1988 Electronic Fuel Injection
JEEP/RENXI THROTTLE BODY INJECTION

2.5L Cherokee, Comanche, Wagoneer, Wrangler

DESCRIPTION

The Throttle Body Injection (TBI) system is a single injector system that introduces fuel into throttle body from above throttle plate. Fuel injector, located within throttle body, is controlled by the Electronic Control Unit (ECU).

The ECU is a sealed microprocessor that receives input signals from several sensors and other related engine components. Based on these inputs, ECU generates output signals that control and adjust air/fuel mixture and ignition timing as necessary for proper engine performance.

ECU also controls engine idle speed, emission control systems, upshift indicator light (manual transmission only), and A/C compressor clutch.

OPERATION

ELECTRONIC CONTROL UNIT (ECU)

On Cherokee, Comanche and Wagoneer, ECU is located under instrument panel, above accelerator pedal. On Wrangler, ECU is located behind glove box. Input information from various engine sensors to ECU is used to determine engine operating conditions and needs. Battery voltage input is used to ensure that correct output voltage is supplied by ECU during fluctuations in battery voltage.

FUEL INJECTOR

Fuel injector is mounted in throttle body so that fuel is injected into incoming airflow. When injector solenoid is energized, armature and plunger move upward against spring. Check ball above injector nozzle moves off seat and opens small orifice at end of injector.

Fuel supplied to injector is forced around ball and through orifice, resulting in fine spray of fuel. Volume of fuel injected is dependent only on length of time that injector is energized by ECU, as fuel pressure is constant at injector. During cold engine starts, extra fuel is supplied so richer mixture will aid in starting.

FUEL PRESSURE REGULATOR

Fuel pressure regulator is integral part of throttle body. Pressure regulator has a spring chamber that is vented to same pressure as tip of injector. Because differential pressure between injector nozzle and spring chamber is same, only the length of time that injector is energized controls volume of fuel injected.

Fuel pump delivers more fuel than is required by engine. Excess fuel goes to fuel tank from pressure regulator via fuel return hose. Fuel pressure regulator function is mechanical and ECU does not control it.

FUEL PUMP
Electric roller type fuel pump is located in fuel tank. Integral check valve is used to maintain pressure in fuel delivery system after pump stops running. Fuel pump operation is controlled by ECU through a fuel pump relay.

**IDLE SPEED ACTUATOR (ISA) MOTOR**

ISA motor acts as movable idle stop to change throttle stop angle. Both engine idle speed and deceleration throttle stop angle are set by ISA. ECU controls ISA motor by providing appropriate voltage outputs to produce idle speed or throttle stop angle required for engine operating condition.

**OXYGEN (O2) SENSOR**

Oxygen sensor is equipped with a heating element that keeps sensor at proper operating temperature at all times. Oxygen sensor is located in exhaust pipe.

Maintaining proper sensor temperature at all times, system enters "Closed Loop" operation sooner and remains in "Closed Loop" during periods of extended idle. Electrical feed to oxygen sensor is through ignition switch.

The ECU receives sensor voltage signal which varies with oxygen content in exhaust gas. Signal is used by ECU as reference for setting air/fuel mixture ratio. ECU varies voltage to injector both to compensate for battery voltage fluctuations and to change duration of injector opening for control of air/fuel mixture.

**MANIFOLD AIR/FUEL TEMPERATURE (MAT) SENSOR**

MAT sensor provides a signal to ECU that changes depending upon temperature of air/fuel mixture in intake manifold. During high temperature conditions, ECU will compensate for changes in density of air.

**MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR**

MAP sensor measures absolute pressure in intake manifold. Both mixture density and ambient barometric pressure are supplied to ECU by MAP sensor. Sensor is mounted in middle of firewall in engine compartment. Sensor receives manifold pressure information through vacuum line from throttle body. See Fig. 1.

![Fig. 1: Manifold Absolute Pressure (MAP) Sensor](image)

**COOLANT TEMPERATURE SENSOR (CTS)**
Coolant temperature sensor is installed in intake manifold water jacket to provide coolant temperature input signal for ECU. During cold engine operation, ECU will make mixture richer, make up for fuel condensation in cold intake manifold, increase idle speed during warm-up period, increase ignition advance and keep EGR system inoperative until engine warms up.

THROTTLE POSITION SENSOR (TPS)

Throttle position sensor provides ECU with input signal, up to about 5 volts, to indicate throttle position. This allows ECU to control air/fuel mixture according to throttle position. TPS is mounted on throttle body assembly.

WIDE OPEN THROTTLE (WOT) SWITCH

WOT switch provides an input signal to ECU when engine is at wide open throttle. The ECU enriches air/fuel mixture. The WOT switch is located on the side of throttle body.

CLOSED THROTTLE (IDLE) SWITCH

Idle switch is integral with ISA motor and provides voltage signal to ECU. ECU will signal ISA motor to change throttle stop angle in response to engine operating conditions.

UPSHIFT INDICATOR LIGHT

On vehicles equipped with a manual transmission, ECU controls upshift indicator light. Indicator light is normally illuminated when ignition is turned on without engine running. Indicator light is turned off when engine is started. Indicator light will be illuminated during engine operation in response to engine load and speed. If transmission is not shifted, ECU will turn light off after 3 to 5 seconds. A switch located on transmission prevents indicator light from being illuminated when transmission is shifted to highest gear.

ENGINE SPEED SENSOR

Engine speed sensor is attached to bellhousing. It senses and counts teeth on flywheel gear ring as they pass during engine operation. Signal from speed sensor provides ECU with engine speed and crankshaft angle. On flywheel gear ring, large trigger tooth and notch is located 90 degrees before each TDC point. Each trigger tooth is followed by 12 smaller teeth and notches before TDC point is reached.

As each of 12 small teeth and notches pass magnetic core in speed sensor, concentration and collapse of magnetic field induces slight voltage (spike) in sensor pick-up coil winding. See Fig. 2. Larger trigger teeth and notches induce higher voltage (spike) in sensor pick-up coil winding. These voltage spikes enable ECU to count teeth as they pass speed sensor.

Higher voltage spike (from larger tooth and notch) indicates to ECU that piston will be at TDC position after 12 smaller voltage spikes have been counted. ECU will then either advance or retard ignition timing depending upon remaining sensor inputs.
Fig. 2: Engine Speed Sensor
Courtesy of Chrysler Motors.

A/C CONTROLS
ECU receives inputs from A/C when either A/C switch is in "ON" position or compressor clutch engages to lower temperature. ECU changes engine idle speed depending upon A/C compressor operation.

POWER STEERING PRESSURE SWITCH

ECU receives input from pressure switch during periods of high pump load and low engine RPM. Input signals from pressure switch to ECU are routed through A/C request and A/C select input circuits. When pump pressure exceeds 250-300 psi (17.5-21.0 kg/cm²), switch contacts close transmitting an input signal to ECU. ECU raises engine idle speed immediately after receiving input from pressure switch.

RELAYS

Starter Motor Relay
Starter motor relay provides an input signal to ECU when starter motor is engaged.

System Power Relay
System power relay, located on right fender inner panel, is energized when engine is started. It remains energized for 3 to 5 seconds after ignition is off. This allows ECU to extend ISA for next start before ECU shuts down.

Fuel Pump Control Relay
Fuel pump control relay is located on right fender inner panel. Battery voltage is supplied to relay from ignition switch. When ground is provided by ECU, relay becomes energized and provides voltage to fuel pump.

A/C Compressor Clutch Relay
ECU controls A/C compressor clutch through this relay. The A/C compressor clutch relay is located beside fuel pump control relay on right fender inner panel.

EGR Valve/Canister Purge Solenoid
Vacuum to both EGR valve and vapor canister is controlled by this solenoid. When solenoid is energized, neither EGR valve nor vapor canister receive vacuum. Solenoid is energized during closed (idle) and wide open throttle operations, engine warm-up and rapid acceleration or deceleration. If solenoid wire connector is disconnected, both EGR valve and vapor canister will receive vacuum at all times.

Load Swap Relay
The load swap relay works in conjunction with power steering switch to disengage A/C compressor clutch. If compressor clutch is engaged when power steering pressure switch contacts close, input signal from switch to ECU also activates load swap relay. Relay then cuts off current to A/C compressor clutch. The A/C compressor clutch remains disengaged until pressure switch contacts reopen and engine idle returns to normal. The load swap relay contains a timer that delays engaging the compressor clutch for 0.5 second to ensure smooth engagement.

ADJUSTMENTS

CAUTION: When working on or near engine that is running, be very careful to avoid pulleys, belts and fan. DO NOT stand in direct line with blades of fan. DO NOT wear clothing that is loose enough to get caught in moving parts.
IDLE SPEED ACTUATOR (ISA) MOTOR

1) Adjust ISA motor plunger to establish initial position of plunger only if motor has been removed or replaced. Remove air filter elbow and start engine. Run engine until engine reaches normal operating temperature. Turn A/C off (if equipped).

2) Connect tachometer leads to diagnostic connector D1, attaching negative lead to terminal D1-3 and positive lead to terminal D1-1. See Fig. 4. Turn ignition off. ISA motor plunger should move to fully extended position.

3) When ISA motor plunger is fully extended, disconnect ISA motor wiring connector and start engine. Engine speed should be 3300-3700 RPM. If incorrect, turn hex head screw at end of plunger to provide engine speed of 3500 RPM.

4) Fully retract ISA motor by holding closed throttle (idle) switch plunger inward as throttle is opened. Closed throttle switch plunger should not touch throttle lever in closed position. If contact is made, check linkage and/or cable for binding or damage. Repair as necessary.

5) Connect ISA motor wiring harness connector and turn ignition off for 10 seconds. ISA motor should move to fully extended position. Start engine. Engine speed should be 3500 RPM for short period of time and then decrease to normal idle speed.

6) Turn ignition off. Disconnect tachometer. After final adjustment of ISA motor, use thread penetrating sealant (Loctite 290) on adjustment screw to prevent movement and maintain adjustment.

NOTE: If adjustment screw must be moved after thread sealant hardens, loosen threads by heating screw with flameless heat such as soldering gun. DO NOT use flame or torch type of heat as damage to ISA motor will result.

FUEL PRESSURE REGULATOR

WARNING: Always relieve residual fuel pressure in fuel delivery system before opening system. To prevent chance of personal injury, cover fittings with shop towel while disconnecting fittings.

1) Replacement fuel pressure regulator must be adjusted to establish correct pressure. Remove air filter elbow and hose. Connect tachometer leads to diagnostic connector D1, attaching negative lead to terminal D1-3 and positive lead to terminal D1-1. See Fig. 4. Remove screw plug and install fuel pressure test fitting.

NOTE: Fuel pressure test fitting is not included with throttle body. Fitting (8983 501 572) must be obtained separately.

2) Connect fuel pressure gauge to test fitting. Start engine and increase speed to approximately 2000 RPM. Turn Torx head screw at bottom of regulator to set correct pressure. Turning screw inward increases pressure and turning screw outward decreases pressure. See Fig. 3.

3) All models require fuel pressure of 14.5 psi (1.0 kg/cm^2). Install lead sealing ball to cover regulator adjustment screw after adjusting fuel pressure. Turn ignition off. Remove measuring equipment and test fitting. Install original plug screw and air filter assembly.
THROTTLE POSITION SENSOR (TPS)

1) Turn ignition on. Check throttle position sensor input voltage. Connect voltmeter negative lead to terminal "B" (M/T), or terminal "D" (A/T) of sensor connector. Connect voltmeter positive lead to terminal "C" (M/T), or terminal "A" (A/T) of sensor connector.

NOTE: On (A/T) models, connector terminals are identified by letters molded into back of connector. On all models, do not disconnect TPS harness connector. Insert voltmeter test leads through back of wire harness connector. On some models, it may be necessary to remove throttle body from intake manifold to gain access to sensor wire harness.

2) Move and hold throttle plate at wide open throttle position (M/T), or close throttle plate completely (A/T). Ensure throttle linkage contacts stop. Note voltmeter reading. Input voltage at terminals "B" and "C" (M/T), or terminals "A" and "D" (A/T) should be 5 volts.
3) Return throttle plate to closed throttle position (M/T), or maintain throttle plate in closed position (A/T). Check sensor output voltage. To do so, disconnect voltmeter positive lead from terminal "C" and connect it to terminal "A" (top) of sensor (M/T), or from terminal "A" and connect it to terminal "B" (A/T).

4) Move and hold throttle plate in wide open throttle position (M/T), or maintain throttle plate in closed position (A/T). Ensure throttle linkage contacts stop. Note voltmeter reading. Output voltage should be 4.6-4.7 volts (M/T), or .2 volt (A/T).

5) If output voltage is incorrect, loosen bottom sensor retaining screw and pivot sensor in adjustment slot for a coarse adjustment. Loosen top sensor retaining screw for fine adjustments. Tighten screws after adjustment.

TESTING & TROUBLE SHOOTING

PRELIMINARY CHECKS & PRECAUTIONS

Subsystem Checks
Before testing fuel injection system for cause of malfunction, check that following subsystems and components are in good operating condition:

* Battery and charging system.
* Engine state of tune.
* Emission control devices.
* Fuel system pressure and delivery volume.
* Wiring connectors at components.

General Precautions
In order to prevent injury to operator or damage to system or component parts, use following techniques:

* Turn ignition off before connecting or disconnecting any component parts.
* DO NOT apply DC voltage greater than 12 volts or any AC voltage to system.
* Disconnect battery cables before charging.
* Remove ECU from vehicle if ambient temperature could exceed 176°F (80°C).
* DO NOT modify or circumvent any system functions.

RESISTANCE & VOLTAGE TESTS

MAT Sensor
1) Disconnect wiring from MAT sensor. Using high input impedance digital volt-ohmmeter (DVOM), check resistance of sensor. Resistance should be less than 1000 ohms when engine is warm. Replace sensor if it does not fall within range shown in TEMPERATURE-TO-RESISTANCE VALUES table.

2) Test resistance in wiring harness between ECU connector terminal No. 32 and sensor connector terminal. Also test resistance in wiring harness between ECU harness terminal No. 14 and sensor connector terminal. See Fig. 5. Repair wiring harness if open circuit or resistance greater than one ohm is indicated.

Coolant Temperature Sensor (CTS)
1) Disconnect wiring harness from CTS. Using high input impedance digital volt-ohmmeter (DVOM), check resistance of sensor. Resistance should be less than 1000 ohms when engine is warm. Replace sensor if it does not fall within range shown in TEMPERATURE-to-RESISTANCE VALUES table.
2) Test resistance in wiring harness between ECU harness terminal No. 32 and sensor connector terminal. Also test resistance in wiring harness between ECU harness terminal No. 15 and sensor connector terminal. See Fig. 5. Repair wiring harness if open circuit or resistance greater than one ohm is indicated.

TEMPERATURE-TO-RESISTANCE VALUES (CTS & MAT SENSOR) TABLE

<table>
<thead>
<tr>
<th>°F</th>
<th>°C</th>
<th>Ohms</th>
</tr>
</thead>
<tbody>
<tr>
<td>212</td>
<td>100</td>
<td>185</td>
</tr>
<tr>
<td>160</td>
<td>70</td>
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<td>100</td>
<td>38</td>
<td>1600</td>
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<td>-18</td>
<td>25,000</td>
</tr>
<tr>
<td>-40</td>
<td>-40</td>
<td>100,700</td>
</tr>
</tbody>
</table>

Throttle Position Sensor (TPS) Test

Turn ignition on. Check voltage at terminal connector without disconnecting from TPS. Terminal "A" (M/T), or terminal "B" (A/T) is output voltage, which should be 4.6–4.7 volts at wide open throttle (M/T), or .2 volt at closed throttle (A/T). Terminal "B" (M/T), or terminal "A" (A/T) is sensor ground. Terminal "C" (M/T), or terminal "D" (A/T) is input voltage, which is about 5 volts.

Closed Throttle (Idle) Switch Test

NOTE: ALL testing of idle switch must be done with ISA motor plunger in fully extended position. If switch cannot be tested without extending plunger, it is possible that ISA motor has failed. See IDLE SPEED ACTUATOR MOTOR ADJUSTMENT.

1) Turn ignition on. Check idle switch voltage at diagnostic connector D2, between terminals No. 13 and 7. See Fig. 4. At closed throttle, voltage should be near zero volts. When switch is off closed throttle position, voltage reading should be greater than 2 volts.

2) If voltage is always zero, test for short to ground in harness or switch. Also check for open circuit between switch and terminal No. 25 of ECU connector. If reading is always greater than 2 volts, check for open circuit in wiring harness between switch connector and ECU. Also check for open between ground and switch connector. Replace or repair wiring harness as necessary.

Manifold Absolute Pressure (MAP) Sensor Test

1) Check and repair vacuum hose connections at throttle body and MAP sensor. Check output voltage at MAP sensor connector terminal "B" (marked on sensor body) with ignition on, engine off. Voltage reading should be 4–5 volts. If engine is hot and idling in Neutral, reading should be 1.5–2.1 volts. Check voltage at terminal No. 33 of ECU connector. Reading should be same as that at terminal "B" on MAP sensor connector. See Fig. 4.

2) With ignition on, check MAP sensor supply voltage at terminal "C". Reading should be 4.5–5.5 volts. Same voltage reading should be obtained at terminal No. 16 on ECU harness connector. If necessary, repair or replace wiring harness. Using Diagnostic Tester (MS 1700), test ECU if necessary. Check MAP sensor ground circuit at terminal "A" and terminal No. 17 of ECU connector. Repair wiring if necessary.
3) Using ohmmeter, check MAP sensor ground circuit between terminals No. 17 and 2 of ECU connector. If circuit is incomplete, check sensor ground connection on bellhousing, near starter motor. Replace ECU if ground is good. If terminal No. 17 is shorted to 12 volts, repair problem BEFORE ECU is replaced.

DIAGNOSTIC TOOLS

To properly test throttle body fuel injection system, service technician must have the following equipment available:

* Digital volt-ohmmeter (DVOM) or volt-ohmmeter with minimum input impedance of one megohm.
* 12-volt test light, jumper wires and probes.
* Hand vacuum pump with gauge.
* Ignition timing light.

Fig. 4: Jeep/Renix Fuel Injection Diagnostic Connectors
Courtesy of Chrysler Motors.

DIAGNOSTIC TESTS
NOTE: When diagnosing fuel system problems using following procedures, no specialized service equipment is needed. Following diagnostic procedures are NOT applicable if special tester M.S. 1700 is used.

Six different test flow charts are used to fully evaluate fuel injection system:

TEST 1: IGNITION OFF
This test checks that system power provides for ECU memory keep-alive voltage.

TEST 2: IGNITION ON: POWER
This test checks system power function and fuel pump power function.

TEST 3 & 3A: IGNITION ON: INPUT
These tests check the following components and their circuits: closed throttle (idle) switch, Throttle Position Sensor (TPS), MAP sensor, A/T gear selector switch, Coolant Temperature Sensor (CTS) and MAT sensor. Coolant temperature and MAT sensors are tested in cold condition. This procedure also checks all interrelated wiring circuits as well.

TEST 4 & TEST 4A: SYSTEM OPERATIONAL
These tests check engine start-up circuit, fuel injector, "Closed Loop" air/fuel mixture function, coolant temperature sensor function, MAT sensor function, detonation sensor "Closed Loop" ignition retard/advance function, EGR valve and canister purge solenoid function, idle speed control and A/C control functions.

TEST 5: BASIC ENGINE
This test indicates failures in related engine components that are not part of fuel injection system.

TEST 6: MANUAL TRANSMISSION UPSHIFT
This test checks upshift indicator light function on vehicles with manual transmissions.

Fig. 5: Jeep/Renix Fuel Injection ECU Connector
Courtesy of Chrysler Motors.

REMOVAL & INSTALLATION
COOLANT TEMPERATURE SENSOR (CTS)

Removal & Installation
Allow engine to cool down. Disconnect CTS wiring harness. Remove CTS from intake manifold and rapidly plug hole to prevent coolant loss. Install replacement CTS and connect CTS wiring harness.

FUEL INJECTOR

WARNING: Always relieve residual fuel pressure in fuel delivery system before opening system. To prevent chance of personal injury, cover fittings with shop towel while disconnecting fittings.

Removal
Remove air cleaner assembly. Remove injector wiring connector. Remove injector retainer screws and clip. Using small pliers, carefully grasp center collar of injector between electrical terminals and carefully remove injector with lifting/twisting motion. Discard both "O" rings. See Fig. 6.

Installation
1) Using light oil, lubricate new upper and lower "O" rings. Install "O" rings in housing bore. Install back-up ring over upper "O" ring. Position replacement injector in fuel body.
2) Center nozzle in lower housing bore and use a pushing/twisting motion to seat injector. Align wire connectors in proper orientation. Install retainer clip and screws. Connect injector wiring. Install air cleaner.

Fig. 6: Fuel Injector & Throttle Body Assembly
Courtesy of Chrysler Motors.

FUEL PRESSURE REGULATOR
Removal & Installation

WARNING: Always relieve residual fuel pressure in fuel delivery system before opening system. To prevent chance of personal injury, cover fittings with shop towel while disconnecting fittings.

With throttle body assembly removed, remove 3 screws holding fuel pressure regulator in throttle body. Remove fuel pressure regulator assembly. Note location of components for installation. Discard gaskets. To install, reverse removal procedure. Adjust regulator after installation. See ADJUSTMENTS in this article.

IDLE SPEED ACTUATOR (ISA) MOTOR

Removal & Installation
1) Disconnect throttle return spring. Disconnect wiring harness connector from ISA motor. Remove ISA motor retaining nuts and remove ISA motor from bracket.
2) To install ISA motor assembly, reverse removal procedure. Adjust ISA motor after installation. See ADJUSTMENTS in this article.

THROTTLE BODY ASSEMBLY

Removal
1) Remove air inlet duct and adapter plate. Remove throttle cable and return spring. Disconnect electrical leads from fuel injector, WOT switch, and ISA motor.
2) Disconnect fuel supply and return lines at throttle body. See Fig. 7. Tag and disconnect vacuum hoses. Disconnect TPS wiring. Remove throttle body assembly. If throttle body assembly is being replaced, transfer ISA motor and WOT switch bracket assembly to new unit.

Installation
Install replacement throttle body assembly on manifold using new gasket. Reconnect all hoses, wires and cable in reverse order of disassembly. Adjust ISA motor after installation. See ADJUSTMENTS in this article.

Fig. 7: Intake Manifold & Throttle Body Assembly
Courtesy of Chrysler Motors.

THROTTLE POSITION SENSOR
Removal & Installation
Remove throttle body assembly as previously described. Remove Torx head retaining screws. Remove throttle position sensor from throttle shaft lever. To install, reverse removal procedure. Adjust TPS after installation. See ADJUSTMENTS in this article.

MANIFOLD AIR/FUEL TEMPERATURE (MAT) SENSOR

Removal & Installation
Disconnect wire harness connector from MAT sensor. Remove MAT sensor from intake manifold. To install, reverse removal procedure. See Fig. 7.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

Removal & Installation
Disconnect wire harness connector, vacuum hose, and retaining nuts from MAP sensor. Remove sensor from firewall. To install, reverse removal procedure.

ELECTRONIC CONTROL UNIT (ECU)

Removal & Installation
1) On Wrangler, remove passenger assist handle and glove box assembly. Remove ECU bracket retaining nuts from engine compartment side of firewall. Disconnect ECU wiring harness. Remove ECU from bracket. To install, reverse removal procedure.
2) On all other models, remove retaining screws and bracket that supports ECU above accelerator pedal. Remove ECU and disconnect wiring harness. To install, reverse removal procedure.

EGR VALVE

Removal & Installation
Disconnect vacuum hose from EGR valve. Remove bolts which hold EGR valve to intake manifold. Remove valve and discard gasket. To install valve, reverse removal procedure. Always use new gasket. See Fig. 7.

TROUBLESHOOTING AND DIAGNOSIS
Fig. 8: TEST 1: IGNITION OFF

WITH THE IGNITION SWITCH OFF, TEST FOR BATTERY VOLTAGE BETWEEN DIAGNOSTIC CONNECTOR TERMINALS D1-5 AND D2-7. TERMINAL D2-7 IS GROUND.

NOTE: THE ECU WIRE HARNESS CONNECTOR COVER CAN BE REMOVED FOR ACCESS TO THE CONNECTOR TERMINALS WHEN THE CONNECTOR IS CONNECTED TO THE ECU. ENSURE THAT THE CONNECTOR PINS HAVE GOOD CONTACT WITH THE ECU WHEN THE COVER IS REMOVED.

TEST FOR BATTERY VOLTAGE BETWEEN DIAGNOSTIC CONNECTOR TERMINALS D2-7 AND D2-1. TERMINAL D2-7 IS GROUND.

BATTERY VOLTAGE?

YES

TEST FOR BATTERY VOLTAGE BETWEEN ECU CONNECTOR TERMINALS 3 AND 1. TERMINAL 1 IS GROUND.

BATTERY VOLTAGE?

NO

TEST 1 COMPLETED, PROCEED TO TEST 2.

YES

IGNITION SWITCH ON?

NO

REPLACE THE ECU AND START TEST 1 AGAIN.

DISCONNECT THE ECU WIRE HARNESS CONNECTOR AND TEST FOR BATTERY VOLTAGE BETWEEN TERMINALS 3 AND 1. TERMINAL 1 IS GROUND.

YES

BATTERY VOLTAGE?

NO

REPLACE THE ECU AND START TEST 1 AGAIN.

DISCONNECT THE COLD START RELAY AND TEST FOR VOLTAGE AT ECU CONNECTOR TERMINAL 7.

TURN THE IGNITION SWITCH OFF AND START TEST 1 AGAIN.

YES

BATTERY VOLTAGE?

NO

REPAIR THE IGNITION SWITCH AND REPEAT THE TEST.

REPAIR THE GROUND CIRCUIT FAULT IN THE WIRED HARNESS.

REPAIR THE POWER SUPPLY FAULT IN THE WIRED HARNESS.

REPLACE THE COLD START RELAY AND REPEAT THE TEST.
**TEST 2: IGNITION ON: POWER**

WITH THE IGNITION SWITCH OFF, TEST FOR BATTERY VOLTAGE BETWEEN DIAGNOSTIC CONNECTOR TERMINALS D1-2 AND D2-7. TERMINAL D2-7 IS GROUND. THERE SHOULD BE NO VOLTAGE.

- **Battery Voltage?**
  - Yes: Repair the ignition switch circuit and start Test 2 again.
  - No: Turn the ignition switch on and test for battery voltage between diagnostic connector terminals D1-2 and D2-7. Terminal D2-7 is ground.

- **Battery Voltage?**
  - Yes: Repair the ignition switch circuit and start Test 2 again.
  - No: With the ignition switch off, insert the voltmeter probes into diagnostic connector terminals D2-2 and D2-7. Terminal D2-7 is ground. Turn the ignition switch on.
    1. The voltage may be very high (spike) for a fraction of a second.
    2. The voltage should decrease to 1 volt or less for 1 second (approximately).
    3. The voltage should increase to battery voltage level (+1 volt).

- **OK?**
  - Yes: Repair the ignition switch circuit and start Test 2 again.
  - No: Test for battery voltage between ECU wire harness connector terminals 3 and 1. Terminal 1 is ground.

- **OK?**
  - Yes: Test 2 is completed. Proceed to Test 3.
  - No: Battery Voltage?
    - Yes: Repair the ignition switch circuit and start Test 2 again.
    - No: Continue on next graphic.

*Fig. 9: TEST 2: IGNITION ON: POWER*
Fig. 10: TEST 2: IGNITION ON: POWER (Cont.)

CONTINUED FROM PREVIOUS GRAPHIC
TEST 3: IGNITION ON: INPUT

TURN THE IGNITION SWITCH ON AND TEST THE VOLTAGE BETWEEN DIAGNOSTIC CONNECTOR TERMINALS D2-13 AND D2-7. TERMINAL D2-7 IS GROUND.

DEPRESS THE THROTTLE AND TEST THE VOLTAGES ACROSS TERMINALS D2-13 AND D2-7.

NO

GREATER THAN 4 VOLTS?

YES

INSPECT THE THROTTLE CABLE AND ENSURE THAT A BINDING CONDITION DOES NOT EXIST. ENSURE THAT THE CABLE IS FULLY RELEASED.

TEST FOR CONTINUITY BETWEEN ISA MOTOR TERMINALS A AND B.

YES

CABLE OK?

NO

REPAIR THE THROTTLE CABLE ASSEMBLY AND START TEST 3 AGAIN.

GREATER THAN 4 VOLTS?

YES

DISCONNECT THE ISA MOTOR WIRE HARNESS CONNECTOR. DEPRESS THE THROTTLE AND TEST FOR CONTINUITY BETWEEN ISA MOTOR TERMINALS A AND B.

NO

RELEASE THE THROTTLE.

YES

REPLACE THE ISA MOTOR AND START TEST 3 AGAIN.

OPEN CIRCUIT?

NO

REPAIR THE SHORT CIRCUIT TO GROUND IN THE WIRE HARNESS BETWEEN THE ECU DIAGNOSTIC CONNECTOR AND THE ISA MOTOR. START TEST 3 AGAIN.

YES

DISCONNECT THE ECU WIRE HARNESS CONNECTOR. CONNECT THE ISA MOTOR CONNECTOR AND REPEAT THE TEST.

OPEN CIRCUIT?

NO

REPLACE THE ECU AND START TEST 3 AGAIN.

CONTINUED ON NEXT GRAPHIC
Fig. 12: TEST 3: IGNITION ON: INPUT (Cont.)
Fig. 13: TEST 3: IGNITION ON: INPUT (Cont.)
TEST 3A: IGNITION ON: THROTTLE POSITION SENSOR

DISCONNECT THE WIRE CONNECTOR AT THE TPS. CHECK VOLTAGE AT TPS CONNECTOR PINS B (GROUND) AND C (5 VOLT SUPPLY) WITH KEY "ON".

TURN KEY OFF. CHECK FOR CONTINUITY BETWEEN ECU CONNECTOR PIN 16 AND TPS CONNECTOR TERMINAL C.

CONNECT THE TPS WIRE CONNECTOR TO THE TPS. CHECK VOLTAGE AT TPS CONNECTOR TERMINALS A (+) AND B (GROUND) WITH KEY "ON" AND THROTTLE PLATE AT WIDE OPEN THROTTLE.

CHECK FOR CONTINUITY BETWEEN ECU CONNECTOR PIN 13 AND PIN B OF THE TPS CONNECTOR.

OUTPUT VOLTAGE 4.647 VOLTS?

TPS SWITCH AND ADJUSTMENT OK

ADJUST OUTPUT VOLTAGE TO 4.647 VOLTS.

ABLE TO ADJUST TPS TO 4.847 VOLTS AT WOT?

TPS AND WIRING OK?

REPLACE THE THROTTLE POSITION SENSOR (TPS) AND ADJUST OUTPUT VOLTAGE.

REPAIR TPS WIRE HARNESS POWER SUPPLY CIRCUIT BETWEEN THE ECU AND THE TPS AND RETEST.

REPAIR THE TPS WIRE HARNESS GROUND CIRCUIT BETWEEN THE ECU AND THE TPS AND RETEST.

CHECK FOR CONTINUITY BETWEEN ECU CONNECTOR PIN 31 AND THE TPS CONNECTOR PIN A.

REPLACE ECU AND RETEST.

REPAIR TPS WIRE HARNESS BETWEEN ECU AND TPS AND RETEST.

DO NOT UNFASTEN THE SENSOR WIRE HARNESS CONNECTOR. INSERT THE VOLTmeter TEST LEADS THROUGH THE BACK OF THE WIRE HARNESS CONNECTOR TO MAKE CONTACT WITH THE SENSOR TERMINALS. ON SOME MODELS, IT MAY ALSO BE NECESSARY TO REMOVE THE THROTTLE BODY FROM THE INTAKE MANIFOLD, TO GAIN ACCESS TO THE SENSOR WIRE HARNESS CONNECTOR.

* DO NOT UNFASTEN THE SENSOR WIRE HARNESS CONNECTOR. INSERT THE VOLTmeter TEST LEADS THROUGH THE BACK OF THE WIRE HARNESS CONNECTOR TO MAKE CONTACT WITH THE SENSOR TERMINALS. ON SOME MODELS, IT MAY ALSO BE NECESSARY TO REMOVE THE THROTTLE BODY FROM THE INTAKE MANIFOLD, TO GAIN ACCESS TO THE SENSOR WIRE HARNESS CONNECTOR.

Fig. 14: TEST 3A: IGNITION ON: THROTTLE POSITION SENSOR (M/T)
TEST 4: SYSTEM OPERATIONAL (Cont.)

Fig. 15: TEST 4: SYSTEM OPERATIONAL
TEST 4A: SYSTEM OPERATIONAL

ALLOW THE ENGINE TO WARM-UP UNTIL THE COOLANT TEMPERATURE STABILIZES

NO

ENGINE WARM?

YES

TEST THE VOLTAGE BETWEEN DIAGNOSTIC CONNECTOR TERMINALS D2-12 AND D2-7
TERMINAL D2-7 IS GROUND

BETWEEN 0.15 VOLT AND 0.35 VOLT (150 MV AND 350 MV)?

NO

YES

AT OR NEAR GROUND POTENTIAL?

APPROXIMATELY 2.5 VOLTS?

DISCONNECT THE CTS WIRE HARNESS CONNECTOR AND TEST THE VOLTAGE AT THE CONNECTOR TERMINAL IN REFERENCE TO THE SYSTEM GROUND REFER TO THE ENGINE WIRING DIAGRAM FOR THE WIRE COLOM

REPLACE THE COOLANT TEMPERATURE SENSOR (CTS) AND RETEST

CONTINUED ON NEXT GRAPHIC

Fig. 16: TEST 4: SYSTEM OPERATIONAL (Cont.)
CONTINUED FROM PREVIOUS GRAPHIC

TEST FOR CONTINUITY BETWEEN DIAGNOSTIC CONNECTOR TERMINAL D2-12 AND ECU CONNECTOR TERMINAL 15

CONTINUITY OK?

NO  REPAIR THE WIRE HARNESS AND RETEST

YES

APPROXIMATELY 25 VOLTS?

NO

YES

TEST THE CTS CONNECTOR GROUND RETURN WIRE TERMINAL FOR CONTINUITY WITH ECU CONNECTOR TERMINAL 32. REFER TO THE ENGINE WIRING DIAGRAM FOR WIRE COLOR.

CONTINUITY OK?

NO

REPLACE THE CTS AND RETEST

YES

TEST FOR A SHORT CIRCUIT TO GROUND IN THE WIRE HARNESS BETWEEN ECU CONNECTOR TERMINAL 15 AND DIAGNOSTIC CONNECTOR TERMINAL D2-12

SHORT CIRCUIT TO GROUND?

NO  REPLACE THE WIRE HARNESS AND RETEST

YES

REPLACE THE ECU AND RETEST

TEST THE VOLTAGE BETWEEN DIAGNOSTIC CONNECTOR TERMINALS D2-6 AND D2-7. TERMINAL D2-7 IS GROUND.

CONTINUED ON NEXT GRAPHIC

Fig. 17: TEST 4A: SYSTEM OPERATIONAL
Fig. 18: TEST 4A: SYSTEM OPERATIONAL (Cont.)

CONTINUED FROM PREVIOUS GRAPHIC

BETWEEN 0.15 VOLT AND 0.35 VOLT (150 AND 350 MV)?

NO

AT OR NEAR GROUND POTENTIAL?

YES

APPROXIMATELY 2.5 VOLTS

NO

DISCONNECT THE (MAT) MANIFOLD AIR/FUEL TEMPERATURE SENSOR AND TEST THE VOLTAGE AT THE MAT SENSOR WIRE CONNECTOR. REFER TO THE ENGINE WIRING DIAGRAMS FOR WIRE COLOR

YES

TEST FOR CONTINUITY BETWEEN THE DIAGNOSTIC CONNECTOR AND ECU CONNECTOR TERMINAL 14

NO

REPLACE THE MANIFOLD AIR/FUEL TEMPERATURE (MAT) SENSOR AND RETEST

YES

REPAIR THE WIRE HARNESS AND RETEST

TEST FOR A SHORT CIRCUIT TO GROUND BETWEEN THE DIAGNOSTIC CONNECTOR AND THE ECU CONNECTOR

NO

SHORT CIRCUIT TO GROUND?

YES

REPLACE THE ECU AND RETEST

ENGINE IDLE SPEED APPROXIMATELY 850 RPM (AUTO) / 750 RPM (MAN)?

YES

REPAIR THE WIRE HARNESS AND RETEST

NO
CONTINUED FROM PREVIOUS GRAPHIC

Fig. 19: TEST 4A: SYSTEM OPERATIONAL (Cont.)
CONTINUED FROM PREVIOUS GRAPHIC

INCREASE THE ENGINE SPEED TO 2500 RPM AND MAINTAIN FOR 15 SECONDS TO HEAT THE O₂ SENSOR. TEST THE O₂ SENSOR VOLTAGE BETWEEN ECU CONNECTOR TERMINALS 35 AND 1 TERMINAL 1 IS GROUND.

VOLTAGE CHANGES FROM 0 VOLT TO 1 VOLT?

NO

YES

1.7 LITER ENGINE?

NO

YES

PROCEED TO THE NEXT PAGE

CONNECT A TIMING LIGHT TO THE NUMBER 1 CYLINDER SPARK PLUG.

WITH THE ENGINE AT IDLE SPEED, OBSERVE THE TIMING SCALE AND INDEX AND STRIKE THE CYLINDER HEAD NEAR THE KNOCK SENSOR WITH THE EDGE OF A SCREWDRIVER BLADE (10 TO 12 TIMES).

REPAIR THE HOSE CONNECTION AND RETEST.

NO

OK?

YES

DISCONNECT THE SOLENOID WIRE HARNESS CONNECTOR.

NO

VACUUM PRESENT?

YES

NO

INSPECT FOR EXHAUST LEAKS BETWEEN THE ENGINE AND THE O₂ SENSOR.

NO

YES

REPLACE THE SOLENOID AND RETEST.

CONTINUITY?

YES

NO

REPAIR THE WIRE HARNESS AND RETEST.

REPLACE THE ECU AND RETEST.

REPAIR AND RETEST.

TURN THE IGNITION SWITCH OFF. DISCONNECT THE ECU WIRE HARNESS CONNECTOR. TEST FOR A SHORT CIRCUIT TO GROUND BETWEEN THE SOLENOID CONNECTOR AND ECU CONNECTOR TERMINAL 5.

SHORT CIRCUIT TO GROUND?

YES

NO

REPLACE THE O₂ SENSOR AND RETEST.
TEST 4A: SYSTEM OPERATIONAL (Cont.)

TEST FOR CONTINUITY BETWEEN ECU CONNECTOR TERMINALS 13 AND 31 AND THE KNOCK SENSOR CONNECTOR TERMINALS

CONTINUE WITH 1.4L/2.4L ENGINE TEST.

REPAIR THE WIRE HARNESS AND REPEAT THE TEST

THE ORIGINAL KNOCK SENSOR IS DEFECTIVE. REPLACE IT AND CONTINUE WITH THE TEST

VEHICLE EQUIPPED WITH A/C?

NO

YES

VEHICLE EQUIPPED WITH UP-SHIFT INDICATOR?

YES

NO

JETI SYSTEM OPERATING NORMAL - TEST COMPLETE

ENGINE IDLE SPEED INCREASES?

YES

NO

Determine if the A/C compressor clutch engages

CONTINUED ON NEXT GRAPHIC

Fig. 22: TEST 4A: SYSTEM OPERATIONAL (Cont.)
TEST 5: BASIC ENGINE

Inspect the engine for air leaks into the vacuum hoses and fittings.

Check the ignition power module operation and the ignition high voltage.

If fuel is leaking from around the base of the injector, replace the O-ring.

Check the fuel pump pressure.

Return to Test 4.
Fig. 24: TEST 6: MANUAL TRANSMISSION UP-SHIFT

CONTINUED ON NEXT GRAPHIC

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Fig. 24: TEST 6: MANUAL TRANSMISSION UP-SHIFT

WIRING DIAGRAMS
Fig. 25: Cherokee, Comanche & Wagoneer Throttle Body Fuel Injection System Wiring Diagram
Fig. 26: Wrangler Throttle Body Fuel Injection System Wiring Diagram