV Intermittent Ignition Analyzer 007-00035 or equivalent available?		Yes	Follow test procedure instruction supplied with tester.
NOTE: The TFI-IV intermittent analyzer cannot be used with TFI-IV modules with Computer Controlled Dwell (CCD) unless a CCD update is added to the analyzer. FORD uses a CCD module; the analyzer must have an update.		No	Go to **3F4-4**.

TEST 3F4 : TFI-IV INTERMITTENT DIAGNOSIS

Test Step		Result	Action to Take
3F4-4	BEGIN DIAGNOSIS		
• Will engine start?		Yes No	Go to **3F4-5.** Go to **3F1-1.**
3F4-5	COLD WIGGLE TEST		
• Engine at idle, raise hood, shake wiring harness and pull wires at connectors for ignition components. • Does engine quit?		Yes No	Service wiring harness or connector. Go to **3F4-6.**
3F4-6	ENGINE WARM-UP		
• Engine at idle, engine cover on. Boat accessories on. • Does engine quit?		Yes No	Go to **3F4-10.** Go to **3F4-7.**
3F4-7	HOT RESTART TEST		
• Engine off, engine cover on, hot soak for 10 minutes. • Will engine restart?		Yes No	Go to **3F4-8.** Go to **3F1-1.**
3F4-8	HOT WIGGLE TEST		
• Engine at idle, engine cover off, shake wiring harness and pull wires at connectors for ignition components. • Does engine quit?		Yes No	Service wiring harness or connector. Go to **3F4-9.**
3F4-9	ON THE WATER TEST		
• On the water test. • Does engine quit?		Yes No	Go to **3F4-10.** Test complete (problem not duplicated).
3F4-10	FINAL TEST		
• Engine cover off, shake wiring harness, pull wires at connectors, separate and reconnect connectors for ignition components. • Does engine start?		Yes No	Service wiring harness or connector. Go to **3F1-1.**

Table of Contents

SECTION 3G : SECONDARY IGNITION SYSTEM TESTS

Preliminary Checkout and Equipment

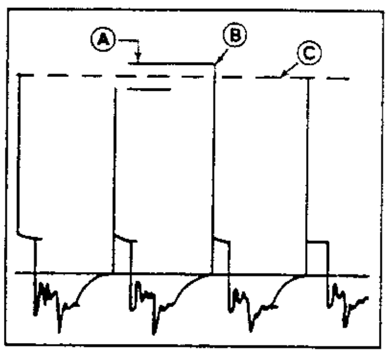
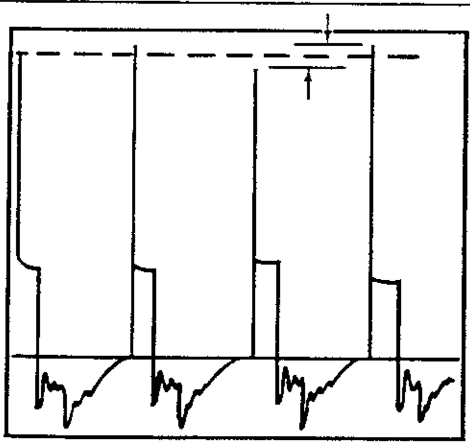
- Visually inspect the engine compartment to ensure all vacuum hoses and spark plug wires are properly routed and securely connected.
- Examine all wiring harnesses and connectors for insulation damage, burned, overheated, loose or broken conditions.
- Be certain the battery is fully charged.
- All accessories should be off during diagnosis.
- Obtain the following test equipment or an equivalent:
  1. Marine Kilovolt Tester
  2. Digital Volt-Ohmmeter
  3. Optional - Engine Analyzer, ***Rotunda*** 002-00373

TEST 3G1 :
IGNITION COIL SECONDARY VOLTAGE

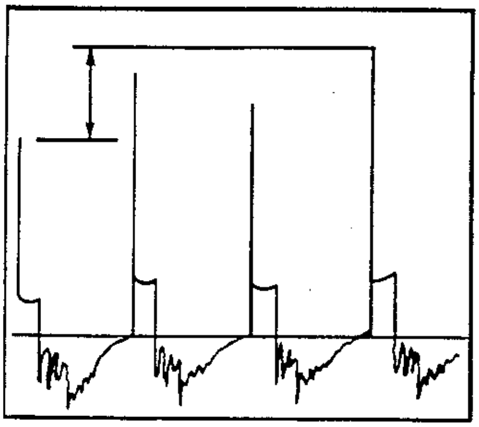
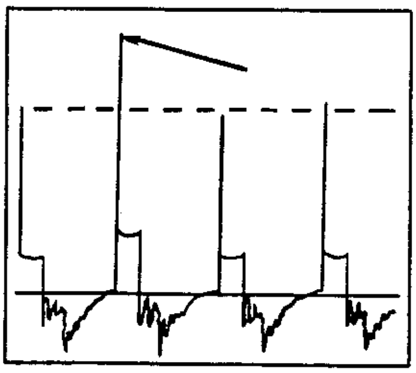
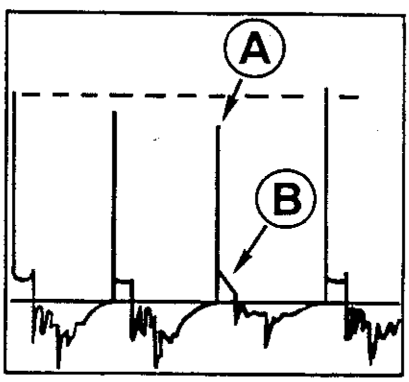
Test Step	Result	Action to Take
3G1-1		
• Will engine start and run?	Yes	Test result OK. Go to **3G2.**
	No	Inspect ignition coil for damage or carbon tracking. Measure resistance of ignition coil wire. Replace if greater than 7000 ohms per foot. Go to Section 3F: TFI-IV Pinpoint Test , Symptom Index.

TEST 3G2 : SECONDARY DISPLAY

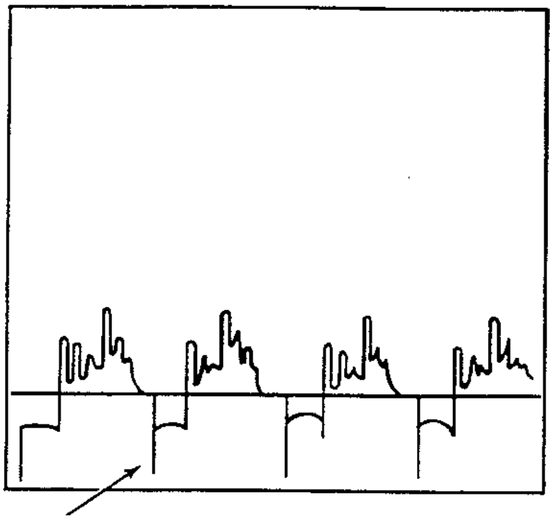
NOTE: To provide accurate results, it is essential that the calibration of your engine analyzer be maintained. Refer to your equipment manual. The spark tester firing voltage should be approximately 28 KV.

Test Step	Result	Action to Take
3G2-1		
• Connect engine analyzer to view **parade** display of ignition system secondary. • While **slowly** increasing engine RPM from idle to 2000 RPM, compare engine analyzer display to the following illustrations. The illustrations shown are four cylinder but are typical for all engines. • Disconnect engine analyzer.		Evaluate display and Go to appropriate step.
3G2-2		
Ⓐ Evenness (High to Low) Ⓑ Firing Voltage Ⓒ Average Voltage 	The average of spark plug firing voltage: 15 KV or less with evenness of spark plug firing voltage: 5 KV or less.	These are normal values for a properly operating ignition system.
3G2-3		
	The average value of spark plug firing voltage: greater than 15 KV with evenness of spark plug firing voltage: 5 KV or less.	Problems affecting all cylinders: Check ignition coil wire for proper installation in coil and distributor cap. Measure resistance of ignition coil wire. Replace if greater than 7000 ohms per foot. Wide spark plug gaps - all cylinders, (usually from worn electrodes due to high mileage). Inspect cap and rotor for problems causing excessive cap to rotor gap.

TEST 3G2 : SECONDARY DISPLAY

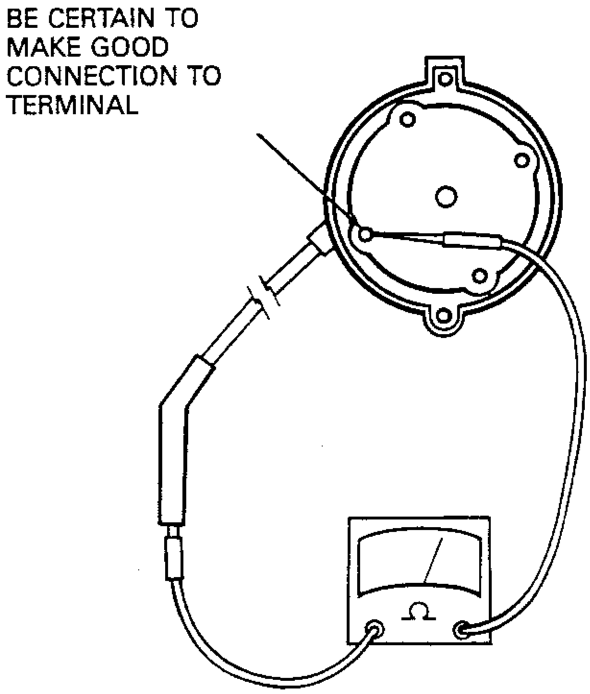
Test Step	Result	Action to Take
3G2-4		
	Evenness of spark plug firing voltage: greater than 5 KV.	Problems affecting some cylinders: Wide spark plug gap(s) or worn electrode(s). Improperly installed cap, adapter, or rotor.
3G2-5		
	Consistent high spark plug firing voltage in one or more cylinders	Spark plug wire(s) not firmly connected to distributor cap or spark plug. Disconnected spark plug wire(s). Wide spark plug gap(s). Open plug wire(s). Go to **3G3**.
3G2-6		
Ⓐ Firing Voltage Ⓑ Spark Line 	Consistent low spark plug firing voltage or sloping spark line in one or more cylinders.	Fouled spark plug(s). Narrow spark plug gap(s). Spark plug wire(s) grounding on engine. Inspect for damage. Carbon tracking in cap and adapter.

TEST 3G2 : SECONDARY DISPLAY

Test Step		Result	Action to Take
3G2-7			
		Spark plug firing voltage negative going.	Ignition coil primary circuit reversed. Check wiring harness for ignition coil primary circuit. If OK, replace ignition coil.

TEST 3G3 : SPARK PLUG WIRE RESISTANCE

Test Step	Result	Action to Take
3G2-1		
• Remove distributor cap from distributor. • Check for spark plug wires firmly seated on cap. • Disconnect spark plug end of suspect wire(s). • Measure resistance from terminal in cap to spark plug terminal. • Reinstall distributor cap and connect spark plug wire to spark plug. CAUTION: Do not, under any circumstances, puncture a spark plug wire when measuring resistance. Measure only as instructed. • Was resistance less than 7000 ohms per foot?	Yes No	Spark plug wire resistance OK. Replace spark plug wire(s).



SECTION 3H : EFI SYSTEM PINPOINT TESTS

NOTE: To prevent the replacement of good components, check the following areas for a fault:

- Battery and charging system low (circuit breaker or fuse integrity).
- Contamination within Idle Speed Control solenoid or Throttle Body.
- Contamination or octane rating of fuel.
- Engine not reaching operating temperature; cooling system leaking.
- PCV system (incorrect/clogged).
- Ignition system.
- Vacuum leaks (intake manifold, vacuum hoses, plenum, throttle body).

VERIFY:

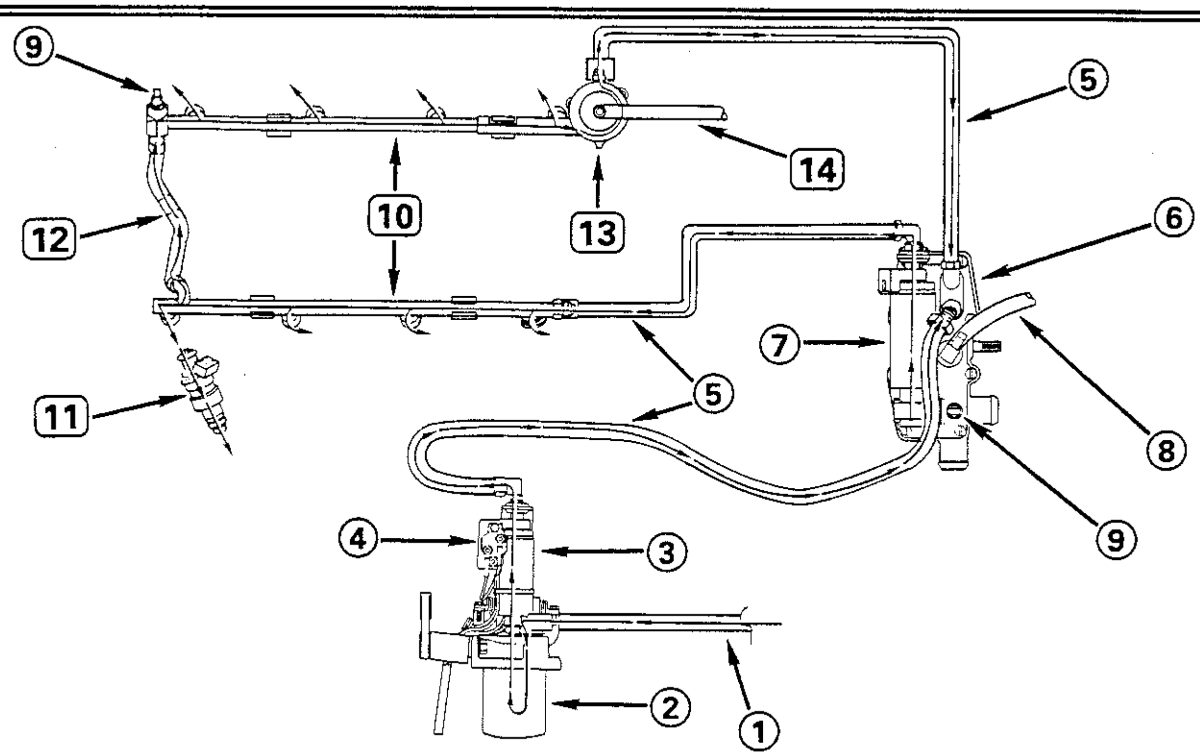
- Alternator belt tension.
- Boat accessories off.
- Throttle Body throttle lever is resting on stop screw.
- EEC-IV Quick Tests performed and service codes resolved.
- Adequate fuel supply in the fuel tank.
- **Vertical Drive must be in NEUTRAL unless otherwise specified.**
- **Fuel system integrity (leaks, restrictions or damage).**
- **Fuel system electrical integrity (no spark-producing faults).**

Special Service Tools

Tool Number	Description
OTC-7211 and OTC-7272	Fuel Pressure Gauge & Adaptor
Rotunda 021-00037	Vacuum Tester
Rotunda 059-00008	Vacuum and Pressure Tester
Rotunda 113-00001	Fuel Injector Tester/Cleaner
-	Mechanic's Stethoscope

WARNING: BEFORE PERFORMING ANY TESTS OR CHECKS RECOMMENDED IN THIS CHAPTER, READ THE SECTION CALLED SAFETY AT THE END OF THIS MANUAL.

DIAGNOSIS



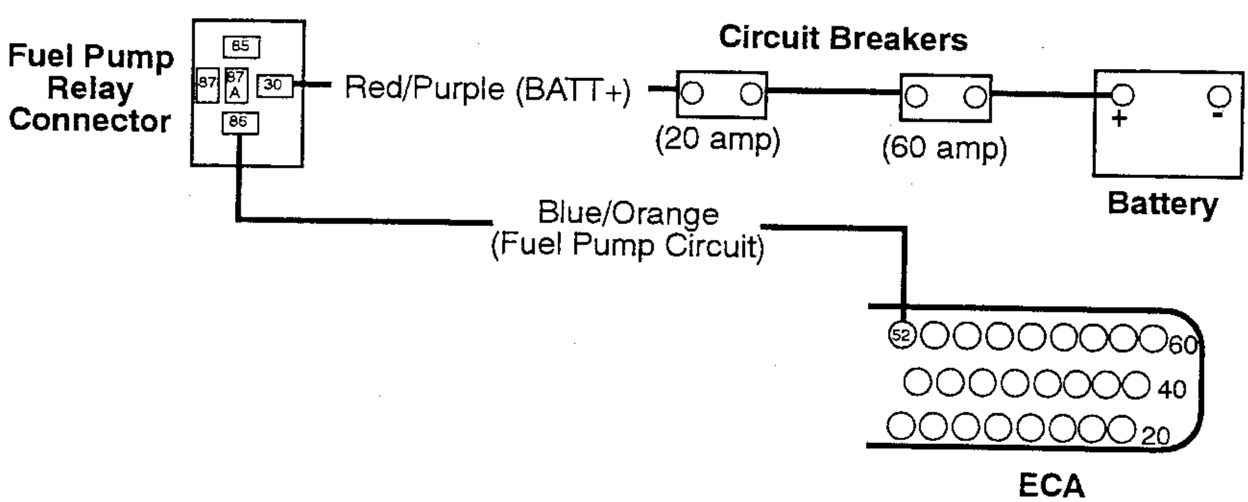
① Boat Fuel Line
② Fuel Filter
③ Low Pressure Fuel Pump
④ 20 Amp Circuit Breaker
⑤ Fuel Line
⑥ Fuel Reservoir / Vapor Separator
⑦ High Pressure Fuel Pump
⑧ Fuel Vapor Vent Hose to Plenum
⑨ Relief Valve / Test Point
⑩ Fuel Rail
⑪ Fuel Injector
⑫ Fuel Rail Crossover Hose
⑬ Fuel Pressure Regulator
⑭ Regulator Vacuum Hose to Plenum

Test Step		Result	Action to Take
3H-1	SYSTEM INTEGRITY CHECK		
• Visually inspect complete fuel delivery system including fuel tank lines, reservoir, filter, pumps, injectors, pressure regulator, battery, electrical lines and connectors. Check for looseness, cracks, pinching, kinking, corrosion, grounding, abrasion, or other damage caused by assembly or usage. • Verify that battery is fully charged and all connections are tight. • Check for sufficient fuel in fuel tanks. Check for water in fuel filter. • Is system free of any evidence of leakage, damage, or any other cause for concern?		Yes No	Go to **3H-11**. Service or replace as required. Verify service.

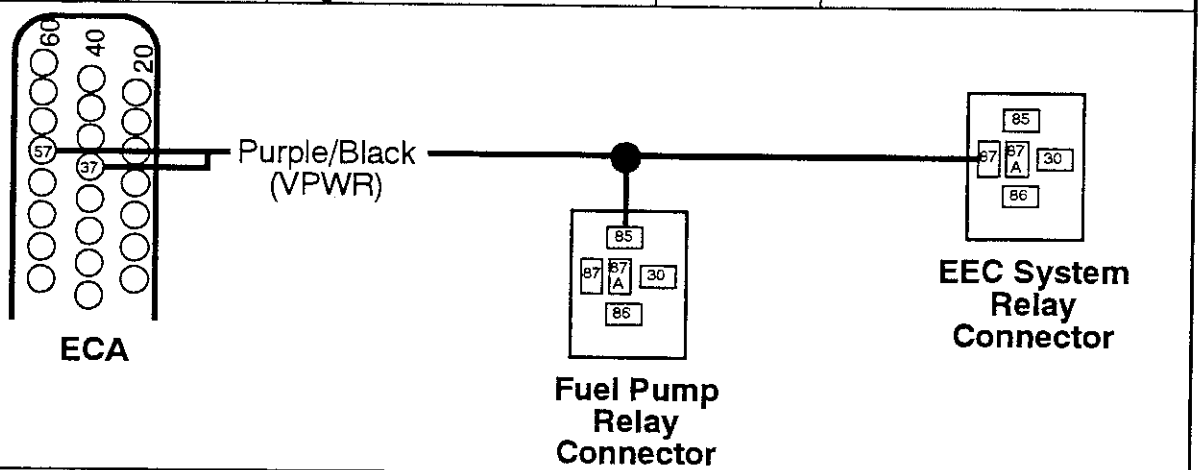
3H-2	FUEL INJECTION PRESSURE TEST	
WARNING: BEFORE SERVICING OR REPLACING ANY COMPONENTS IN FUEL SYSTEM, REDUCE POSSIBILITY OF INJURY OR FIRE, AS OUTLINED UNDER "NOTES AND SAFETY WARNINGS". • Key off. • Before connecting Fuel Pressure Gauge, read Safety Warning Instructions to avoid fuel spillage and injury. • Install Fuel Pressure Gauge. • Ground blue/orange fuel pump lead of the STO Self-Test connector. • Key On, Engine Off, to operate fuel pumps. • Verify that fuel pressure is within specified limits. • Is fuel pressure within specifications?	Yes No	Go to **3H-3**. If zero or low: Go to **3H-12**. If high: Go to **3H-16**.
NOTE: Maximum fuel pressure is obtainable at WOT, or with vacuum hose removed from fuel pressure regulator. When attempting to operate fuel pump from the STO Self-Test connector, be sure to use correct terminal.	**Engine Idling: 31±3 psi (214±21 kPa)** **Key On, Engine Off: 39±3 psi (269±21 kPa)**	
3H-3	**CHECK FUEL PRESSURE LEAKDOWN**	
• Read "Notes and Safety Warnings" to avoid fuel spillage and injury. Connect Fuel Pressure Gauge to relief valve on rail. • Connect a jumper wire to blue/orange lead of the STO Self-Test connector. • Key on, engine off. Ground blue/orange jumper lead to run fuel pump. Run fuel pump for 30 seconds minimum. • Remove test lead ground and note fuel pressure. • Verify whether fuel pressure remains within 3 psi of running pressure for 3 minutes after test lead is ungrounded. • Does fuel pressure remain within 3 psi for 3 minutes after test lead is ungrounded?	Yes No	Go to **3H-4**. Go to **3H-15**.

3H-4	CHECK PRESSURE REGULATOR DIAPHRAGM CONDITION	
• Key off. • Connect Fuel Pressure Gauge to relief valve on rail. Read "Notes and Safety Warnings" to avoid fuel spillage and injury. • Start engine and run for 10 seconds. Stop engine and wait 10 seconds. Start engine and run for 10 seconds. • Stop engine and remove vacuum hose from pressure regulator. • Examine vacuum port and regulator body for evidence of fuel leakage. • Is vacuum port and regulator body free of any fuel?	Yes No	Go to **3H-5**. Verify regulator leakage with a vacuum pump. Replace pressure regulator and rerun test **3H-2**.
3H-5	CHECK FUEL PRESSURE WITH ENGINE LOAD	
• Install Fuel Pressure Gauge. Start engine. • Disconnect vacuum hose at fuel pressure regulator. Does hose have vacuum? If not, correct cause then plug it. • Check fuel pressure while operating boat under repeated hard acceleration. • Does fuel pressure reading remain within ± 3 psi during test.	Yes No	Unplug vacuum hose and connect it to fuel pressure regulator. Go to **3H-6**. Go to **3H-14**.
3H-6	CHECK FUEL PRESSURE REGULATOR	
• Install Fuel Pressure Gauge. • Connect vacuum gauge to a Tee between intake manifold and regulator. • Start engine and check both gauge readings. • Accelerate engine speed to lower vacuum gauge reading. • Does fuel pressure gauge reading increase as vacuum gauge reading decreases, and/or does fuel pressure gauge reading decrease as vacuum gauge reading increases?	Yes No	Remove vacuum gauge and Fuel Pressure Gauge. Go to Section 3C : Diagnostic Routines for other possible causes. Go to **3H-7**.

3H-7	CHECK VACUUM SUPPLY	
• Key off. • Remove vacuum hose from fuel pressure regulator and plug it. • Connect a hand operated vacuum pump to the fuel pressure regulator. • Start engine. • Check fuel pressure while applying vacuum. • Does fuel pressure reading change as vacuum changes?	Yes No	Service vacuum system. Remove hose plug and reconnect hose to fuel pressure regulator. Replace fuel pressure regulator.
3H-8	**CHECK FOR VOLTAGE AT FP RELAY**	
• Key off. • Battery fully charged. • Ground blue/orange fuel pump lead of the STO Self-Test connector. • Key On, Engine Off. • Measure voltage at fuel pump relay. Contacts Normally Open and Common. Refer to Wiring Diagrams. • Is voltage greater than 10.5 volts?	Yes No	Service open circuit between fuel pump relay and ECA. Go to **3H-9**.



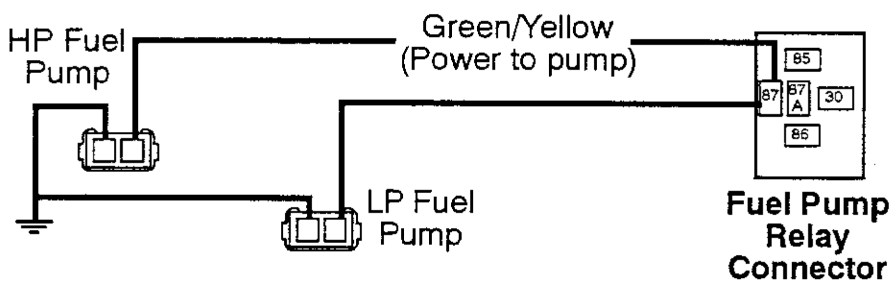
3H-9	CHECK POWER SUPPLY TO FP RELAY		
• Key off. • Battery fully charged. • Disconnect/remove fuel pump relay. • Key On, Engine Off. • Measure voltage between engine ground of fuel pump relay connector, and both B+ pins #30 and #85. • Is voltage on both B+ pins greater than 10.5 volts?		Yes No	Go to **3H-10**. Service defective circuit between fuel pump relay and EEC power relay or battery (+).



3H-10	CHECK FUEL PUMP RELAY OPERATION		
• Remove fuel pump relay from engine. Refer to Wiring Diagrams. • Ground Terminal #86. Connect a B+ 12V supply to terminal #85. • Measure resistance between terminals #30 and #87 • (see **3H-9**). • Is resistance lower than 1 ohm with power applied, and greater than 10,000 ohms with power off?		Yes No	Go to EEC-IV Quick Test Section 3D. Replace fuel pump relay. Verify service.

3H-11	CHECK PUMP OPERATION, AUDIBLE	
• Key off. • Battery fully charged. • Verify that a good electrical connection is made to pumps. • Ground blue/orange fuel pump lead of the STO Self-Test connector. • Key On, Engine Off. • Listen and touch fuel pumps. • Are fuel pumps running? Can vibration be felt?	Yes No	Go to **3H-14.** Check 20 amp circuit breaker and wiring. Go to **3H-2.**

3H-12	CHECK VOLTAGE TO PUMP	
• Battery fully charged. • Disconnect electrical connectors at fuel pumps. • Ground blue/orange fuel pump lead of the STO Self-Test connector as shown. • Key On, Engine Off. • Measure voltage on the green/yellow power supply leads to fuel pumps. • Is voltage greater than 10.5 volts for each pump?	Yes No	Go to **3H-13.** Service circuit between ECA and fuel pump connector. Go to **3H-8.**



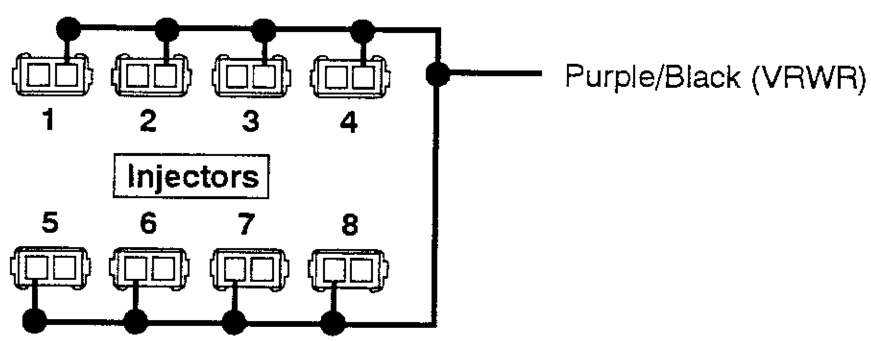
3H-13	CHECK FUEL PUMP GROUND	
• Key off. • Disconnect electrical connectors at fuel pumps. • Measure resistance of the black wires to engine ground (see **3H-12**). • Is resistance less than 1 ohm for each?	Yes No	Replace Fuel Pumps. Go to **3H-2**. Service open wire to ground. Go to **3H-2**.

3H-14	CHECK FUEL FILTER CONDITION	
• Read "Notes and Safety Warnings" to avoid fuel spillage and injury. • Check customer's service records versus maintenance schedule. Remove fuel filter. Check its condition and check for water. If water is present, purge entire fuel system including boat tank to remove water. • Does fuel filter need to be replaced?	Yes No	Go to **3H-13**. Replace fuel filter and rerun test **3H-2.**

3H-15	CHECK PRESSURE REGULATOR VALVE SEAT LEAKAGE	
• Read "Notes and Safety Warnings" to avoid fuel spillage and injury. • Inspect O-ring, gasket and mounting surfaces for cracks, cuts or other defects that may affect sealing. • Connect vacuum tester to regulator fuel outlet and apply a 20 in-Hg vacuum. • Verify whether vacuum retention meets specification of 10 in-Hg maximum loss of vacuum within 10 seconds. • Does vacuum drop below 10 in-Hg within 10 seconds?	Yes No	Replace regulator. Rerun test **3H-2.** Go to **3H-19**.

3H-16	CHECK REGULATOR FOR HIGH PRESSURE CAUSES	
• Key off. • Remove fuel return line at both fuel rail and reservoir/vapor separator. Install a clear, fuel-resistant hose between the fuel rail and reservoir. • Ground FP lead as in **3H-2**. • Key on, engine off. • Record fuel pressure and note whether fuel is being returned to reservoir. Maintain FP ground for no more than 10 seconds. • Is fuel pressure still high?	Yes No	Replace fuel pressure regulator, and Go to **3H-2**. Fuel return system is restricted. Go to **3H-17**.
3H-17	**CHECK FUEL RETURN SYSTEM FOR HIGH PRESSURE CAUSES**	
• Read "Notes and Safety Warnings" to avoid fuel spillage and injury. • Check fuel return system for restriction due to blockage, kinking, or pinching. • Remove fuel return line at fuel pressure regulator. • Apply 3-5 psi regulated shop air to fuel return line. • Do you hear air entering reservoir?	Yes No	Reconnect fuel return line. Refer to appropriate service manual Go to **3H-18**.
3H-18	**CHECK FUEL RETURN SYSTEM**	
• Key off. • Read "Notes and Safety Warnings" to avoid fuel spillage and injury. • Disconnect fuel return line at fuel pressure regulator. • Disconnect fuel return line at fuel reservoir. • Apply 3-5 psi regulated shop air to return line at pressure regulator side. • Does air flow freely through line?	Yes No	Service Fuel Reservoir. Refer to appropriate service manual. Service fuel return line. Reconnect fuel line. Go to **3H-2**.
3H-19	**CHECK FUEL INJECTOR FUNCTION**	
• With engine warm and idling (or cranking if it does not start), use a mechanics' stethoscope or equivalent and listen for regularly spaced operating sounds at each fuel injector. • Is operating sound present?	Yes No	Go to **3H-22**. Go to **3H-20**.

3H-20	CHECK FUEL INJECTOR RESISTANCE		
• Key off. • Disconnect fuel injector electrical connector one at a time. • Measure resistance of each injector using a DVOM. • Are all resistances between 13.0 and 16.0 ohms?		Yes No	Go to **3H-21**. Replace faulty injectors. Reconnect injectors.
3H-21	CHECK FUEL INJECTOR ELECTRICAL CONTINUITY SIGNAL		
• Key off. • Disconnect any Bank1 (cylinders 1,4,5,8) injector lead. Connect a 12 volt test light to the B+ harness connector terminal. Touch test light to other connector terminal. • Start engine. • Observe whether test light blinks (showing a completed circuit for injector being tested). • Repeat check for any Bank 2 injector (cylinders 2,3,6,7). • Does each injector Bank circuit show continuity? NOTE: This test is a quick check the ECA's control of the two injector Banks (four injectors are in one Bank). It may be necessary to conduct this continuity check on each individual injector circuit to find one injector that is not operating.		Yes No	Go to **3H-22**. Check for 12 volts at each injector lead. Service or Replace leads as required. Refer to EEC-IV Quick Test Section 3D.



3H-22	CHECK FUEL INJECTOR FLOW AND LEAKAGE	
• Read "Notes and Safety Warnings" to avoid fuel spillage and injury. • Using Fuel Injector Tester/Cleaner 113-00001 (or equivalent), clean, test and reclean fuel injectors. Verify that flow rate for injector group is within specification, using color range on tester flow meter corresponding to injector top color. • With Tester/Cleaner still installed on fuel system, note any significant pressure loss due to injector leakage when tester pump is turned off. • Check fuel injectors individually for leakage using Injector Bench Fixture and Fuel Injector Bench Testing procedure associated with Rotunda Tester/Cleaner. Verify that each injector leakage rate is within specification (1 drop/min. maximum). • Is flow rate for injector group and leakage rate for individual injectors within specification?	Yes No	Check fuel lines for leaks. If none found replace fuel pump assembly. Go to **3H-2**. Replace defective injectors as required. Rerun test **3H-22**. Repeat **3H-3**.

SECTION 4 : SPECIFICATIONS

Fastener Torque's

Component	N.m	ft.lb.	in.lb.
IAC to throttle body	8-12		71-106
TP sensor to throttle body	1-2		9-18
Upper to lower intake manifold bolts	17-24	12-18	
Fuel supply manifold to lower intake	8-12		71-105
Fuel pressure regulator to fuel manifold	3-5		27-44
Coil bracket to manifold stud	6-7		53-62
TFI module to heat sink screws	1.7-4		15-35
Distributor clamp down	24-32	17-25	
Distributor cap screws	2-2.6		18-23
Spark plugs	14-20	10-15	
Pipe threads 1/8 - 27	7-11	5-8	
Pipe threads 1/4 - 18	17-24	12-18	
Pipe threads 3/8 - 18	30-44	22-33	
Pipe threads 1/2 - 14	34-47	25-35	

5.0L - General Engine Specifications

Engine base timing	5 degrees BTDC
Computed timing	Additional 15°±2°
Fuel pressure - engine running	30-45 psi (207-310 Kpa)
Fuel pressure - key on/engine off	35-45 psi (241-310 Kpa)
Firing Order	1-5-4-2-6-3-7-8

5.8L - General Engine Specifications

Engine base timing	5 degrees BTDC
Computed timing	Additional 15°±2°
Fuel pressure - engine running	30-45 psi (207-310 Kpa)
Fuel pressure - key on/engine off	35-45 psi (241-310 Kpa)
Firing Order	1-3-7-2-6-5-4-8

Service Part Numbers

ITEM	Base Part Number
Injectors	-9F593-
Processor (ECA)	-12A650-
Fuel Rail	-9F792-
Knock Sensor	-12A699-
Distributor	-12127-
TFI Modules	-12A297-
Heat Sink	-12B586-
Hall Switch	-12A112-
Idle Air Control (IAC)	-9F715-
MAP Sensor	-9F479-
TP Sensor	-9B989-
Fuel Pump	-9A407-
Fuel Pump Relay	-9345-
ACT Sensor	-12A697-
ECT Sensor	-12A648-
Pressure Regulator	-9C968-
E-Core Coil	-12029-
Power Relay (ECA)	-12A646-
Throttle Body	-9E926-
Butt Connector	-14488-

SECTION 5 : GLOSSARY

This glossary is a list of technical terms or acronyms and their definitions. It's not intended to be a dictionary of components and their functions.

ACCELEROMETER
An electronic device that measures vibration and converts this signal to an electrical output.

ACT
Air Charge Temperature sensor or its signal circuit. Used to determine air density.

ACRONYM
Alphabetical letters used as an abbreviated way of representing words.

ACTUATOR
12-volt device whose operation is controlled by the ECA by opening or closing a ground circuit.

ADAPTIVE SPEED/DENSITY
FORD's type of EFI system. Requires an ECA programmed with engine displacement, and requires the following data;

- Engine RPM (PIP signal)
- Manifold Absolute Pressure (MAP
- Air Charge Temperature (ACT, for air density)

This system also allows for wear and aging of components (adaptive ability).

ADAPTIVE STRATEGY
ECA feature that adjusts operating parameters to compensate for normal wear and aging of engine and EEC components.

AMBIENT TEMPERATURE
Temperature of air surrounding an object, i.e., temperature where engine is being worked on.

ATDC
After Top Dead Center. In reference to piston position in cylinder bore.

AVOM
Analog Volt-Ohm Meter. Readings are indicated by a sweep pointer on a printed scale rather than a digital display.

BANK-TO-BANK
Fuel injector operating mode. Fuel injectors actuate on one crank revolution and the other four actuate on the next crank revolution.

BASE TIMING
Ignition timing that occurs when SPOUT connector is unplugged, or when TFI module has lost SPOUT signal. Can be adjusted by rotating distributor.

BATT(+)
Battery positive post or its circuit.

BATT(-)
Battery negative post or its circuit.

BPA
Bypass Air Valve. A valve that is mounted to the ISC solenoid and provides additional bypass air when the engine is cold or idling.

BREAKOUT BOX
A troubleshooting instrument that "tees" between the EEC-IV processor and the 60 pin engine harness connector. It contains 60 test pins that can be probed for EEC system testing during the Diagnostic Manual Pinpoint Tests.

BTDC
Before Top Dead Center. In reference to piston position in cylinder bore.

CBD
Closed Bowl Distributor (no external openings). The TFI-IV module is electrically connected to the distributor through a wire harness, not a direct plug-in connection.

CCD
Computer Controlled Dwell. Spark firing strategy controlled by the TFI module.

COMPUTED TIMING
The total spark advance in degrees before top dead center. Calculated by the EEC-IV processor based on input from a number of sensors. A check performed during ER Self-Test.

CONTINUOUS MEMORY CODES
Service codes representing Intermittent Faults. Accessed from ECA memory only during KOEO Self-Test.

CONTINUOUS SELF-TEST
A continuous test (check for faults) of the EEC-IV system conducted by the ECA whenever the engine is in operation.

DIAGNOSTIC ROUTINES
Section of the EFI Diagnostic manual that provides diagnostic procedures based on operational symptoms. All troubleshooting procedures **MUST** start with this section of the manual.

DVOM
Digital volt-Ohm Multimeter that displays information in numerical form.

DYN RSP
Dynamic Response. An operator action that takes place during Engine Running Self-Test. A quick throttle opening to WOT followed immediately by a quick return to idle.

E-CORE COIL
Provides ignition system spark output, and whose operation is controlled by the TFI-IV module. Gets its name from its externally-wound laminations.

ECA
Electronic Control Assembly; the EEC system controller. An electronic module that accepts sensor inputs, compares these inputs to designed-in operating parameters, then controls actuator functions to maintain proper engine operation.

ECT
Engine Coolant Temperature sensor or its signal circuit.

EEC-IV
Engine Coolant Temperature sensor or its signal circuit.

EFI
Electronic Fuel Injection. A computer controlled fuel system that distributes atomized fuel through an injector located in each intake port of the engine. The fuel injectors are actuated using bank-to-bank circuitry.

ENGINE RUNNING SELF-TEST (KOER)
A test of the EEC-IV system conducted with the engine running and at rest. Performed with a Star Tester.

ENGINE TEMPERATURE CYCLE
The engine is started and run until it reaches normal operating temperature, then is shut off and allowed to cool down to ambient temperature.

ER
Engine Running Self-Test (same as KOER).

FI
Fuel Injector or its control circuit.

FMEM
Failure Mode Effects Management. This alternative strategy protects engine function from the adverse effect of an EEC input sensor failure by substituting signals from an operable sensor of comparable value.

FP
Fuel Pump relay or its control circuit.

FPM
Fuel Pump Monitor. a circuit in the EEC system used to monitor the electric fuel pump operation.

FREQUENCY
Refers to number of times something repeats itself (such as a signal from a sensor) in one second.

GND OR GRND
A common ground circuit for all engine power.

HALL EFFECT
A process where current is passed through a small slice of semi-conductor material at the same time as a magnetic field to produce a small voltage in the semi-conductor. Produces ignition system PIP signal.

HARD FAULT
A component or circuit failure that is only present at time of KOEO or ER Self-Test (not intermittent). Represented by on-Demand Service Codes.

HEAT SINK
TFI-IV Module mounts to it (with the use of a special thermal grease) in order to dissipate heat.

HERTZ SIGNAL
A frequency provided by the MAP sensor to the ECA.

IDM
Ignition Diagnostics Monitor. A continuous monitor of the ignition input to the EEC-IV processor used to detect intermittent ignition faults. Reads tachometer signal from the TFI-IV Module.

IGN
Ignition circuit or system.

INJ
Injector (Fuel). Its operation (pulse width) is controlled by the ECA.

INTERMITTENT FAULT
A component or circuit failure that occurred sometime during normal engine operation. Was recognized by Continuous Self-Test and stored in the ECA Keep Alive Memory for later service access. Represented by Continuous Memory Service Codes.

ISC
Idle Speed Control solenoid or its control circuit. Mounts on the throttle body assembly.

ISC-BPA
An idle speed control device that combines an ISC solenoid and a BPA valve.

KAM
Keep Alive Memory. A series of engine battery powered memory locations in the microprocessor. Allows the microprocessor to store input failures identified during normal operation for use in later diagnostic routines. Adapts some calibration parameters to compensate for changes in the engine system.

KAPWR
Keep Alive Power. Engine battery current that supplies KAM.

KEY ON ENGINE OFF SELF-TEST (KOEO)
A test of the EEC-IV system conducted with power applied and the engine at rest. Performed with a Star Tester.

KOEO
Key On Engine Off Self-Test.

KOER
Key On Engine Running Self-Test (same as Engine Running ER Self-Test).

KS
Knock Sensor or its signal circuit. An electronic device (accelerometer) that measures vibration and converts this frequency signal to a voltage signal.

LCD
Liquid Crystal Display. Means of displaying information on a Star Tester.

MAP
Manifold Absolute Pressure sensor or its signal circuit. A vacuum controlled device that senses engine load and transmits this information via a hertz frequency to the ECA.

MONITOR
An optional EEC-IV test device which connects in series with the EEC-IV processor and its harness, and permits measurements in various processor inputs and outputs.

MULTI-POINT
Descriptive name for Ford's EFI system. So called because various sensors and actuators and located at "multiple points" around the engine.

NDS
Neutral Drive Switch or its signal circuit.

ON-DEMAND CODES
Service codes representing Hard Faults. Accessed during KOEO or ER Self-Tests.

OPEN CIRCUIT
A circuit which does not provide a complete path for the flow of current.

OVERLAY CARD
A plastic card used with the Monitor to identify EEC-IV signals for a specific engine calibration. The card also programs the monitor for auto mode measurements.

PCV
Positive Crankcase Ventilation. A system which controls the flow of crankcase vapors into the engine intake manifold where they are burned in combustion rather than discharged into the atmosphere.

PINPOINT TESTS
Section of the EFI Diagnostic Manual. Troubleshooting procedures for checking EEC-related wiring or components. Requires use of a Breakout Box and DVOM.

PIP
Profile Ignition Pickup. A distributor - housed "hall effect" vane switch that furnishes crankshaft position data to the EEC-IV processor and TFI-IV Module.

PLENUM
Upper half of intake manifold.

POTENTIOMETER
A variable resistor with three connections. Two are to the ends of the resistive element. The third is to a wiper that moves up and down the resistive element.

PROCESSOR
EEC-IV System electronic control assembly (ECA).

PROMPT
Abbreviated words that appear on a Star Tester screen.

PULSE WIDTH
Amount of time a fuel injector is actuated in order to spray fuel into an intake port. Controlled by the ECA.

QUICK TEST
Section of the EFI Diagnostic Manual. Functional troubleshooting tests of the EEC system consisting of engine preparation and hookup, Key On Engine Off, Engine Running, Computed Timing and Continuous Self-Tests.

RECORDER
An optional EEC-IV test device which works jointly with the Monitor. It allows up to eight EEC-IV signals to be electronically recorded over a 50 second period.

RELAY
A switching device operated by a low current circuit which controls the opening and closing of another circuit of higher current capacity.

SELF-TEST
One of four subsets of the EEC Quick Test: Key On Engine Off, Engine Running, Timing Control and Continuous.

SENSOR
A monitoring device that transmits data to the ECA.

SERVICE CODES
Two-digit numbers that represent EEC component/circuit failures, some of which are stored in ECA memory. Can be called up from the ECA using a Star Tester.

SIG RTN
Signal Return circuit for some sensor inputs.

SIGNAL GENERATORS (MAP, KS)
Creates a frequency or a voltage. These signals are sent to the ECA to indicate a condition such as engine knock or manifold pressure.

SOLENOID
A wire coil with a movable core that changes position by means of electro-magnetism when current flows through the coil.

SPOUT
Spark Output signal from the EEC-IV processor. Controls operation of the TFI-IV Module. Loss of this signal puts engine in BASE Timing Mode.

STAR
Self-Test Automatic Readout. A testing device, that can be used on EEC systems to put the ECA in a Self-Test mode to obtain service codes.

S/T
Self-Test.

STI
Self-Test Input. Circuit in the ECA used to initiate service code output.

STO
Self-Test Output. Circuit in the ECA system that transmits service codes.

STOICHIOMETRY
A "balanced" air/fuel ratio which is neither too rich nor too lean. Stoichiometry is a ratio of 14.7 pounds of air for every one pound of fuel.

TFI-IV
Thick Film Ignition, fourth generation. An ignition module comprised of a custom integrated circuit, Darlington output device and associated thick film integrated components. Controls E-coil primary circuit operation.

TIMING
Relationship between spark plug firing and piston position usually expressed in crankshaft degrees before (BTDC) and after (ATDC) top dead center of the compression stoke.

THERMISTOR
A sensor whose resistance changes with temperature. As temperature increases, thermistor resistance decreases.

THROTTLE BODY
Controls engine air intake only. Does not contain fuel passages.

TP
Throttle Position sensor or its signal circuit.

VPWR
Vehicle Power. Battery power supplied to various EEC components through the EEC power relay.

VREF
Voltage reference signal supplied by the EEC-IV processor to some sensors and regulated to .1 - 4.9 volts.

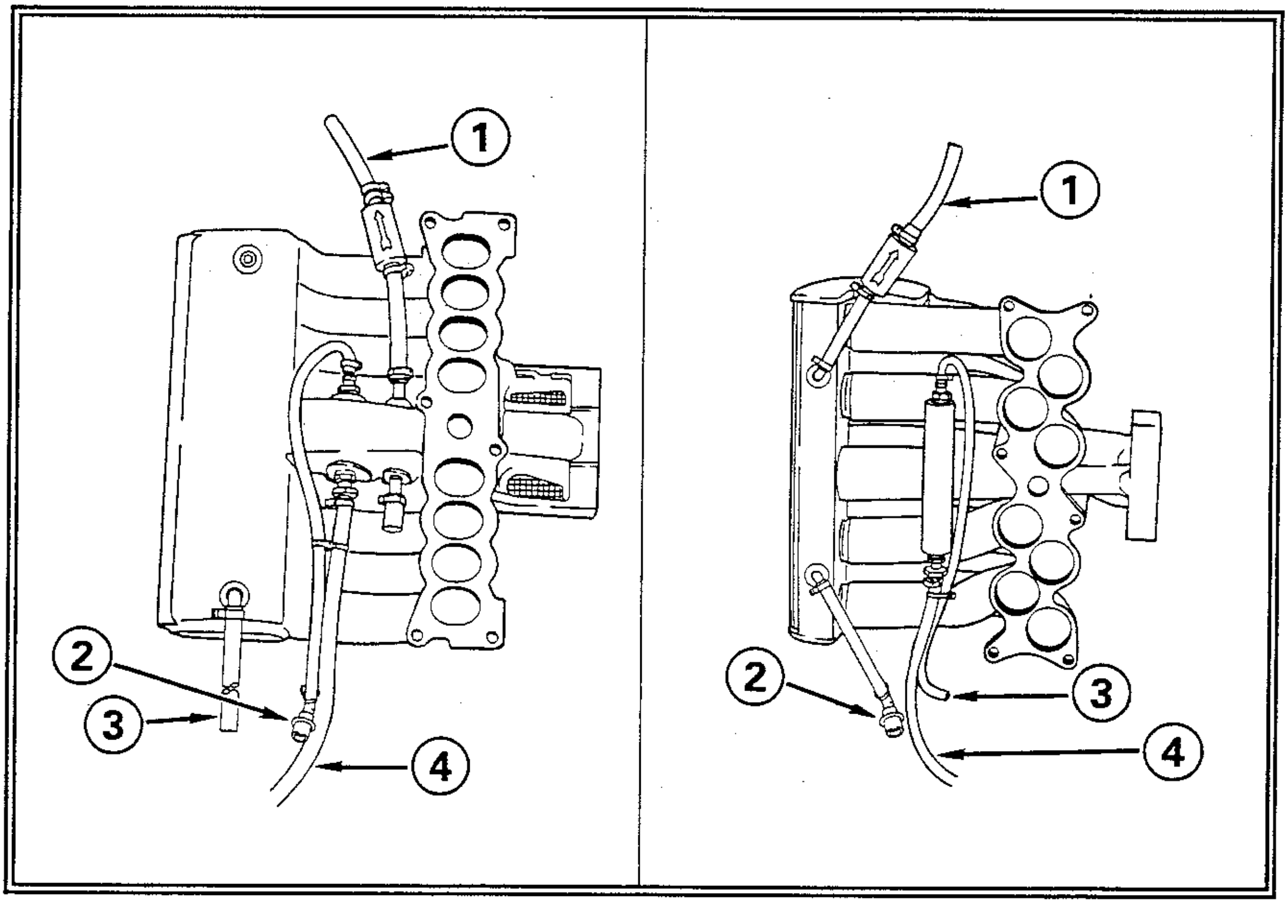
WIGGLE TEST
A Star Tester mode that provides an audible "beep" when checking EEC-related circuit continuity for an intermittent condition.

SECTION 6 : DIAGRAMS

Standard Color Abbreviations

Abbreviation	Color	Abbreviation	Color
BK	Black	O	Orange
BL	Blue	PK	Pink
BR	Brown	P	Purple
GY	Gray	R	Red
GR	Green	T	Tan
LB	Light Blue	W	White
LG	Light Green	Y	Yellow

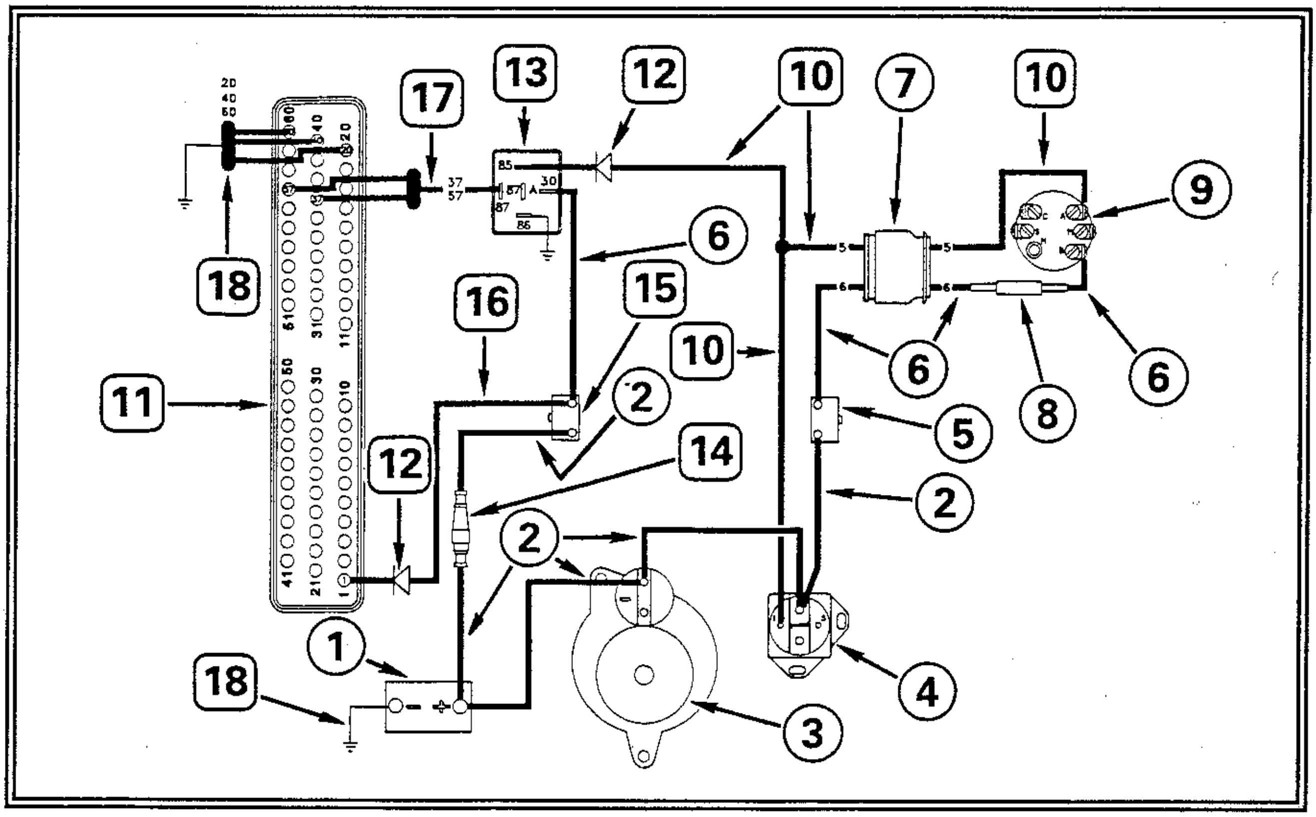
VACUUM HOSE DIAGRAM



5.0 EFI Models **5.8 EFI Models**

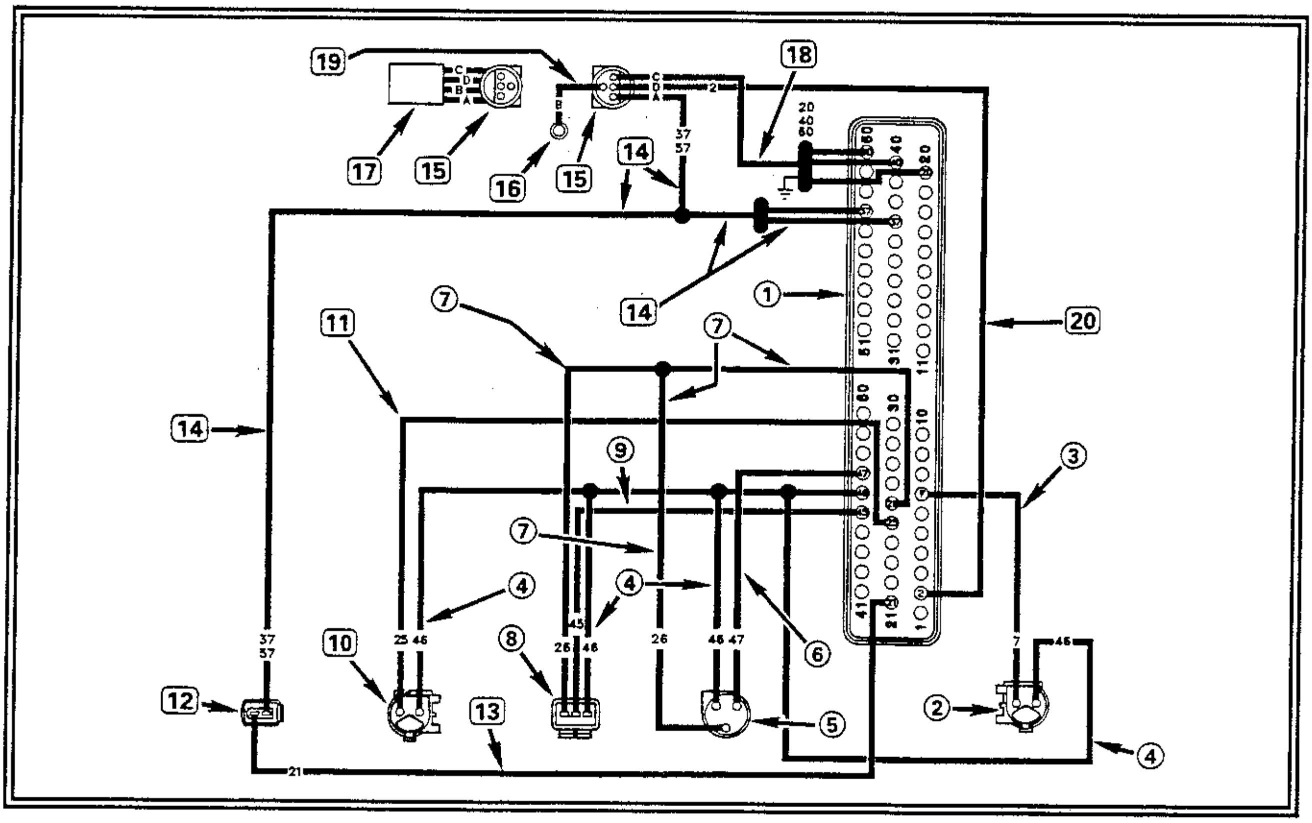
1. Manifold Absolute Pressure (MAP) Sensor
2. PCV Valve
3. Fuel Pressure Regulator
4. Fuel Reservoir / Vapor Separator

EEC Power and Keep Alive Circuits



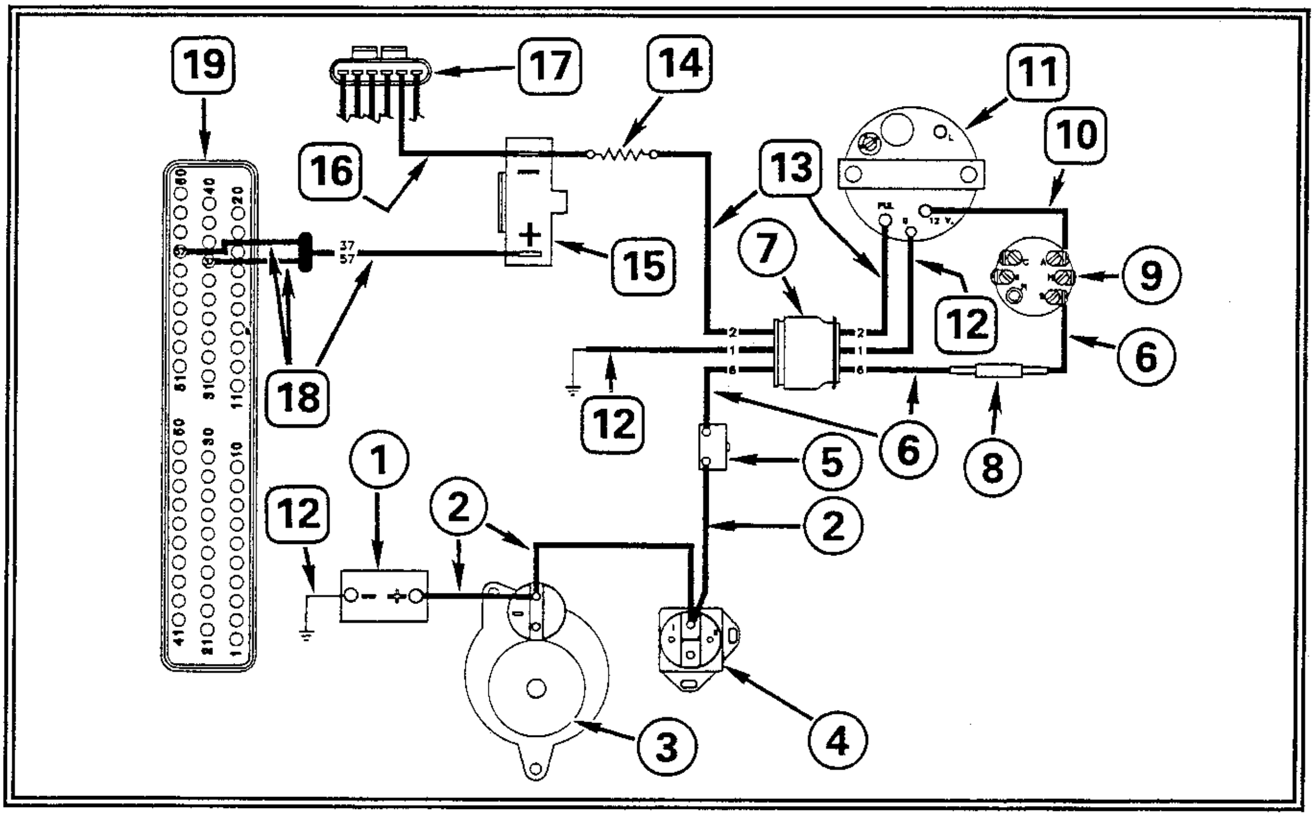
1. Battery
2. Red
3. Starter Motor
4. Assist Solenoid
5. 60 Amp circuit Breaker
6. Red/Purple
7. 10 Way Connector
8. 20 Amp Fuse
9. Ignition Switch
10. Purple
11. Electronic Control Assembly (ECA)
12. Diode
13. EEC System Relay
14. 50 Amp Fuse
15. 12.5 Amp Circuit Breaker
16. Pink/Blue
17. Purple/Black
18. Black

Sensor and Actuator Circuits



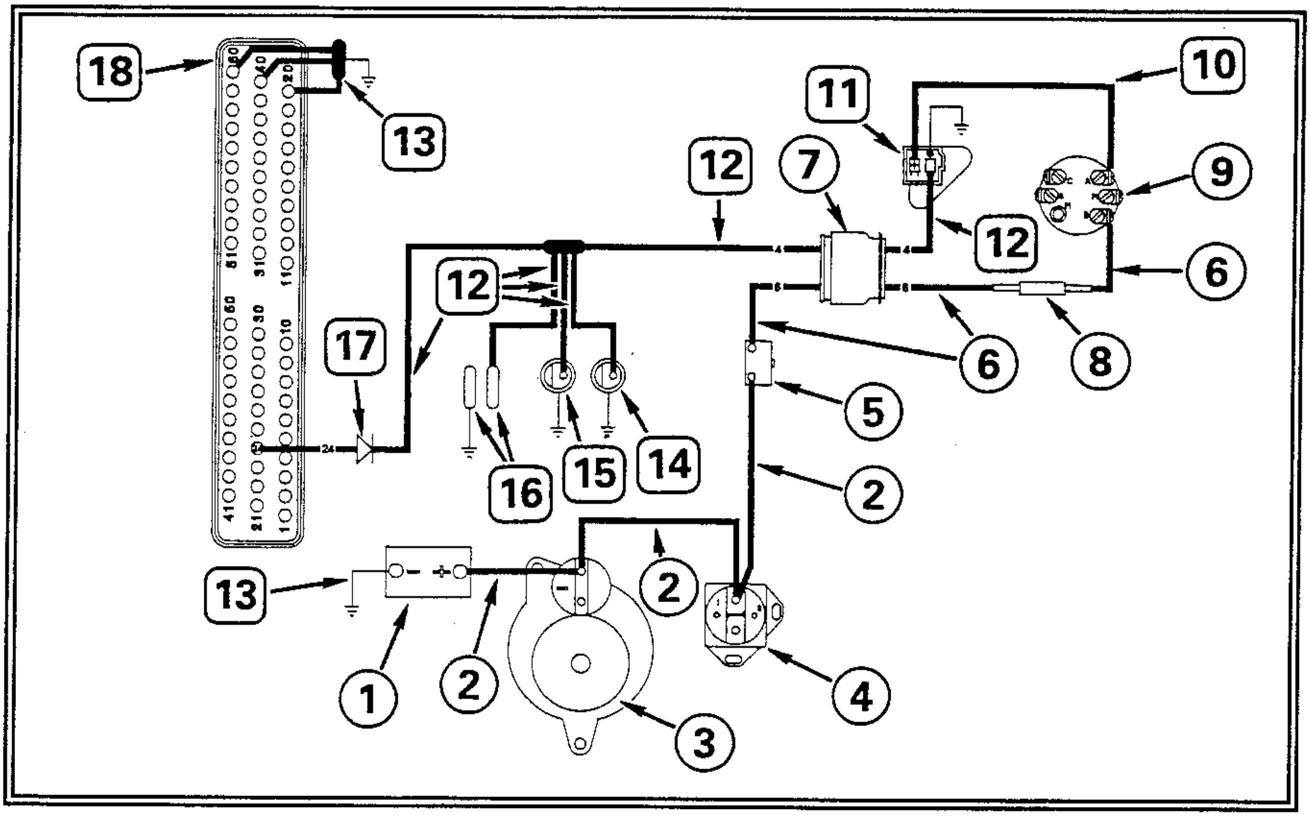
1. Electronic Control Assembly (ECA)
2. Engine Coolant Temperature (ECT) Sensor
3. Green/Orange
4. Gray/Red
5. Throttle Position (TP) Sensor
6. Gray/White
7. Brown/Yellow
8. Manifold Absolute Pressure (MAP) Sensor
9. Green/Black
10. Air Charge Temperature (ACT) Sensor
11. Gray/Black
12. Idle Speed Control - Bypass Air (ISC-BPA) Solenoid
13. White/Black
14. Purple/Black
15. Connector
16. Knock Sensor (KS)
17. Knock Module
18. Black
19. Black/Green
20. Yellow

Tachometer Circuit



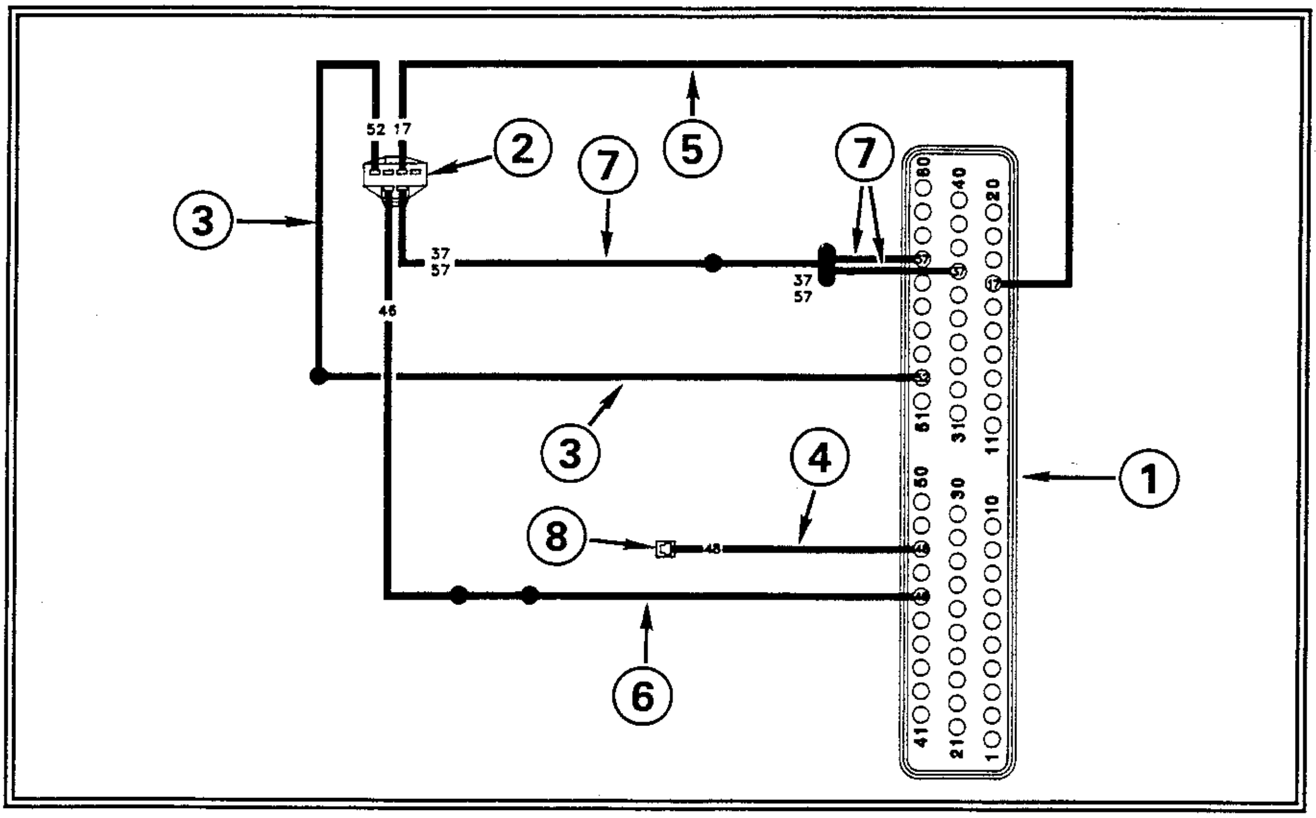
1. Battery
2. Red
3. Starter Motor
4. Assist Solenoid
5. 60 Amp Circuit Breaker
6. Red/Purple
7. 10 Way Connector
8. 20 Amp Fuse
9. Ignition Switch
10. Purple
11. Tachometer
12. Black
13. Gray
14. 22K Ohm Resistor
15. E-core Coil
16. Dark Green
17. Thick Film Ignition (TFI) Module
18. Purple/Black
19. Electronic Control Assembly (ECA)

S.L.O.W. Circuit



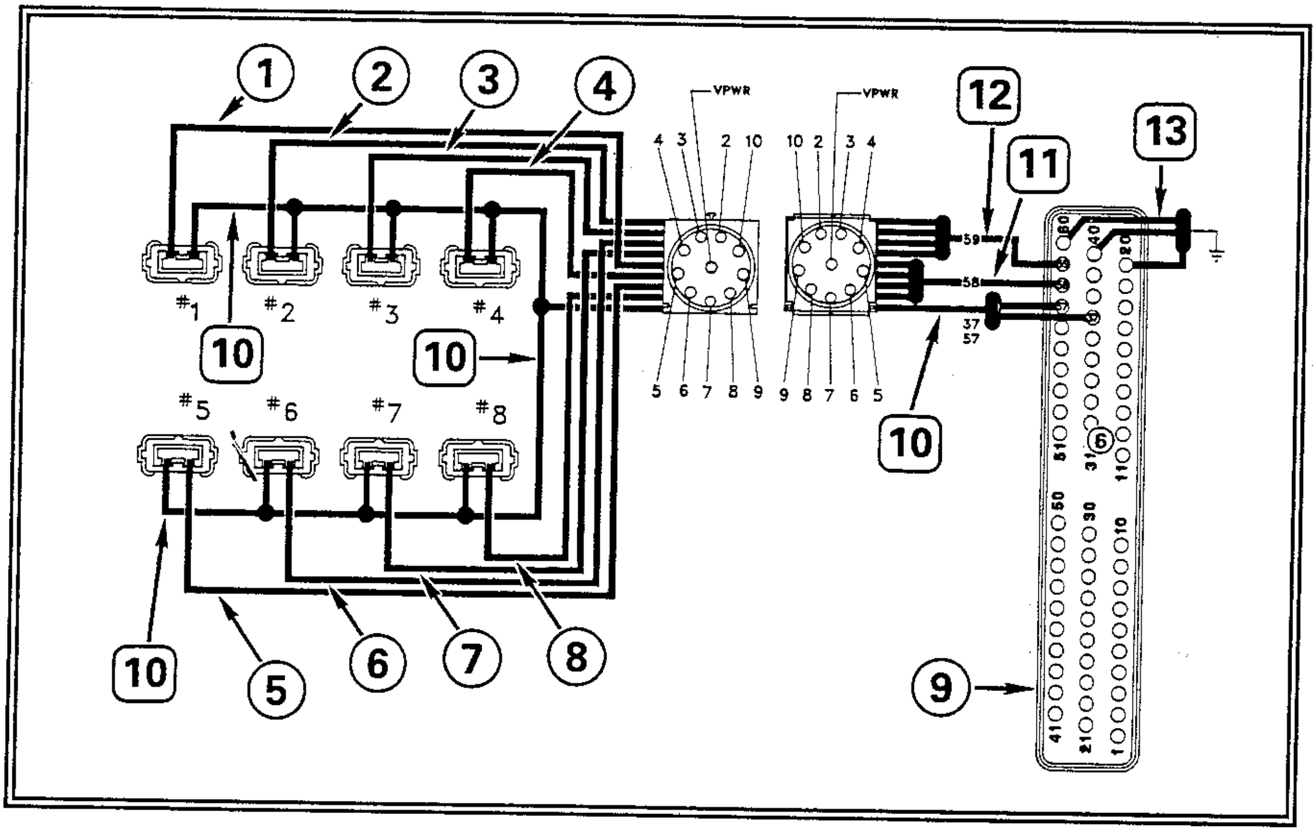
1.	Battery	10.	Purple
2.	Red	11.	Audible Warning Device
3.	Starter Motor	12.	Tan/Black
4.	Assist Solenoid	13.	Black
5.	60 Amp Circuit Breaker	14.	Water Temperature Switch
6.	Red/Purple	15.	Oil Pressure Switch
7.	10 Way Connector	16.	Unused Terminals
8.	20 Amp Fuse	17.	Diode
9.	Ignition Switch	18.	Electronic Control Assembly (ECA)

Self-Test Circuit



1. Electronic Control Assembly (ECA)
2. Self-Test Output (STO) Connector
3. Blue/Orange
4. White/Purple
5. Pink/Green
6. Gray/Red
7. Purple/Black
8. Self-Test Input (STI) Connector

Fuel Injector Circuits



1. Tan (Pin 7 - INJ 1)
2. White (Pin 8 - INJ 2)
3. Brown/Yellow (Pin 9 - INJ 3)
4. Black/White (Pin 10 - INJ 4)
5. Tan/Blue (Pin 2 - INJ 4)
6. Green (Pin 3 - INJ 6)
7. Tan/Orange (Pin 4 - INJ 7)

Pin 6 - Vacant

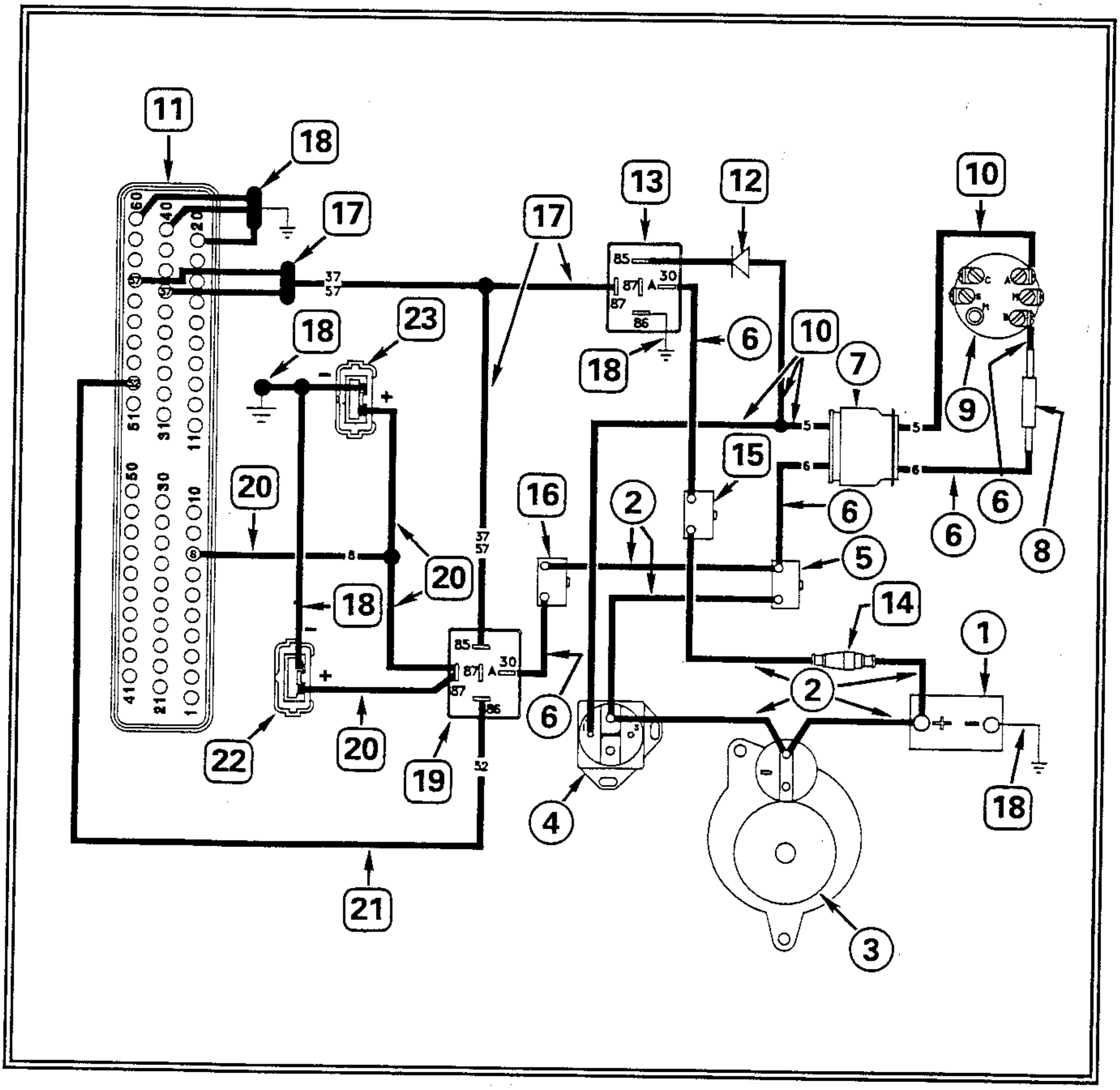
8. Blue (Pin 5 - INJ 8)
9. Electronic Control Assembly (ECA)
10. Purple/Black (VPWR - Pin 1)
11. Blue/Yellow (Bank 1)
12. Purple/White (Bank 2)
13. Black

Fuel Injectors #1 through #8

Bank 1 - Injectors 1,4,5,8

Bank 2 - Injectors 2,3,6,7

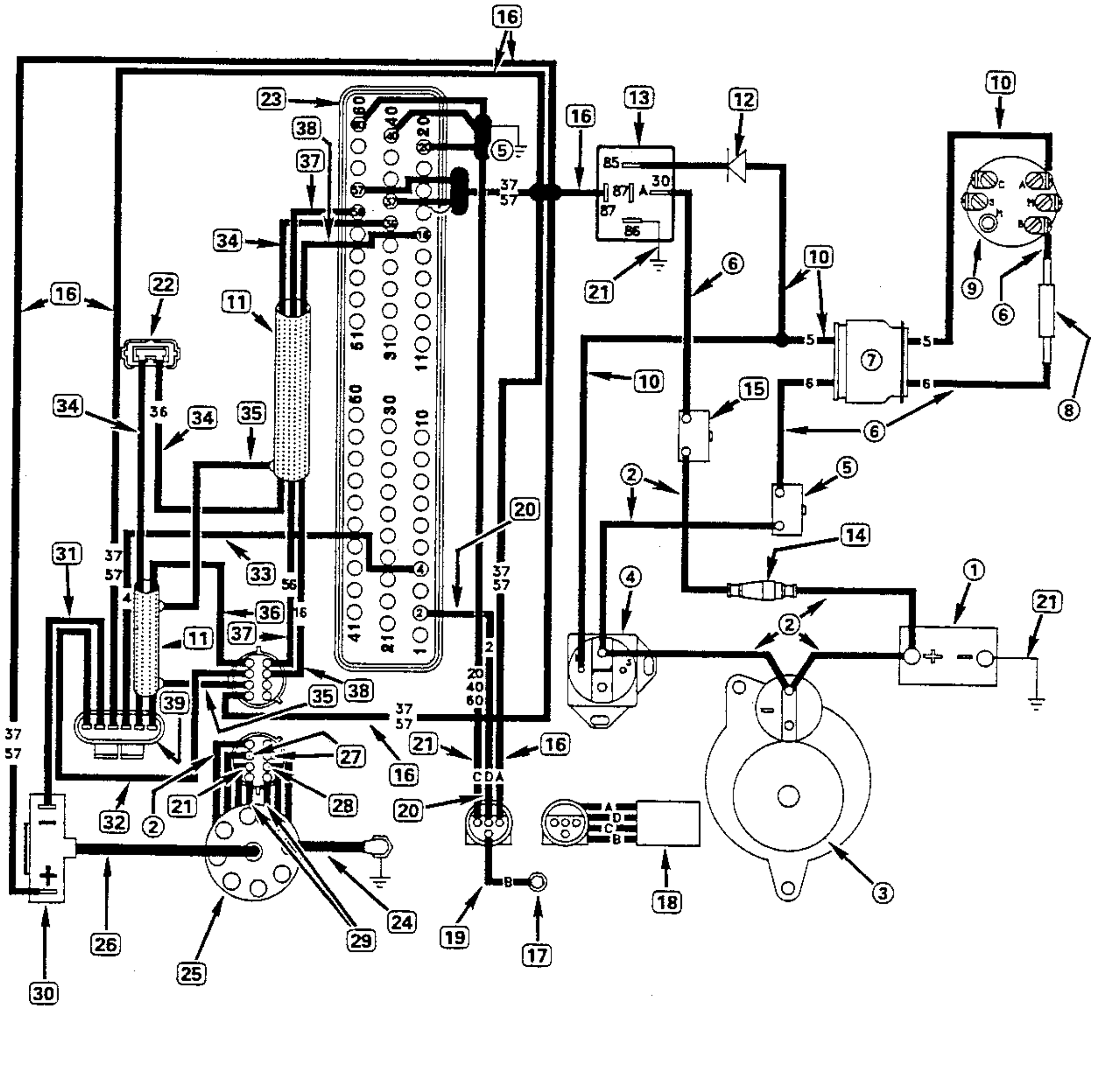
LP and HP Fuel Pump Circuits



LP and HP Fuel Pump Circuits

1. Battery
2. Red
3. Starter Motor
4. Assist Solenoid
5. 60 Amp Circuit Breaker
6. Red/Purple
7. 10 Way Connector
8. 20 Amp Fuse
9. Ignition Switch
10. Purple
11. Electronic Control Assembly (ECA)
12. Diode
13. EEC System Relay
14. 50 Amp Fuse
15. 12.5 Amp Circuit Breaker
16. 20 Amp Circuit Breaker
17. Purple/Black
18. Black
19. Fuel Pump Relay
20. Green/Yellow
21. Blue/Orange
22. Low Pressure Pump
23. High Pressure Pump

TFI-IV Ignition Circuit



TFI-IV Ignition Circuit

1. Battery
2. Red
3. Starter Motor
4. Assist Solenoid
5. 60 Amp Circuit Breaker
6. Red/Purple
7. 10 Way Connector
8. 20 Amp Fuse
9. Ignition Switch
10. Purple
11. RFI Suppression Shielding
12. Diode
13. EEC System Relay
14. 50 Amp Fuse
15. 12.5 Amp Circuit Breaker
16. Purple/Black
17. Knock Sensor (DS)
18. Knock Module
19. Black/Green
20. Yellow
21. Black
22. Spark Output (SPOUT) Connector
23. Electronic Control Assembly (ECA)
24. Spark Plug and Lead
25. Distributor
26. High Tension Lead
27. Black/Yellow
28. Black/White
29. Green
30. E-core Coil
31. Dark Green
32. Orange
33. Tan/Yellow
34. Pink
35. Shielding Ground
36. Gray/Orange
37. Gray/Blue
38. Orange/Blue
39. Thick Film Ignition (TFI) Module

ECA 60 Pin Connector

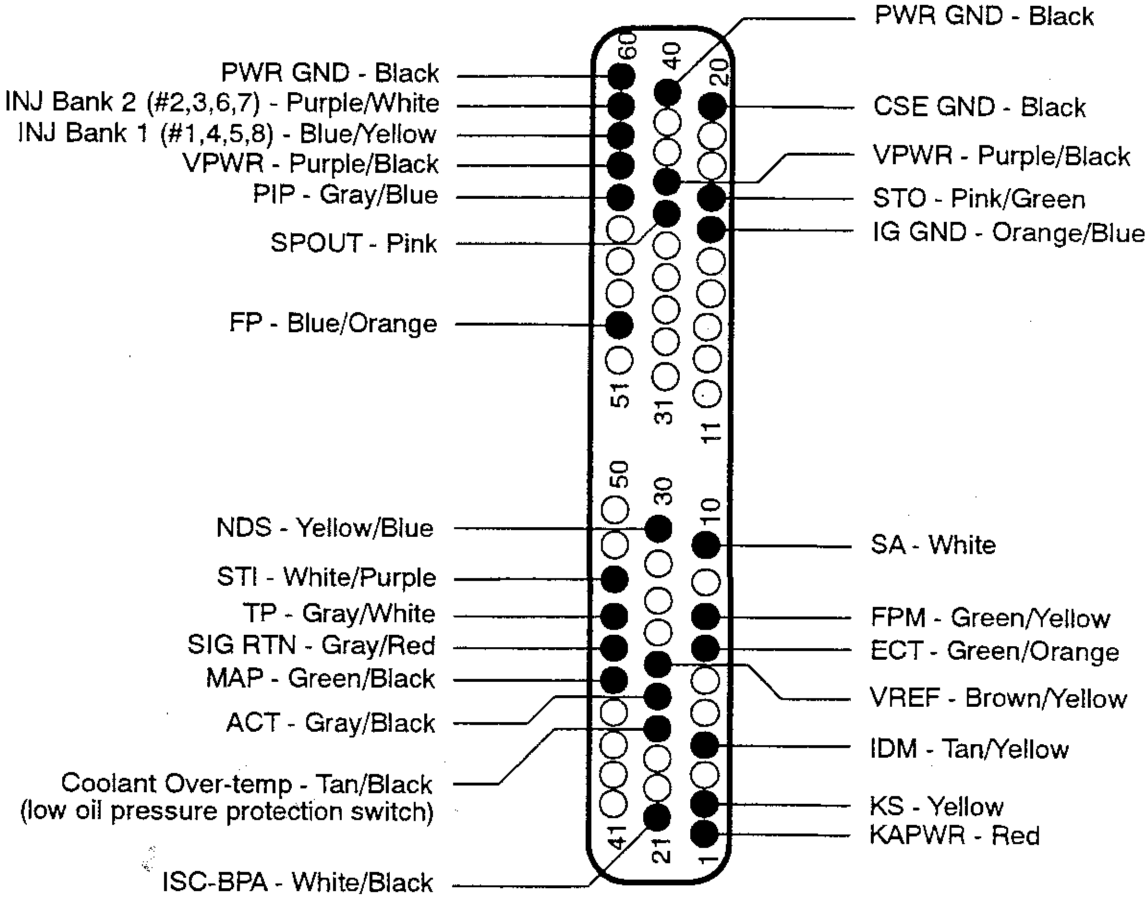


Table of Contents

SECTION 7 : SAFETY

SECTION 7A : People Who Use Them

SECTION 7B : People Who Fix Them

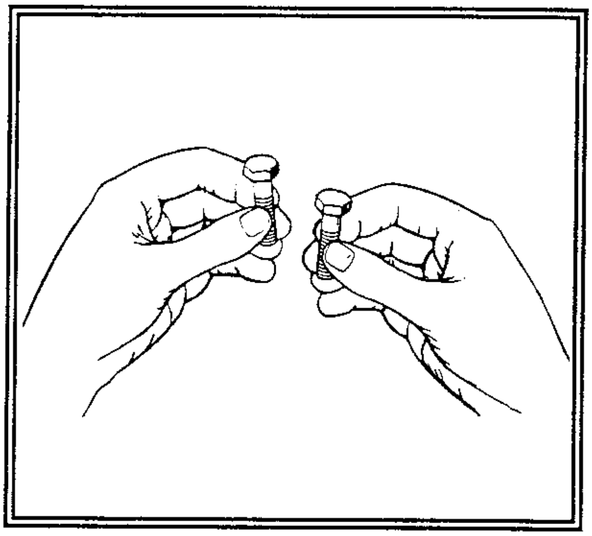
Enjoyable boating is the goal of people who design and build marine products. To reach this goal, manufacturers are careful to make sure the product user is informed and that the products are safe and reliable.

It's up to you, the people who install accessories, service and maintain the boat, to keep the products safe and reliable. This section talks about safe boating and how you can help keep it safe.

Fasteners

Do not substitute fasteners. They may look the same, but are they:

- The same size?
- The same strength?
- The same material?
- The same type?
- Standard or Metric thread?



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

Consider also:

- Special locking screws and nuts are often used .
- When you remove any part, keep track of special screws and nuts. Don't mix with other parts.
- When reassembling, use only the special screws and nuts intended.
- Service with parts of known quality that meet Marine Industry (BIA/ABYC) Standard.

Shift System

When the control lever is in Forward, Neutral or Reverse position, the shift mechanism must match control lever position.

What could happen?

If the control lever is in Neutral while the boat is in forward or reverse, the propeller is still powered (turning) unknown to the operator, or engine will start in gear and boat will move unexpectedly.

If the control lever is in Forward while the boat is in Reverse, the boat will move in the opposite direction intended by the operator.

How Can Loss of Shift Control be Minimized?

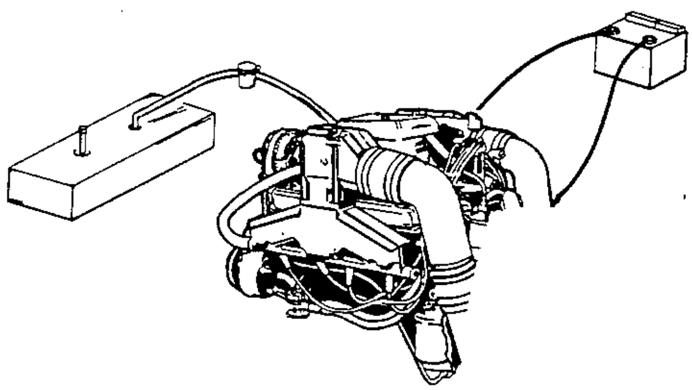
- Read, understand and follow manufacturers instructions.
- Closely follow the **WARNINGS.**
- Assemble parts and make adjustments carefully.
- Test your work. Don't guess. Make sure propeller does just what the operator wants and nothing else.
- Do not shift gears when engine is stopped. Adjustments can be lost, and parts weakened.

Throttle Control System

The operator must be able to slow to idle RPM in order to shift from Forward or Reveres to Neutral.

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

How Can Loss of Throttle Control be Minimized?
- Read, understand and follow manufacturers instructions.
- Closely follow the **WARNINGS.**
- Assemble parts and make adjustments carefully.
- Test your work. Don't guess. Make sure engine throttle response is smooth.
- Make sure full throttle operating RPM can be obtained so operator won't overload engine.

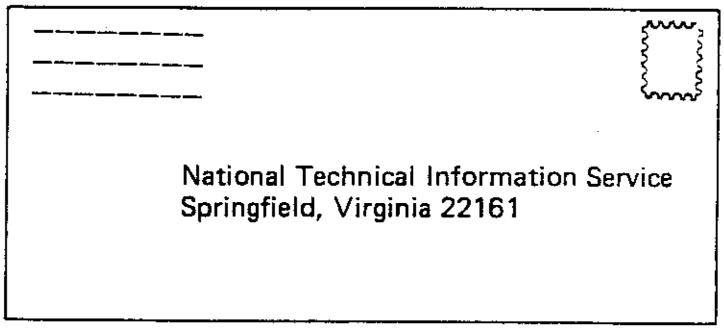


Fuel and Electrical Systems

What's important?
- Fuel leakage must be prevented.
- Stray electric sparks must not happen

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

How Can Fire and Explosion be Minimized?
- Read, understand and follow manufacturers instructions.
- Closely follow the **WARNINGS.**
- Do not substitute fuel or electrical parts with other parts which may look the same. These parts are designed and manufactured to meet special U.S. Coast Guard safety regulation requirements to prevent fire and explosion.

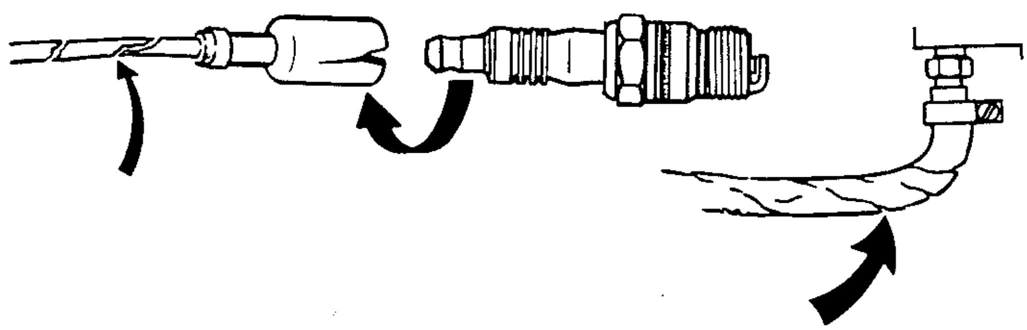


Where to Write for Information:

You must understand these Coast Guard Requirements. If you don't have them, write to the above address, and ask for copies of:

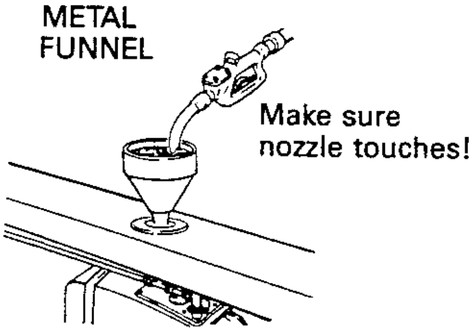
1. Electrical System Compliance Guideline (AD/A-049-638)
2. Fuel System Compliance Guideline (AD/A-047-767)

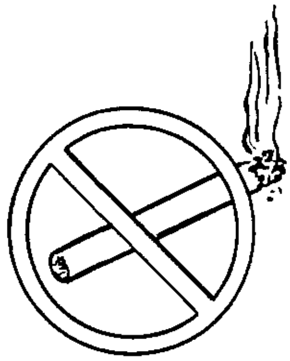
These are concise guidelines - easy to read and understand. They explain what must be done to prevent fire and explosions.



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

SECTION 7A - People Who Use Them



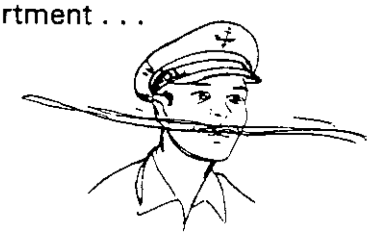


Using parts which meet Coast Guard requirements is only half the job. The other half is your job. It's time for replacement BEFORE sparks and/or fuel leaks occur:

- Replace parts carefully. Make sure nuts and bolts are tight especially where they anchor electrical wires (to prevent sparking). If lock washers are specified - use them. No short cuts or missing parts with either of these CRITICAL safety related systems.

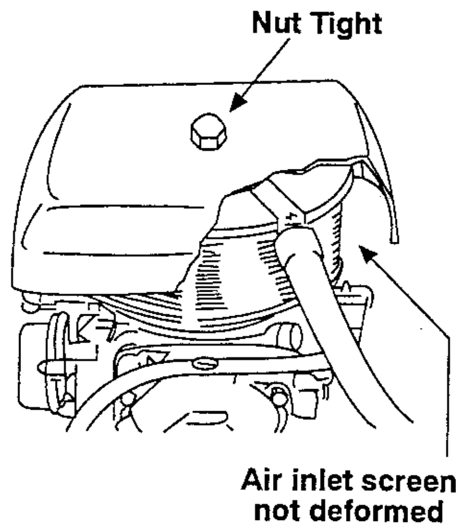
- When refueling, always ground fuel nozzle to the inlet fitting on the boat to prevent to build-up of electrostatic sparks. If you use a funnel, make sure it's metal and ground the fuel nozzle to the funnel.

- If you smell gasoline in the engine compartment . . . find its source and stop the leakage.



Follow "Starting Procedures" outlined in the operator's manual:

- Always make sure there are no gasoline fumes in the engine compartment before starting the engine. Open the compartment and use your nose. Don't gamble.
- Backfire flame arrestor must be in place and securely attached.



Do not alter the backfire flame arrestor. If loose, damaged or altered, an engine "backfire" may pass through the flame arrestor assembly into the engine compartment. If fumes are present in compartment, fire and explosion could result.

Summing Up:

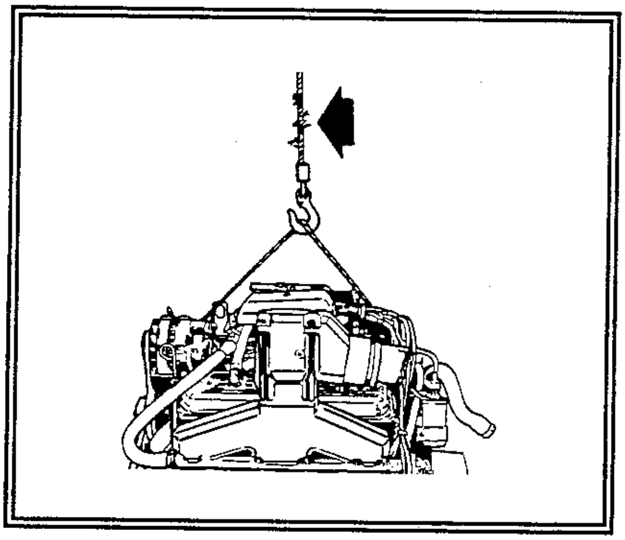
• Read and understand instructions. • Read and understand **WARNINGS**. • Put parts together right. • Make adjustments right. • Test your work.	• Make sure worn or damaged parts are replaced. • Replacement parts should be like originals in every way. • Be sure customer is told of things which need attention. (do you really want the alternative?).

SECTION 7B - People Who Fix Them

Section 7A talked about safe boating and how you, the mechanic, can help keep it safe for the boater. But what about you: Mechanics can be hurt while:

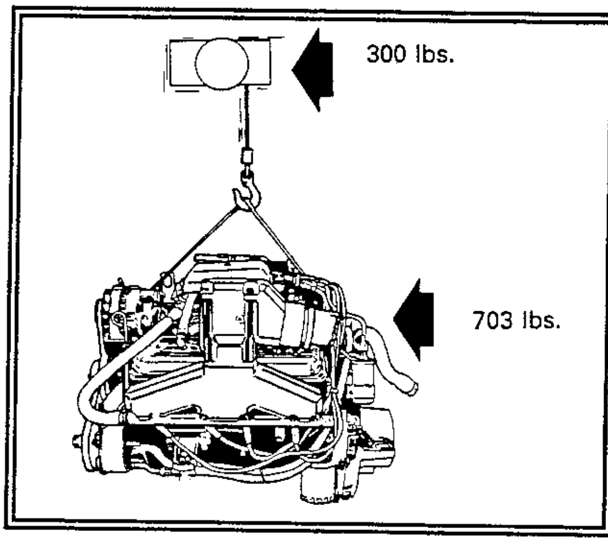
- Servicing boats
- Troubleshooting problems
- Testing their work

Handling Engines



If hoist is in poor shape or too small for the job, **Engine may suddenly .**

Make sure shop aids have extra capacity and keep them in good repair.



SECTION 7B - People Who Fix Them

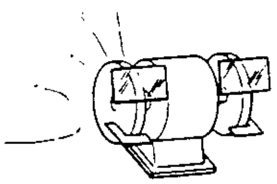
When Running Engine with Cover Removed

Engine compartment cover is a guard. When you remove cover/guard to work on the engine remember :

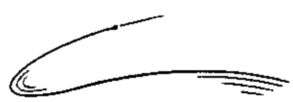
- Loose clothing (open shirt sleeves, neckties), long hair, jewelry (rings, watches, bracelets), hands, arms and belts can be caught by moving belts or spinning pulleys.
- Handle high voltage ignition components carefully. They can shock you and may cause you to recoil into moving parts.
- Never, ever hit the key to start engine before signaling your partner. (he may be leaning over the engine with hands on a belt... or a hot electrical part...or near the propeller, etc.
- Exhaust gases of running engines contain carbon monoxide. You can't see it....smell it...or taste it...but it's there whenever an engine runs...and it's deadly!

When you smell the other gases in the exhaust, you are inhaling carbon monoxide. Run engines only in well ventilated areas.

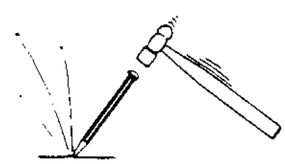
Protect Your Eyes



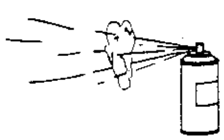
Grinding



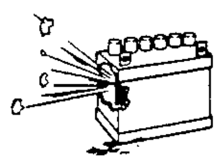
Ends of Cables



Chiseling



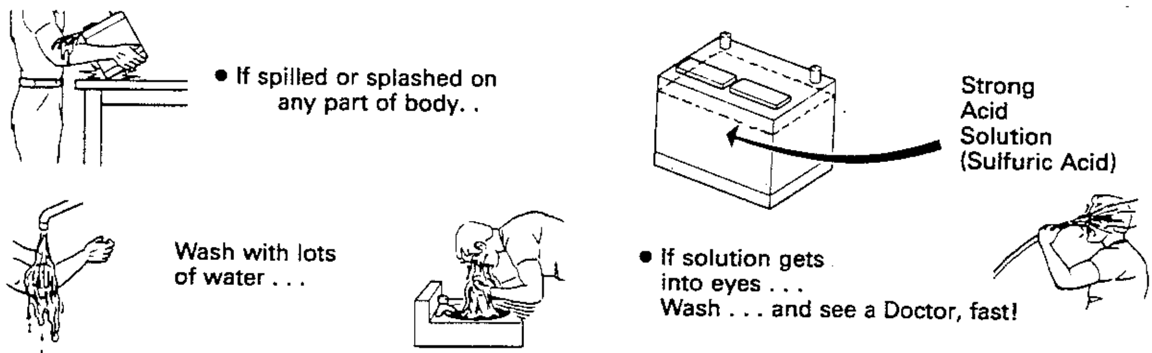
Spray Cans



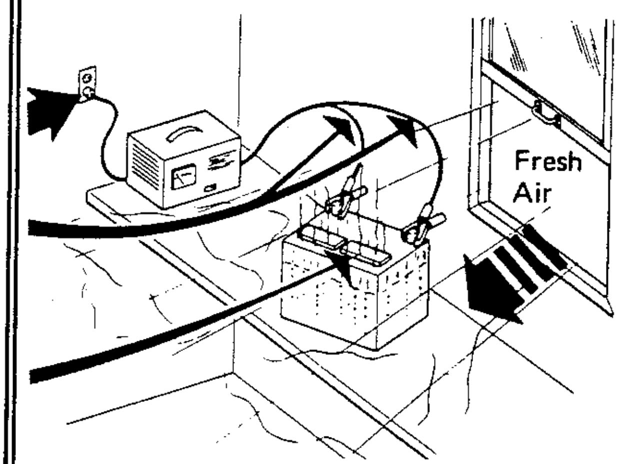
Acid

Wear Safety Glasses

Handling Lead Acid Batteries



Charging Lead Acid Batteries

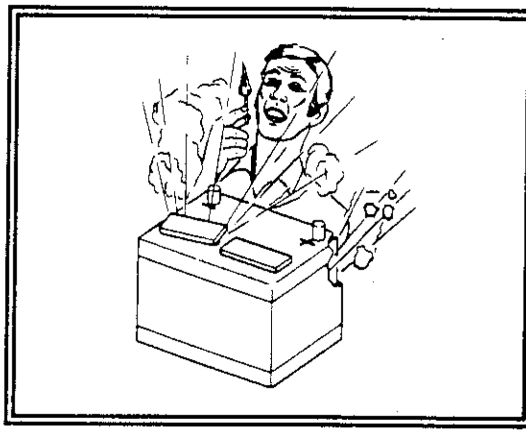


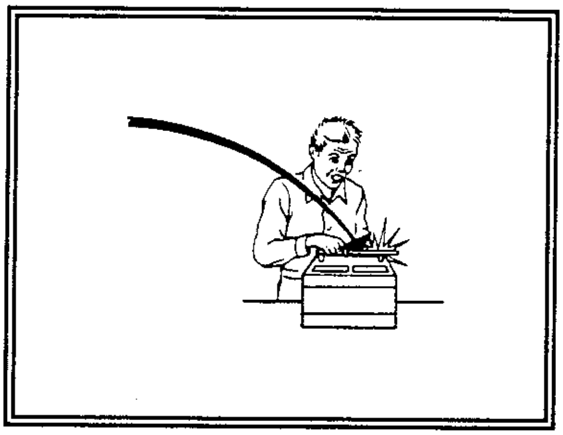
1. Attach and remove these cables with charger unplugged from 110 volt wall socket (prevents shocks if the charger is defective).
2. Observe correct polarity when connecting these charger leads
3. Always charge in a well ventilated area. Charging causes acid solution to give off hydrogen gas through the vents in the caps. Make sure vents are open. If clogged, pressure inside may build..**battery may explode!**

Battery Gas is Explosive

While charging or discharging, remember:

- No Smoking
- No Flames
- No Sparks
- Never yank cables off battery posts...it's a sure way to make lots of sparks...surrounded by battery gas.





Don't check battery condition by placing metal objects across posts. You're sure to make sparks and serious burns are possible.

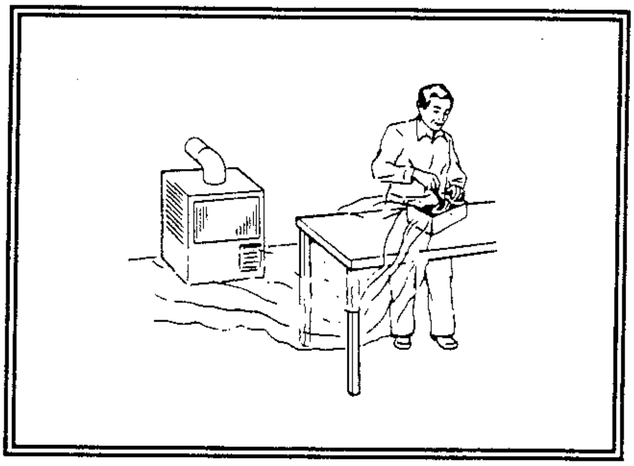
After Charging:

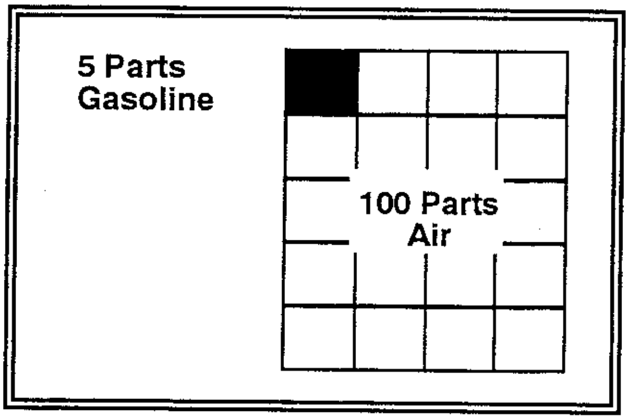
- Shut off charger
- Pull charger plug out of 110V outlet
- Then...Take charger cables off battery posts.

Gasoline! Handle With Care!

When you smell any odor of gasoline, explosion is possible.

- Gasoline fumes are heavy and will sink to the lowest point in the boat or room, and will stay there.....waiting!
- If the air around you is quiet, the pilot light in the heater may ignite the heavy fumes before your nose ever smells them.





Gasoline explodes easily and violently when mixed as shown

What Can You Do?

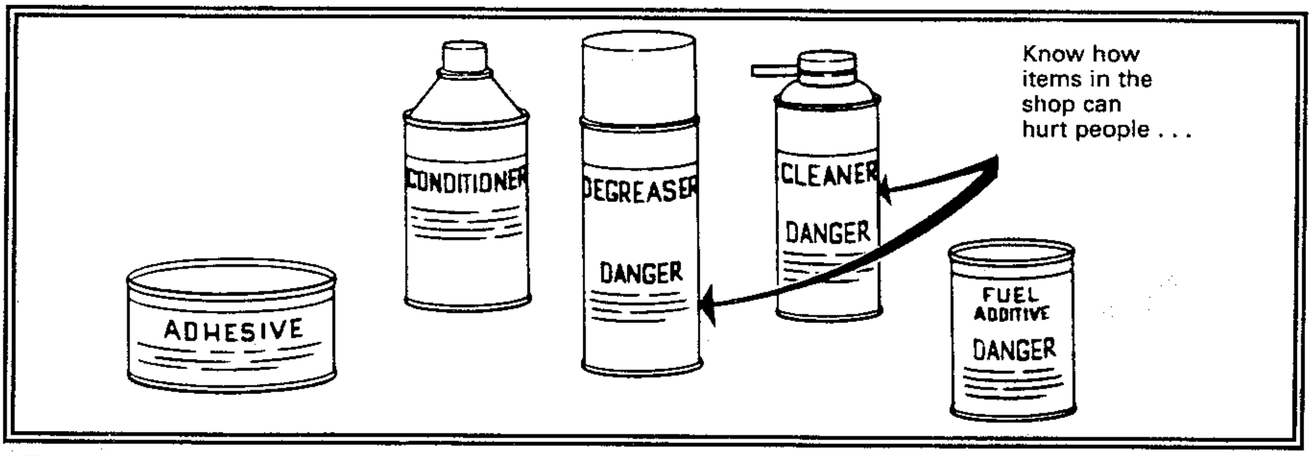
- Store gas in a sturdy, sealed gas can and keep outside.
- Fill portable tanks outside boat to prevent spillage in boat.
- Use fuel for fuel, not for a cleaner or degreaser.

If You Smell Fuel:

- Put out open flames, cigarettes, sparking devices.
- Wipe up spill or leak; get towels, rags outside fast.
- Check lowest area for fumes; open doors or windows.

Know Items Which can Ignite Fumes
- Matches, cigarettes, torches, welders
- Electric motors and generators (with unsealed cases)
- Light switches
- Appliance pilot lights (furnace, dryer, water heater)
- Loose wires on running engines

Hazardous Products



Read the container label. It tells you:
- How and where to use
- How to give first aid and have recommended first aid materials on hand should an emergency arise
- How to dispose of can

Remember little children are very curious