# MOTORCRAFT EEC III IGNITION SYSTEM

**Ford Motor Co.**
**Calif. LTD and Marquis**
**5.0L (302") and 5.8L (351")**
**All Lincoln and Mark VI**

## DESCRIPTION

The Electronic Engine Control System (EEC III) is used on California Ford and Mercury models with 302" or 351" engines and on all Lincoln and Mark VI models with 302" engines. Other models use Dura-Spark II ignition systems.

The ignition portion of the EEC III system is referred to as Dura-Spark III, a solid state system which provides power switching of the ignition coil. Dura-Spark III input signals are controlled by the EEC system.

The EEC distributor, unlike Dura-Spark II, has no centrifugal or vacuum advance. Also, it has no armature (reluctor) or stator (pick-up coil). See *Fig. 1*. Secondary wires and spark plugs are the same, however, as used in Dura-Spark II systems.

Although control modules appear similar, they must not be interchanged. Dura-Spark III control modules have no purple wire and can also be identified by a brown grommet (Dura-Spark II modules have a blue grommet).

Ignition timing is determined by the crankshaft position (CP) sensor and 6 or 7 other engine sensors which feed information to the EEC III system Electronic Control Assembly (ECA) through a special 32-pin connector.

These other sensors vary between carbureted and fuel injection engines, but include exhaust gas oxygen (EGO), engine coolant temperature (ECT), EGR valve position (EVP), throttle position (TP), barometric manifold absolute pressure (BMAP), and air charge temperature (ACT) sensors.

Unlike conventional distributors that are restricted to approximately 20° advance, the EEC system permits up to 50° distributor advance. Both distributor cap and rotor have upper and lower electrode levels. As the rotor turns, one of the high voltage electrode pick-up arms is aligned with one arm of the distributor cap center electrode plate. This allows high voltage to pass from the center plate arms through the rotor, distributor cap, and spark plug wire to the appropriate spark plug.

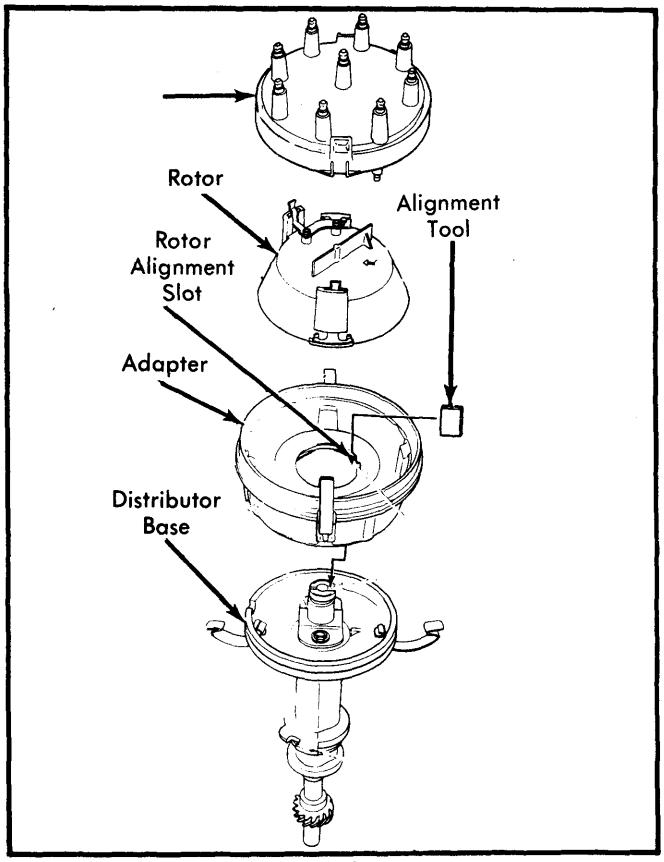


***Fig. 1 EEC III Distributor Components***

NOTE – *The numbers on top of the distributor cap are for spark plug wire or cylinder identification only. The engine firing order cannot be read from the top of the distributor cap, due to the rotor's 2-level electrode design. In EEC III system, the upper and lower level electrodes fire alternately in a pattern jumping from one side of the cap to the other.*

## OPERATION

With the ignition switch turned on, the primary circuit is on and the ignition coil is energized. See *Fig. 2*. The EEC system (not the distributor as in Dura-Spark II systems) provides a signal telling the ignition module to turn off the coil primary circuit.

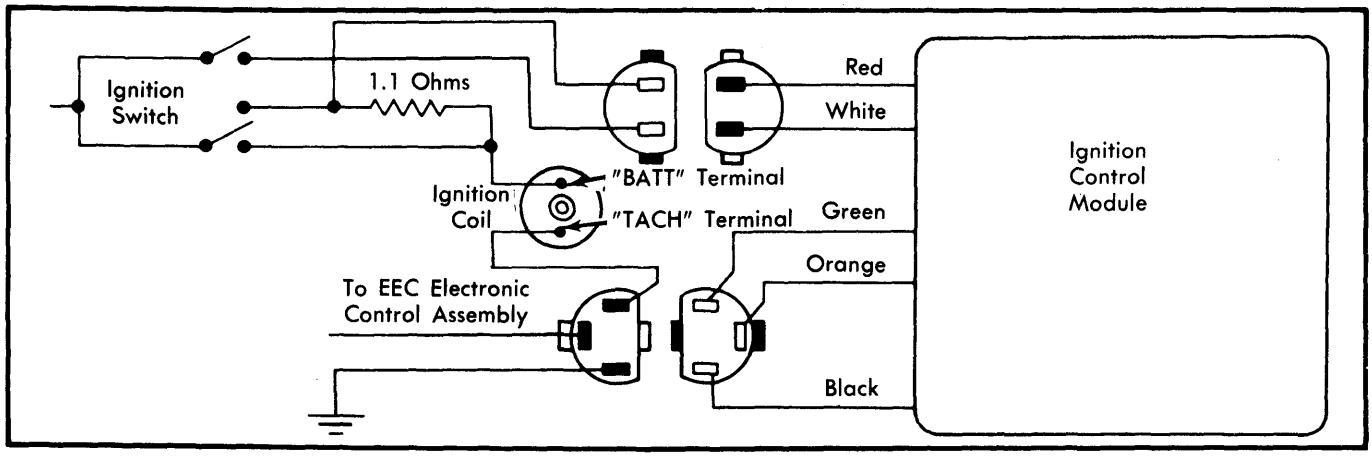


***Fig. 2 EEC III Ignition System Schematic***

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The length of time the primary circuit is turned on or off is controlled by the EEC Electronic Control Assembly (ECA). See *Fig. 3*. When the current is on, it flows from the battery through the ignition switch, primary windings of ignition coil, and ignition module circuits to ground.

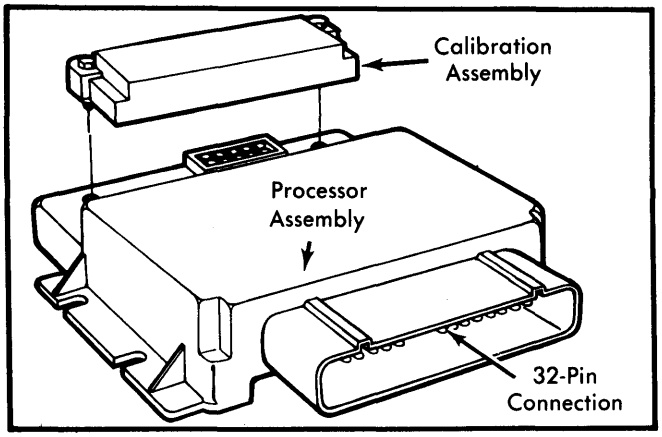


***Fig. 3 EEC III Electronic Control Assembly***

When the current is turned off, the magnetic field which built up in the ignition coil collapses, inducing high voltage to the secondary windings of the coil. This high voltage, produced each time the magnetic field builds and collapses, is transmitted by the coil to the distributor, rotor and cap to individual spark plugs.

The function of the electronic control assembly and engine sensors follows:

**Electronic Control Assembly** – The ECA is the "brain" of the EEC system. It is a solid-state, pre-programmed microcomputer, consisting of a processor assembly and a calibration assembly. The ECA is located under the instrument panel to the left of the steering column.

**Processor Assembly** – The processor assembly contains circuits designed to:

- Continuously sample the 7 (8 on EFI models) engine sensor input signals for analysis. See *Fig. 4*.
- Convert the input signals to a form usable by the computer section in calculations.
- Choose the proper operating strategy (base engine, modulator, or limited operational) for the operating conditions.
- Perform spark, EGR, air/fuel ratio, canister purge, throttle kicker, thermactor air control and other functions.
- Send electrical output signals to the fuel injectors, ignition module, and control solenoids to adjust timing and dwell, air/fuel ratio, canister purge mode, EGR flow rate, thermactor air mode, throttle kicker mode and fuel control.

The processor assembly also provides a continuous reference voltage (about 9 volts) to the sensors.

**Calibration Assembly** – The calibration assembly is attached to the top of the processor assembly and contains electronic circuits in its black plastic case. It is capable of:

- Providing calibration information necessary for that particular vehicle, for use by the processor assembly.
- Recalling appropriate data previously stored in the memory bank, as vehicle requires.

**Power Relay** – A power relay is attached to the lower right side of ECA mounting bracket. It supplies battery voltage to the EEC system.

**Crankshaft Position Sensor** – A crankshaft pulse ring with 4 lobes is pressed onto the vibration damper at the front of the crankshaft. The 4 lobes are spaced 90° apart. The EEC ring is positioned 10° BTDC on the crankshaft. As the crankshaft rotates, the pulse ring lobes pass the tip of the crankshaft position sensor. The sensor contains a permanent magnet and coil. As the lobes cut through the magnetic field of the sensor, an output voltage is generated in the coil and sent to the ECA. The ECA converts these signals to crankshaft (piston) position for spark timing and into RPM for spark advance calculation. The sensor is attached to the engine block and locked in place by a clip and screw. The sensor has no adjustment.

NOTE – *A broken sensor or open wiring will prevent the ECA from receiving a position signal and prevent the engine from starting.*

**Barometric & Manifold Absolute Pressure Sensor** – The barometric and manifold absolute pressure (BMAP) sensor is actually an assembly containing 2 sensors. The BMAP sensor monitors the value of intake manifold absolute pressure and atmospheric pressure. Manifold absolute pressure is defined as barometric pressure minus manifold vacuum. Barometric and manifold pressure are converted into electrical signals for use by the ECA, in calculating spark advance, EGR flow and air/fuel ratio. The sensor is located on the right-hand fender apron.

**Air Charge Temperature Sensor** – Sensor is located on left rear side of fuel injection unit and is not used on carbureted models. Threaded into a cylinder runner of the intake manifold, the sensor provides EFI system with air/fuel mixture temperature information. It is used both as a density corrector to air flow calculation and to proportion the cold enrichment fuel flow.

**Coolant Temperature Sensor** – The sensor converts engine coolant temperature to an electrical signal to the ECA. The ECA then controls EGR operation. Also, if the engine overheats, the ECA will advance ignition timing. The sensor is located in the heater outlet fitting at the front of the intake manifold, near the right-hand valve cover.

**Throttle Position Sensor** – The sensor is a variable resistor control, mounted on a bracket on the right side of carburetor or EFI. With a reference voltage applied by the ECA, a signal is sent to the ECA which classifies the signal into one of 3 modes:

- Closed throttle (idle or deceleration).
- Part throttle (cruise).
- Wide open throttle (maximum acceleration).

The sensor has slotted mounting holes to permit rotational adjustment. If sensor is replaced or if curb idle speed is adjusted, sensor must be positioned correctly or erroneous throttle position information will be sent to the ECA.

**EGR Valve Position Sensor** – Sensor monitors EGR valve position. This signals ECA on the amount of EGR flow. It is located at base of carburetor or to rear of EFI unit.

**Exhaust Gas Oxygen Sensor** – Sensor is threaded into the right-hand exhaust manifold directly in the path of exhaust gas stream. EGO sensor provides information to the ECA

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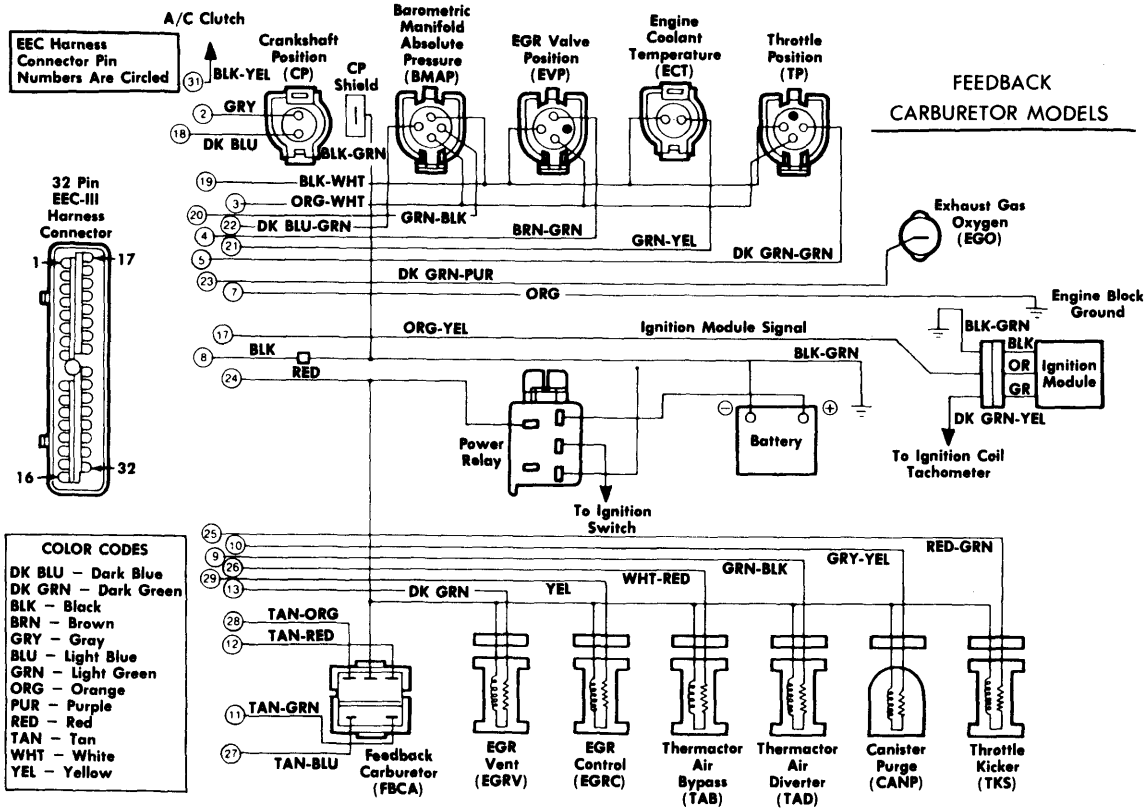


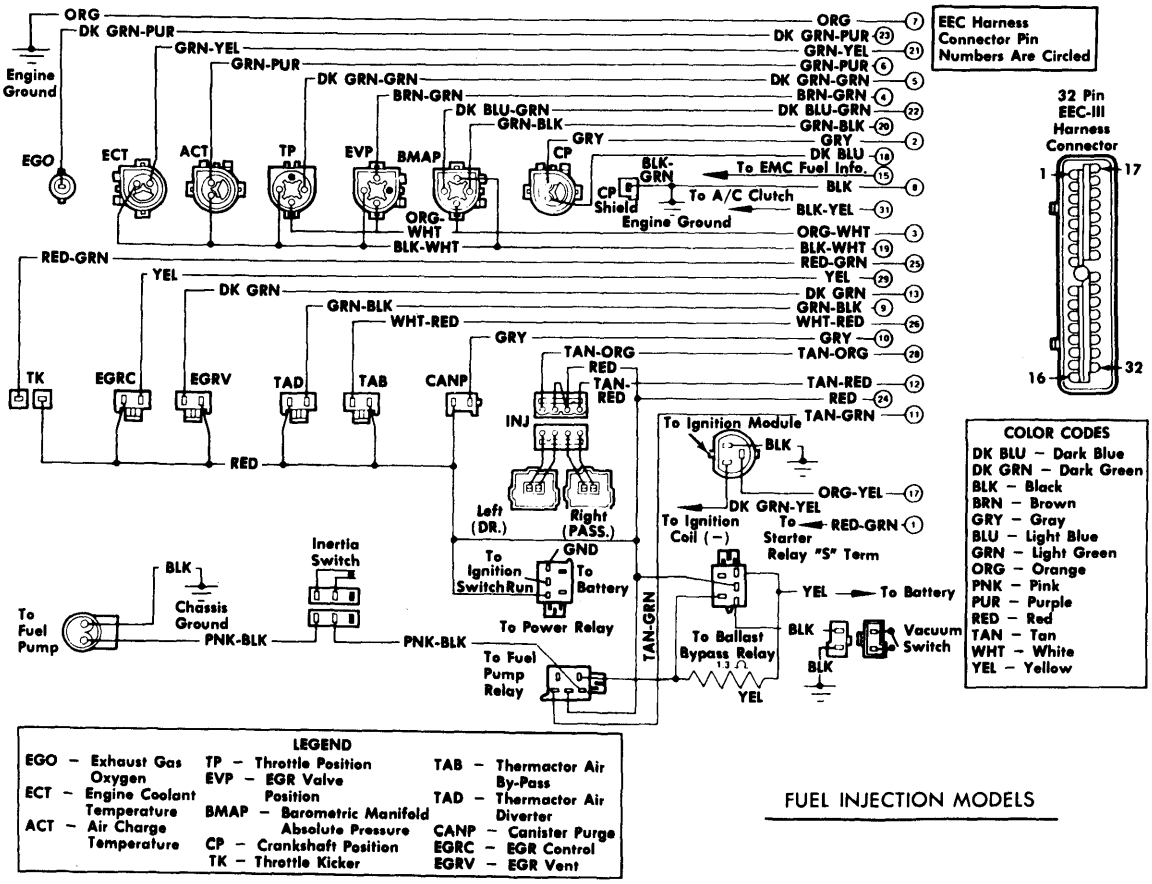


***Fig. 4 1981 EEC III Wiring Diagram***

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about air/fuel ratio (rich or lean) as indicated by oxygen concentration of the exhaust gases.

### TESTING

NOTE – *The following tests (Spark Plug Required Voltage, Coil Reserve Voltage and Distributor Rotor to Cap Voltage Drop) are designed to diagnose poor operating characteristics. If vehicle cranks, but will not start, proceed to Secondary Voltage Check to begin testing.*

#### SPARK PLUG REQUIRED VOLTAGE CHECK

**1)** Connect diagnostic console to display "parade" pattern. Connect timing light to No. 1 spark plug wire. Attach clamp-on voltage pick-up to coil high tension wire. Start engine and run at approximately 2000 RPM for 2 minutes.

NOTE – *If vehicle will not start, test while cranking.*

**2)** Apply 25 in. Hg vacuum to "BP" port of BMAP sensor. Read highest spark plug required voltage for each cylinder. If reading is 6,000-20,000 volts, required voltage is OK.

**3)** If timing is 27-30° BTDC, timing is OK. If not, timing cannot be adjusted. Check lobes on pulse ring for damage, check gap (.075") between crankshaft position sensor and pulse ring. If no problem is found, correct problem in non-ignition portion of EEC system.

**4)** If voltage was less than 6,000 volts, proceed to Fouled Spark Plug Check. If voltage was greater than 20,000 volts or 50 per cent higher than other cylinders, proceed to Ignition Coil Primary Voltage Check. If both voltage and timing are correct, proceed to next test.

NOTE – *If an abnormal scope pattern is evident, remove distributor cap and rotor. Check for damaged components or internal arcing. Also check rotor alignment.*

#### COIL RESERVE VOLTAGE

**1)** Disconnect wire from either No. 2 or No. 4 spark plug. Connect a spark tester to spark plug wire. *See Fig. 5.*

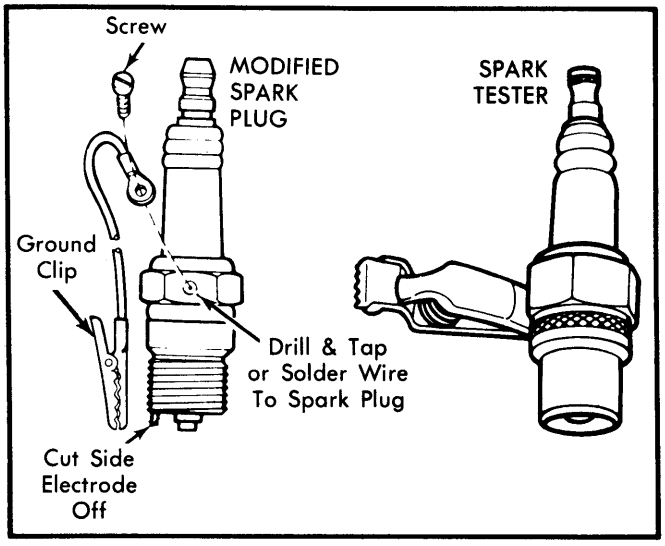


***Fig. 5 Modified Spark Plug and Spark Tester***

NOTE – *If no tester is available, modify spark plug by attaching ground to metal case and clip off outer electrode.*

**2)** Start engine and run at approximately 1000 RPM. Limit engine operation to 30 seconds to prevent damage to emission system components. If spark occurs at plug, coil reserve voltage is OK. Proceed to next test.

**3)** If no spark occurs, remove distributor cap, rotor and adapter (in order) and check components. Then proceed to Secondary Voltage Check.

#### DISTRIBUTOR ROTOR-TO-CAP VOLTAGE DROP CHECK

**1)** Connect diagnostic console. Remove spark tester from spark plug wire and ground wire. Connect clamp-on voltage pick-up to coil high tension wire. Start engine and run at idle.

NOTE – *If high voltage secondary spike is negative going on the scope, the "BATT" lead and "TACH" lead could be reversed at the coil connection or coil could be worn or damaged.*

**2)** If reading is 8,000 volts maximum, distributor rotor-to-cap voltage drop is OK. If more than 8,000 volts, remove distributor cap and inspect for worn or damaged rotor or for silicone grease leak on rotor. Measure resistance of coil wire. Replace wire if resistance is more than 5,000 ohms per inch.

**3)** If an abnormal scope pattern appears, inspect for worn or damaged distributor components or for a misaligned rotor.

#### SECONDARY VOLTAGE CHECK

**1)** Connect timing light to No. 1 spark plug wire. Crank engine with timing light pointing at mark on timing pointer. Refer to engine decal for proper timing.

**2)** If light flashes and timing marks line up on damper, proceed to Start Check. If light flashes, but marks do not line up, remove distributor cap and check for rotor damage or misalignment. If light does not flash, proceed to Ignition Coil Output Check.

**3)** Connect a spark tester to No. 2 or No. 4 spark plug wire. If spark occurs, proceed to Fouled Spark Plug Check and then Start Check. If no spark occurs, proceed to Ignition Coil Output Check.

#### START CHECK

Attempt to start engine. If it starts, problem is resolved. If engine does not start, proceed to next test and check fuel system.

#### IGNITION COIL OUTPUT CHECK

**1)** Connect spark tester to ignition coil high tension wire's distributor end. Crank engine. If spark occurs, check distributor cap, rotor and secondary wires for damage. Service as necessary and rerun test. If problem still exists, proceed to Ignition Coil Primary Voltage Check.

**2)** If no spark resulted, remove distributor cap, crank engine, and check for rotor movement. If none, check distributor and engine for damage. Then, proceed to next test.

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### TRIGGER CHECK

**1)** Disconnect ignition control module's 3-pin connector (black, orange and green wires). Install diagnostic test adapter (T79P-12127-A) between 3-pin module and harness connectors. *See Fig. 6.*

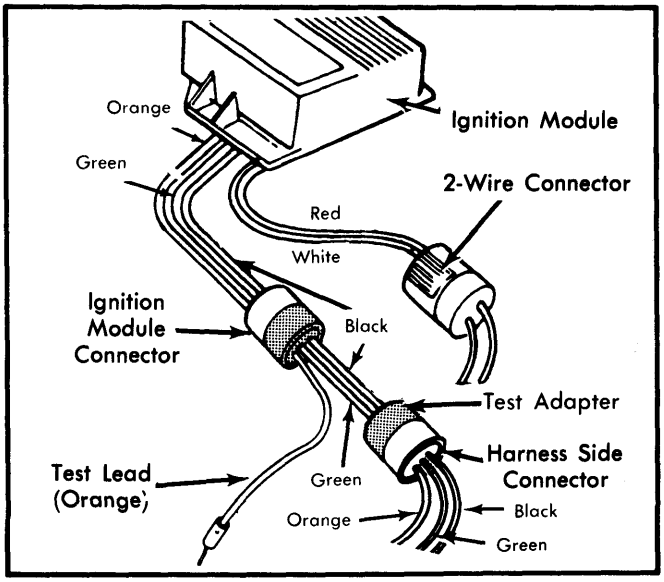


***Fig. 6 Installation of Test Adapter or Jumper Wires for Performing EEC III Diagnosis***

NOTE — *If adapter is not available, use jumper wires. Connect black and green wires to their mating harness wires. Attach jumper wire to orange module wire, but do not attach this wire to its mating harness wire. Leave it free for testing.*

**2)** Remove coil high tension wire from distributor. Install spark tester on end of wire. Turn ignition switch to "RUN" position. Tap the adapter diagnostic lead wire (jumper wire to orange module wire) against battery positive terminal. A spark should occur at spark tester each time diagnostic lead touches battery.

**3)** If spark results, ignition system is OK. Check other parts of EEC system. Then check fuel system. If no spark results, proceed to next test after reconnecting all vehicle wiring.

### IGNITION COIL PRIMARY VOLTAGE CHECK

**1)** Turn ignition switch to "RUN" position. Measure battery voltage at coil positive ("BATT") terminal.

**2)** If more than 8 volts is read, proceed to Ground Circuit Check. If 5-8 volts, ignition primary is OK. Proceed to next test. If less than 5 volts, proceed to Wiring Harness Shorts Check and then Ignition Coil Circuit Check. Then check for open power feed wires (battery positive wire to ignition coil and module). If problem still is not solved, check non-ignition portion of EEC system.

### MODULE RUN CIRCUIT VOLTAGE CHECK

**1)** Turn ignition switch to "RUN" position. Using a small straight pin, puncture red wire between control module and connector. *See Fig. 7.* Attach positive voltmeter lead to straight pin and negative lead to ground. Do not let pin touch ground.

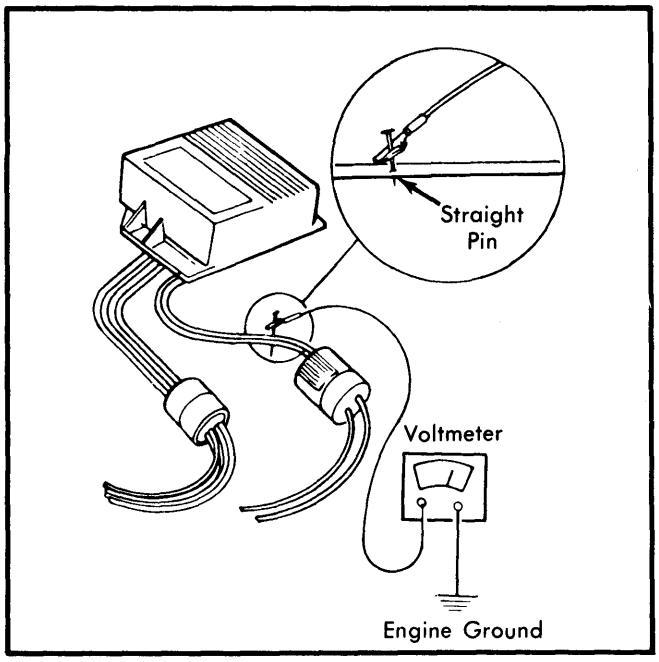


***Fig. 7 Checking Control Module Feed Wires (Red or White Wire Circuits)***

**2)** If voltage is more than 90 per cent of battery voltage, the module run circuit is OK. Proceed to next test. If less than 90 percent, check for an open wire in run circuit.

### MODULE START CIRCUIT VOLTAGE CHECK

**1)** If starter relay has an "I" terminal, disconnect cable from relay to starter motor. If there is no "I" terminal, disconnect wire at "S" terminal.

**2)** Hold ignition switch in "START" position. Connect voltmeter positive lead to coil positive ("BATT") terminal and negative lead to ground. *See Fig. 8.* Record reading. Then puncture white wire with a straight pin between control module and connector. *See Fig. 7.* Attach positive voltmeter lead to pin and negative lead to ground. Do not let pin touch ground.

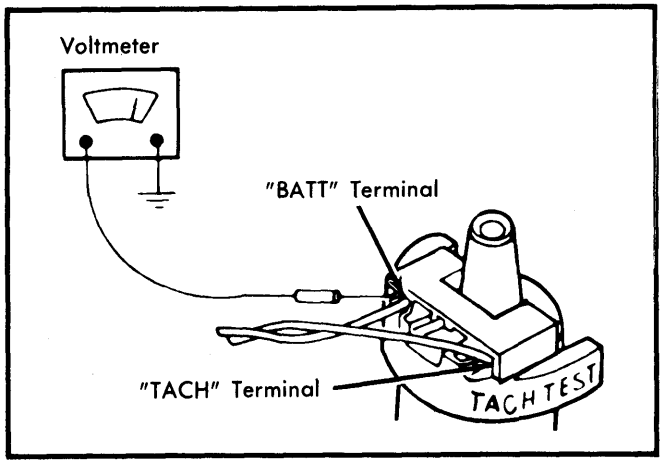


***Fig. 8 Checking Battery Voltage at Coil***

**3)** If voltage is more than 90 percent of battery voltage (measured at coil), module start circuit is OK. Proceed to Module Output Check.

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**4)** If voltage is less than 90 percent of battery voltage, proceed to next test. Then check for an open ballast resistor by-pass wire or for an open condition in the module white wire circuit. Also check ignition switch connections and switch condition.

### WIRING HARNESS SHORTS CHECK

**1)** Disconnect and check ignition module, ignition coil and EEC electronic control assembly connectors for dirt or damage. Check also for overheated, burned or bare wires connecting to red, white or green control module wires or to "BATT" or "TACH" terminals of coil connector.

**2)** Set parking brake and place transmission lever in "NEUTRAL" or "PARK" position. Connect ohmmeter leads to module wiring harness orange wire and to ground.

**3)** Connect an ohmmeter between harness connector wires that would mate with control module harness red and white wires, red and green wires, red and orange wires, white and green wires, and white and orange wires.

**4)** If resistance is greater than 70,000 ohms, proceed to Ignition Coil Circuit Check. If less than 70,000 ohms, repair or replace wires as necessary.

### GROUND CIRCUIT CHECK

**1)** Disconnect 3-pin module connector and inspect it for dirt or damage. Connect ohmmeter leads to ground and to harness connector terminal that mates with control module black wire.

**2)** If resistance is less than 1 ohm, proceed to next test. If more than 1 ohm resistance, inspect ground strap connecting to battery for poor connection or open condition.

### IGNITION COIL CIRCUIT CHECK

**1)** Disconnect control module and coil connectors and inspect for dirt or damage. Connect one ohmmeter lead to harness connector terminal mating with control module green wire. Connect other lead to end of same wire disconnected from coil "TACH" terminal.

**2)** If less than 2 ohms, resistance is OK. Proceed with test. If more than 2 ohms, service open in wiring harness "TACH" wire and inspect for corrosion.

**3)** Connect ohmmeter leads in same manner to harness terminal connecting with control module red wire and to other end of wire disconnected from coil "BATT" terminal.

**4)** If less than 2 ohms, resistance is OK. Proceed to next test. If greater than 2 ohms, service ballast resistor wire for open or corrosion.

### MODULE OUTPUT CHECK

**1)** Be sure all wires and harnesses are connected. Connect positive lead of voltmeter to coil "TACH" terminal and negative lead to ground. Set voltmeter on highest scale. Ground distributor cap end of coil high tension wire. Crank engine, and while cranking, switch voltmeter to lowest scale.

**2)** Meter needle should oscillate. If so, module output is OK. Proceed to Ignition Coil Primary Resistance Check. If needle does not oscillate, proceed to next test.

NOTE – *If voltmeter is not available, connect test light across coil terminals. Check for light flashing instead of needle oscillation.*

### MODULE OPERATION CHECK

**1)** Disconnect 3-pin control module connector. Connect positive voltmeter lead to wiring harness terminal that mates with control module green wire. Attach negative lead to ground. Turn ignition switch to "RUN" position and check voltage.

**2)** If reading is greater than 90 percent of battery voltage, turn switch to "OFF" position and replace ignition control module. If reading is less than 90 percent of battery voltage, turn switch to "OFF" position and proceed to next test.

### "TACH" WIRE CONTINUITY CHECK

**1)** Connect one ohmmeter lead to harness terminal that mates with control module green wire. Connect other end to coil "TACH" wire in coil connector (do not remove).

**2)** If less than 1 ohm, wire is OK. Proceed to next test. If more than 1 ohm, service open wire between control module harness connector and "TACH" terminal of coil.

### IGNITION COIL PRIMARY RESISTANCE CHECK

**1)** Disconnect ignition coil connector. Attach ohmmeter leads to "BATT" and "TACH" terminals of coil (not connector).

**2)** If reading is greater than 1 ohm, but less than 2 ohms, primary resistance is OK. Proceed to next test. If reading is not 1-2 ohms, replace ignition coil.

### IGNITION COIL SECONDARY RESISTANCE CHECK

**1)** With coil connector still removed from coil, connect ohmmeter leads to "TACH" terminal and to coil tower (with high tension wire removed).

**2)** If resistance is 7,700-9,600 ohms, secondary resistance is OK. If not within specified range, replace ignition coil.

### FOULED SPARK PLUG CHECK

**1)** Remove distributor cap. Connect 500V DC megohmmeter between each spark plug wire at distributor and engine ground.

NOTE – *If megohmmeter is not available, proceed to Power Balance Check.*

**2)** If reading is more than 50 megohms, spark plug is OK. If less than 50 megohms, check spark plug wire. If good, replace spark plug.

### POWER BALANCE CHECK

**1)** Connect tachometer to ignition coil. Start engine and let it run at idle until engine reaches normal operating temperature. Remove spark plug wire at distributor.

**2)** If RPM drops approximately 100-200 RPM, spark plug tested is OK. Proceed until all plugs have been tested. If all plugs test OK, check fuel system for problems. If engine RPM

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does not drop when spark plug wire is removed, check spark plug and wire as instructed in next test.

### SPARK PLUG WIRE CHECK

**1)** Disconnect spark plug end of suspected wire or wires. Remove distributor cap. Measure resistance of spark plug wires by touching ohmmeter probes to each end of wire. Measure from inside distributor cap. If resistance is less than 5,000 ohms per inch, wire is OK.

**2)** If resistance is more than 5,000 ohms per inch, remove wire from cap and measure resistance of wire only. If it is less than 5,000 ohms, wire is OK. Check distributor cap and spark plug terminal for corrosion. Also check spark plug. If more than 5,000 ohms, replace spark plug wire.

### ELECTRONIC CONTROL ASSEMBLY AND SENSOR CHECK

Due to the complexity of the EEC system, 2 special diagnostic aids are required. One is a Digital Volt/Ohmmeter. This is a highly accurate, high input impedance meter that is more accurate than conventional needle-type Volt/Ohmmeters.

The second diagnostic aid is the special EEC System Diagnostic Tester (Rotunda T79L-50-EEC II or T80L-50-EEC II). The tester plugs into the vehicle harness between the electronic control assembly and its harness. Testing instructions are provided in the operator's manual furnished with the tester. Specifications required are on vehicle emission control information decal on engine valve cover.

Other equipment necessary for testing includes a timing light compatible with Dura-Spark systems, a pressure/vacuum gauge, tachometer, spark tester, jumper wire, EFI pressure gauge (T80L-9974-A) and EFI adapter harness (T80L-50-EFI).

## OVERHAUL

### ROTOR

**Removal** – Remove distributor cap. Remove rotor by pulling up on rotor pull tab. Rotor is held in place by a spring clip.

NOTE – *Rotor removal is only necessary when replacing rotor or adapter or when checking rotor condition. No adjustment to distributor is needed when rotor is replaced.*

**Installation** – **1)** Coat rotor lower electrode blade only (not upper blades) using silicone grease. Coat all 4 distributor cap center blade arms to a 1/32" thickness.

**2)** To check rotor alignment, set No. 1 piston on compression stroke, rotate crankshaft until rotor alignment tool (T79P-12200A) can be inserted into alignment slots in rotor and center of shaft. See *Fig. 9*. Read timing mark on damper that is aligned with pointer. If timing mark is within 4° of specification, do not reset rotor alignment. EEC models with feedback carburetors should be adjusted to TDC; those with EFI to 5° ATDC. Either adjustment may be ±4°.

**3)** If alignment is not within 4° of specified timing or when installing rotor, remove alignment tool, position crank at proper timing mark and loosen 2 sleeve assembly adjustment screws. Rotate sleeve until alignment tool fits into alignment slots. Tighten adjustment screws and remove tool.

**4)** Align arrow molded into top of rotor with large key way slot in distributor sleeve. Press down on rotor until retaining spring snaps into place.

NOTE – *Since EEC distributors have no vacuum or centrifugal advance mechanisms, overhaul is limited to removal, inspection and alignment of rotor or removal and inspection of cap.*

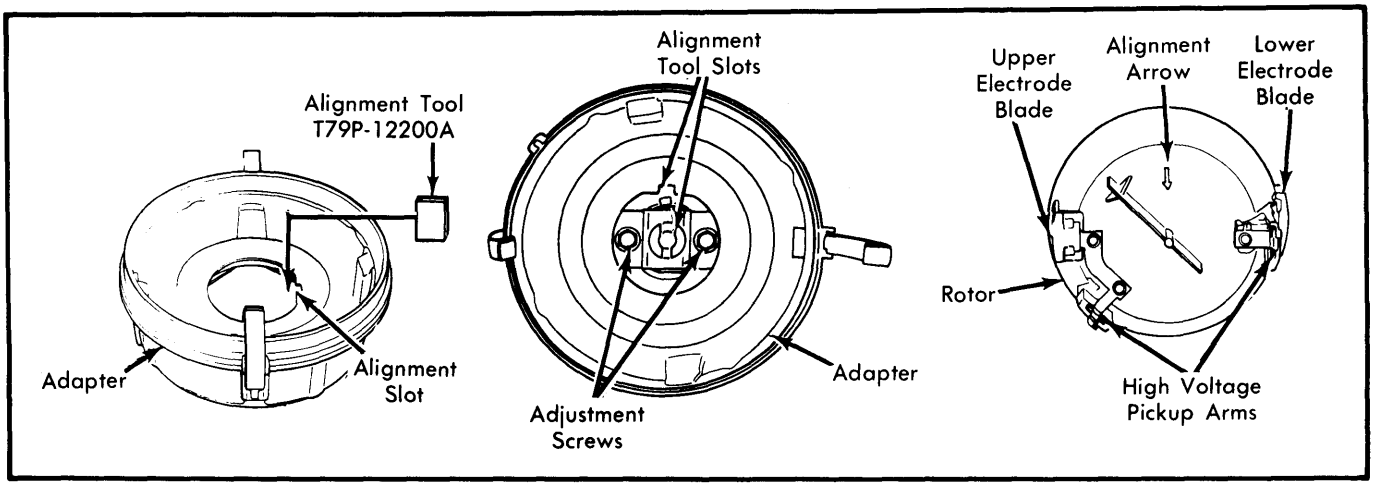


***Fig. 9 EEC III Rotor, Adapter and Alignment Procedure***