4.0L CEC SYSTEM

1988 Jeep Cherokee

1988 COMPUTERIZED ENGINE Controls
ENGINE CONTROL SYSTEM
JEEP 4.0L MPFI 6-CYLINDER

Cherokee, Comanche & Wagoneer

DESCRIPTION

The 4.0L engine control system controls engine operation to lower exhaust emissions while maintaining good fuel economy and driveability. The system is designed to maintain a 14.7:1 air/fuel ratio under all engine operating conditions. When the ideal air/fuel ratio is maintained, the catalytic converter can control oxides of nitrogen (NOx), hydrocarbon (HC), and carbon monoxide (CO) emissions.

The system consists of the following sub-systems: Fuel Control, Data Sensors and Switches, Electronic Control Unit (ECU), Diagnostics, Electronic Spark Advance, Idle Speed Control, Exhaust Gas Recirculation, and Transmission Shift Light.

OPERATION

FUEL CONTROL

The fuel control system delivers fuel to the engine. Fuel from the in-tank fuel pump flows to the fuel rail, injectors and pressure regulator. The pressure regulator maintains fuel system pressure at 31-39 psi (2.1-2.7 kg/cm^2). Excess fuel is returned to the tank by a fuel return line.

The fuel pump is energized through the fuel pump relay that is located on the right inner fender panel in the engine compartment. Battery voltage is provided through the ignition switch and is energized when the ECU completes the ground path.

The fuel injectors are electrically operated solenoid valves. The ECU determines injector pulse width ("on/off") time based upon engine operating conditions and delivers the proper pulse width to maintain an air/fuel ratio of 14.7:1.

The ECU varies the amount of voltage applied to the injectors to compensate for battery voltage changes. Battery voltage information is provided to the ECU through the wiring harness. No sensor or switch is required.

DATA SENSORS & SWITCHES

Each sensor and/or switch furnishes electronic impulses to the ECM. Based on these input signals, the ECM computes spark timing and air/fuel mixture for proper engine operation.

Coolant Temperature Sensor (CTS)

The CTS is located on the left side of the block, just below exhaust manifold. The sensor provides coolant temperature information to the ECU. Engine coolant temperature is used by the ECU for the following functions:

* Enrich air/fuel mixture for cold engine starts.
* Control idle speed during warm-up.
* Increase spark advance during cold engine operation.
* Prevent EGR flow during cold engine operation.

Manifold Absolute Pressure (MAP) Sensor

The MAP sensor measures changes in intake manifold pressure resulting from engine load and speed changes. The MAP sensor is located in the engine compartment, on the firewall behind the engine. The ECU uses this information to control fuel delivery and ignition timing.

Oxygen (O2) Sensor

The oxygen sensor is mounted in the exhaust manifold to monitor oxygen content of exhaust gases. The oxygen content reacts with the oxygen sensor to produce a voltage output signal which is sent to the ECU.

The oxygen sensor is equipped with a heating element that keeps the sensor at a consistent temperature under warm-up and idle conditions. This allows the engine control system to enter "closed loop" mode of operation much earlier, and to remain in "closed loop" during extended idle periods.

The heating element of the sensor is controlled by the ECU through the O2 sensor heater relay. This is a normally closed relay that supplies voltage to the sensor under warm-up and idle conditions. When the ECU receives information from the MAP and speed sensors indicating that the sensor will stay heated due to exhaust gas temperature, the ECU opens the relay to stop voltage to the heating element.

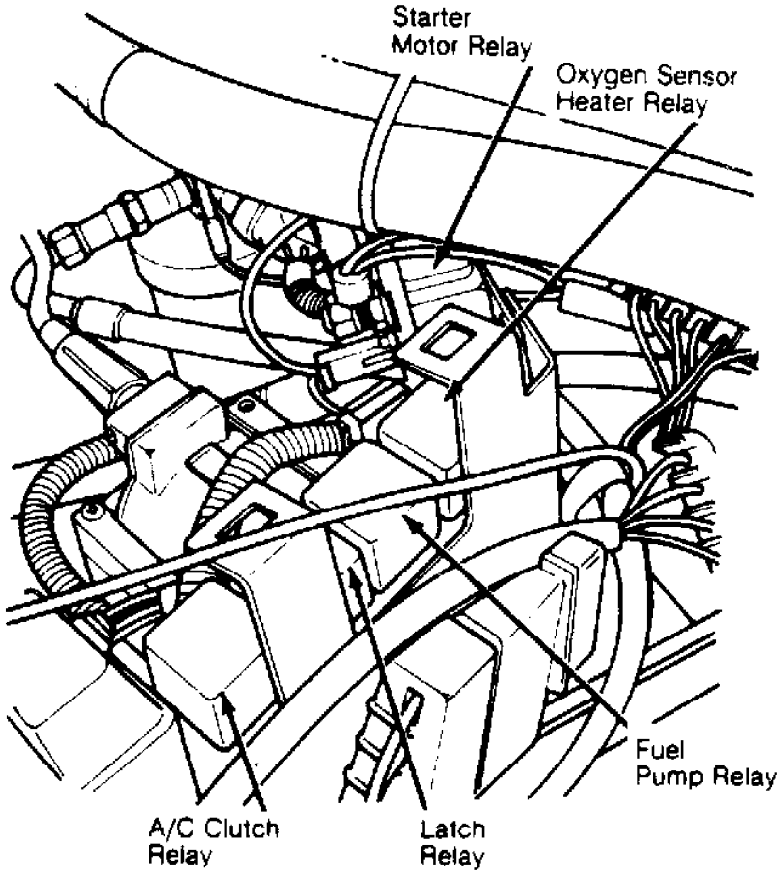


Fig. 1: Location & Identification of 4.0L Relays

Throttle Position Sensor (TPS)

The TPS is a variable resistor connected to the throttle shaft. The sensor is a potentiometer that has one end connected to the

ECU signal line and the other end connected to ground. As throttle valve angle changes, a return voltage is sent back to the ECU through the third wire. Output voltage to the ECU is about one volt when throttle valve is at idle position, and about 5 volts when throttle valve is at wide open throttle.

A dual TPS is used on automatic transmission equipped models. The additional sensor provides throttle position information to the transmission.

Knock Sensor

A knock sensor is mounted on the lower left side of block, just above the oil pan. This sensor detects abnormal engine vibration due to "detonation" and/or "pre-ignition". The knock sensor supplies detonation information to the ECU. The ECU then alters ignition timing as needed to maintain maximum timing under most operating conditions.

Park/Neutral (P/N) Switch

The P/N switch is mounted in automatic transmission equipped vehicles. The switch indicates when the transmission is in Park or Neutral.

Speed Sensor

The speed sensor is a nonadjustable sensor attached to the flywheel/drive plate housing with special shoulder bolts. This sensor provides Top Dead Center (TDC) and engine speed information to the ECU by counting the flywheel teeth as they pass during engine operation. The flywheel has a large trigger tooth and notch located 12 small teeth before each TDC position. See Fig. 2.

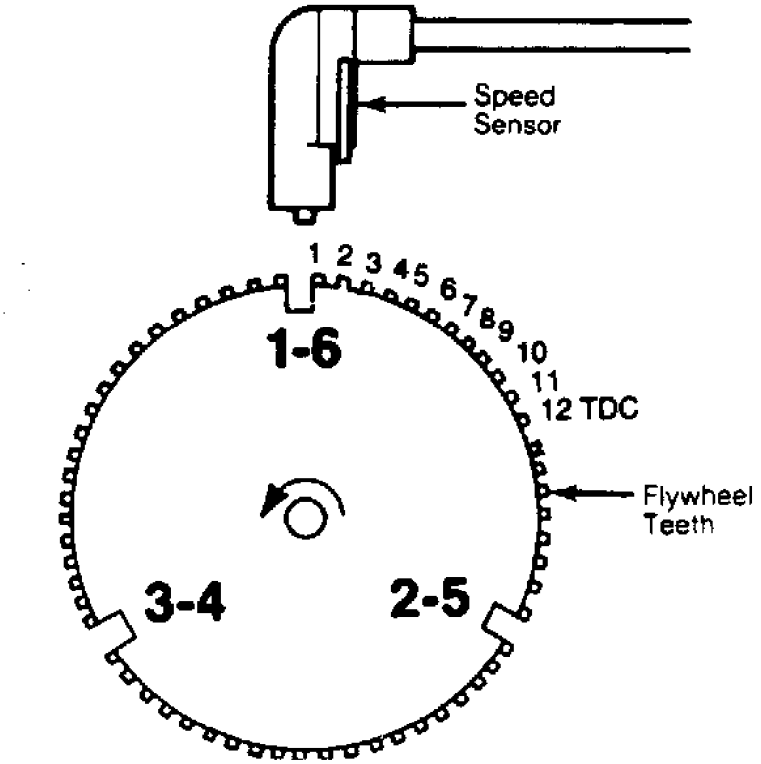


Fig. 2: Design of Speed Sensor

When a small tooth and notch pass the magnetic core of the sensor, the concentration and collapse of the magnetic field created induces a small voltage spike into the sensor pick-up coil windings.

These small voltage spikes give the ECU information for calculating engine speed.

When a large tooth and notch pass the magnetic core of the sensor, the concentration and collapse of the magnetic field created induces a higher voltage spike into the sensor pick-up coil windings. This higher voltage spike indicates to the ECU that a piston will soon be at TDC (12 teeth later).

The ECU uses speed sensor information for advancing or retarding ignition timing, dependent upon input from other sensors and switches.

A/C "ON" Switch

This switch signals the ECU that the A/C system is energized. This signal is used by the ECU to increase idle speed.

Starter Motor Relay

Although no switch or sensor is used, the ECU requires this information for fuel enrichment during starting. This information is passed on the the ECU through the starter motor relay.

Distributor Reference Signal

Although no switch or sensor is used, the ECU requires this information for ignition timing and fuel supply. This information is relayed to the ECU through a "synch pulse" provided by the distributor stator. This allows the ECU to synchronize injector opening with intake valve opening.

ELECTRONIC CONTROL MODULE (ECM)

The Electronic Control Unit (ECU) is the "brain" of the engine control system. The ECU is located in the passenger compartment, under left side of dash to right of steering column.

The ECU senses engine operating conditions, processes input signals, and controls the various systems that affect vehicle performance.

DIAGNOSTICS

The engine control system has diagnostic capabilities. Using System Tester (M.S. 1700), diagnostics can be performed on the system to more accurately determine faulty components. The diagnostic connectors are located in the engine compartment at the right shock tower (or under left side of instrument panel).

NOTE: Information for diagnosing the engine control system using the System Tester (M.S. 1700) was not available from manufacturer. Only component testing is provided.

ELECTRONIC SPARK ADVANCE

Based upon engine operating conditions received from the sensors and switches, the ECU controls spark timing. The ECU triggers the ignition coil through the ignition control module.

IDLE SPEED CONTROL

Idle speed is controlled by the ECU through the idle speed stepper motor. A latch relay is used to program the stepper motor for engine start-up. The relay is located on the right inner fender panel. See Fig. 1. The ECU energizes the latch relay when engine is in cranking mode, and keeps the relay energized for 3-5 seconds after the engine is stopped. In this way, the stepper motor can provide the

proper increased enrichment for the next engine start. Idle speed is nonadjustable.

EMISSION CONTROL

The ECU electrically controls Exhaust Gas Recirculation (EGR). An ECU-controlled solenoid valve is used to control EGR valve function. This valve is located on the left inner fender panel and is operated by the ECU in response to coolant temperature, throttle position, and manifold pressure.

Under conditions of engine warm-up, engine idle, wide open throttle, or rapid acceleration/deceleration, the solenoid valve is energized, blocking vacuum to the EGR valve. At normal operating temperatures with engine speed above idle, the solenoid valve is de-energized, allowing normal EGR valve function.

NOTE: If the electrical connector is removed from the EGR solenoid, EGR flow will be allowed at all times.

A/C CLUTCH CONTROL

The ECU controls the A/C compressor clutch to improve idle quality. The A/C compressor clutch will be engaged or disengaged as deemed necessary by the ECU through the A/C clutch relay.

SHIFT LIGHT CONTROL

The shift light system is used on all manual transmission equipped vehicles. The ECU monitors coolant temperature, throttle position, vehicle speed, and engine speed to control the shift light. The ECU calculates what gear position the vehicle should be in and uses this information to turn on the light. The light indicates the best shift point to the driver for maximum fuel economy.

The light is tested when the ignition switch is turned on. When the engine is started, the light should go out. A transmission-mounted switch prevents the light from illuminating when the transmission is shifted into high gear. The ECU turns the light off if the shift to the next higher gear is not performed within 3-5 seconds after light comes on.

DIAGNOSIS & TESTING

PRELIMINARY CHECKS

Before assuming that the ECU is faulty, the following systems and components must be in good condition and operating properly:

* Air filter.
* All support systems and wiring.
* Battery connections and specific gravity.
* Compression pressure.
* Electrical and vacuum connections to components, sensors and switches.
* Emission control devices.
* Ignition system.
* All vacuum and fuel line (hose) connections.

FUEL SYSTEM TEST

Fuel Pressure

1) Remove cap from pressure test port on fuel rail and

connect Fuel Pressure Gauge (J-34730-1). See Fig. 3. Start engine and observe fuel pressure. With vacuum hose connected to pressure regulator, pressure should be about 31 psi (2.2 kg/cm²)), and about 39 psi (2.7 kg/cm²)) with vacuum hose disconnected.

2) If pressure is not as specified, inspect fuel supply and return lines for kinks and obstructions. If fuel lines are okay, replace pressure regulator. Remove gauge and install cap on test port.

Fuel Flow

1) Remove cap from the pressure test port on the fuel rail. See Fig. 3. Connect piece of hose to port and place other end in graduated container of at least one quart (1L) capacity.

2) Pinch off fuel return line. Run fuel pump by placing jumper wire between terminals "D1-5" and "D1-6" of diagnostic connector "D1". If fuel flow is less than one quart (1L) in one minute, replace fuel pump. Remove hose and install test port plug.

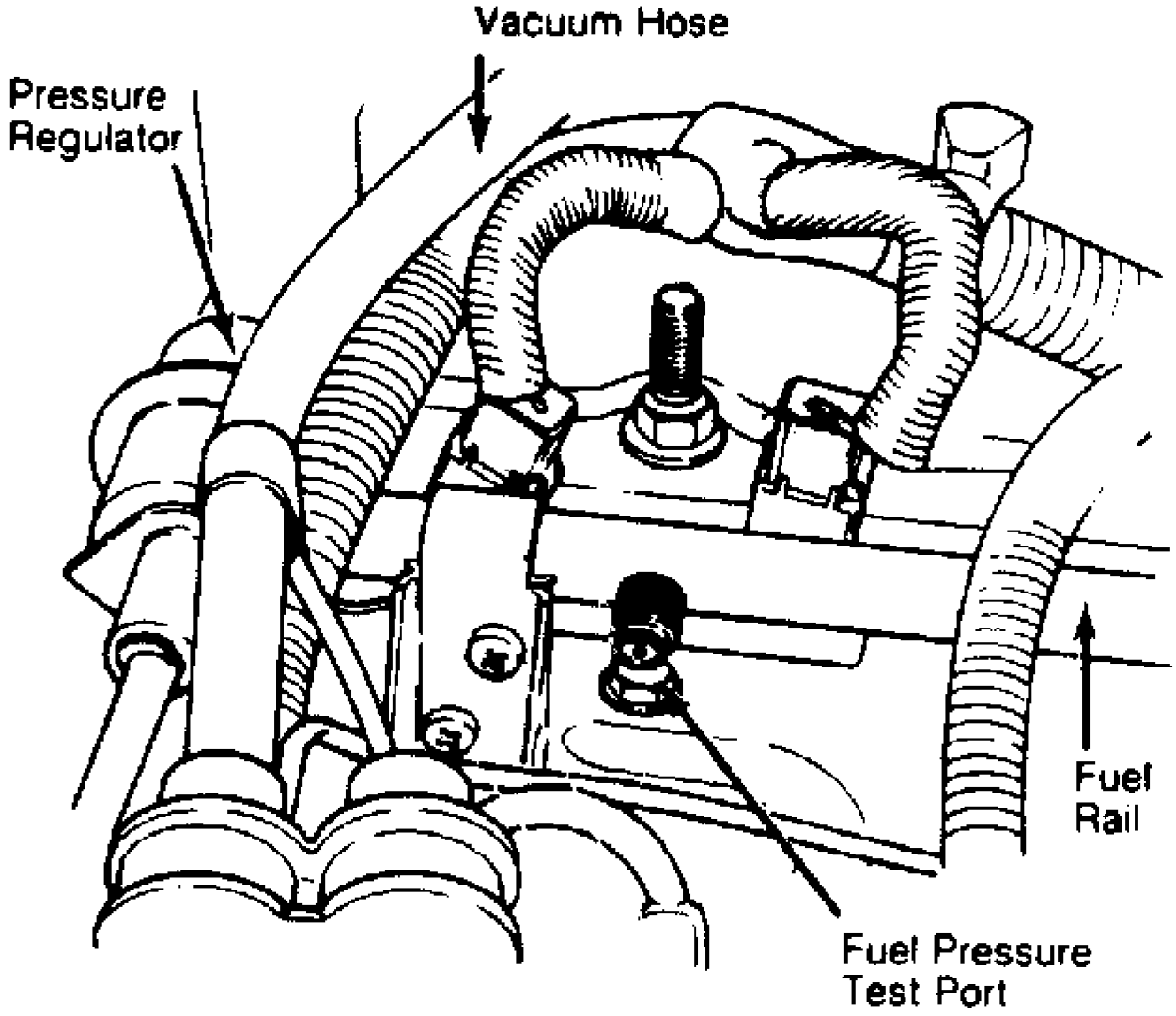


Fig. 3: Location of Fuel Pressure Test Port

Fuel Injector Test

See the FUEL INJECTOR DIAGNOSTICS chart near the end of this article. See Fig. 9

COMPONENT TESTING

Throttle Position Sensor

See THROTTLE POSITION SENSOR DIAGNOSTICS chart near the end of this article. See Fig. 8.

Coolant Temperature Sensor (CTS) &
Manifold Air Temperature (MAT) Sensor

1) Disconnect the electrical connector from the sensor. Using a high impedance, digital volt/ohmmeter, measure the resistance of the sensor. If measured resistance is not as specified, replace sensor. See the CTS & MAT SENSOR TEMPERATURE-TO-RESISTANCE VALUE table.

2) Test electrical harness resistance of both sensors by testing between ECU harness connector "D-3" and sensor connector. Also test between sensor connector and ECU harness connector "C-10" ("C-8" on MAT sensor). Repair wire if open circuit is detected. Repair MAT sensor wiring harness if resistance is greater than one ohm.

CTS & MAT SENSOR TEMPERATURE-TO-RESISTANCE VALUE

°F(°C)	Ohms
212 (100)	185
160 (71)	450
100 (38)	1600
70 (21)	3400
40 (4)	7500
20 (-7)	13,500
0 (-18)	25,000
-40 (-40)	100,700

Manifold Absolute Pressure (MAP) Sensor

NOTE: Terminal identification letters are stamped on MAP sensor body.

1) Disconnect electrical connector from sensor. With ignition on and engine stopped, measure voltage output of sensor terminal "B". See Fig. 4. Ensure wiring harness is okay by also measuring voltage at ECU terminal "C-t". Output voltage should be 4-6 volts at both points. Repair or replace wiring harness as required.

2) With ignition on and engine stopped, measure supply voltage of sensor terminal "C". See Fig. 4. Ensure wiring harness is okay by also measuring voltage at ECU terminal "C-14". Supply voltage should be 4.4-5.5 volts at both points. Repair or replace wiring harness as required.

3) Using an ohmmeter, measure ground circuit resistance at sensor terminal "A" and ECU connector terminal "D-3". Ensure wiring harness is okay by also measuring resistance between ECU terminal "D-3" and "B-11". If ohmmeter indicates an open circuit, check for defective sensor ground connection at right side of cylinder block.

4) If ground connection is okay, replace ECU. If ECU terminal "D-3" has short to 12-volts, repair wire before replacing ECU. Repair or replace wiring harness as required.

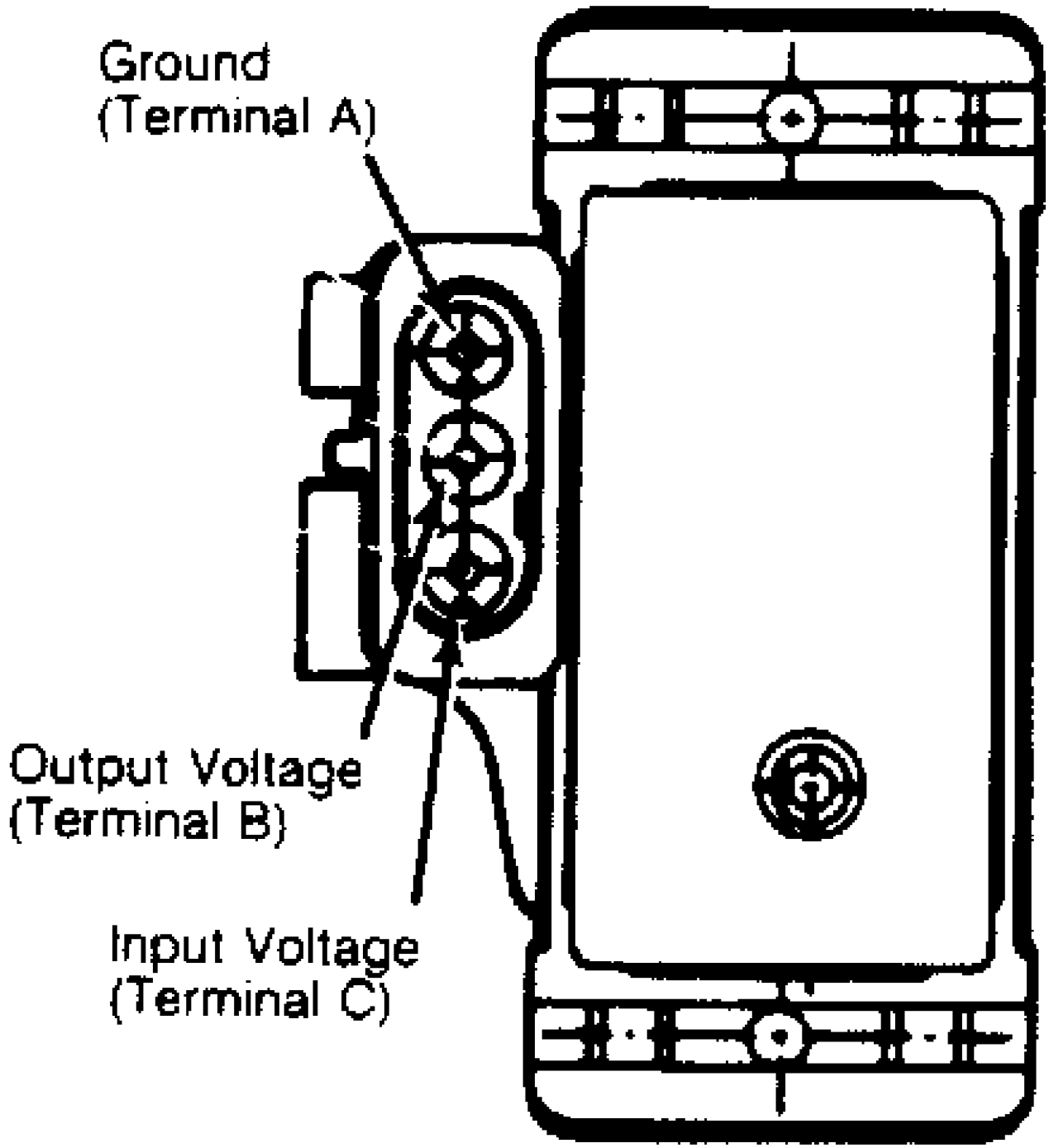


Fig. 4: MAP Sensor Terminal Identification

Oxygen Sensor

Oxygen sensor must be tested with System Tester (M.S. 1700).

Oxygen Sensor Heating Element

Disconnect electrical connector from oxygen sensor. Using an ohmmeter, measure resistance between connector terminals "A" and "B" (marked on connector). See Fig. 5. If resistance is not 5-7 ohms, replace sensor.

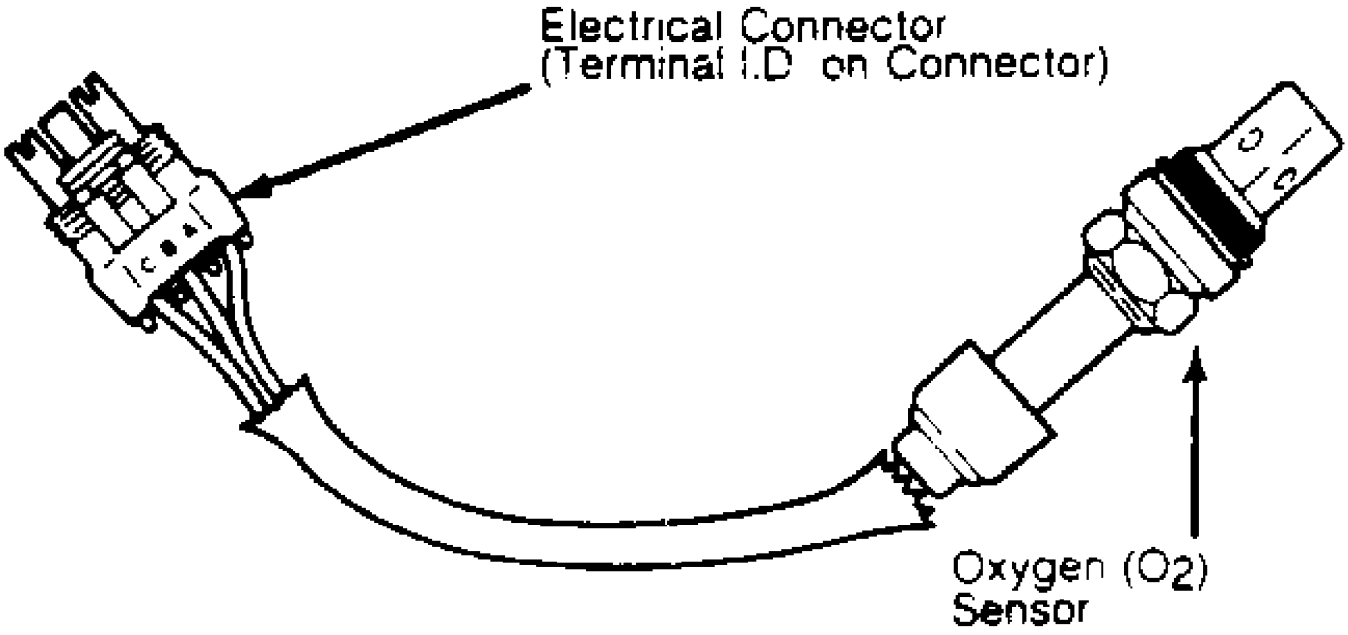


Fig. 5: Testing Oxygen Sensor Heating Element Resistance

Knock Sensor

Knock sensor must be tested with System Tester (M.S. 1700).

Speed Sensor

Disconnect speed sensor electrical connector from the sensor. Using an ohmmeter, measure resistance between connector terminals "A" and "B" (marked on connector). If reading is not 125-275 ohms with engine at normal operating temperature, replace speed sensor.

"Synch Pulse" (Stator)

1) Using an analog voltmeter, insert positive probe into Blue wire at distributor connector. Insert negative probe into Gray wire with tracer at distributor connector.

NOTE: Do not remove connector from distributor. Insert voltmeter leads from rear of connector. Do not puncture wire.

2) With voltmeter set on "15-Volt A/C" scale, turn ignition on. Voltmeter should indicate 5 volts. If voltage is indicated, go to step 4). If no voltage is indicated, check voltmeter leads for good connection and go to next step.

3) If there is still no voltage reading, turn ignition off and remove ECU. Reconnect harness and turn ignition off and remove ECU. Reconnect harness and turn ignition on. Check for voltage between ECU pin "C-16" and good ground. If voltage still does not register, test system with System Tester (M.S. 1700).

4) If 5 volts was detected, check for continuity at the following points:

* Between Blue wire at distributor connector and terminal "C-16" at ECU.
* Between Gray wire with tracer at distributor connector and terminal "C-5" at ECU.
* Between Black wire at distributor connector and good ground.

If no continuity is shown, repair wiring harness. If continuity is shown, reconnect voltmeter as in step 2).

5) While observing voltmeter, crank engine. Voltmeter needle should fluctuate back and forth during engine cranking. This verifies proper operation of distributor stator. If voltmeter needle does not fluctuate, replace stator.

EGR Solenoid Valve

1) Make sure vacuum is present at port "C" of the solenoid. See Fig. 6. Remove vacuum connector from ports "A" and "B" of solenoid. Connect vacuum gauge to port "B". Start engine and run at idle. Vacuum should not be present at port "B".

2) Disconnect electrical connector from solenoid. Vacuum should now be present at port "B". Stop engine. Reconnect electrical connector at solenoid. Remove vacuum gauge and reconnect vacuum hoses.

Relays - General Testing

1) The relays used on the 4.0L engine are all of the same basic construction and design. Terminal No. 30 is usually connected to battery voltage ("switched" or battery positive at all times). Terminal No. 87A is connected to terminal No. 30 in de-energized position.

2) Terminal No. 87 is connected to terminal No. 30 in the energized position. This connection supplies battery voltage to the operated device.

3) Terminal No. 86 is connected to the electromagnet of the operated device; usually through a "switched" power source. Terminal No. 85 is connected to the electromagnet of the operated device; usually grounded through a switch or the ECU.

NOTE: Not all relays have battery voltage applied at terminal No. 30. Some may have battery voltage applied at terminal Nos. 87 or 87A. Check design of relay before testing.

4) When testing relays, there should be continuity between terminal Nos. 87A and 30 when relay is in de-energized position. Resistance between terminal Nos. 85 and 86 should be 70-80 ohms for resistor-type relays and 81-91 ohms for diode-type relays.

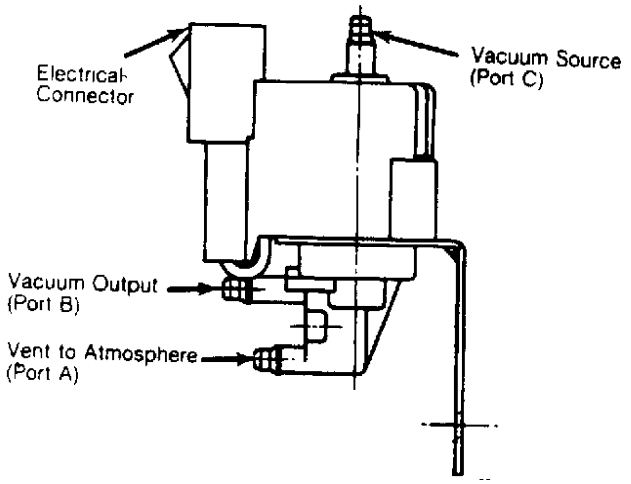


Fig. 6: Testing EGR Solenoid Valve

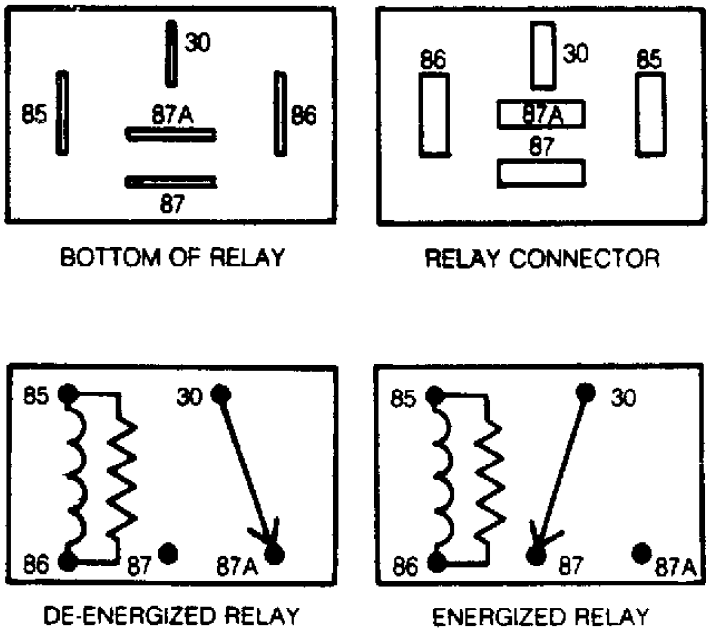
Starter Motor Relay

1) Disconnect electrical connectors from terminals "I" and "G". Using an ohmmeter, measure resistance between the terminals.

Resistance value should be about 22 ohms. Measure resistance between either terminal and battery negative post. Resistance value should be infinite. If resistance values are not as specified, replace relay. If okay, reconnect electrical connectors.

2) Disconnect electrical connector from "SOL" terminal. Connect voltmeter between terminal and battery negative post. While observing voltmeter, turn ignition switch to "START" position. If 12 volts is not indicated, check and repair wiring harness, bulkhead connector, and/or ignition switch. If battery voltage is present, go to next step.

3) If battery voltage is present, but starter relay does not work, place transmission in Park (Neutral for man. trans.) and apply parking brake. Disconnect electrical connector from terminal "I" (Dark Green wire) and apply battery voltage to terminal. Using a jumper wire, touch terminal "G" to ground. If relay does not click, replace relay. If relay does click, repair ground circuit.



Terminal 30 - Usually battery voltage ("switched" or battery voltage at all times)
Terminal 85 - Connected to electromagnet of device (usually grounded by switch or through ECU)
Terminal 86 - Connected to electromagnet of device (usually connected to switched power source)
Terminal 87 - Connected to terminal 30 (de-energized)
Terminal 87A - Connected to terminal 30 (energized) to supply battery voltage to device

Fig. 7: Design & Function of Relays

REMOVAL & INSTALLATION

ELECTRONIC CONTROL UNIT (ECU)

Removal & Installation
Information not available from manufacturer.

COOLANT TEMPERATURE SENSOR (CTS)

Removal & Installation
Drain cooling system. Remove air cleaner assembly. Disconnect electrical connector and remove sensor from block. To install, reverse removal procedure. Refill cooling system.

OXYGEN (O2) SENSOR

Removal & Installation
Raise and support vehicle. Disconnect electrical connector from sensor. Remove sensor from exhaust manifold. Install and tighten sensor to 35 ft. lbs. (47 N.m). Reconnect electrical connector. Lower vehicle.

THROTTLE POSITION SENSOR (TPS)

Removal
Disconnect electrical connector from TPS. Bend lock tabs away from retaining screws and remove screws. Remove TPS.

Installation
With throttle valve in normal closed position, install TPS. Install TPS retaining screws. Perform OUTPUT CHECK.

NOTE: Throttle position sensor is nonadjustable. Only output voltage can be monitored.

Output Check (Manual Transmission Only)
1) Connect negative lead of digital voltmeter to terminal "B" and positive lead to terminal "A" of TPS connector. Do not disconnect electrical connector. Insert leads through back of connector. It may be necessary to remove throttle body from vehicle to gain access to connector.
2) Turn ignition on, engine off. With throttle closed and resting against idle stop, input voltage should be about 5 volts. Move positive lead from terminal "B" to terminal "C" and read voltage output. Output voltage should be about 0.8 volt with throttle closed and resting against idle stop.
3) If voltage is not as specified, loosen lower retaining screw and pivot sensor for large adjustments. Loosen upper retaining screw and pivot sensor for small adjustments. Adjust sensor so output voltage reading equals 16 percent of input voltage. If voltage specifications cannot be obtained, replace sensor. Remove voltmeter. Tighten screws and bend retaining tabs into position.

ALL OTHER SENSORS, SOLENOIDS & SWITCHES

Removal & Installation
Removal of sensors, switches, and solenoids is accomplished by disconnecting the electrical and/or vacuum connectors and removing or detaching the component. To install, reverse removal procedure.

TESTING

NOTE: Refer to Figs. 8-10 for Testing information.

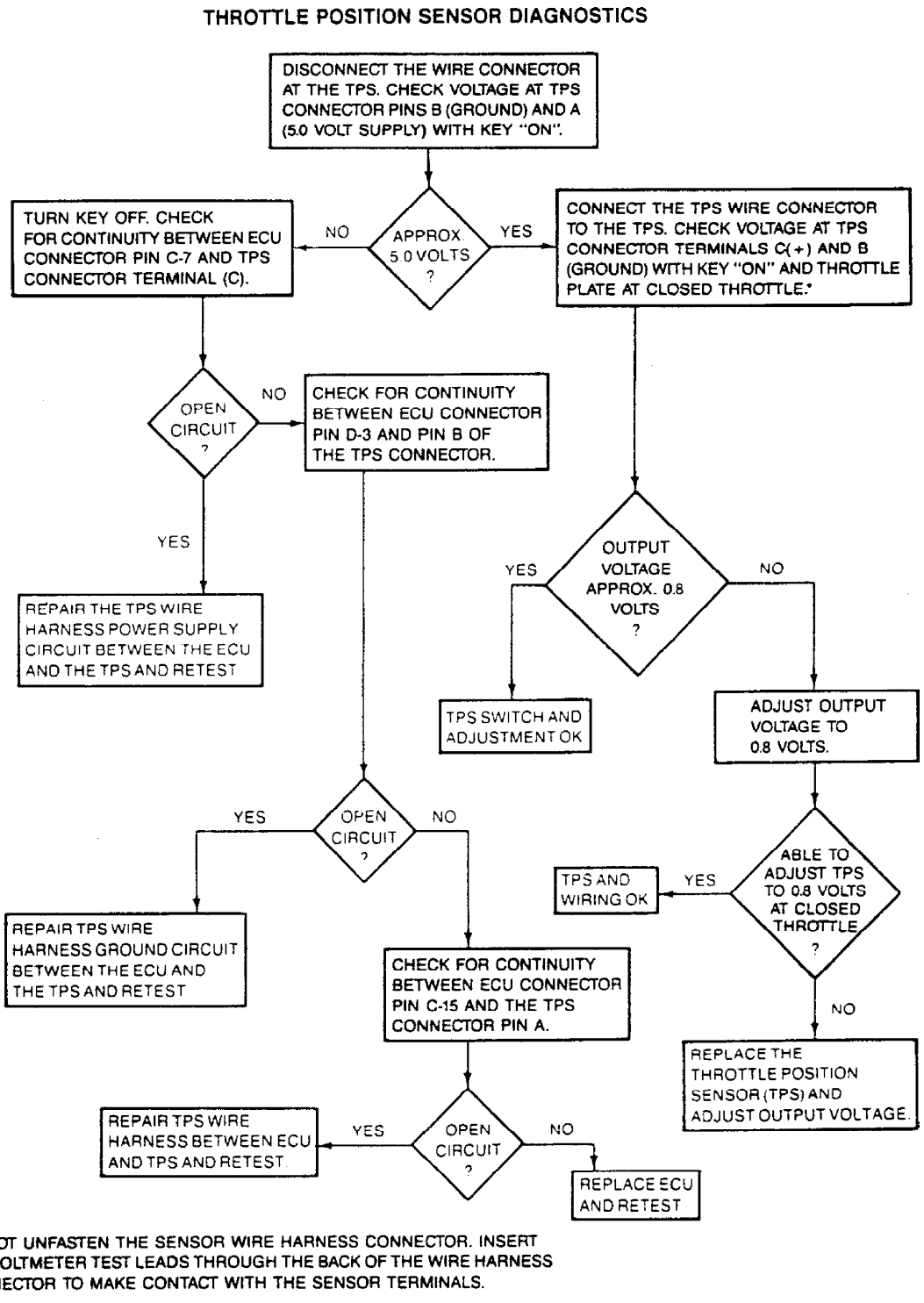


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Fig. 8: Throttle Position Sensor Diagnostics

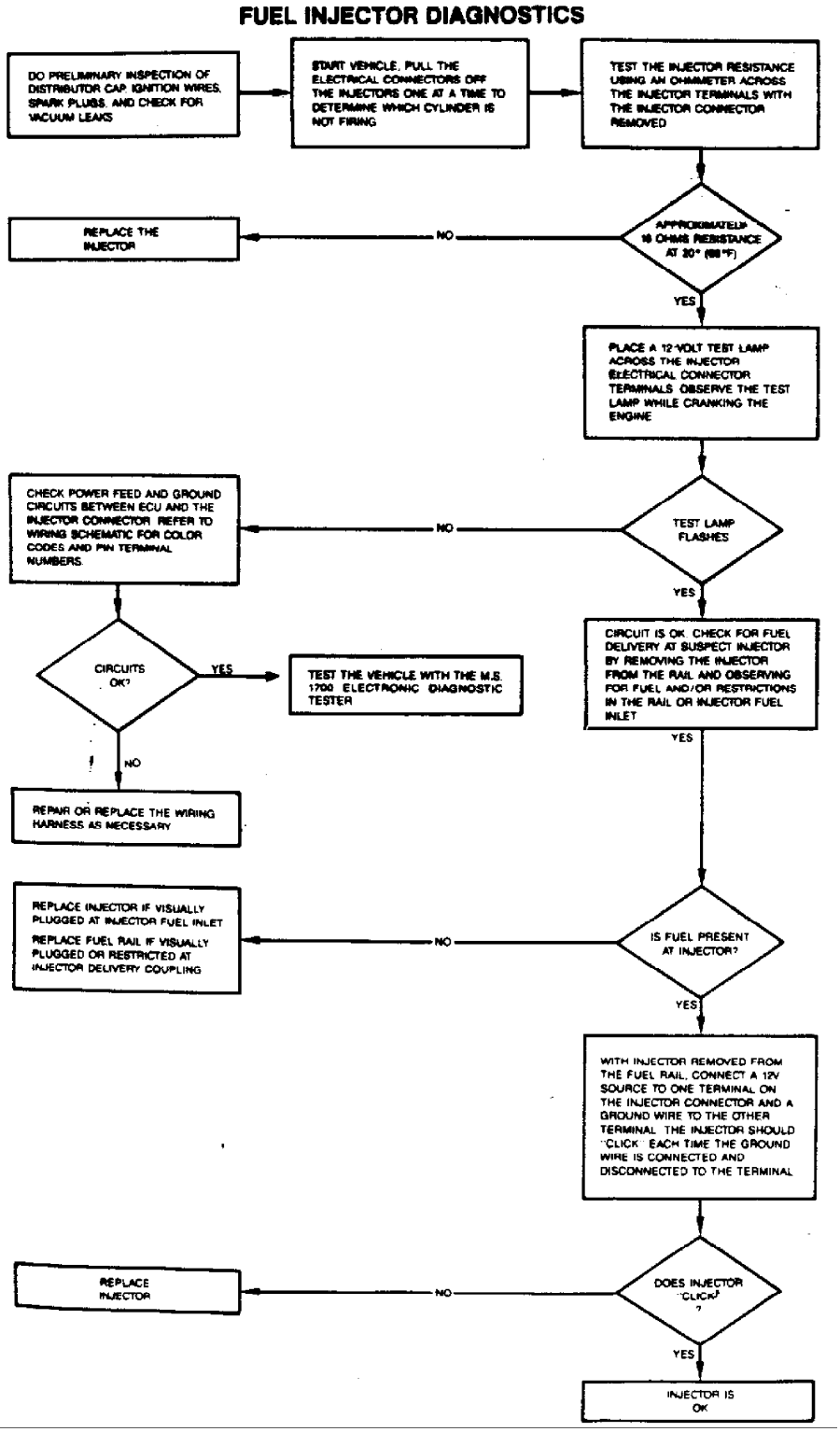
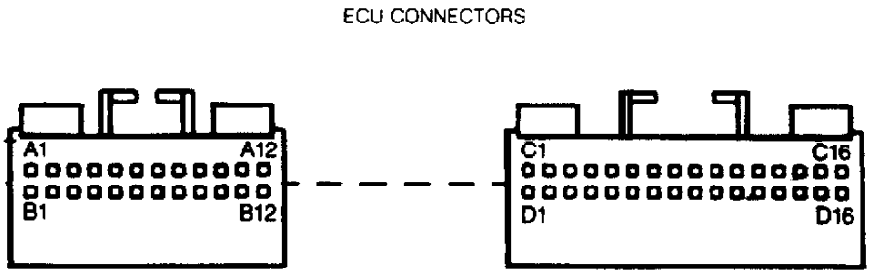


Fig. 9: Fuel Injector Diagnostics



24-PIN CONNECTOR

32-PIN CONNECTOR

24-PIN CONNECTOR
TERMINAL IDENTIFICATION

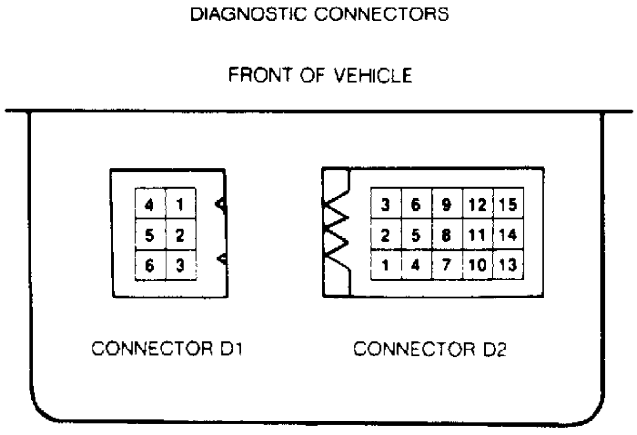
A1. Injector No. 3
A2. Injector No. 6
A3. Injector No. 2
A4. Injector No. 4
A5. Fuel Pump Relay Ground
A6. Not Used
A7. Oxygen Sensor Heater Relay Ground
A8. Shift Lamp
A9. Latch Relay Ground
A10. EGR Solenoid
A11. Not Used
A12. A/C Relay Ground

B1. Injector No. 1
B2. Injector No. 5
B3. Idle Speed Stepper Motor A_1
B4. Idle Speed Stepper Motor A_1
B5. Idle Speed Stepper Motor C_1
B6. Idle Speed Stepper Motor C_1
B7. Positive Battery Voltage
B8. Ignition Switch
B9. Not Used
B10. Latched Positive Battery Voltage
B11. Ground
B12. Ground

32-PIN CONNECTOR
TERMINAL IDENTIFICATION

C1. Speed Sensor Input
C2. A/C Request
C3. Start Signal
C4. Park/Neutral Switch
C5. "Sync" Input
C6. MAP Sensor Input
C7. TPS Input
C8. MAT Sensor Input
C9. Not Used
C10. CTS Input
C11. Injector Supply
C12. TX Serial Data
C13. Not Used
C14. MAP Sensor Output
C15. TPS Output
C16. "Sync" Output

D1. Speed Sensor Ground
D2. A/C Select
D3. Sensor Ground
D4. Not Used
D5. Not Used
D6. Not Used
D7. Not Used
D8. Knock Sensor Ground
D9. Oxygen Sensor Input
D10. Injector Feed
D11. RX Serial Data
D12. Not Used
D13. Spark/Dwell
D14. Not Used
D15. Not Used
D16. Knock Sensor Input



CONNECTOR D1
TERMINAL IDENTIFICATION

1. Tach Input
2. Ignition
3. Ground
4. Start Solenoid
5. Battery
6. Fuel Pump

CONNECTOR D2
TERMINAL IDENTIFICATION

1. Shift Lamp
2. Power Latch Relay
3. Park/Neutral
4. Power Latched Relay (B+)
5. Air Conditioning Clutch Relay
6. Wide-Open Throttle Switch
7. Ground
8. Air Mixture Temperature
9. M.P.A. (Ignition Output)
10. EGR/Canister Purge Solenoid
11. Idle Speed Control Motor Forward
12. Coolant Temperature Sensor
13. Closed Throttle Switch
14. Idle Speed Control Motor Reverse
15. Not Used

Fig. 10: ECU Connector Pin & Diagnostic Connector Pin Identification

WIRING DIAGRAM

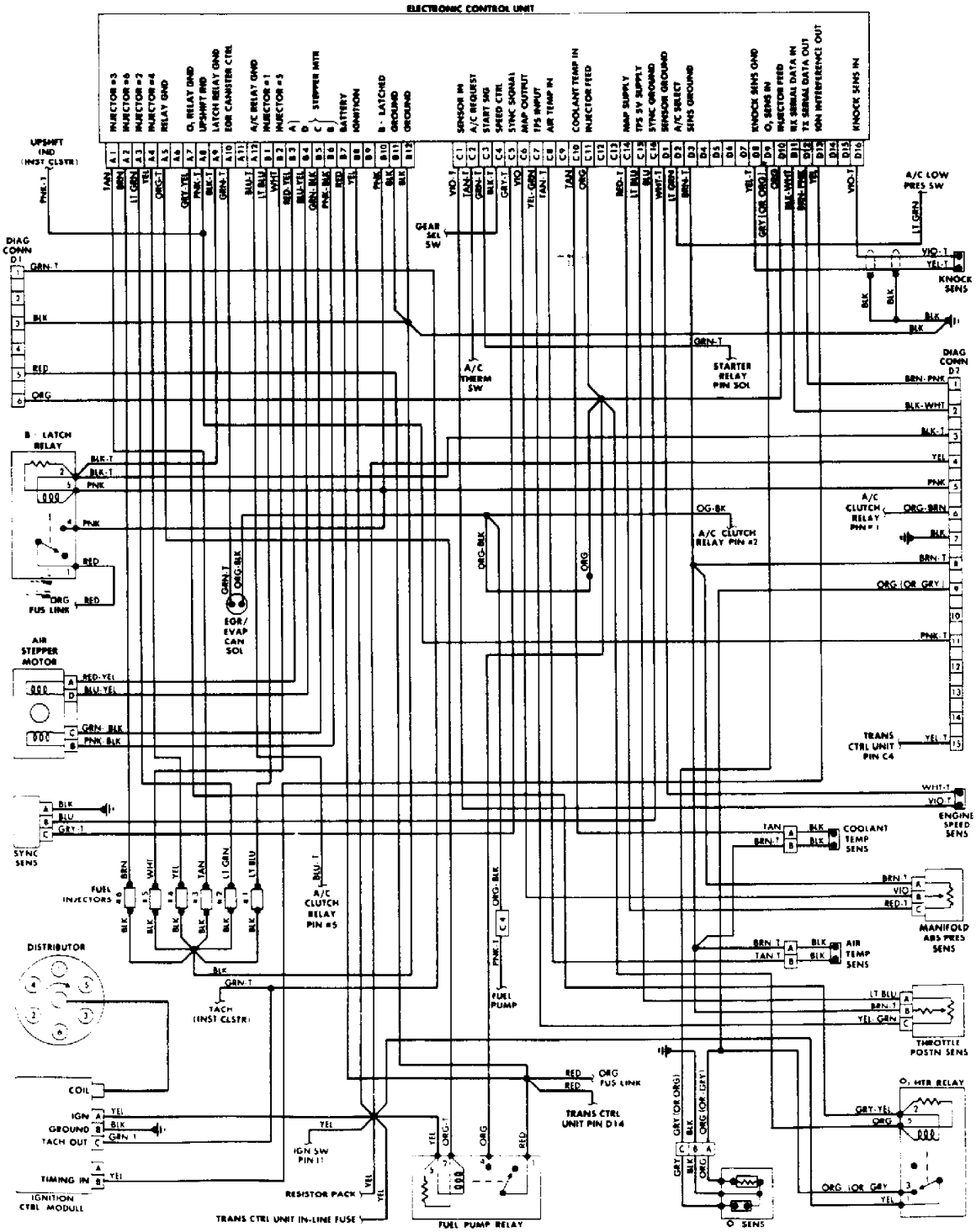


Fig. 11: Comanche Engine Control System Wiring Diagram

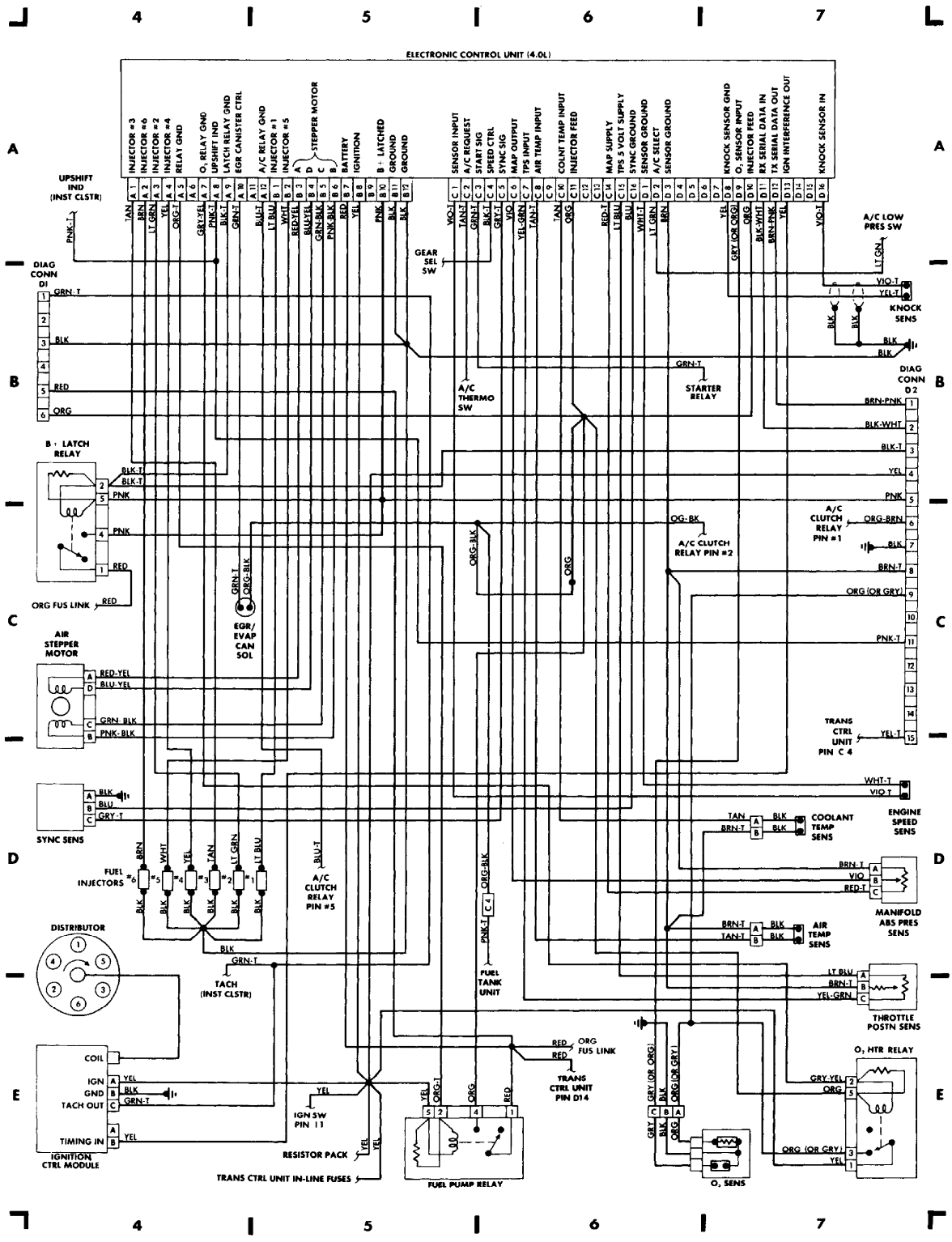


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Fig. 12: Cherokee Engine Control System Wiring Diagram