FOCUS

AJ6 4.0L Engine Management System / OBD I

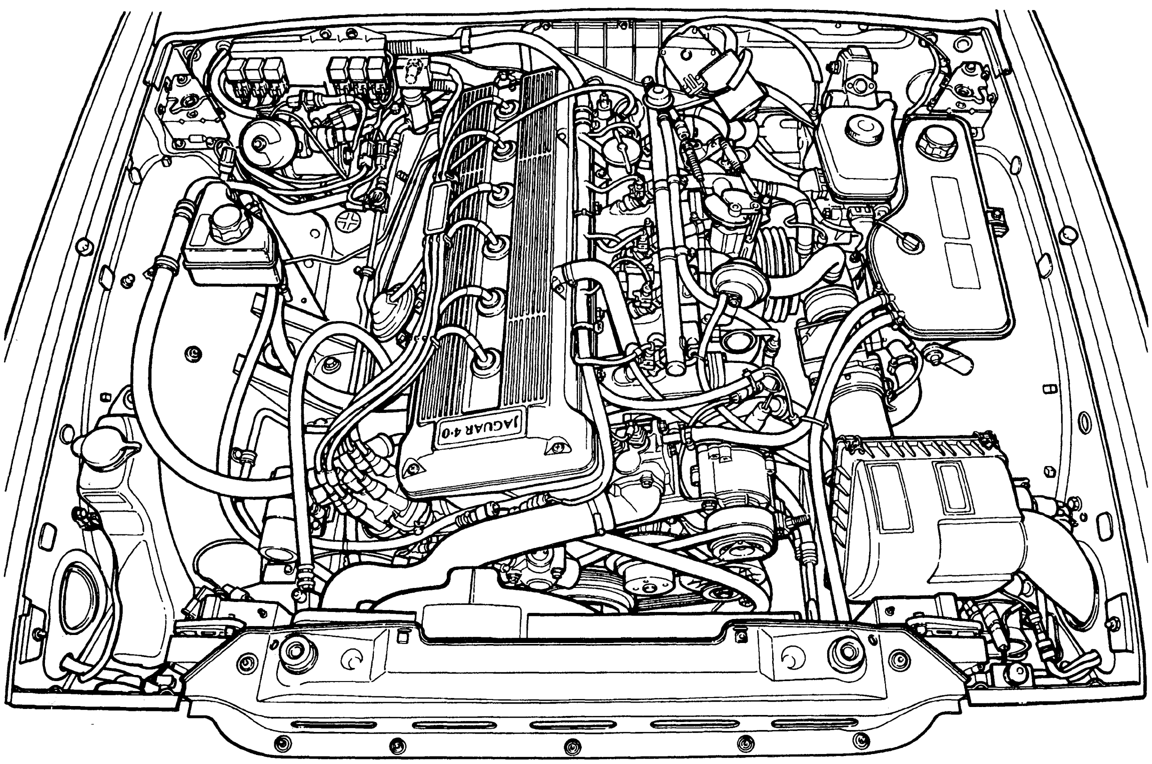
Diagnostic Guide

Publication S-91

Foreword

The AJ6 4.0 Litre Engine Management System (EMS) is used in 1990 – 1994 model year Sedan Range vehicles and 1993 – 1994 model year XJS Range vehicles. This system combines the control of all engine operating and emission related components through a single microprocessor based Engine Control Module (ECM). The ECM incorporates an On-Board Diagnostics (OBD) system that monitors certain ECM control and drive functions for faults. The OBD system is known as "OBD level one specification". OBD I is the common abbreviation.

AJ6 4.0 LITRE ENGINE



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This FOCUS booklet is designed to serve as a single source document for all descriptive, diagnostic and reference information relating to the AJ6 4.0 Litre Engine Management System. The information is arranged in four tabbed sections:

Each of the sections can be used either to gain an understanding of the EMS system or to aid in diagnosing a specific fault.

⚠ WARNING: THE OPERATIONS AND PROCEDURES CONTAINED IN THIS PUBLICATION ARE INTENDED FOR USE BY PROFESSIONAL TECHNICIANS WITH KNOWLEDGE OF JAGUAR VEHICLE SYSTEMS. ALL NECESSARY SAFETY PRECAUTIONS MUST BE TAKEN WHEN SERVICING OR TESTING SYSTEMS THAT HAVE THE POTENTIAL FOR CAUSING BODILY INJURY OR DEATH.

System Description

Contents

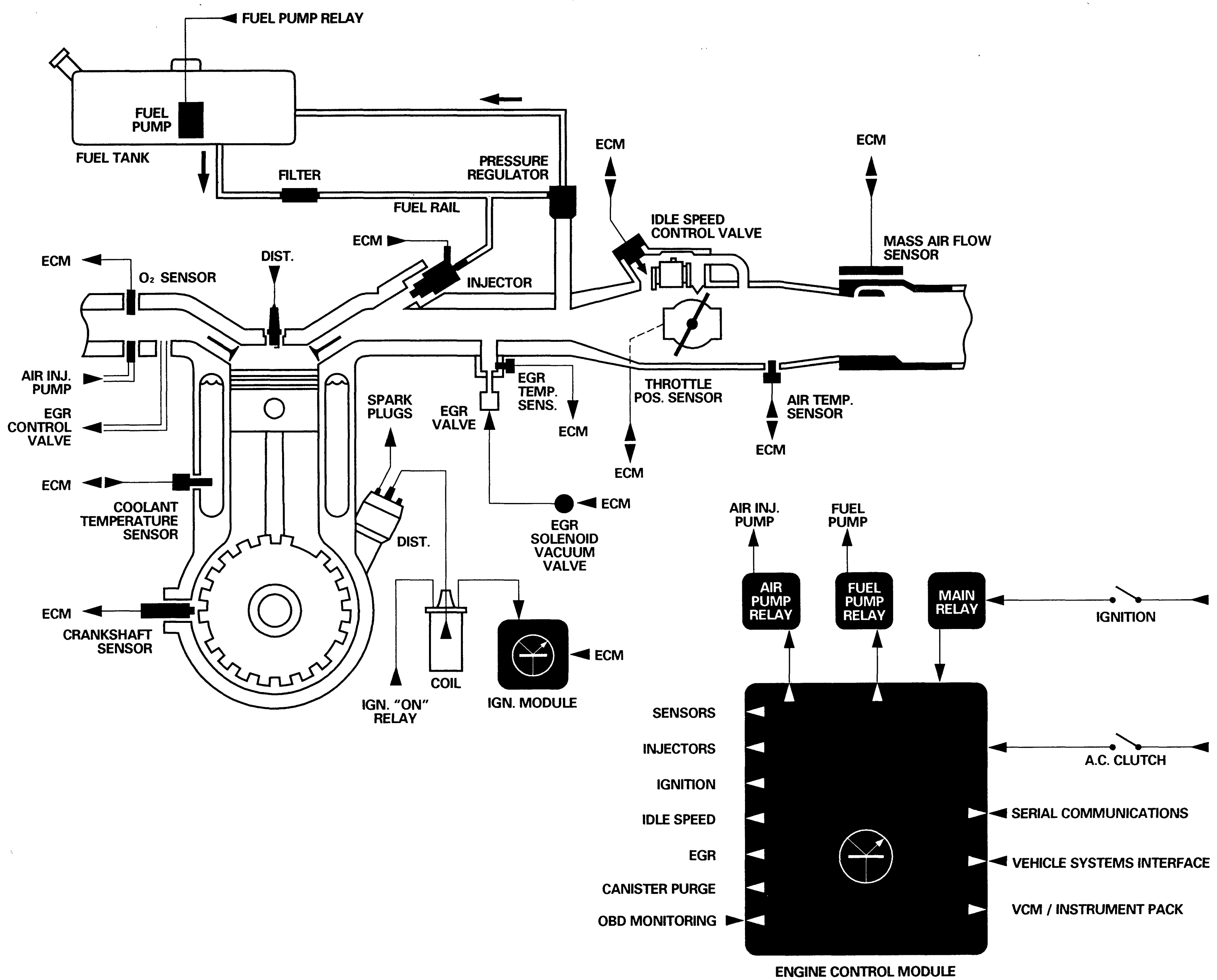
Overview

The AJ6 4.0 Litre Engine Management System (EMS) is an integrated engine management system, controlled through a digital Electronic Control Module (ECM) containing a microprocessor. The system maintains optimum performance over the engine operating range by precisely controlling fuel injection, ignition timing and emission control functions. In addition, the ECM provides various interface outputs and incorporates an on-board diagnostic function.

A summary of EMS function and control includes:

- Fuel delivery (fuel pump)
- Evaporative emission control (canister purge)
- Fuel injection
- Cold start
- Warm-up
- Exhaust emission
- Oxygen sensor feedback
- Overrun fuel cut-off
- RPM limitation (engine overspeed)
- Wide-open-throttle fuel cut-off
- Ignition timing
- Idle speed control
- Air injection
- Exhaust gas recirculation
- Adaptive idle fuel metering (1993 MY ON)
- On-Board Diagnostics (OBD)
- "Limp home" capability
- Vehicle systems interfaces
- Serial communication (ISO)

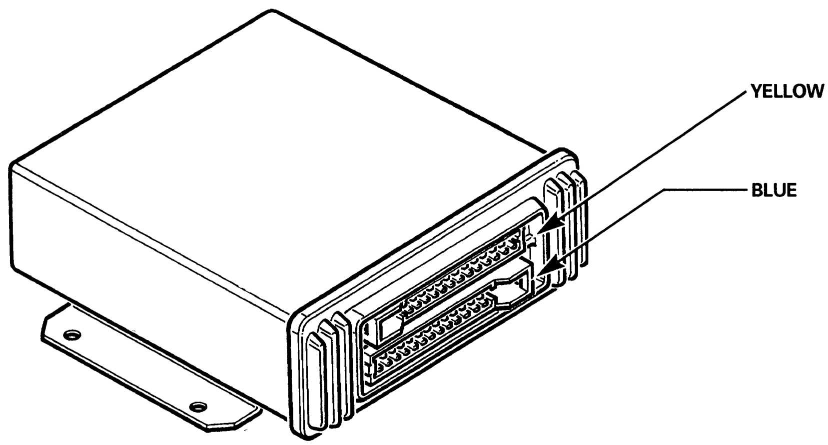
TYPICAL AJ6 4.0 LITRE ENGINE MANAGEMENT SYSTEM



Engine Control Module (ECM)

The AJ6 4.0L EMS is microprocessor based using the Lucas 15 CU ECM as the heart of the system. The 15 CU ECM microprocessor runs at 2.0 MHz. The ECM uses discrete components plus analog-to-digital circuits to interface between the microprocessor and the input sensors and output devices. Software, programmed into an EPROM, is divided into "control code" and "data" (engine calibration). Control code is common to all engine specifications; data is written for specific market specifications such as US EPA emission regulations.

15 CU ENGINE CONTROL MODULE



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The ECM contains two double sided printed circuit boards. One is a low power board and the other is a high power board. The yellow and blue 25-way connectors are therefore referred to as the low and high power connectors respectively. Most of the input signals from engine mounted sensors, and interfaces with other systems are located on the low power (Yellow) connector. The high power connector (Blue), mainly serves outputs such as fuel injector drive and relay activation. Inputs and outputs are included with the wiring diagrams. Refer to the REFERENCE section of this publication.

The ECM receives sensor inputs and feedbacks, which are used to determine the optimum strategy for the prevailing conditions. The ECM's strategy has 256 memory locations containing injector pulse durations and ignition timing angles for 16 different engine loads (engine load sites) and 16 different engine speeds (engine speed sites). Canister purge, idle speed, air injection and exhaust gas recirculation are controlled by the ECM from stored strategies.

Crankcase Emission Control

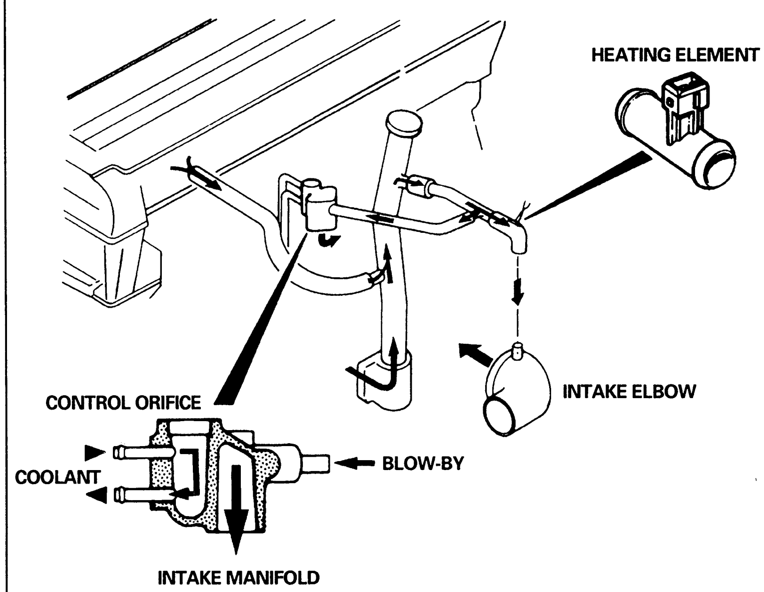
In order to prevent crankcase vapor from escaping to the atmosphere, a closed crankcase emission control system is employed that maintains a slight vacuum in the crankcase under all engine operating conditions.

Crankcase vapor is collected from the camshaft cover and from the oil filler tube. At part throttle, the gases are fed into the intake manifold through a coolant heated restrictor. During full load operation the gases are fed into the engine through both the coolant heated restrictor and air intake elbow connection.

The necessary crankcase vacuum is balanced by the part throttle restrictor and the full throttle orifice in the inlet elbow. The restrictor and orifice sizes have been carefully chosen to control the crankcase vacuum while not flowing so much gas that idle speed is affected.

The part throttle restrictor is coolant heated to prevent icing during cold weather operation. An additional electrical breather heater element is located in the full throttle breather hose. The electrical heater provides heat to the gases passing through the hose, preventing ice formation in the inlet elbow orifice. The electrical heater element is controlled independently of the EMS ECM by an ambient temperature sensor, thermal switch and relay. Starting in the 1994 model year, a throttle housing heated by engine coolant was introduced.

CRANKCASE EMISSION CONTROL



PART LOAD RESTRICTOR: 2.5mm; FULL LOAD ORIFICE: 8.0mm

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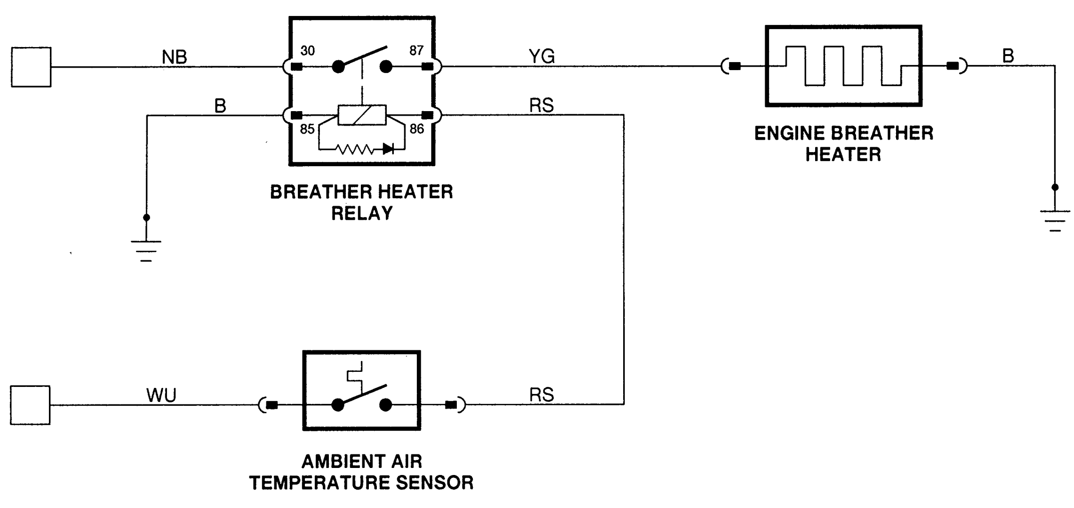
TYPICAL ENGINE BREATHER HEATER CIRCUIT



REFER TO THE APPLICABLE ELECTRICAL GUIDE FOR DETAILED INFORMATION

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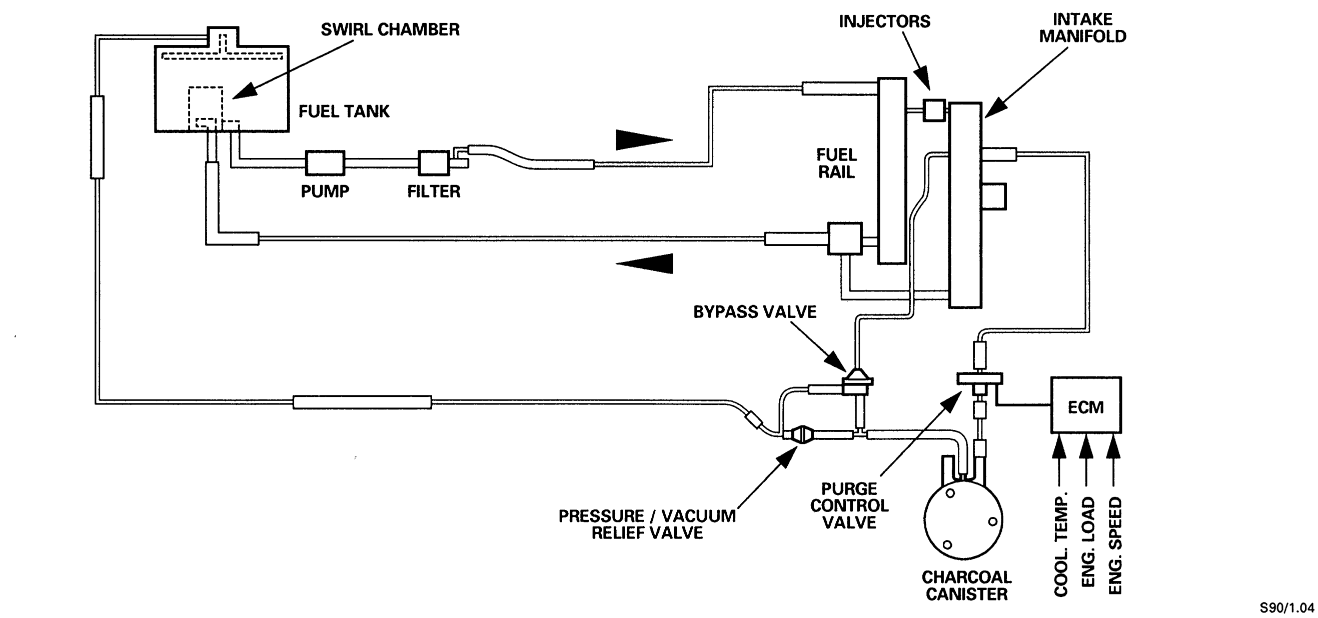
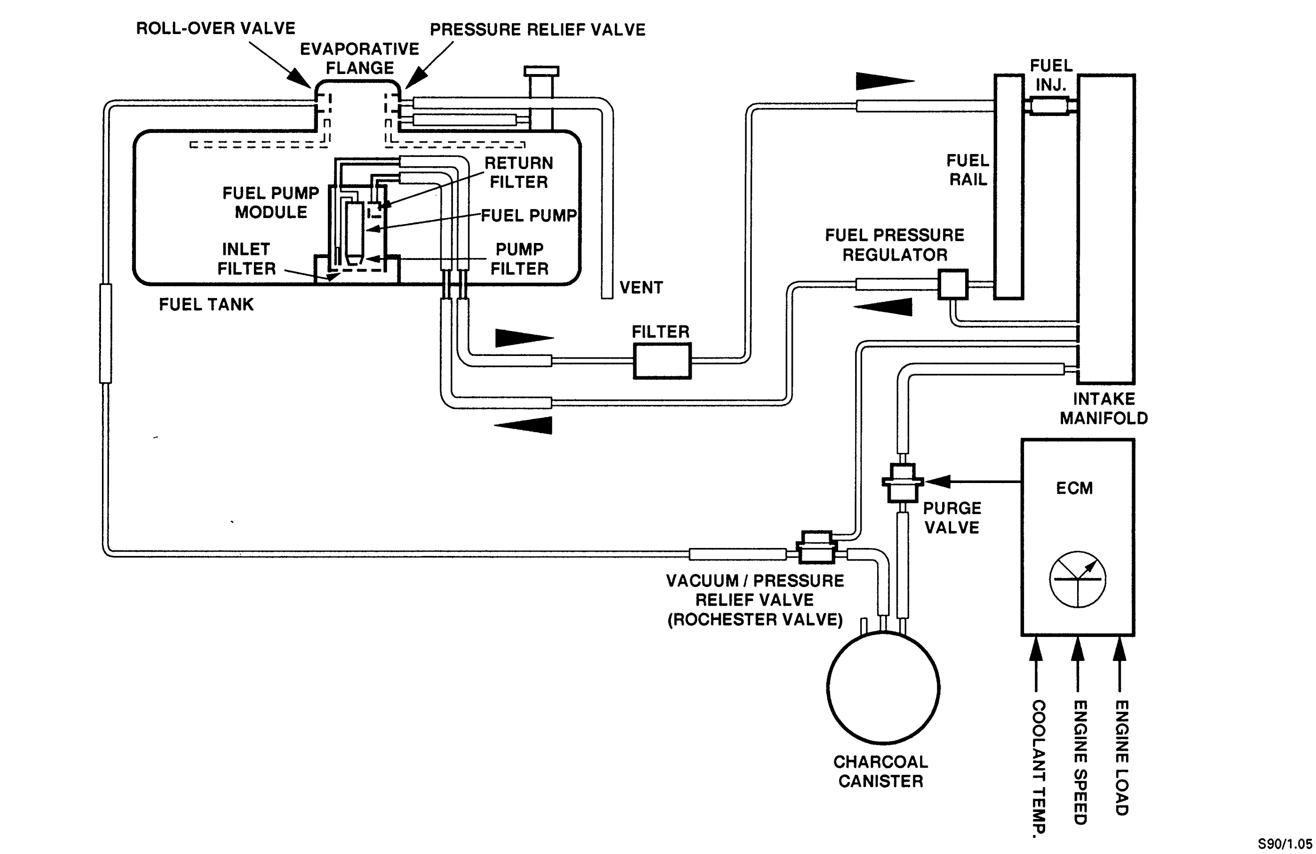
Fuel Delivery and Evaporative Emission Control

Since the 1990 model year, two fuel delivery and evaporative emission control systems have been used for all AJ6 4.0 litre installations. The two systems are illustrated below.

FUEL DELIVERY AND EVAPORATIVE EMISSION CONTROL: XJ6 SEDAN RANGE 1990 MY



FUEL DELIVERY AND EVAPORATIVE EMISSION CONTROL: XJ6 SEDAN RANGE 1991 – 94 MY; XJS RANGE 1993 – 94 MY

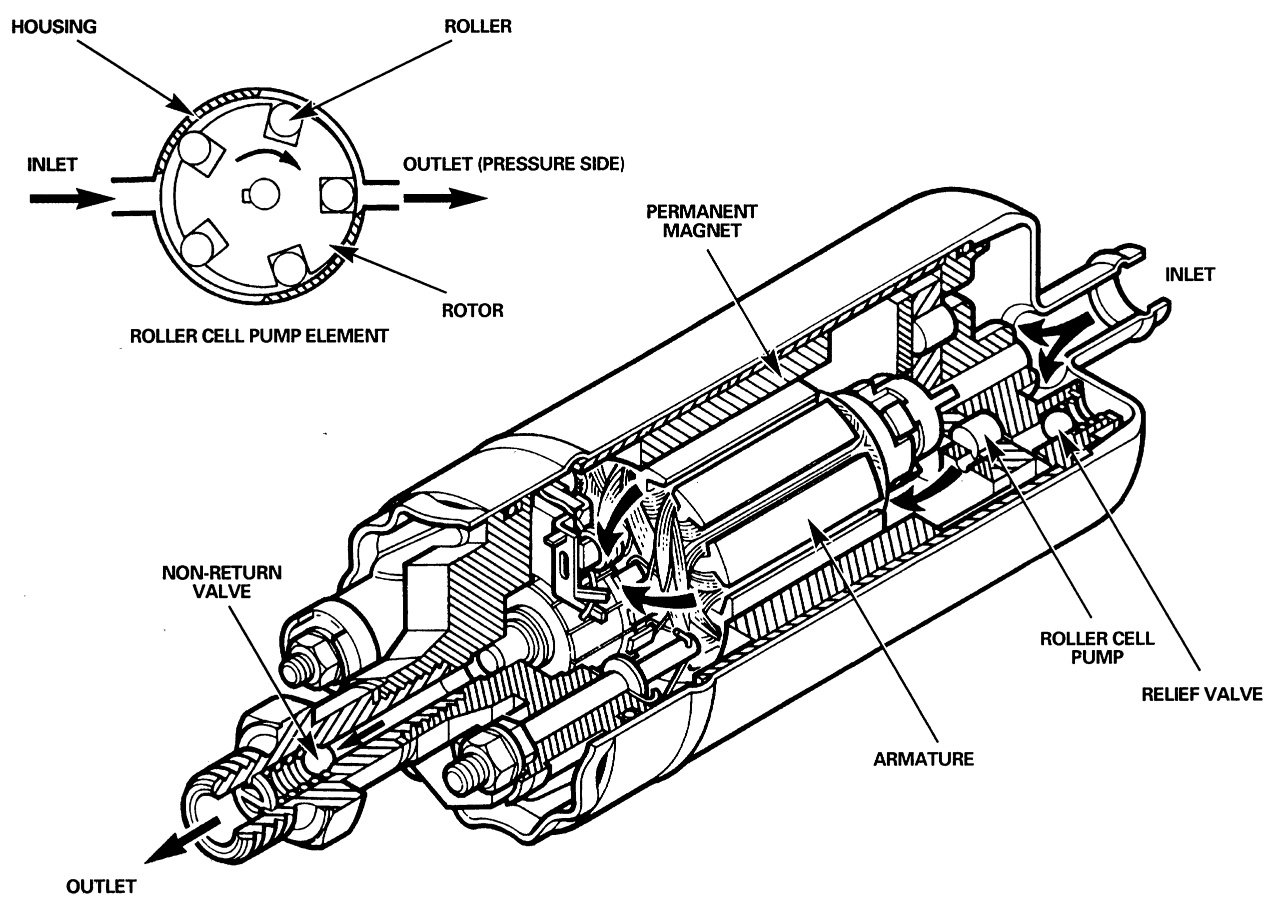


Fuel Delivery

A recirculating fuel system provides a continuous supply of pressurized, cooled fuel to the fuel rail. There is sufficient fuel flow to allow full load engine operation at all times.

Fuel pump: XJ6 Sedan 1990 MY
Fuel is drawn from the fuel tank by an electric pump located on the rear subframe and is delivered to the fuel rail through a renewable filter mounted to the underbody. Unused fuel is returned to the tank swirl chamber where it passes through a venturi before mixing with the remaining fuel in the tank. This action cools the returning fuel.

FUEL PUMP: XJ6 SEDAN RANGE 1990 MY



The in-line fuel pump is a roller type pump driven by a permanent magnet electric motor. An eccentric rotor mounted on the armature shaft has metal rollers housed in pockets around the circumference. When the motor is energized, centrifugal force acting on the rollers forces them outward so that they act as seals. The fuel between the rollers is then forced to the outlet side of the pump.

Fuel Delivery and Evaporative Emission Control (continued)

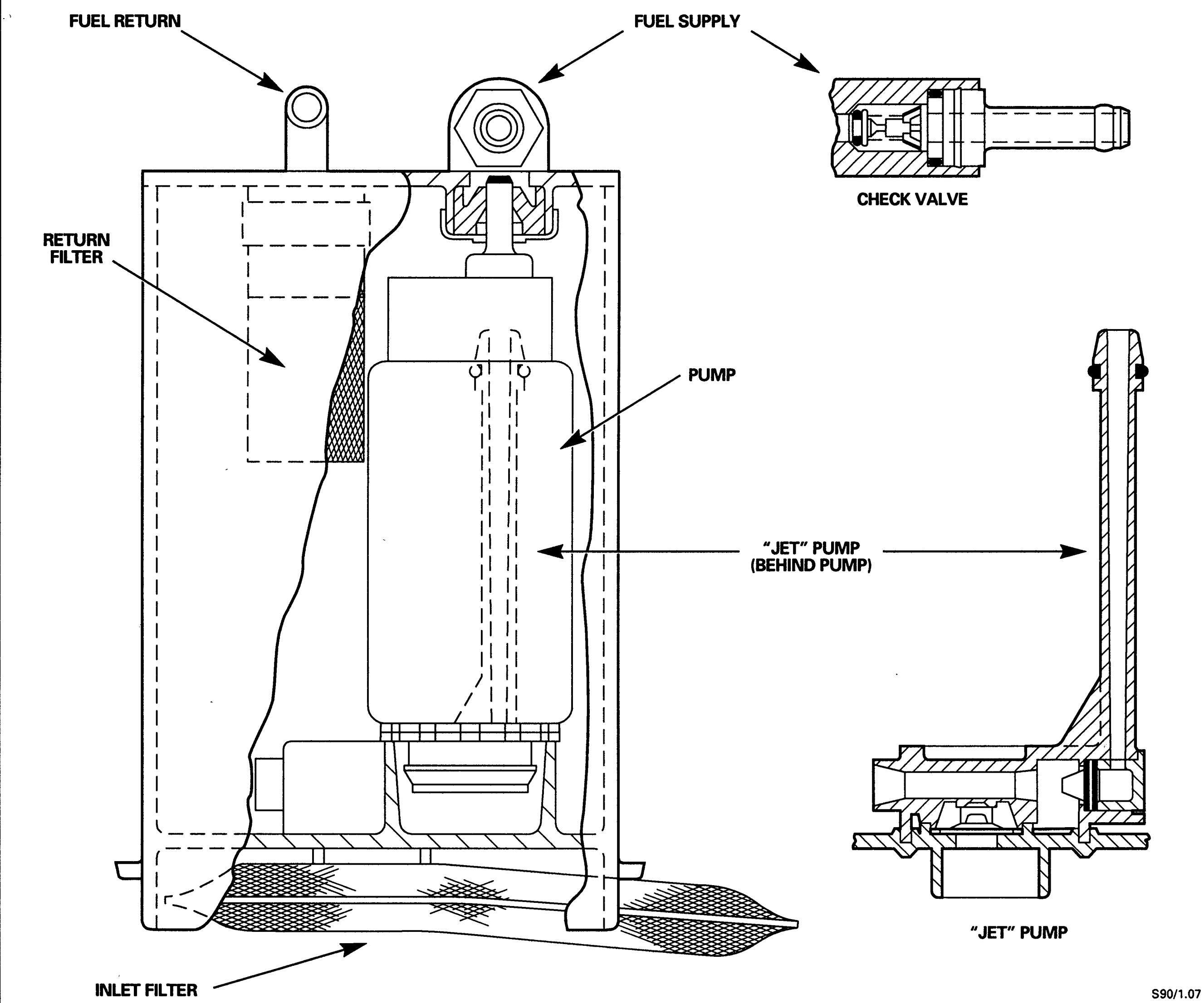
Fuel Delivery (continued)

Fuel pump module: 1991 MY ON vehicles
The fuel pump is an integral component of an in-tank fuel pump module. The fuel pump module mounts in a rubber holder attached to the bottom of the fuel tank on brackets. The fuel pump module and the rubber holder are indexed to ensure correct alignment in the tank.

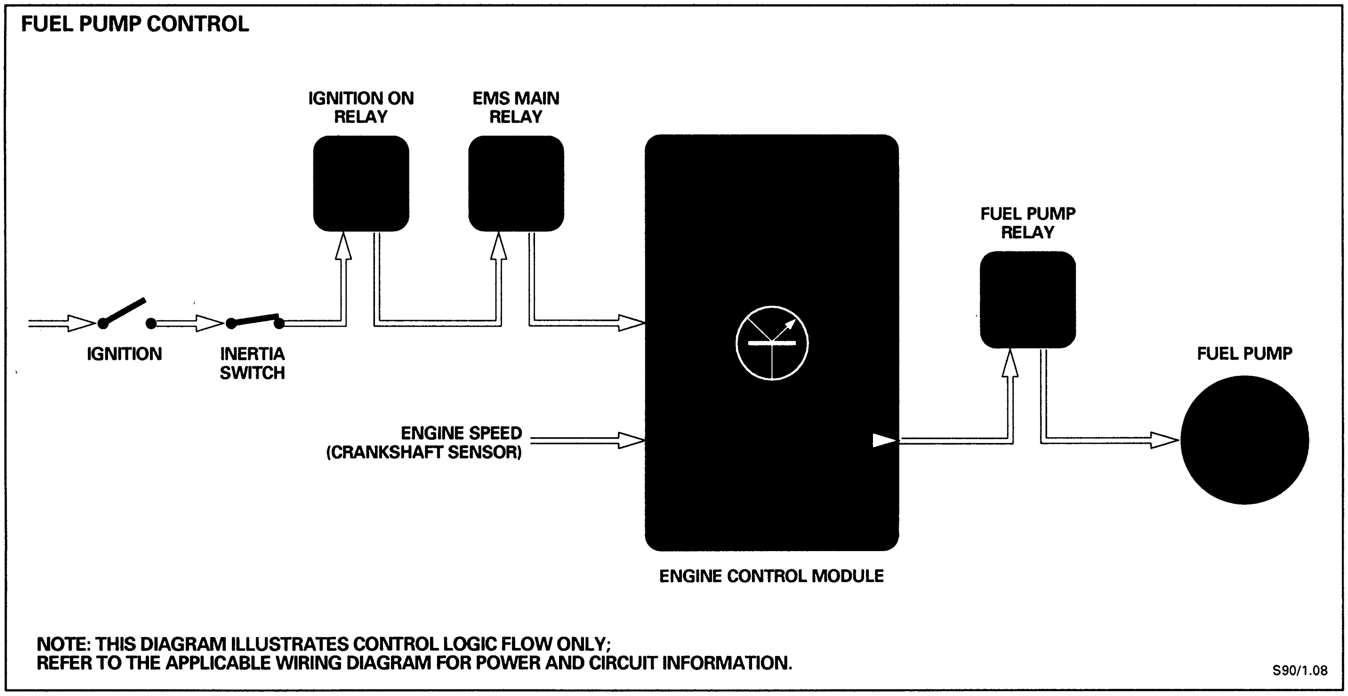
Fuel is drawn from the fuel tank through a 70 micron filter at the base of the module, then through a 400 micron filter at the pump inlet. The pump delivers the fuel to the fuel rail through a renewable in-line filter mounted to the underbody. Unused fuel is returned to the fuel pump module where it passes through another 70 micron filter. A small portion of the pressurized fuel flows through a venturi "teed" into the supply side inside the module. This flow enables a "jet pump" to pick up fuel so that the module remains full at all times.

Both the outlet and return ports through the pump module have check valves. The outlet check valve reduces back flow from the fuel rail when the pump is off. The return check valve holds fuel pressure in the return line from the fuel rail and prevents siphoning if a fuel line is disconnected.

FUEL PUMP MODULE: 1991 MY ON VEHICLES



Fuel pump control
The electrically powered fuel pump is controlled by the ECM via the fuel pump relay. After the ignition is turned on (position II), the pump runs for about 1 second to build fuel pressure for starting. When the ECM receives an engine speed signal from the crankshaft position sensor, it activates the fuel pump relay, which in turn switches on the fuel pump. The fuel pump will continue to run either until the ignition is turned off or until approximately 1 second after there is no speed signal. The ECM monitors the output to the fuel pump relay for on-board diagnostics.



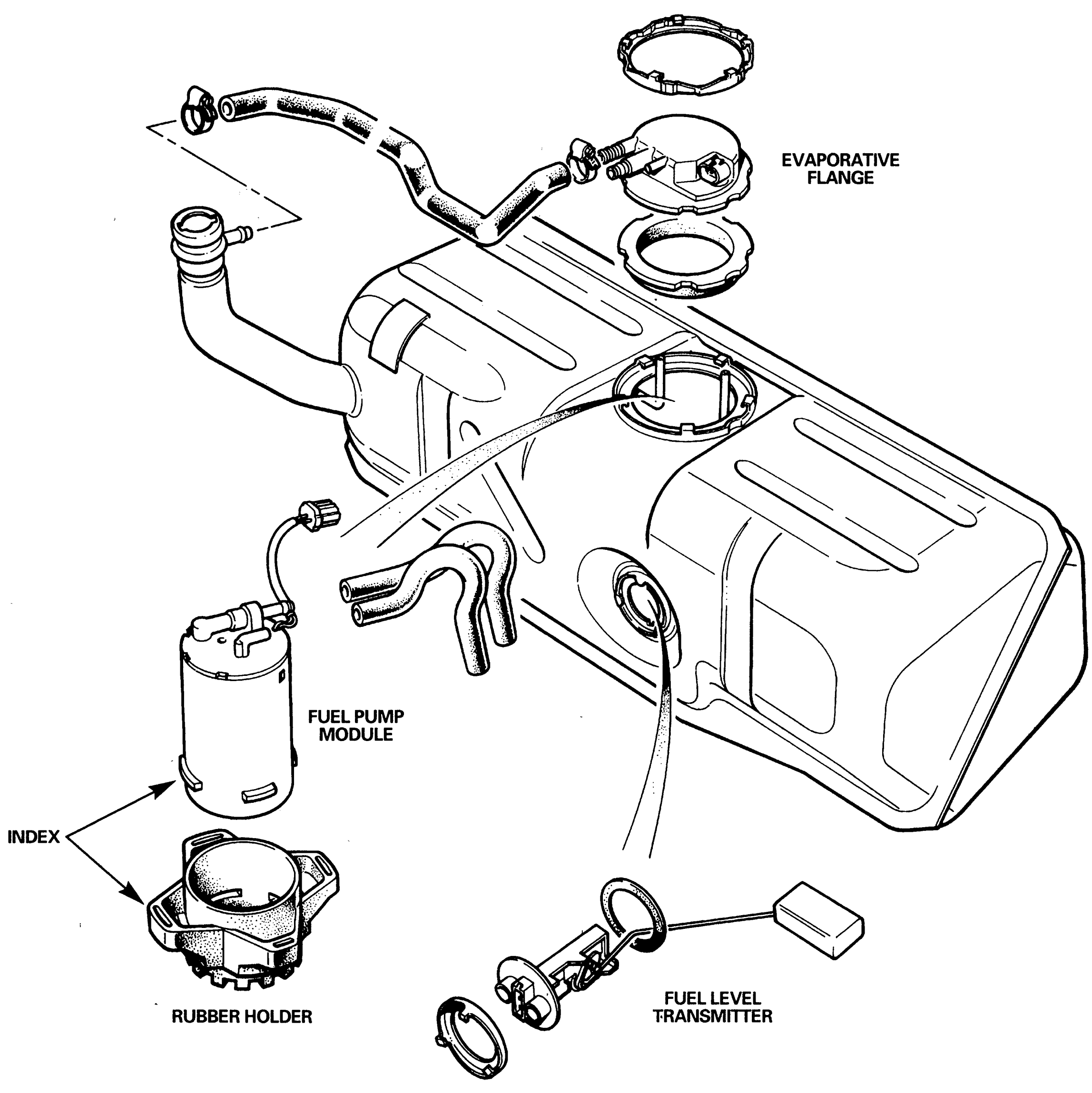
NOTE: In the event of a vehicle collision, the inertia switch will switch off all ignition powered circuits, including the EMS main relay. This action will remove power from the ECM and cause the fuel pump relay to de-energize, switching off the fuel pump.

Fuel Delivery and Evaporative Emission Control (continued)

Fuel Delivery (continued)

Fuel tank assembly: 1991 MY ON vehicles
The fuel pump module connects to the tank outlet and return ports via flexible hoses. Electrical connection to the wiring harness is made through the evaporative flange.

FUEL TANK ASSEMBLY: 1991 MY ON VEHICLES



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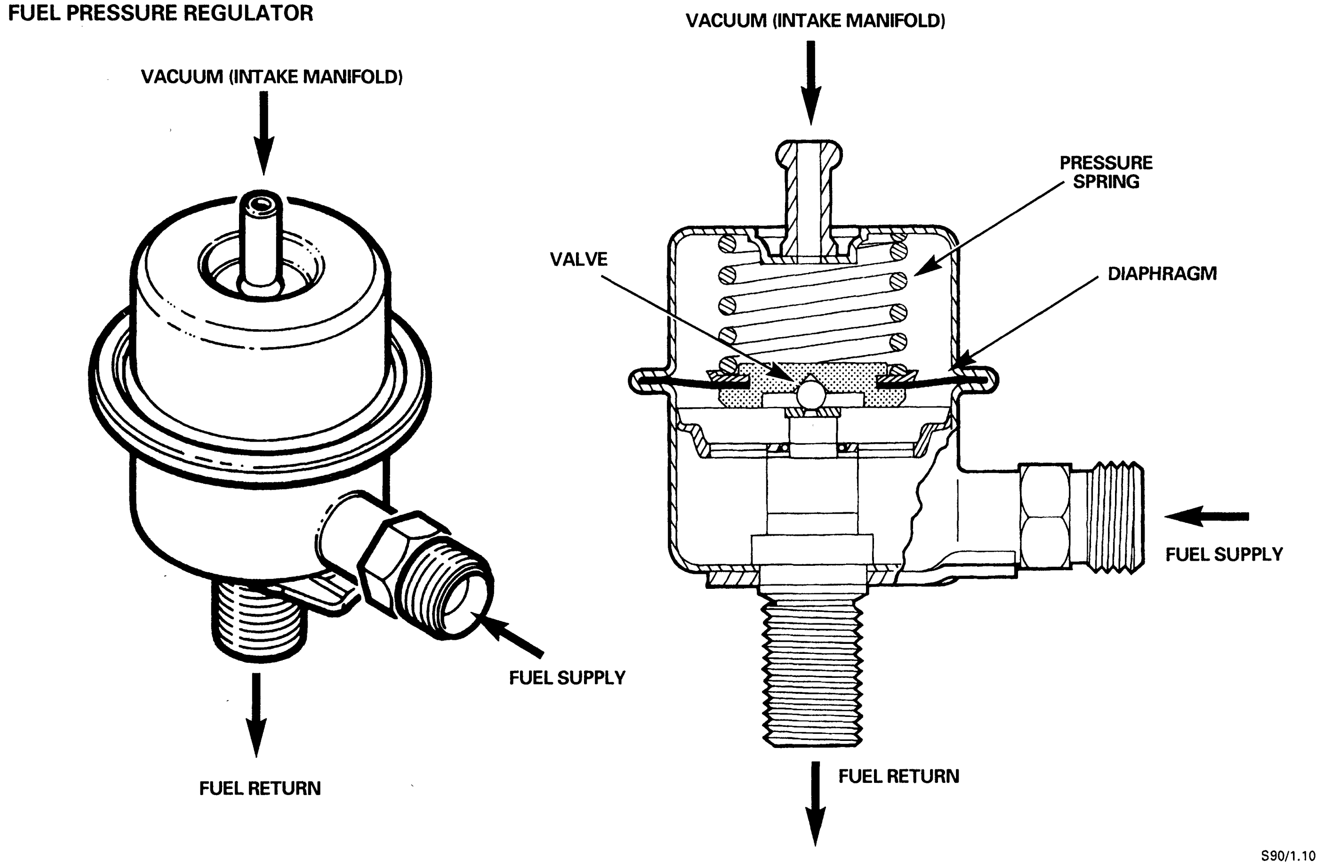
Fuel rail and pressure regulator

Fuel is pumped to the fuel rail and injectors, where fuel pressure is controlled by the fuel pressure regulator. Excess fuel, above the engine requirement, is returned to the fuel tank. The pressure regulator spring chamber above the diaphragm is referenced to intake manifold vacuum. The differential pressure across the fuel injector nozzles is therefore maintained constant at 44 psi (3.0 bar) and the quantity of fuel injected for a given injector pulse duration is also constant. Fuel pressure measured on a test gauge will vary between 32 psi (2.3 bar) at overrun to 44 psi (3.0 bar) at full load.

The fuel pressure regulator is located as close as possible to the fuel rail so that good dynamic control of fuel pressure is achieved. This design provides the same pressure across each injector, and delivers an equal quantity of fuel to each of the six cylinders.

FUEL PRESSURE REGULATOR



Fuel Delivery and Evaporative Emission Control (continued)

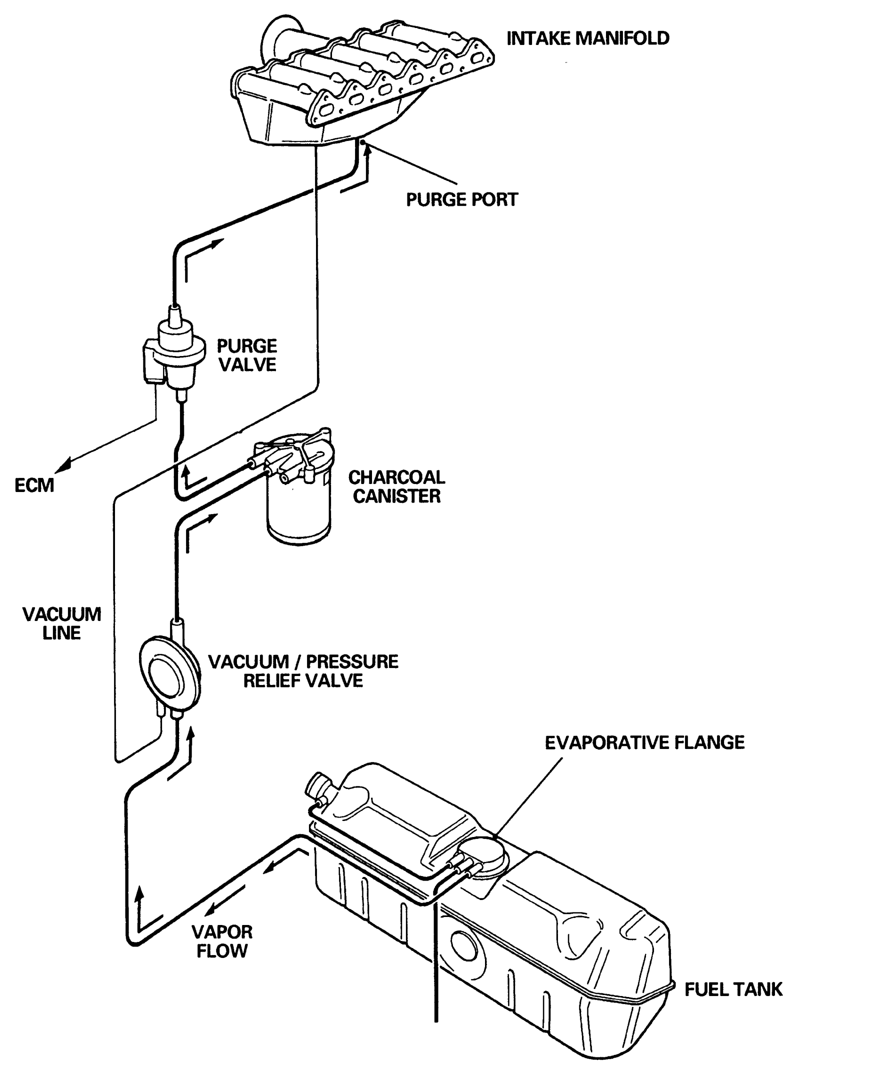
Evaporative Emission Control: XJ6 Sedan 1990 MY

The fuel tank incorporates a plastic vessel that limits the fill level and allows for 10% fuel expansion. Tank venting is via a system of vapor tubes and a liquid / vapor separator in the tank to the charcoal canister, located in the left front wheel well. Vapor flow to the canister is controlled by an engine vacuum-operated bypass valve which allows vapor flow to the canister when the engine is operating. A pressure / vacuum relief valve prevents excessive pressure or vacuum from building in the fuel tank. Canister purging to the intake manifold is controlled by the ECM through an electric purge valve located at the canister.

Evaporative Emission Control: All models 1991 MY ON

The fuel tank is designed with a limited fill feature which allows about 10% fuel expansion. The vapor pipe connected to the filler neck is connected into the tank at the maximum fuel level. When the fuel covers the bottom of the vapor tube, fuel rises in the filler neck shutting off the fuel delivery nozzle. Purging and control of vapor flow to the canister are identical to the 1990 model year system.

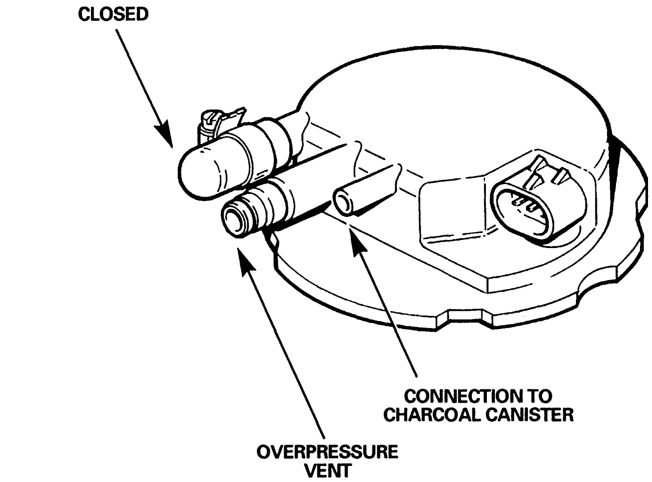
AJ6 4.0L EMS EVAPORATIVE EMISSION CONTROL (TYPICAL)



Evaporative flange

The top of the fuel tank incorporates a removable evaporative flange with three outlets. One outlet is used for the filler neck vent hose on 1991 model year vehicles and is capped-off on later vehicles. The center outlet incorporates a 2.5 – 3 psi pressure relief valve and is connected to a relief tube that vents to under the vehicle. The third outlet incorporates a roll-over valve and connects to the charcoal canister. Electrical connection to the fuel pump module is made through the evaporative flange.

EVAPORATIVE FLANGE



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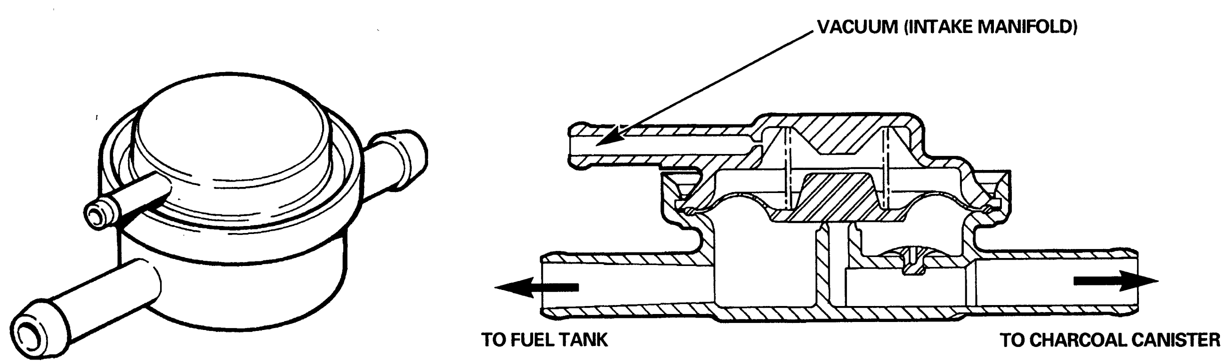
Vacuum / pressure relief valve

The flow of vapor to the canister is controlled by the vacuum / pressure relief valve (Rochester valve). The valve has three functions: fuel tank pressure relief, fuel tank vacuum relief, and vapor flow control.

When the vehicle is not operating and fuel temperature in the tank is increasing, vapor is released, limiting the tank pressure to approximately 1 to 1.25 psi. When the vehicle is not operating and fuel temperature in the tank is decreasing, a negative pressure is created. The umbrella check valve in the vacuum / pressure relief valve allows vapor to flow back into the tank from the charcoal canister, preventing the tank from collapsing. When the engine is operating, a manifold vacuum signal, from the intake manifold, opens the valve allowing vapor flow to the canister and reducing the fuel tank pressure to near zero. An additional fuel tank overpressure safeguard is provided by a 4 psi relief valve in the fuel cap.

VACUUM / PRESSURE RELIEF VALVE



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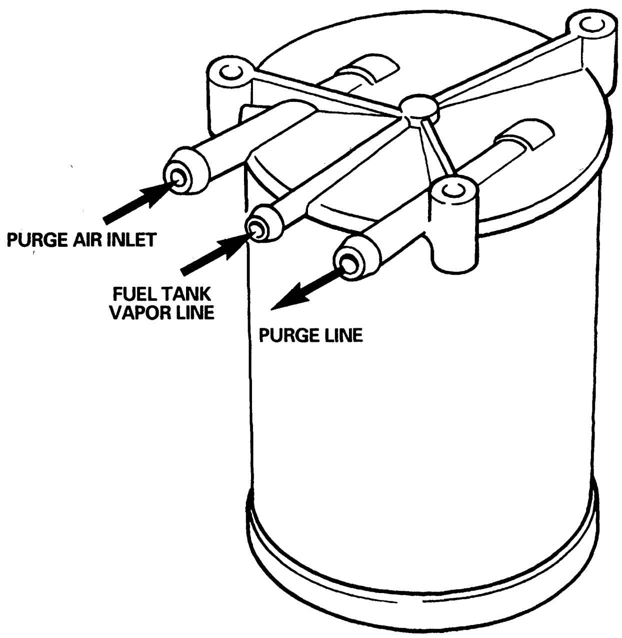
Fuel Delivery and Evaporative Emission Control (continued)

Evaporative Emission Control: All models

CHARCOAL CANISTER



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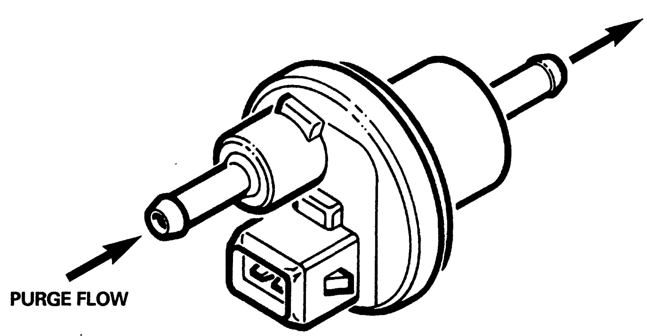
Charcoal canister
The charcoal canister contains activated charcoal that absorbs the fuel tank vapors. As the charcoal can become saturated, the canister is purged of the collected vapors during engine operation. Three ports are provided on the canister: one for vapor flow in, one for purge flow to the intake manifold, and one to allow air to enter the canister during purging.

PURGE VALVE



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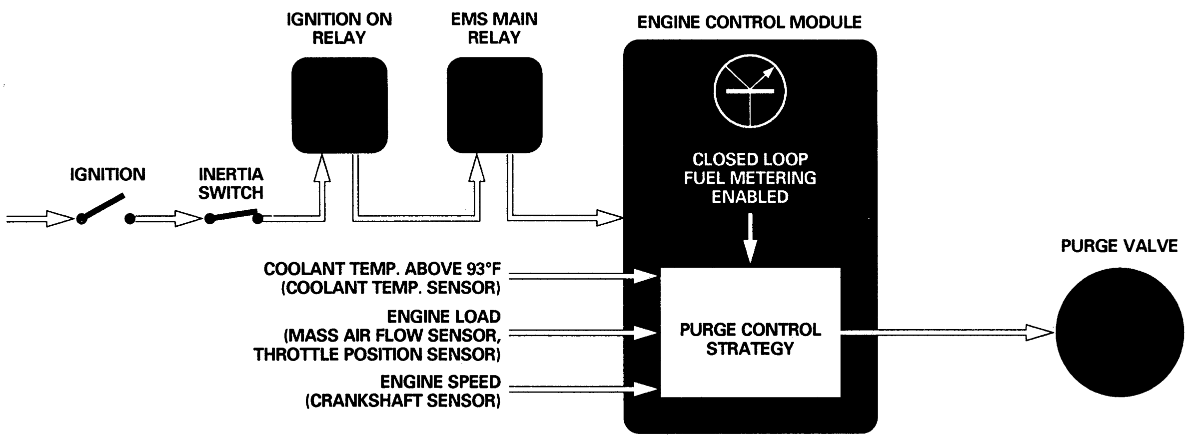
Purge valve
The engine management ECM operates the purge control valve to allow a regulated vapor flow to the intake manifold dependent on engine operating conditions. The purge valve is a solenoid operated valve that is normally open. The valve closing and subsequent rate of vapor flow (opening) is varied by the "length" of a pulsed electrical signal provided from the ECM.

Canister purging

The vapor adsorbed by the activated charcoal in the canister is purged by using engine vacuum to draw air through the charcoal and into the intake manifold. The conditions during which vapor is purged and the quantity purged is programmed into the ECM. The purge rate has to be sufficient to prevent the charcoal canister from venting vapor to the atmosphere. On the other hand, purge rates that are too high would cause driveability problems.

CANISTER PURGE CONTROL



NOTE: THIS DIAGRAM ILLUSTRATES CONTROL LOGIC FLOW ONLY;
REFER TO THE APPLICABLE WIRING DIAGRAM FOR POWER AND CIRCUIT INFORMATION.

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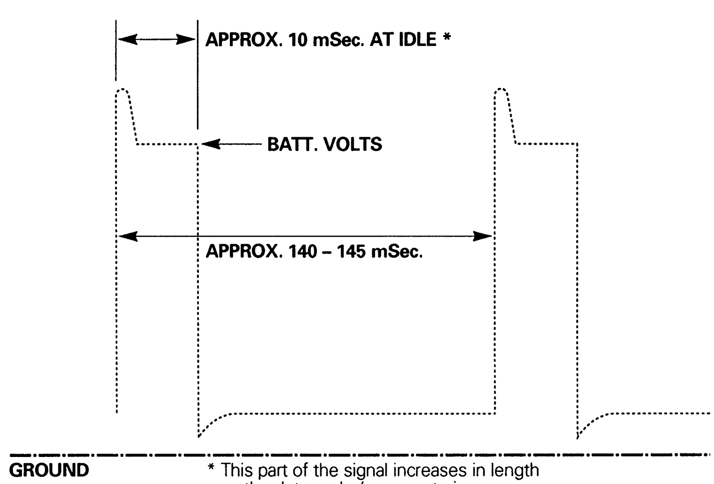
Canister purge is enabled by the ECM when the engine coolant temperature exceeds 93°F (34°C) and closed loop fuel metering control is operational. The rate of purge is determined from an 8 x 16 load versus engine speed strategy.

When the ignition is turned ON (engine inoperative), the valve is fully energized and closed to prevent vapor flow to the engine. When the engine is operating at idle and purge flow is enabled, the purge flow will be small. As engine load and speed increases, the purge rate will increase proportionally. When the ignition is turned off the valve is fully energized and held closed for a short period to prevent vapor from being drawn into the engine as it slows to stop to prevent run-on. Purge valve operation at idle can be detected by holding the valve in the palm of the hand. The ECM monitors the output signal to the purge valve for on-board diagnostics.

PURGE VALVE SIGNAL



* This part of the signal increases in length as the duty cycle / purge rate increases

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Fuel Injection; Idle Speed Control

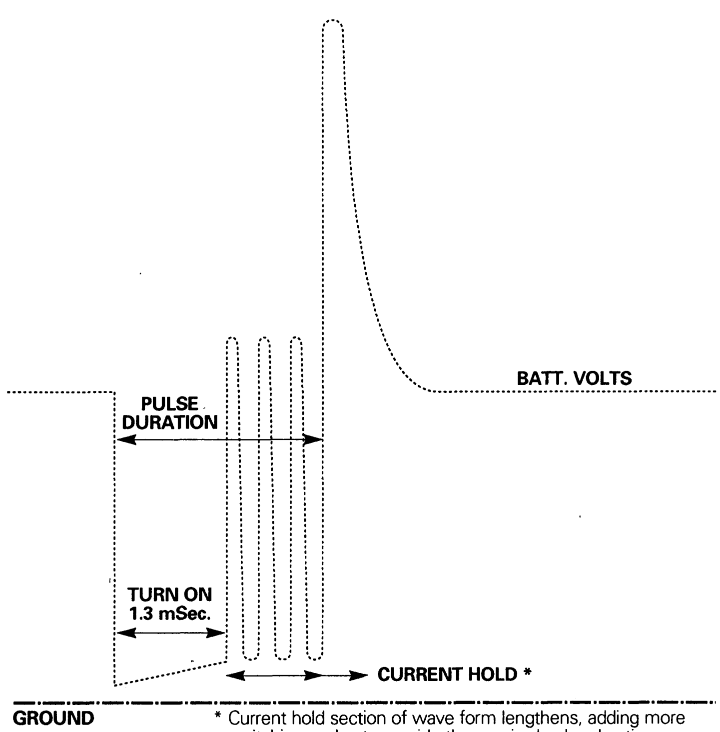
Fuel Injection

Fuel metering is obtained by controlling the injector pulse duration during each engine revolution. The pulse duration is varied by the engine control module (ECM) according to several sensor inputs. The sensed control inputs form two groups – primary and secondary. Primary control inputs are intake mass air flow (engine load) and engine speed; secondary control inputs consist of engine coolant temperature, cranking signal, throttle movement and position and exhaust oxygen content. The injector pulse is then trimmed for battery voltage. Except during "cranking" and rapid throttle application, all six injectors are pulsed once per engine revolution (twice per engine cycle). Half of the fuel requirement is delivered at each pulse and the pulse duration is recalculated before each succeeding injection.

Fuel metering strategies are held in memory (EPROM) in the ECM and form an engine load versus engine speed matrix. The load and speed range of the engine is divided into 16 loads and 16 speeds (256 memory sites). Digital numbers representing injector pulse duration in milliseconds fill each site and cover the entire engine load and speed range.

NOTE: The sites are numbered 0 to 15 (16 total). Site 0 is less than overrun load, and low engine speed. Site 15 is higher than full load and high engine speed. The load and speed sites are purposely chosen to extend beyond the operational envelope of the engine.

INJECTOR WAVE FORM



* Current hold section of wave form lengthens, adding more switching cycles to provide the required pulse duration.

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All fuel injectors are pulsed simultaneously by the ECM "output stage". To reduce power consumption, the current drawn by the injectors is controlled by the ECM. The injectors are opened by a relatively large "turn on" pulse and are held open for the required duration by a series of smaller "hold on" pulses.

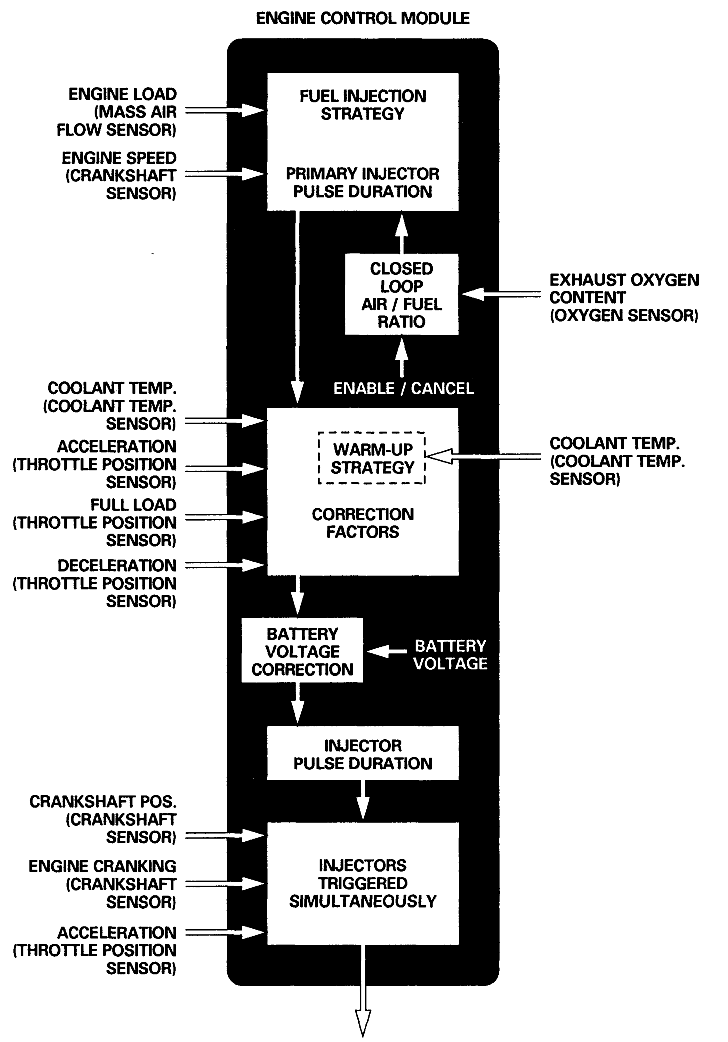
Additional fuel injection controls are used for overrun fuel cut-off, engine overspeed prevention and wide-open-throttle during cranking fuel cut-off.

The ECM monitors its output signals to the fuel injectors and its input signals from sensors for on-board diagnostics.

Fuel Injection Primary Control

Fuel metering is controlled primarily as a function of engine load and speed. Engine load is sensed by a mass air flow sensor located in the engine air intake before the throttle housing. Engine speed is sensed by a crankshaft sensor located behind the engine damper. In addition to engine speed, the sensor supplies crankshaft position inputs to the ECM for ignition timing. The ECM processes the input from the mass air flow meter and the crankshaft sensor to access pulse duration from the fuel metering strategy. Usually, the load and speed at which the engine is running will be between sites. A function known as two dimensional interpolation is used to calculate the correct pulse duration for the between-sites engine condition.

FUEL INJECTION PRIMARY AND SECONDARY CONTROL



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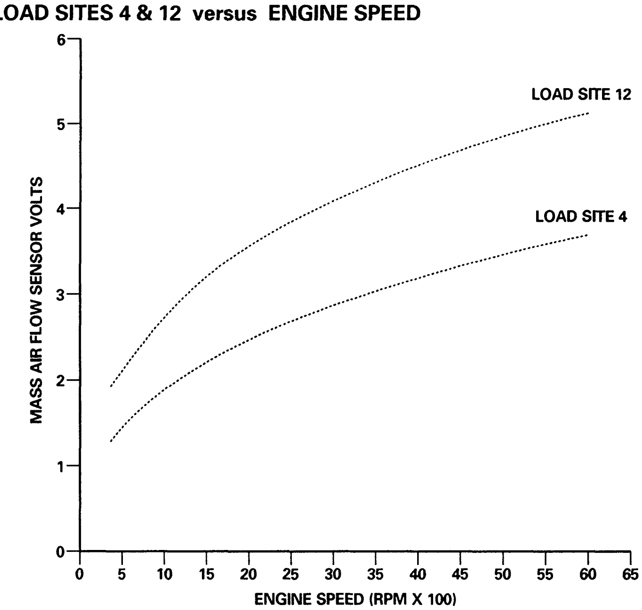
LOAD SITES 4 & 12 versus ENGINE SPEED



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Fuel injection; Idle Speed Control (continued)

Fuel Injection Secondary control

Secondary fuel metering control adjusts for engine coolant temperature, cranking signal, throttle movement and position and exhaust oxygen content.

Cranking and after-start enrichment
The ECM provides fuel metering enrichment for cranking and after-start conditions.

The ECM recognizes engine cranking from the engine speed input (less than 200 rpm) and increases the injector pulse frequency to three injection pulses per engine revolution. The pulse duration is determined by engine coolant temperature. Cranking fuel metering is canceled at 250 rpm above a coolant temperature of 107°F (42°C) and at 500 rpm below the same temperature. At that point, injection reverts to one pulse per revolution and after-start enrichment is then applied. The pulse duration, and the rate at which the enrichment is decreased back to the warm-up phase is dependent upon engine coolant temperature.

Warm-up
The programmed warm-up enrichment provides extra fuel during engine warm-up based on the engine temperature measured by the coolant temperature sensor. The injector pulse duration is increased above the fully warm requirement when the coolant temperature is less than 186°F (85°C).

Acceleration enrichment
When the ECM senses that the throttle is opening (throttle position sensor input), the injector pulse duration is lengthened by an amount dependent upon the rate at which the throttle is opened and on engine coolant temperature. This acceleration enrichment prevents a momentary lean condition that can cause driveability or exhaust emission problems. If the throttle is opened rapidly, a single "extra" injector pulse of about 5 milliseconds is generated to improve engine response.

Full load enrichment
If the ECM senses a full throttle input from the throttle position sensor, full load enrichment is applied and closed loop operation is temporarily canceled.

Deceleration leaning
When the ECM senses that the throttle is closing (throttle position sensor input), the injector pulse duration is shortened dependent on the rate at which the throttle closed. This action prevents a momentary rich condition that can cause exhaust emission problems.

Summary of ECM functions based on throttle position sensor input:

Throttle Position	ECM Function
Throttle closed (signal 0.25 – 0.75 volts)	Idle speed control function Ignition idle strategy Overrun fuel cut-off Idle fuel trim (adjustable mass air flow sensor potentiometer only) Adaptive idle fueling trim
Part throttle (signal above closed throttle voltage and below full throttle voltage)	Main fuel metering strategy Main ignition strategy EGR enabled
Opening throttle (signal voltage increasing)	Acceleration enrichment
Closing throttle (signal voltage decreasing)	Deceleration leaning
Full throttle (signal greater than 3 volts)	Full load enrichment (load dependent)

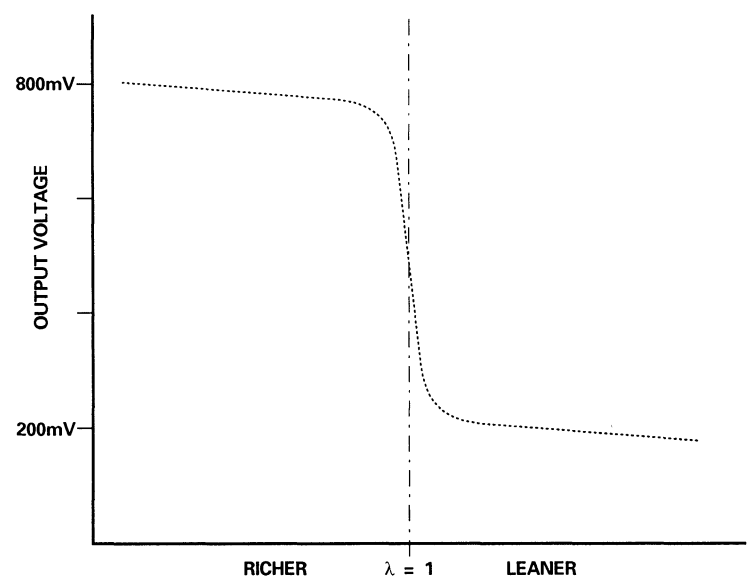
NOTE: Other sensor inputs are required for the initiation of most of the above listed ECM functions as described in Fuel Injection, Idle Speed Control, Ignition, EGR and Adaptive Idle Fuel Metering.

Closed loop operation
In order to significantly reduce exhaust emission, the exhaust system incorporates 3-way catalytic converters that oxidize CO and HC, and reduce NOx. These converters operate efficiently only if engine combustion is as complete as possible. It is generally accepted that optimum combustion occurs with an air / fuel ratio of 14.7 : 1 (Lambda = 1). A closed loop system between fuel injection, ECM control and exhaust oxygen content feedback is used to maintain the air / fuel ratio as close to 14.7 : 1 as possible.

In response to the oxygen sensor voltage, the ECM continuously drives the air / fuel ratio rich-lean-rich by adding to, or subtracting from, the injector pulse duration determined from the main fuel metering strategy.

Note that the oxygen sensor voltage switches abruptly at an air / fuel ratio of 14.7 : 1 (Lambda = 1).

OXYGEN SENSOR CHARACTERISTIC (HO2SRAW)



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Closed loop operation is canceled by the ECM during the following functions:

- full load enrichment
- after-start enrichment
- warm-up (below 95°F [35°C])
- deceleration fuel cut-off

Fuel injection; Idle Speed Control (continued)

Fuel Injection Secondary Control (continued)

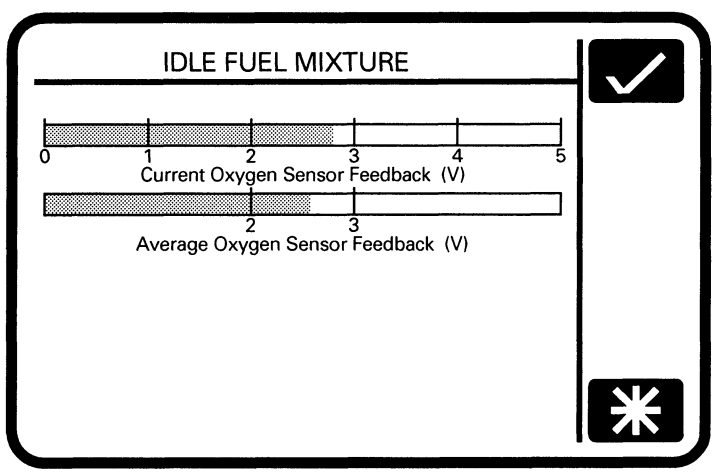
Oxygen sensor feedback
Oxygen sensor feedback is an ECM output voltage that is used for technician monitoring of closed loop operation. Oxygen sensor feedback can only be accessed through serial communications using JDS or PDU. The dampened or "average" feedback voltage is used to measure the amount of "dynamic" correction applied by the ECM to the fuel metering strategy in response to exhaust gas oxygen content.

NOTE: Oxygen sensor feedback may also be called Lambda feedback or integrator voltage.

The range for oxygen sensor feedback is 0 – 5 volts, representing a fuel metering strategy correction of -22% to +22%. The normal "average" feedback voltage is 2 – 3 volts.

Average oxygen sensor feedback voltage	Correction (dynamic) applied by ECM
2.5 volts	No correction is being applied. When closed loop operation is canceled, the ECM holds feedback at 2.5 volts.
Less than 2.5 volts	The ECM is correcting for a rich condition by subtracting from the injector pulse duration held in the engine load / speed site.
Greater than 2.5 volts	The ECM is correcting for a lean condition by adding to the injector pulse duration held in the engine load / speed site.

OXYGEN SENSOR FEEDBACK



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Battery voltage correction
Because the time to achieve full lift of the injector pintle decreases as voltage increases, the amount of fuel delivered by the injector for a given pulse duration is dependent upon the injector operating voltage.

The ECM is programmed with a voltage correction strategy. The supply voltage is monitored by a software routine and the correction applied to the pulse duration.

Additional Fuel Injection Controls

Overrun fuel cut-off

In order to improve fuel economy and aid in controlling exhaust emission, the ECM cancels fuel injection during engine overrun conditions. The ECM determines overrun conditions from inputs received from the throttle position sensor, crankshaft sensor and coolant temperature sensor.

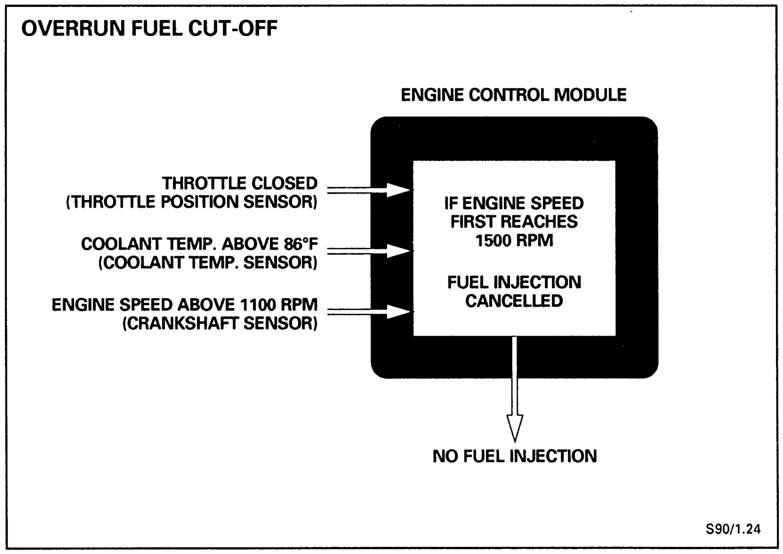
With the throttle closed and the engine speed above 1100 rpm, the ECM cancels fuel injection, provided that the coolant temperature is above 86°F (30°C). The engine speed must always reach 1500 rpm first for overrun fuel cut-off to occur. In order to smooth the transition back to power, the ECM retards the ignition timing and shortens the injector pulse duration as the throttle opens and fuel injection is reinstated.

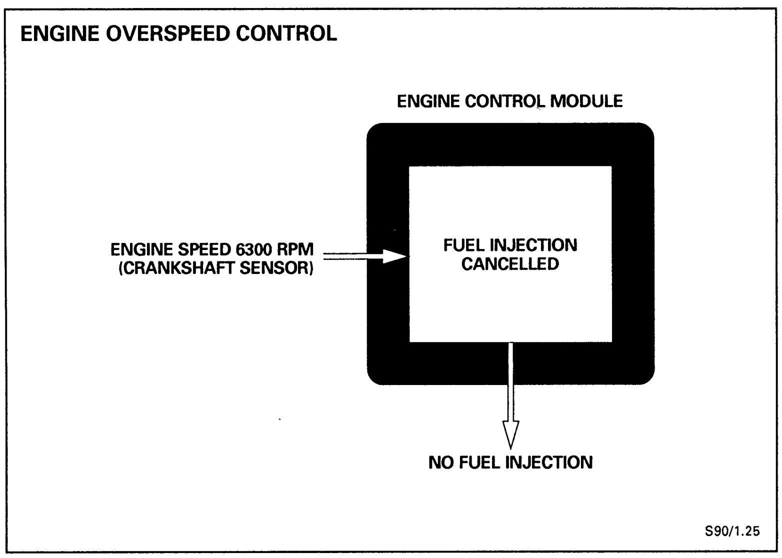
Engine overspeed control

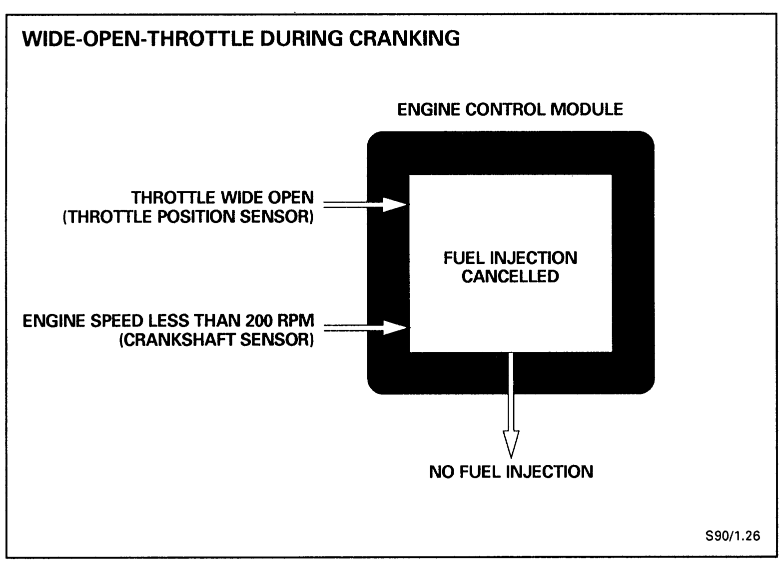
An engine overspeed control function limits the maximum engine speed to 6300 rpm by canceling fuel injection. Fuel injection is reinstated at a slightly lower engine speed.

Wide-open-throttle during cranking

If the ECM senses that the throttle is wide open (throttle position sensor input) during cranking (less than 200 rpm), fuel injection is canceled to help clear a flooded engine.







Fuel Injection; Idle Speed Control (continued)

Idle Speed Control

Idle speed is regulated by the motorized idle speed control valve that controls throttle bypass air. The control valve is driven by the ECM. The ECM uses inputs received from ignition ON, the crankshaft sensor, coolant temperature sensor and throttle position sensor as well as inputs for gear position, air conditioning compressor operation and road speed to control idle speed.

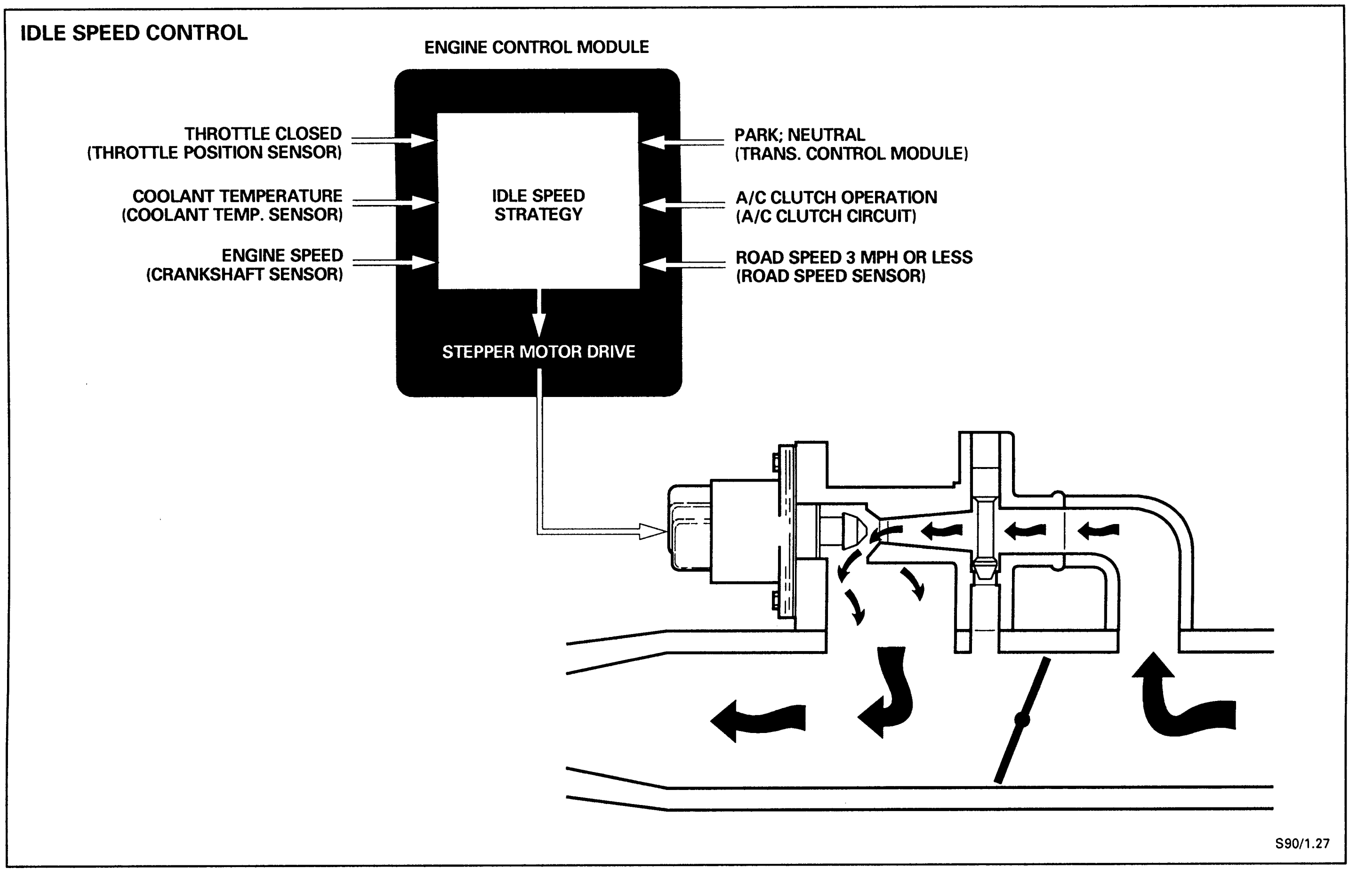
ECM idle speed control occurs at closed throttle when road speed is less than 3 mph. The programmed idle speed accounts for engine temperature and the loads placed on the engine by the transmission (gear position N, D, etc.), and air conditioning compressor clutch operation.

Typical controlled engine idle speeds	
Cold engine (68°F [20°C]) / Neutral	800 rpm
Cold engine (68°F [20°C]) / Drive	650 rpm
Warm engine (193°F [90°C]) / Neutral	700 rpm
Warm engine (193°F [90°C]) / Drive	580 rpm

An ECM software function allows for a correction to the idle speed "base line" as the engine base idle changes with age. The automatic adjustment values are held in RAM within the ECM and will be retained or updated as long as the ECM is connected to battery voltage. If battery voltage is removed for any reason, the stored correction values will be lost. The values will be relearned only after the battery is reconnected, the engine operated from cold to normal operating coolant temperature at idle, and the vehicle driven for approximately 50 yards above 3 mph.

NOTE: At road speeds above 3 mph, the idle speed control valve is opened to limit overrun intake manifold pressure. The amount that the valve is opened is based on engine speed and throttle opening.

The ECM monitors its output signal to the idle speed control valve for on-board diagnostics.



Engine start-up
ECM idle speed control begins shortly after the engine is started, provided the throttle is closed (throttle position sensor at idle) and the road speed is less than 3 mph. The stepper motor in the control valve is closed in stages until the target idle speed is reached.

Gear position
When the gear selector is moved to Park or Neutral from drive, the engine management ECM receives a ground signal from the transmission rotary switch (XJS) or transmission decoder (XJ6 Sedan). The ECM then closes the idle speed control valve a predetermined number of steps in anticipation of the reduced engine load. When the engine is at normal operating temperature, the ECM maintains idle speed at 700 rpm in P or N and at 580 rpm in R, D, 2 or 3.

Air conditioning compressor clutch operation
When the air conditioning compressor clutch is energized, a parallel circuit inputs battery voltage to the engine management ECM. The ECM opens the idle speed control valve a predetermined number of steps to anticipate the change in engine load.

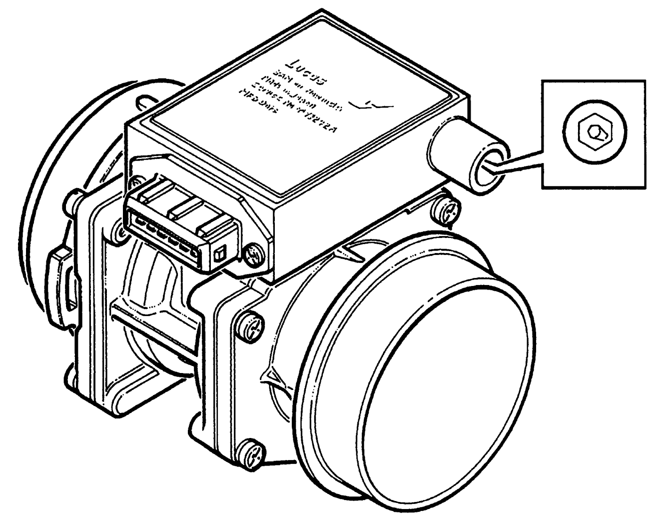
Ignition switched OFF
When the ignition is switched OFF, the control valve indexes to a known parked position. On 1990 model year vehicles, the reference is from the fully opened position. On later vehicles, the reference is from the fully closed position, 7 seconds after the ignition is switched OFF.

Fuel Injection; Idle Speed Control (continued)

Idle Trim (1990 – 1992 MY)

In order to compensate for slight differences from one vehicle to another, the ECM baseline to the *idle fuel metering strategy* can be adjusted with the mass air flow sensor idle trim potentiometer.

IDLE TRIM ADJUSTMENT



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Adaptive Idle Fuel Metering (1993 MY ON Systems)

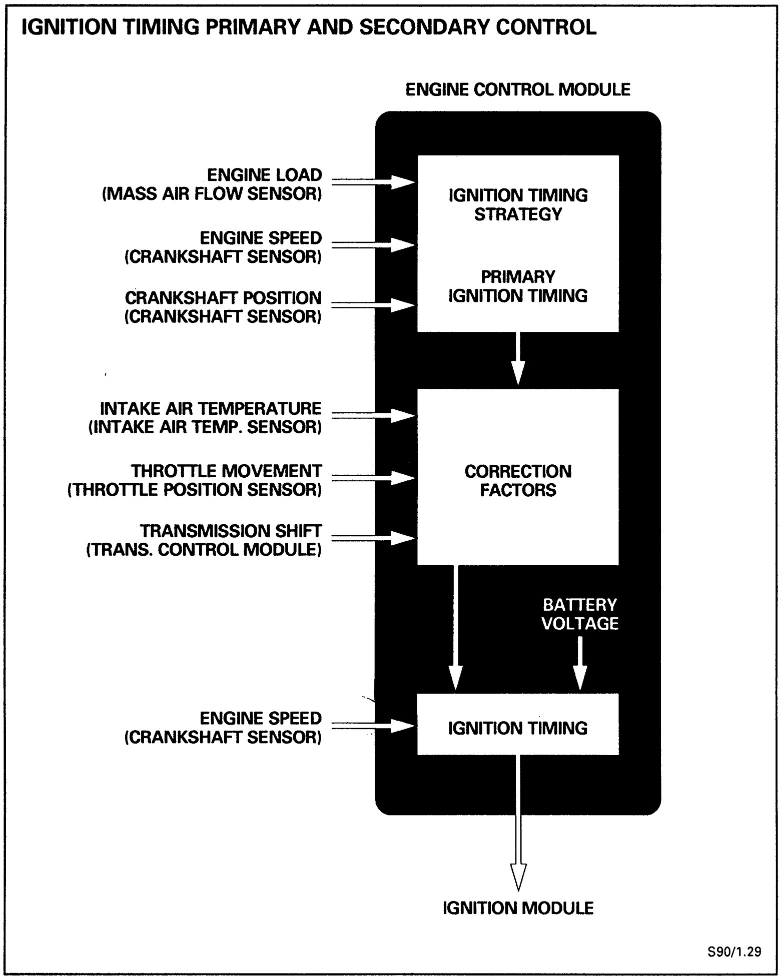
In order to ensure optimum performance, the ECM contains an adaptive idle fuel metering software function that automatically makes a baseline correction to the *idle fuel metering strategy*, throughout the life of the vehicle. The total available trim to the nominal injector pulse duration is ± 10%. Adaptive idle fuel metering is performed by the ECM at idle, only when diagnostic trouble codes (DTC) are cleared, and certain preconditions are met. If the DTCs are cleared and the preconditions are met, the ECM cancels purge flow and adapts the fuel metering strategy. Between adaptations, there is a delay of approximately eight minutes. The correction is applied across the entire engine speed and load range.

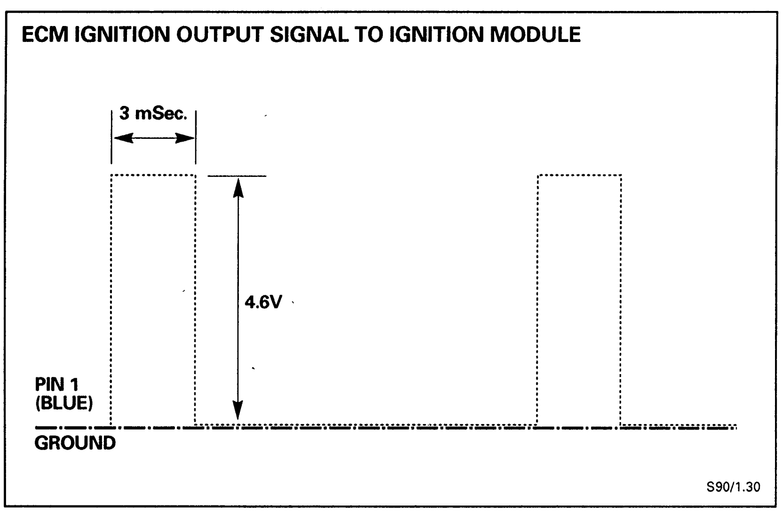
NOTE: With the incorporation of adaptive idle fuel metering, the idle trim potentiometer was removed from the mass air flow sensor.

Adaptive idle fuel metering preconditions:

- throttle is closed
- engine speed is below 1000 rpm
- road speed is below 3 mph (6 kph)
- engine coolant temperature is above 170°F (76°C)
- idle speed adaptive delay is complete (vehicle speed reached 3 mph for approximately 100 yards traveled)
- closed loop air / fuel ratio control is operating and in control
- oxygen sensor feedback (HO2SFB) voltage outside of the normal range (2 – 3 volts)

If the ECM loses its battery voltage supply for any reason, the stored correction will be lost and fueling will revert to the programmed values.





Ignition Timing Control

Ignition Timing

Ignition timing is controlled by the engine control module (ECM) according to sensor inputs. As with fuel injection, the sensed control inputs form two groups: primary and secondary. Primary control inputs are intake mass air flow (engine load) and engine speed; secondary control inputs consist of engine intake air temperature, throttle movement and position and transmission upshift (automatic transmission).

Ignition timing strategies are held in memory (EPROM) in the ECM and form an engine load versus engine speed matrix. The load and speed range of the engine is divided into 16 loads and 16 speeds (256 memory sites). Digital numbers representing ignition timing values fill each site. The resulting 256 ignition timing values cover the entire engine load and speed range. Ignition timing is then calculated from the ignition timing strategy according to secondary input correction factors.

The ECM drives the ignition module to switch the ignition coil low tension circuit and monitors the output signal for on-board diagnostics.

Ignition Timing Primary Control

Ignition timing is controlled primarily as a function of engine load and speed. Engine load is sensed by a mass air flow sensor located in the engine air intake before the throttle housing. Engine speed is sensed by a crankshaft sensor located behind the engine damper. In addition to engine speed, the sensor supplies crankshaft position inputs to the ECM for ignition timing. The ECM processes the inputs from the mass air flow meter and the crankshaft sensor and accesses ignition timing from the ignition timing strategy. Usually, the load and speed at which the engine is running will be between load and speed sites. Two dimensional interpolation is used to calculate the correct ignition timing for the between-sites engine condition.

Ignition Timing Secondary Control

Secondary ignition timing control inputs consist of engine intake air temperature, throttle movement and position, battery voltage and transmission upshift (automatic transmission).

Intake air temperature
Ignition timing is corrected by the ECM for engine intake air temperature measured by the air temperature sensor mounted in the air inlet elbow. A portion of the ignition strategy (load sites 6 through 15; speed sites 4 through 15) is programmed with the temperature at which ignition retard commences for each load / speed site. In general, light loads / low speeds have retard thresholds set to a high temperature (approximately 212°F [100°C]) while high loads / high speeds have retard thresholds set about 86°F (30°C). Above the threshold temperature, ignition timing is retarded at the rate of 2.25° per 10°C.

Dwell angle
The dwell angle and peak coil current are controlled by the ignition module, located in the engine compartment near the ignition coil. A feature called "stall turn-off" is used to prevent coil overheating and battery discharge. If the ignition switch is left on without the engine running, the ignition module switches the coil current off.

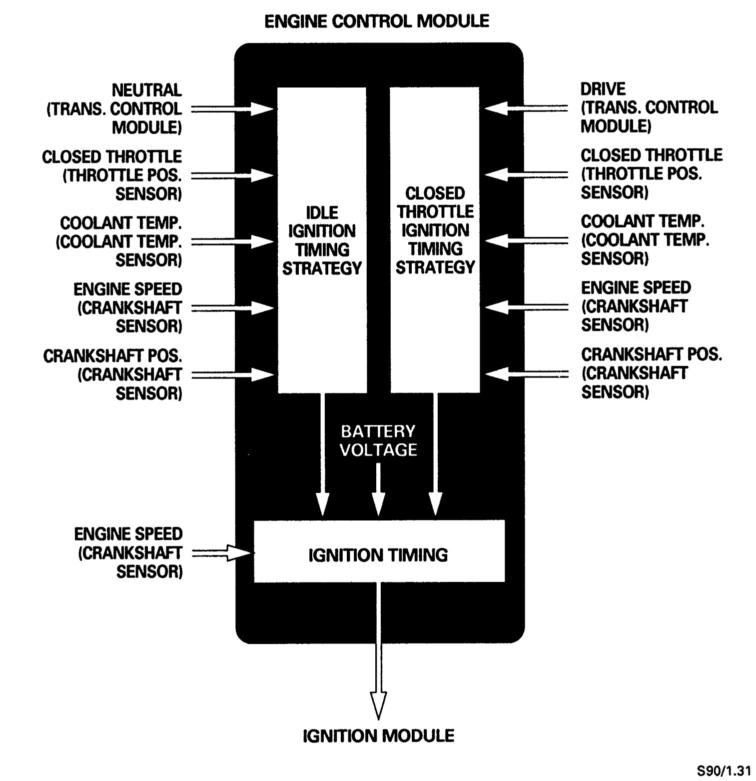
Closed Throttle / Idle

There are separate closed throttle ignition strategies for gear positions Neutral and Drive, each with 8 speed break points for engine speed versus timing. With the engine at normal operating temperature, the Ignition timing at idle will be 10° BTDC in N (700 rpm) and 16° BTDC in D (580 rpm).

Ignition Secondary Circuit

The ignition secondary circuit consists of a distributor and a standard ignition coil. The distributor contains only a rotor arm and a cap. The distributor must be correctly positioned to index the rotor to the cap; however, it has no affect on ignition timing.

CLOSED THROTTLE / IDLE IGNITION TIMING CONTROL



Air Injection

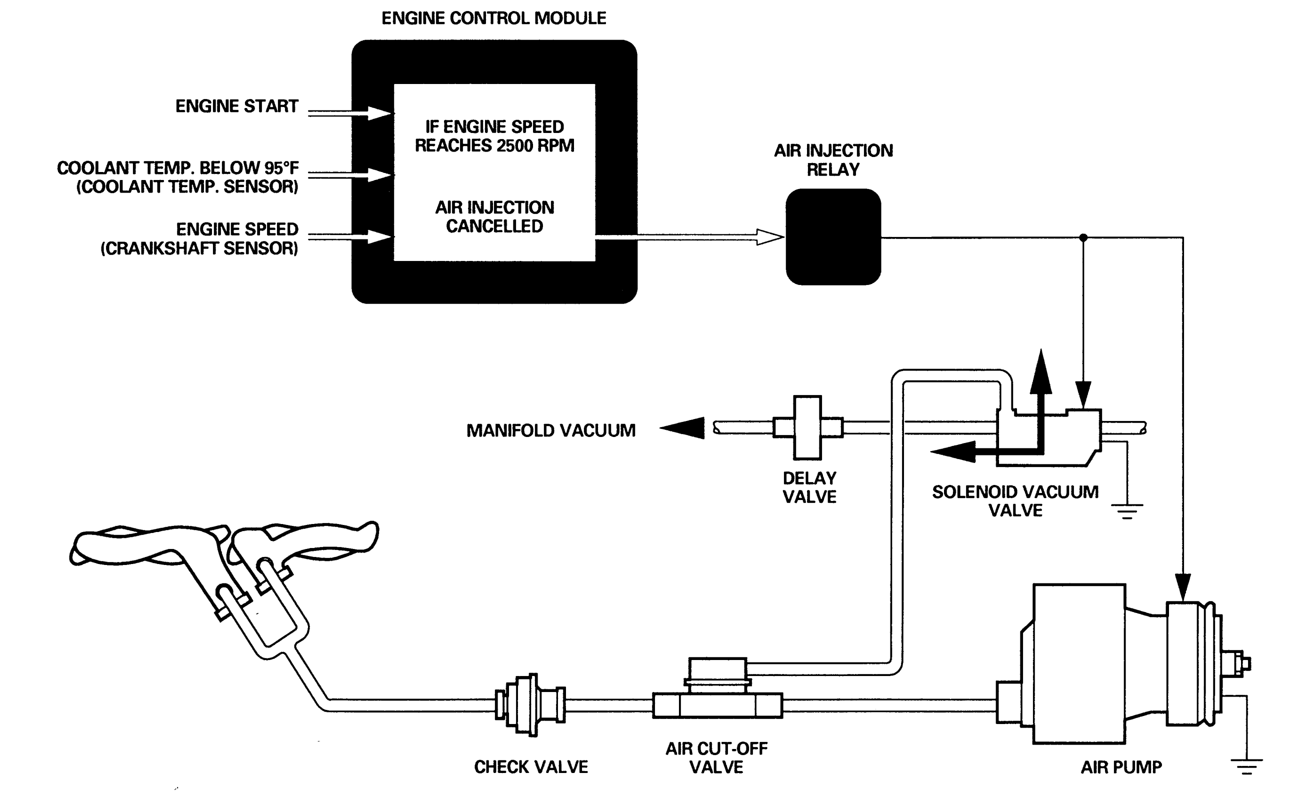
Air Injection Operation

Air injection is used to promote reaction in the exhaust down pipe catalyst, reducing the time required for the catalyst to reach working temperature. The air pumped into the exhaust manifolds mixes with exhaust gas and oxidation takes place. The heat generated in this process reduces the time required for the catalyst to reach operating temperature.

Air injection is enabled by the ECM following each cold start and remains on until the engine coolant temperature reaches 95°F (34°C). At 95°F the air injection circuit is switched off and closed loop air / fuel ratio control is enabled. If the engine speed exceeds 2500 rpm while air injection is enabled, the ECM will switch off the circuit.

On 1993 – 94 MY vehicles, air injection is also enabled for approximately 30 seconds after each hot start.

AIR INJECTION



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The ECM switches the air injection relay, which in turn switches both the air pump clutch and the air injection solenoid vacuum valve. The solenoid vacuum valve controls the vacuum signal to the air switching valve. The air switching valve performs two functions. It backs-up the air injection check valve and it prevents air from being sucked through the pump and check valve into the exhaust. Such leakage would cause an air / fuel ratio error at the oxygen sensor. The vacuum supply to the air switching valve is sourced from the intake manifold through a delay valve. The delay valve is used to ensure that the air switching valve is held open during short periods of high engine load.

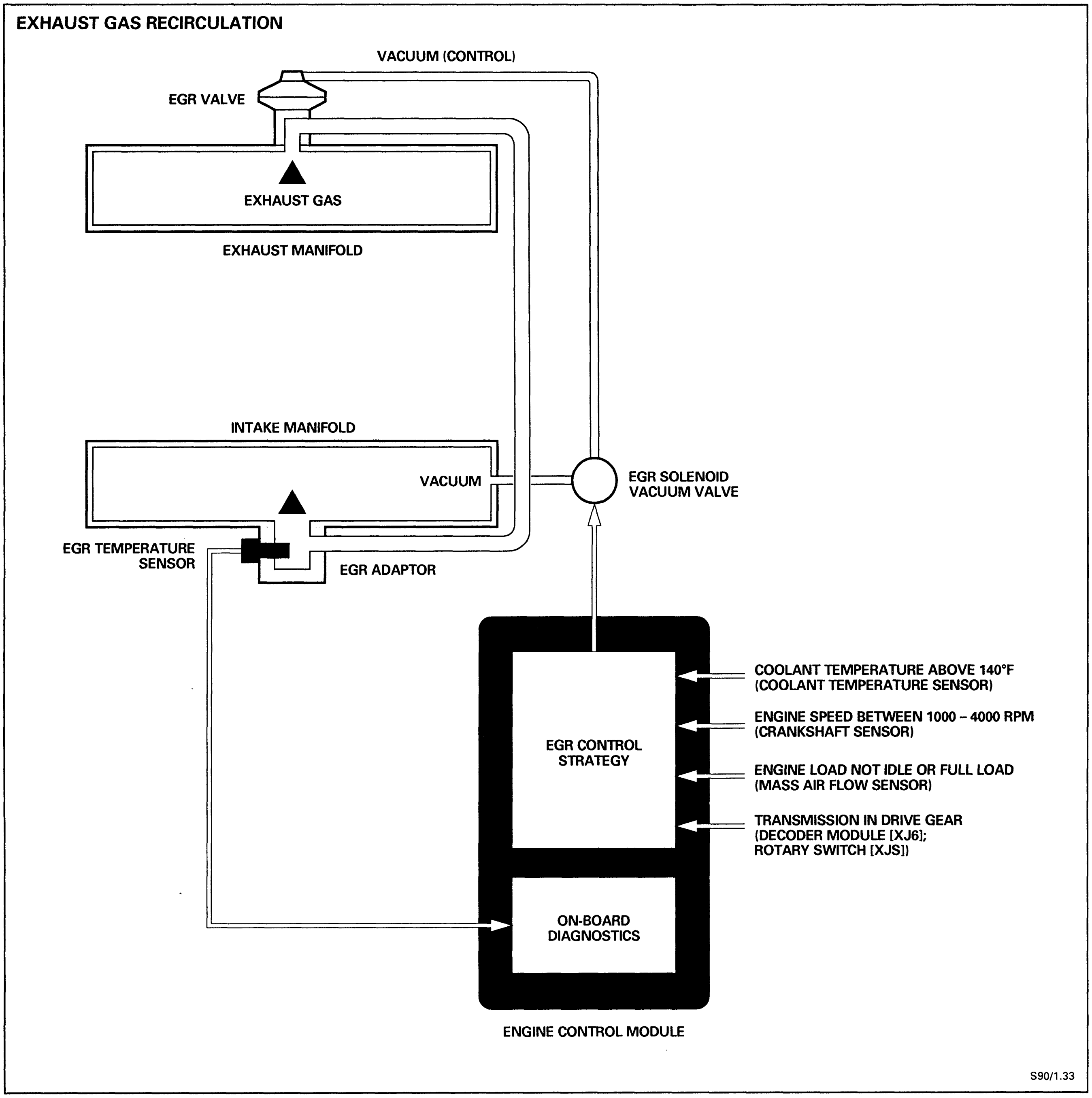
The ECM monitors its output to the air injection relay for on-board diagnostics.

Exhaust Gas Recirculation

EGR Operation

Exhaust gas recirculation (EGR) is used to reduce the "oxides of nitrogen" (NOx) in the exhaust during periods of high engine combustion temperatures (high loads and engine speeds). The introduction of exhaust gas into the combustion chambers lowers the peak combustion temperature by reducing the volume of air / fuel mixture to be combusted.

The ECM both controls and monitors the operation of the system.



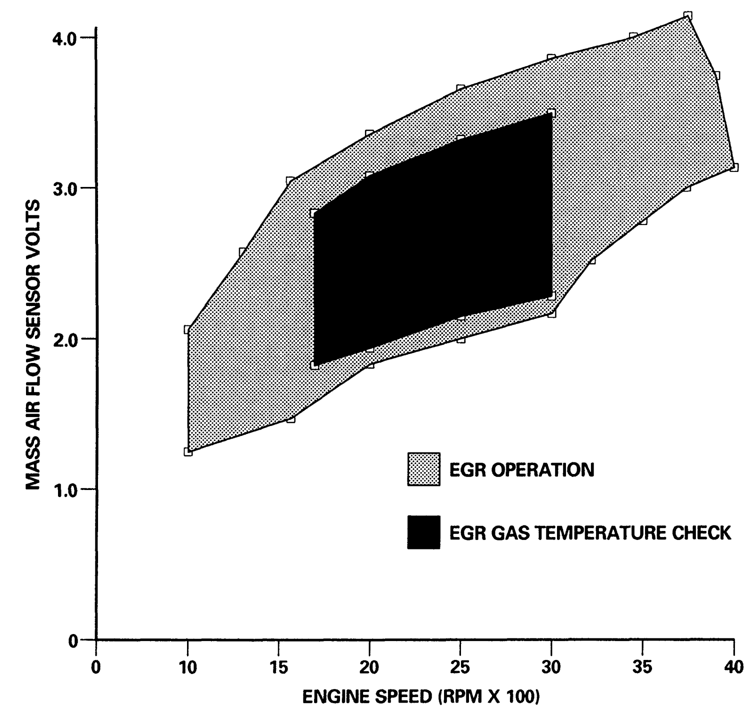
Exhaust Gas Recirculation (continued)

EGR Operation (continued)

EGR is enabled by the ECM when the following conditions exist:

- The engine coolant temperature exceeds 140°F (60°C)
- The engine is within a load / speed envelope that excludes idle and full load in the engine speed range 1000 – 4000 rpm
- The transmission is in a driving gear (not P or N)

EGR OPERATING ENVELOPE



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The ECM controls EGR by switching the EGR solenoid vacuum valve, which in turn, controls vacuum application to the EGR valve. The vacuum operated EGR valve controls the flow of exhaust gases between the exhaust and intake manifolds. Flow through the valve is proportional to exhaust back pressure, which is itself proportional to engine load. Vacuum is applied to the EGR valve via the ECM switched solenoid vacuum valve.

The ECM monitors its output to the EGR solenoid vacuum valve for on-board diagnostics.

The temperature of the exhaust gas flow to the intake manifold is also monitored by the ECM for on-board diagnostics. Monitoring takes place over a load / speed range within the EGR operational envelope.

On-Board Diagnostics (OBD)

On-Board Diagnostic Facility (OBD I)

The ECM includes a fault diagnosis facility that continuously monitors the operation of the engine management sensors and components. If a fault is detected, the OBD system will activate the Malfunction Indicator Lamp (MIL) (CHECK ENGINE) warning in the instrument pack and flag a diagnostic trouble code (DTC) in the ECM memory. The ECM can be interrogated through the instrument pack LCD display (XJ6 Sedan Range) or center console LCD display (XJS Range). To display the code, switch the ignition OFF; wait 5 seconds, then switch the ignition ON (do not crank the engine). On Sedan Range vehicles, press the VCM button. On XJS Range vehicles, a code is automatically displayed 5 seconds after the ignition is switched ON. The CHECK ENGINE warning will display and the DTC.will appear 5 seconds later. If two or more DTCs are flagged in memory, only the highest priority code will be displayed. If the vehicle battery is disconnected, all stored codes will be cleared from the ECM's memory. DTCs can also be accessed via serial communication. Refer to the DIAGNOSTICS section of this publication for more information on retrieving codes.

Limp Home Default

In order to allow vehicle operation if a malfunction occurs, "limp home" default values are incorporated as an ECM facility. If a sensor fault is detected by the OBD system, the ECM will substitute a nominal value for the missing input(s) as follows:

Missing Sensor Input	Default value
Engine coolant temperature	78° F (25° C)
Intake air temperature	86° F (30° C)
Mass air flow	Throttle position (voltage) Vs. pulse duration matrix; ignition timing = 8° BTDC @ idle, 20° BTDC above idle
Throttle position	1.5 volts
EGR temperature	Switches off EGR
Oxygen sensor voltage	Closed loop operation canceled (feedback = 2.5 volts)
Idle trim adjustment (1990 – 1992 MY only)	2.5 volts

On-Board Diagnostics (OBD) (continued)

Diagnostic Trouble Code Summary (listed in order of priority)

DTC	Limp Home Default	Fault Area	JDS / PDU Description
29		ECM self test	Lucas injection ECM
44	X	Oxygen sensor circuit	HO2S / circuit
24		Ignition drive circuit	IA drive circuit
12	X	Mass air flow sensor circuit	Mass air flow sensor / circuit
33		Injector drive circuit	Fuel injector / circuit
34		Rich condition during overrun fuel cut-off	Fuel injector leakage
14	X	Coolant temperature sensor circuit	ETC Sensor / Circuit
17	X	Throttle position sensor circuit	TP potentiometer / circuit
18		Throttle position sensor and mass air flow sensor (high throttle pos. voltage; low air flow voltage)	TP / potentiometer / calibration 1
19		Throttle position sensor and mass air flow sensor (low throttle pos. voltage; high air flow voltage)	TP / potentiometer / calibration 2
89		Purge valve drive circuit	EVAP valve / circuit
26		Oxygen sensor feedback (lean)	Air leak
37		EGR drive circuit	EGR valve / circuit
39	X	EGR temperature sensor circuit	Exhaust gas temperature sensor
22		Fuel pump drive circuit	Fuel pump / HO2S relay / circuit
23		Oxygen sensor feedback (rich)	Fuel supply
46		Idle speed control valve (coil 1 drive circuit)	IACV circuit, coil 1
47		Idle speed control valve (coil 2 drive circuit)	IACV circuit, coil 2
48		Idle speed control valve	IACV position error
11	X	Idle fuel trim (1990 – 92 MY XJ6)	
68		Road speed sensor circuit	Vehicle speed sensor / wiring
69		Drive / Neutral input circuit	PNPS / circuit
16	X	Intake air temperature circuit	IAT Sensor / Circuit
66		Air injection pump drive circuit	AIR relay / circuit

NOTE: 1992 MY ON systems (ECM part no. DBC 9622 ON): In order to prevent incorrect flagging of DTCs related to low fuel supply, fuel metering diagnostics are canceled when the fuel tank level falls below approximately 2.5 gallons (11 litres).

Vehicle Systems Interfaces

The engine management system interfaces with the transmission control module, the instrument pack and the air conditioning compressor clutch circuit to provide operational control, sensor input and data input.

Transmission Control Module Interface

Engine torque reduction
The ECM receives two ignition timing retard inputs from the TCM: transmission shift "up / down" signal (IGNITION SELECT) (pulsed signal), and transmission "shift in progress" signal (IGNITION RETARD) (pulsed signal). Refer to Ignition Timing, page 27, for a detailed explanation.

Engine speed and load
The ECM outputs engine load and speed signals (PULSED SIGNALS) to the TCM. The TCM uses the engine load and speed data to determine shift patterns and torque converter clutch apply and release.

Engine idle speed
The transmission decoder module (XJ6), rotary switch (XJS) outputs gear position signals to the ECM. When the gear selector is in R, D, 2 or 3, the signal is 5 volts; when the gear selector is in P or N, the signal is ground or 0 volts. The ECM uses the gear position inputs to control idle speed and for DTC 69. Refer to Ignition Timing, page 27, and Idle Speed Control, pages 24 – 25, for a detailed explanation.

Instrument Pack Interface

Vehicle road speed
The instrument pack outputs a road speed signal (pulsed signal) to the ECM. The ECM uses the signal to determine idle speed control functions.

Low fuel level (1992 MY ON [ECM part no. DBC 9622 ON])
The instrument pack outputs a fuel level voltage signal to the ECM. When the voltage drops below 5.7 volts (2.5 gallons [11 litres] fuel remaining), fuel metering diagnostics (OBD) are canceled. Cancelling the fuel metering diagnostics prevents the ECM from flagging DTCs caused by the vehicle running out of fuel.

Engine speed
Engine speed is output to the instrument pack for operation of the tachometer. Engine speed is sensed from the ignition coil primary circuit (1990 – 92 MY Sedan and XJS). The ECM outputs an engine speed signal (pulsed signal) to the instrument pack (1993 MY ON Sedan).

Fuel metering pulse
The ECM outputs a fuel metering pulse to the instrument pack for use by the trip computer (average fuel consumption, instantaneous fuel consumption).

Fuel fail warning
If the OBD system detects a fault, the ECM outputs a fuel fail warning signal (ground) to the instrument pack. Refer to On-Board Diagnostics, page 33.

Air Conditioning Compressor Clutch Interface

When the air conditioning compressor clutch is operating, a parallel circuit applies battery voltage to the ECM. The ECM uses this signal to determine the need for idle speed control compensation.

Serial Communication

Serial communication between the engine management system and JDS or PDU is available. Serial communication is used for engine setup, accessing stored DTCs, fault diagnosis and erasing DTCs. Refer to the DIAGNOSTICS section of this publication for detailed information.

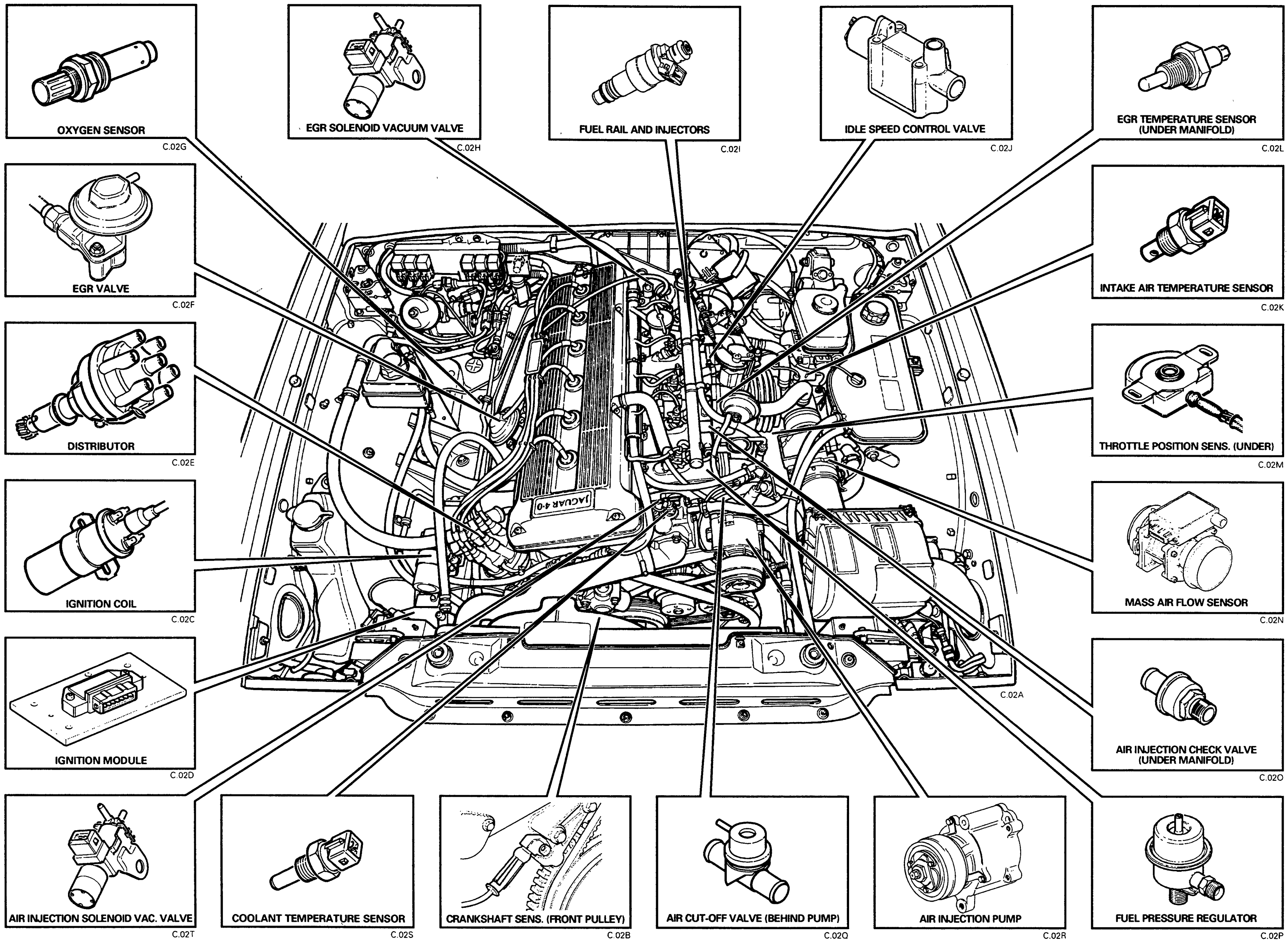
Component Description

Component Description

Contents

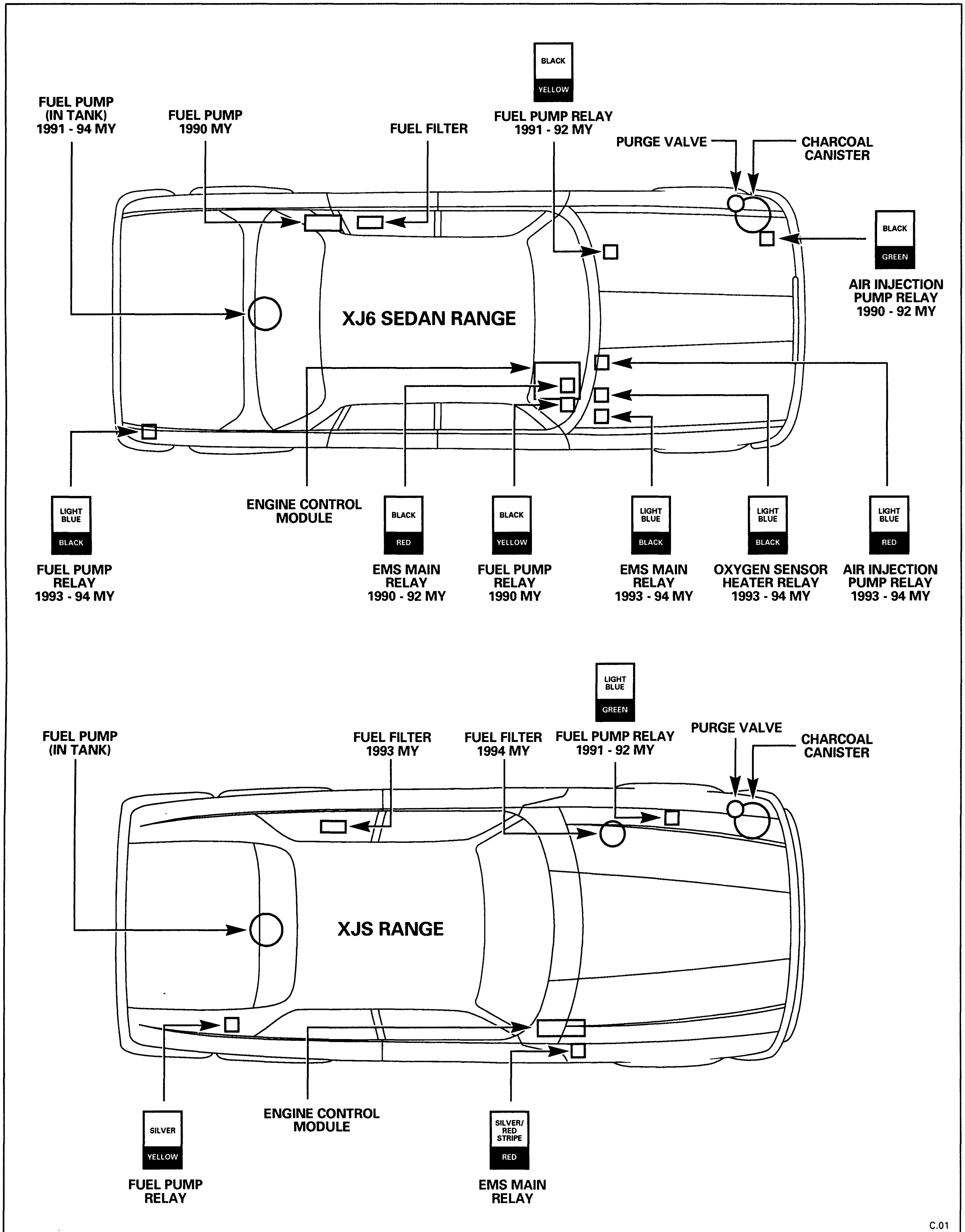
Component Description

EMS Components Installed on Engine



XJ6 SEDAN RANGE SHOWN; XJS RANGE IDENTICAL

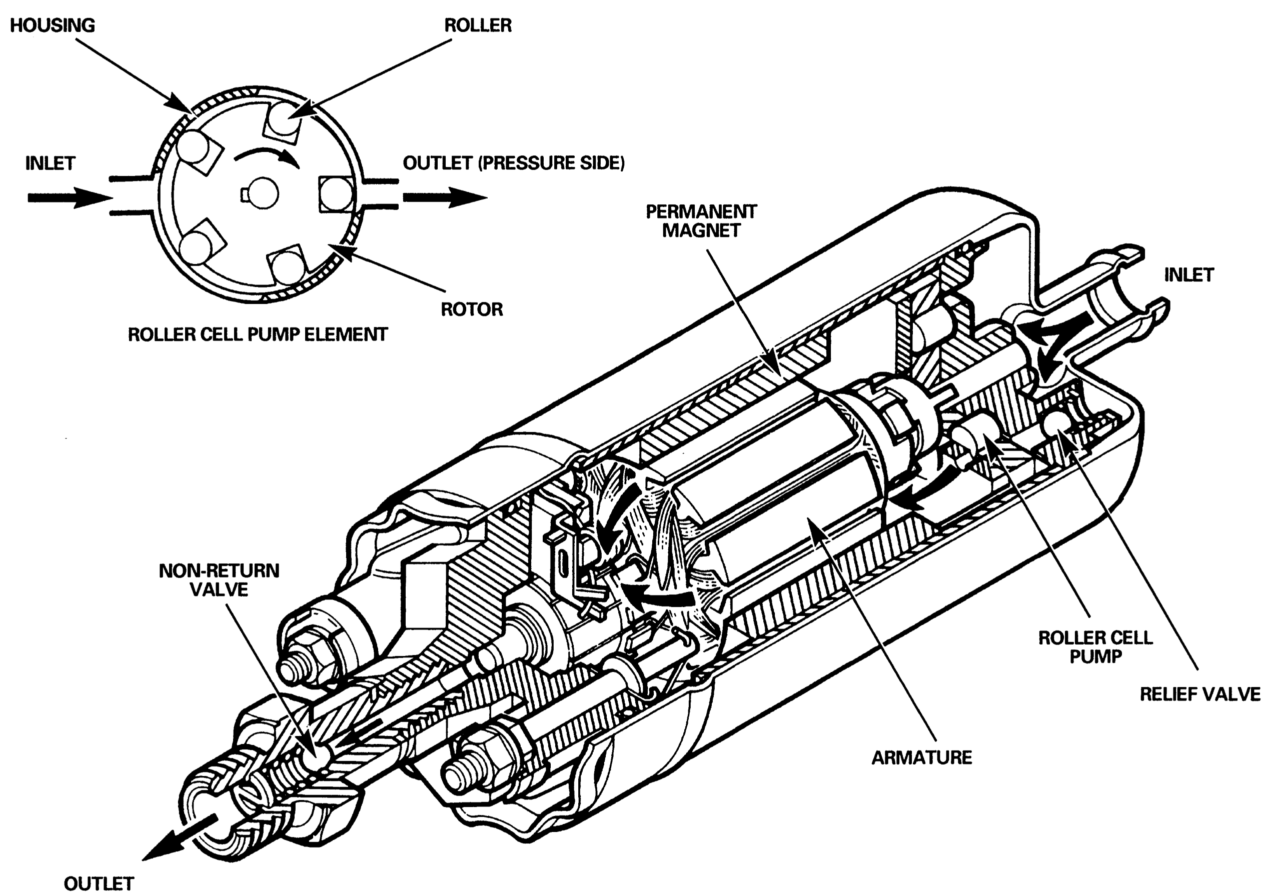
EMS Components Installed on Vehicle



Fuel Pump (XJ6 Sedan 1990 MY)

The in-line fuel pump is a roller type pump driven by a permanent magnet electric motor. An eccentric rotor mounted on the armature shaft has metal rollers housed in pockets around the circumference. When the motor is energized, centrifugal force acting on the rollers forces them outward so that they act as seals. The fuel between the rollers is then forced to the outlet side of the pump. A replaceable non-return valve is threaded into the pump outlet. The non-return valve prevents fuel pressure loss when the pump is not running. The pump is located on the rear suspension subframe.

FUEL PUMP: XJ6 SEDAN RANGE 1990 MY



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Fuel Pump Module (1991 MY ON vehicles)

The fuel pump is an integral component of an in-tank fuel pump module. The fuel pump module mounts in a rubber holder attached to the bottom of the fuel tank on brackets. The fuel pump module and the rubber holder are indexed to ensure correct alignment in the tank.

Fuel is drawn from the fuel tank through a 70 micron filter at the base of the module, then through a 400 micron filter at the pump inlet. The pump delivers the fuel to the fuel rail through a renewable in-line filter mounted to the underbody. Unused fuel is returned to the fuel pump module where it passes through another 70 micron filter. A small portion of the pressurized fuel flows through a venturi "teed" into the supply side inside the module. This flow enables a "jet pump" to pick up fuel so that the module remains full at all times.

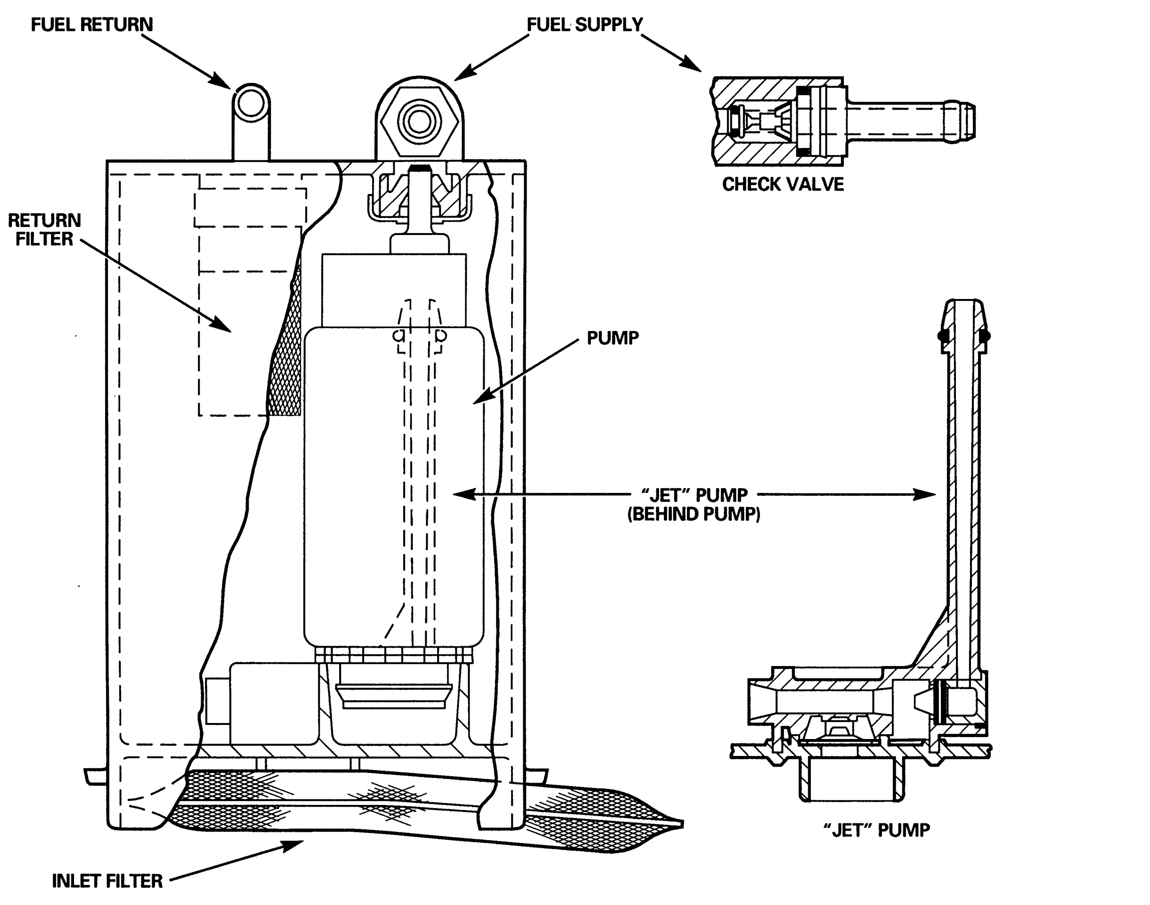
Both the outlet and return ports through the pump module have check valves. The outlet check valve reduces back flow from the fuel rail when the pump is off. The return check valve holds fuel pressure in the return line from the fuel rail and prevents siphoning if a fuel line is disconnected.

The inlet filter must not be folded or damaged and must be squarely mounted on its neck. If the filter is damaged in any way, the fuel pump module must be replaced.

Fuel Pump Specifications

Speed	7000 rpm
Flow rate	640 ml / 20 sec. @ 36 psi
Current	8 – 9 A @ 13.2 volts and 36 psi

FUEL PUMP MODULE: 1991 MY ON VEHICLES

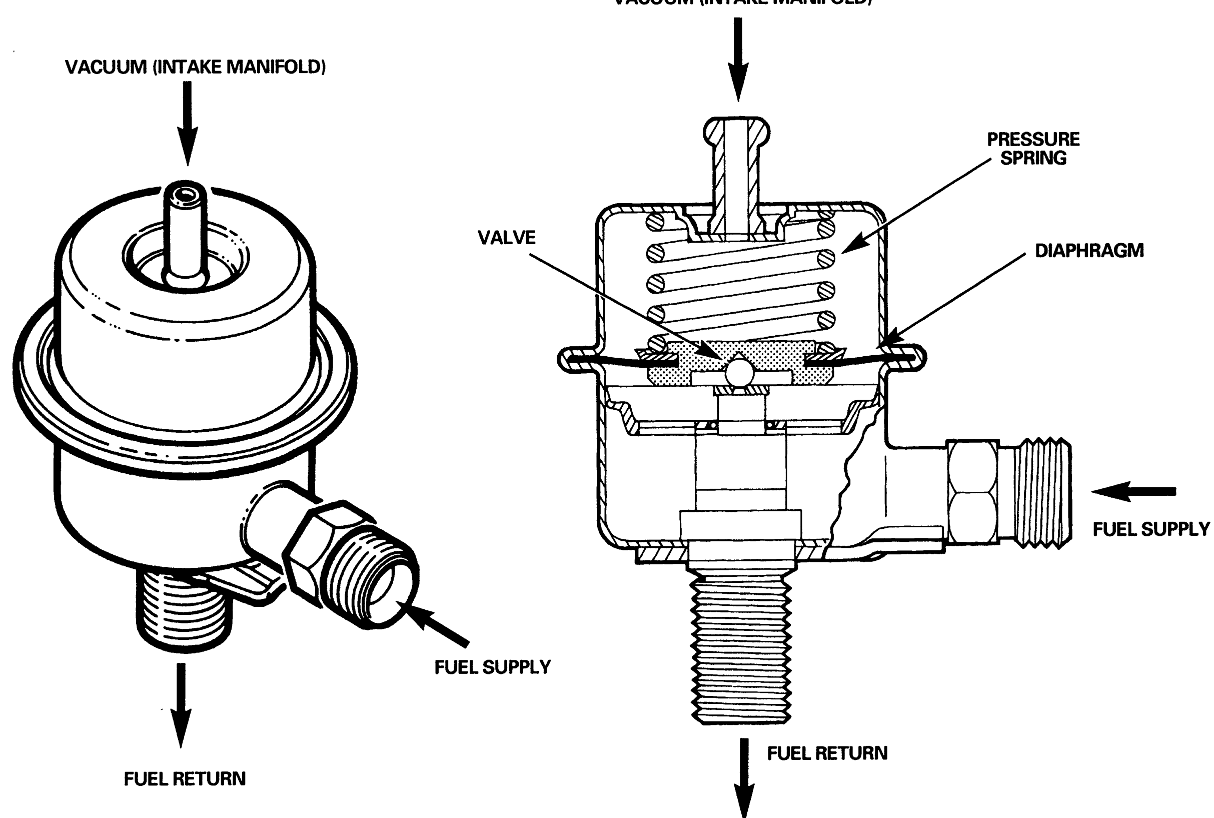


Fuel Pressure Regulator

Fuel is pumped to the fuel rail and injectors, where fuel pressure is controlled by the fuel pressure regulator. Excess fuel, above the engine requirement, is returned to the fuel tank. The pressure regulator spring chamber above the diaphragm is referenced to intake manifold vacuum. The differential pressure across the fuel injector nozzles is therefore maintained constant at 44 psi (3.0 bar) and the quantity of fuel injected for a given injector pulse duration is also constant. Fuel pressure measured on a test gauge will vary between 32 psi (2.3 bar) at overrun to 44 psi (3.0 bar) at full load.

The fuel pressure regulator is located as close as possible to the fuel rail so that good dynamic control of fuel pressure is achieved. This design provides the same pressure across each injector, and delivers an equal quantity of fuel to each of the six cylinders.

FUEL PRESSURE REGULATOR



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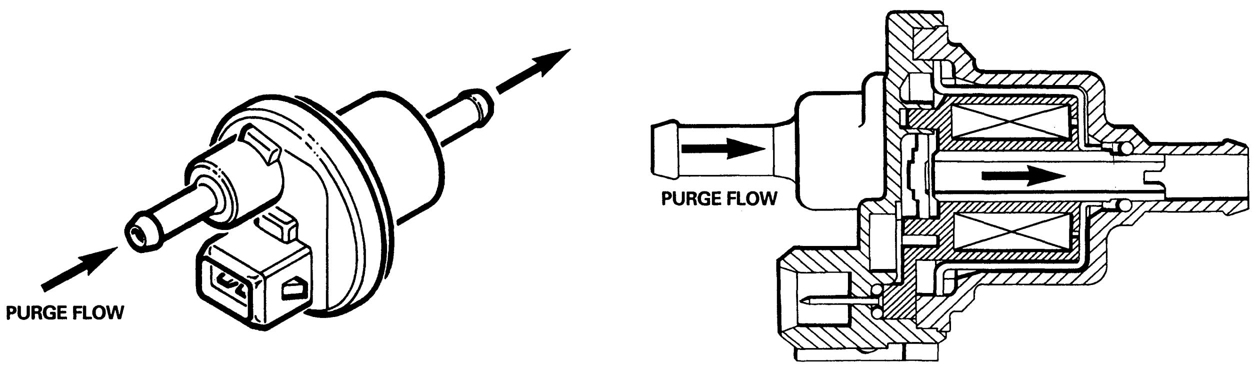
The main component of the pressure regulator is the diaphragm, below which a steel ball valve is mounted on a disc. The upper side of the diaphragm incorporates a spring retaining cup. Spring length is set during manufacturing by deforming the top cover until the fuel pressure at which the diaphragm lifts at atmospheric pressure is set at 44 psi (3.0 bar). A filter screen prevents any small pieces of debris from the fuel rail becoming trapped under the disc.

The tube on the top of the upper case is connected to the intake manifold. During engine operation, intake manifold vacuum "assists" the pressurized fuel to lift the diaphragm against the spring. When fuel pressure exceeds the control value, the valve lifts off the seat allowing a portion of the fuel to be directed to the outlet port, thereby maintaining fuel pressure at the control value. The excess fuel is returned to the fuel tank.

Purge Valve

The engine management ECM operates the purge control valve to allow a regulated vapor flow to the intake manifold dependent on engine operating conditions. The purge valve is a solenoid operated "duty cycle" valve that is normally open. The valve closing and subsequent rate of vapor flow (opening) is varied by the "length" of a pulsed electrical signal provided from the ECM. The resistance of the purge valve coil is approximately 42 ohms. The purge valve is located in the left front fender arch, next to the charcoal canister.

PURGE VALVE



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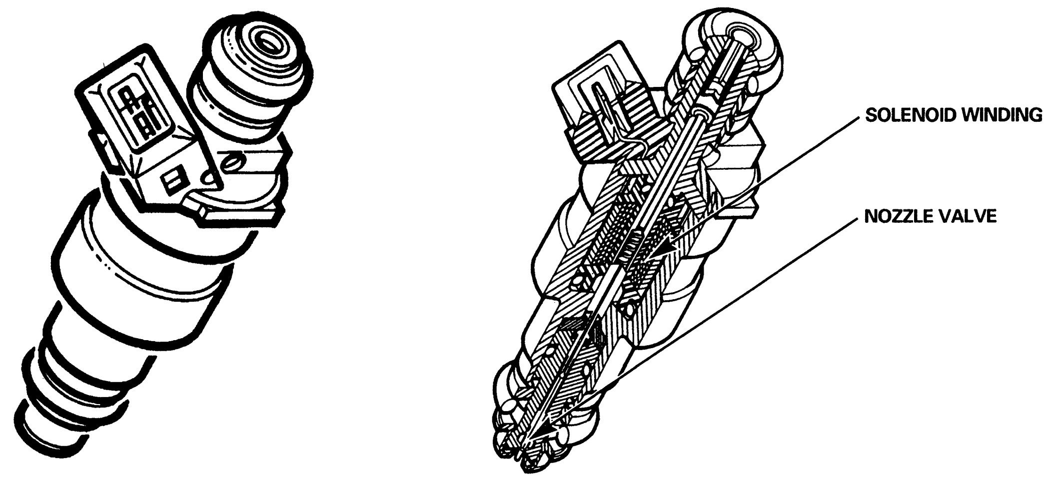
Fuel Injectors (1990 – 1992 MY)

The fuel injectors are solenoid operated valves that are pulsed by the ECM. The mechanical design of the injectors incorporates a pintle valve with a waisted shape tip passing through the orifice at the bottom of the injector body. The waisted shape of the pintle tip and orifice cause the fuel flow to form a cone-shaped spray of small fuel particles. The fuel inlet at the top of the injector has a small filter to trap any debris that may be present in the fuel. "O" Rings are used to seal the injector between the fuel rail and intake manifold.

PINTLE-TYPE FUEL INJECTOR



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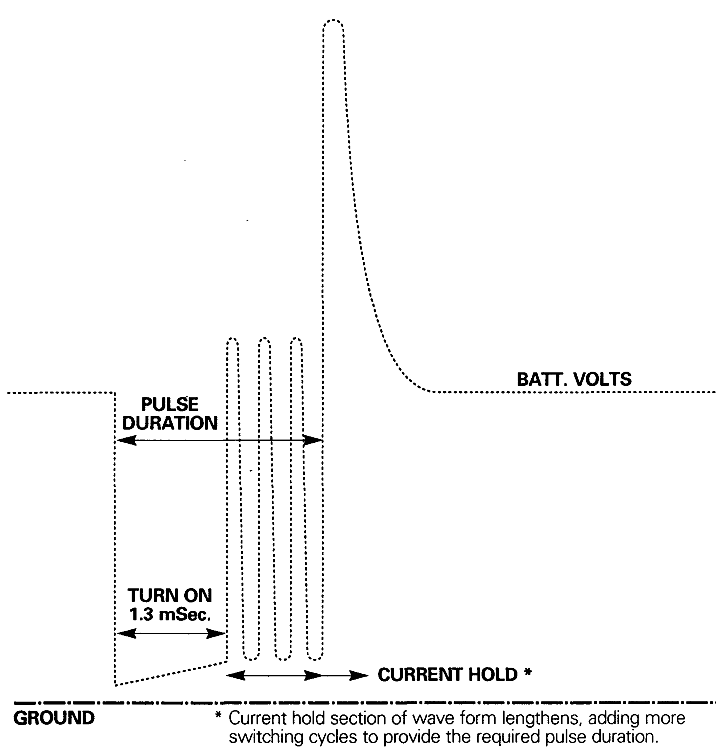
INJECTOR WAVE FORM



* Current hold section of wave form lengthens, adding more switching cycles to provide the required pulse duration.

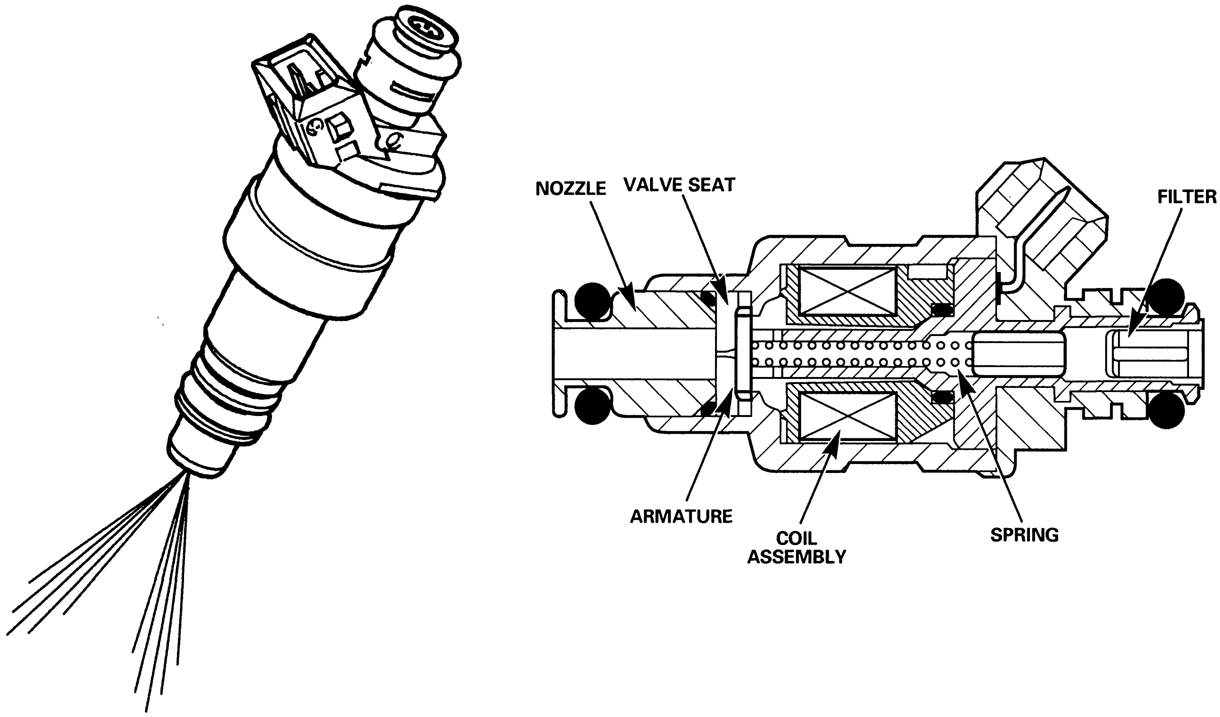
S90/2.06

The electrical pulses applied to the injector coil by the ECM attract the head of the pintle to the coil armature. This action overcomes spring pressure and allows fuel to flow through the annulus between the pintle tip and the orifice. Full valve lift (approximately 0.006 in) is reached in about 1 millisecond. The resistance of the fuel injector coil is approximately 2.5 ohms.

Fuel Injectors (1993 MY ON)

The basic design and operation of the fuel injectors is similar to the earlier type; however, the injector tips use a plate-type, twin-spray design. This design has several benefits: it aims a fuel spray a each intake valve throat, it is quieter in operation, and the tip is less prone to contamination. The injectors are secured to the fuel rail with custom clips that ensure the twin jets of fuel are directed to the intake valve throats. A green band is used to identify the plate-type, twin-spray injector.

TWIN-SPRAY FUEL INJECTOR

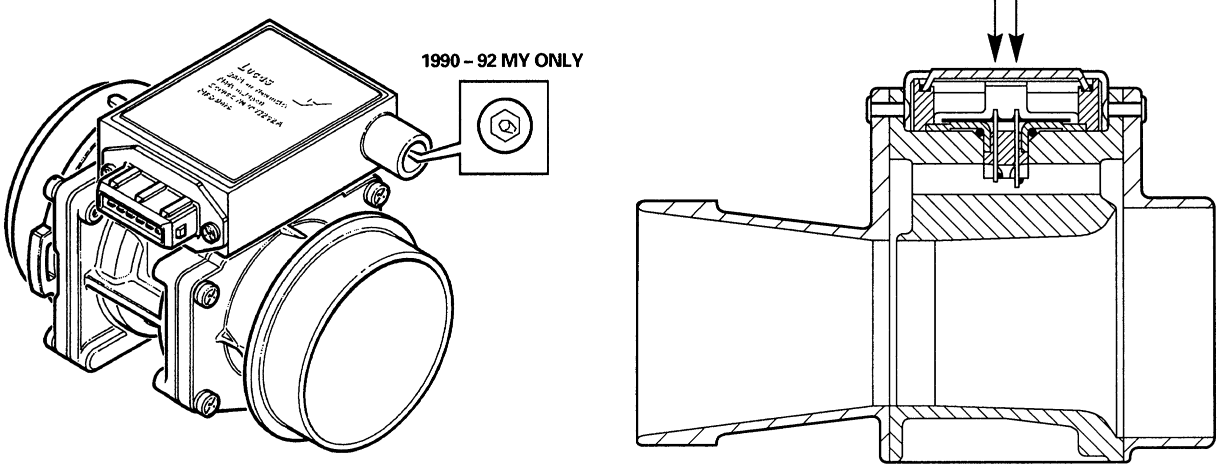


S90/2.07A, B

Mass Air Flow Sensor

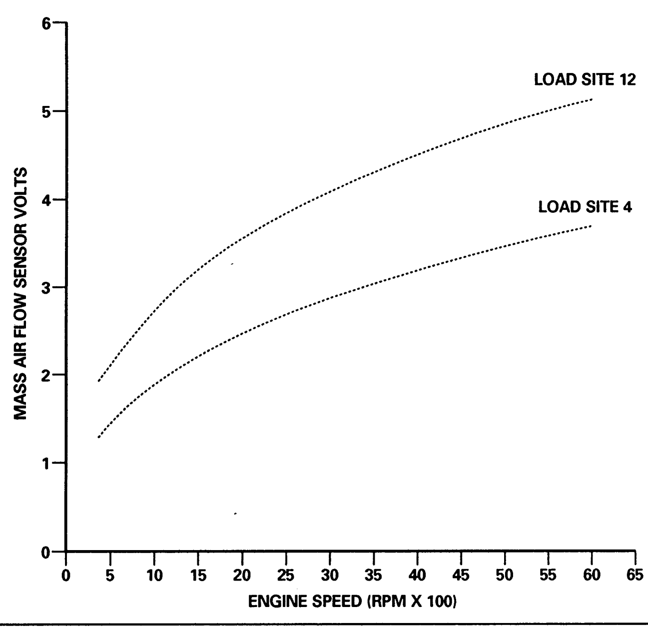
The mass air flow sensor, located in the intake tract downstream of the air cleaner, measures the volume of air flow into the engine intake. The sensor has a cast alloy body with an integral electronic module. Some of the air flows through a bypass channel containing two small wire coils: a sensing coil and a compensating coil. The sensing coil is electrically heated by the electronic module; the compensating coil remains unheated.

MASS AIR FLOW SENSOR



S90/2.08A, B

LOAD SITES 4 & 12 VERSUS ENGINE SPEED



S90/2.09

Intake air volume is determined by measuring the electrical current required to keep the temperature differential of the two coils constant. This measurement occurs in the circuitry of the sensor. The sensor then provides a voltage signal representing air flow to the ECM. The theoretical full range of the signal is 0 – 5 volts. Idle voltage is normally 1.10 – 1.40 volts and torque converter stall (full throttle; 1850 – 2150 rpm) voltage is normally 3.00 – 3.30.

On 1990 to 1992 MY vehicles, an adjustable potentiometer is incorporated into the mass air flow sensor to provide for idle fuel trim adjustment during initial engine setup. This potentiometer operates independently of the air flow elements and provides a constant voltage signal to the ECM. The idle trim potentiometer has an adjustment range of approximately 0 – 1000 ohms, measured between pins 1 and 6 of the mass air flow sensor connector. The ECM applies a 5 volt reference to pin 6 and a ground to pin 1. With the mass air flow sensor connected, the reference measured at pin 6 must be less than 4 volts or DTC 11 will be flagged. Typically, the voltage is between 2 and 3 volts.

During 1994 MY, gold-plated connector pins were introduced to prevent corrosion and resistance build-up. The gold-plated pins can be identified by their color.

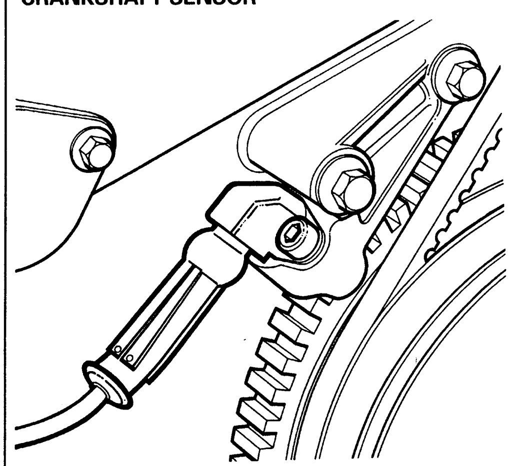
⚠ CAUTION! Tin-plated pins and gold-plated pins must not be matched; they are not compatible.

Crankshaft Sensor

The crankshaft sensor provides both engine speed and crankshaft position signals to the ECM. The sensor is a variable reluctance device, consisting of a bobbin coil with a magnetic core. The resistance of the coil is approximately 1.35 kilo ohms. The steel teeth on the crankshaft timing ring are used as a rotor. As the rotor teeth pass by the crankshaft sensor, pulses are generated.

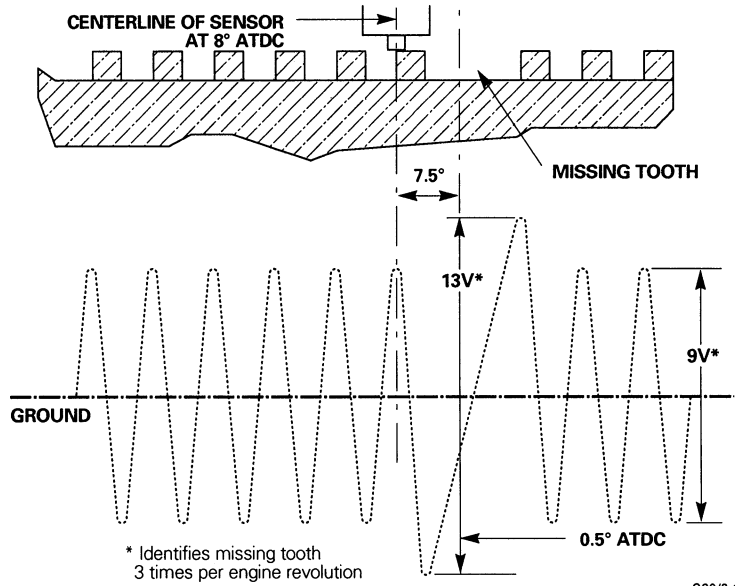
The rotor has 60 tooth positions set at 6° intervals with three teeth missing. The gaps identify the TDC position of the 6 cylinders during one complete engine cycle (two crankshaft revolutions). The rotor thus provides both engine speed and crankshaft position information to the ECM. The missing pulses identify crankshaft position. Each tooth pulse after the missing pulse represents 6° of crankshaft rotation. Thus the frequency of the toothed pulses are a measure of engine speed. The sensor is mounted to the timing cover on the front of the engine.

CRANKSHAFT SENSOR



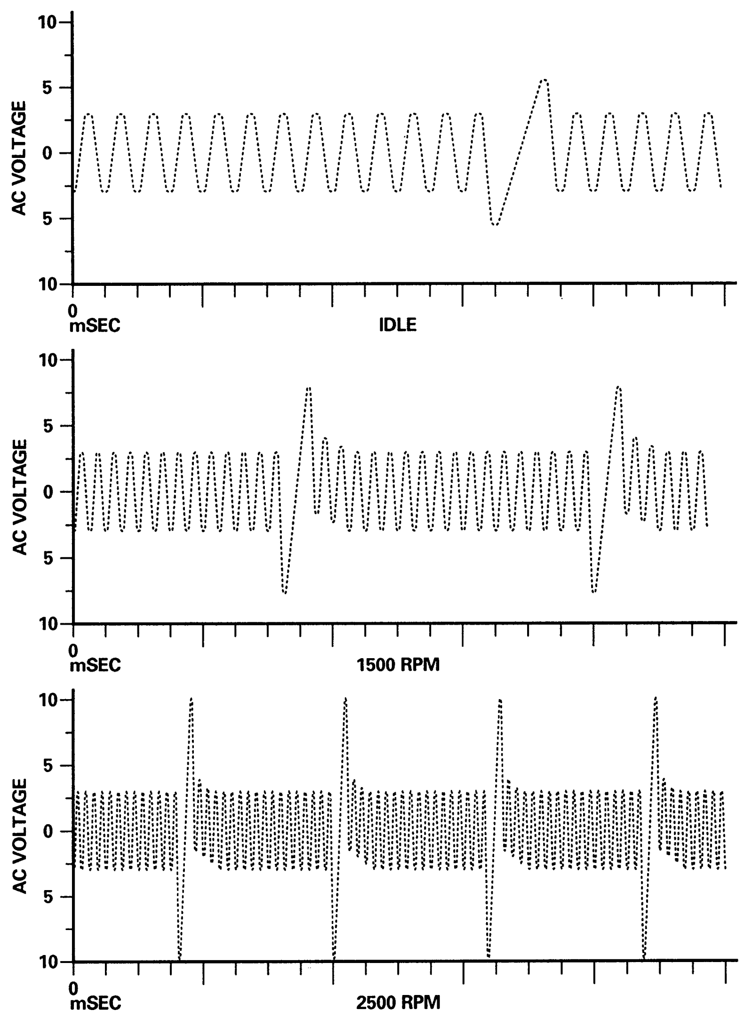
S90/2.10

CRANKSHAFT SENSOR SIGNAL



S90/2.11

CRANKSHAFT SENSOR SIGNAL AT VARIOUS ENGINE SPEEDS



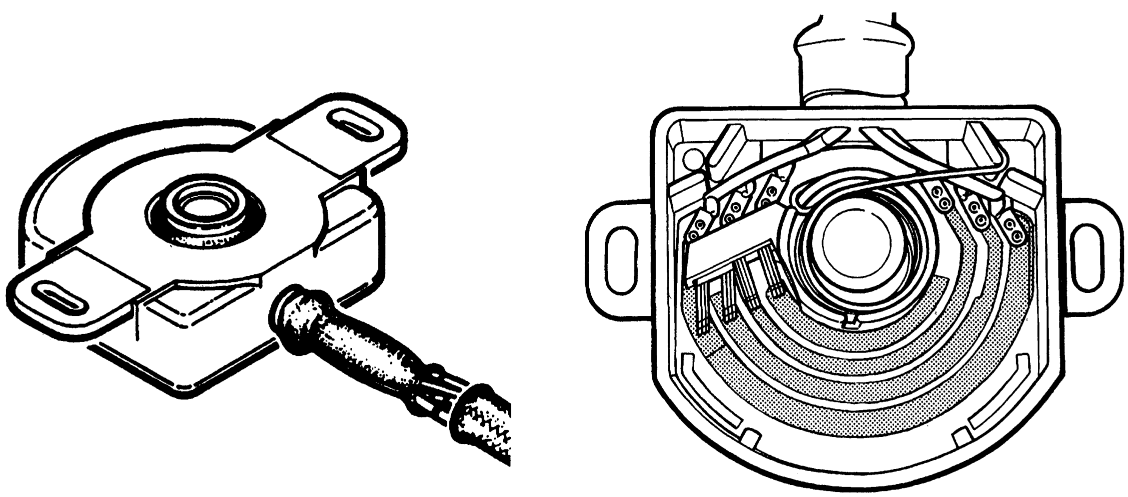
S90/2.12

Throttle Position Sensor

The throttle position sensor is a twin track design containing two separate potentiometer tracks with wipers driven by a common spindle. The sensor is mounted on the throttle housing with the spindle connected to the throttle shaft. One potentiometer track is used by the engine management system; the other track is used by the transmission control system. Both potentiometers have the same resistance, voltage and angle of rotation characteristics. The range of resistance is approximately 500 ohms to 5.5 kilo ohms. The throttle position sensor provides a voltage signal to the ECM that indicates throttle position and movement. The theoretical full range of the signal is 0 to 5 volts.

The throttle position sensor output relative to the throttle valve position is set at closed throttle using JDS or PDU. The ECM software function that recognizes closed throttle is "adaptive" and will "learn" that voltage in a range from 0.25 to 0.75 volts is the closed throttle position. However, to avoid the ECM having to relearn the idle setting each time the battery is disconnected, the idle voltage should be set very close to 0.6 volts.

THROTTLE POSITION SENSOR



S90/2.13

The ECM uses the voltage signal provided by the sensor for a number of ECM functions:

Throttle Position	ECM Function
Throttle closed (signal 0.25 – 0.75 volts)	Idle speed control function Ignition idle strategy Overrun fuel cut-off Idle fuel trim (adjustable mass air flow sensor potentiometer only) Adaptive idle fueling trim
Part throttle (signal above closed throttle voltage and below full throttle voltage)	Main fuel metering strategy Main ignition strategy EGR enabled
Opening throttle (signal voltage increasing)	Acceleration enrichment
Closing throttle (signal voltage decreasing)	Deceleration leaning
Full throttle (signal greater than 3 volts)	Full load enrichment (load dependent)

NOTE: Other sensor inputs are required for the initiation of most of the above listed ECM functions.

Coolant Temperature Sensor

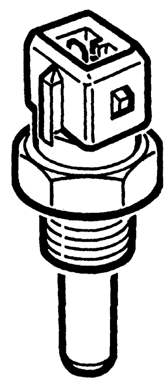
The coolant temperature sensor, located on the thermostat housing, is a negative temperature coefficient (NTC) thermistor. NTC means that the resistance of the thermistor decreases as the sensed temperature increases. Pin 1 of the sensor is connected to ground through the ECM. The ECM applies 5 volts to pin 2 of the sensor and monitors the voltage across the sensor pins. The theoretical full voltage range is from 5 to 0 volts representing maximum cold to maximum hot.

The ECM converts the monitored voltage into a digital number that relates to an engine coolant temperature. The temperature signal is then used for a number of functions:

- Cranking enrichment
- Warm-up enrichment
- Acceleration enrichment
- Air injection
- Idle speed control
- Enable EGR
- Evaporative canister purge

NOTE: Other sensor inputs are required for the initiation of most of the above listed ECM functions.

COOLANT TEMPERATURE SENSOR



S90/2.14

Coolant temperature sensor – temperature versus resistance:

Coolant temperature °F	°C	Resistance (kilo ohms)
14	-10	9.20
32	0	5.90
50	10	3.70
68	20	2.50
86	30	1.70
104	40	1.18
122	50	0.84
140	60	0.60
158	70	0.435
176	80	0.325
193	90	0.25
212	100	0.19

Coolant temperature sensor – temperature versus typical approximate voltage:

Coolant temperature °F	°C	Voltage (measured at ECM Yellow connector pin 2 or sensor pin 2)
14	-10	4.05
32	0	3.64
59	15	2.89
78	25	2.42
86	30	2.20
104	40	1.78
122	50	1.44
140	60	1.17
158	70	0.95
176	80	0.78
193	90	0.65
212	100	0.55

Intake Air Temperature Sensor

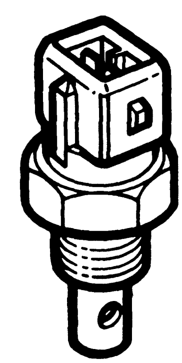
The air temperature sensor, located in the air intake elbow, is a negative temperature coefficient (NTC) thermistor. NTC means that the resistance of the thermistor decreases as the sensed temperature increases. The air temperature sensor construction differs from the coolant temperature sensor in that the thermistor element is exposed by holes in the tip of the housing. The holes are designed to allow fast response in measuring air temperature changes while at the same time providing the necessary mechanical protection. Pin 1 of the sensor is connected to ground through the ECM. The ECM applies 5 volts to pin 2 of the sensor and monitors the voltage across the sensor pins. The theoretical full voltage range is from 5 – 0 volts representing maximum cold to maximum hot.

The ECM converts the monitored voltage into a digital number that is used to control the ignition timing strategy. Refer to Ignition Timing Control on pages 27 – 29 of the SYSTEM DESCRIPTION section of this publication.

Intake air temperature sensor – temperature versus resistance:

Intake air temperature °F	°C	Resistance (kilo ohms)
14	-10	9.20
32	0	5.90
50	10	3.70
68	20	2.50
86	30	1.70
104	40	1.18
122	50	0.84
140	60	0.60
158	70	0.435
176	80	0.325
193	90	0.25
212	100	0.19

AIR TEMPERATURE SENSOR



S90/2.15

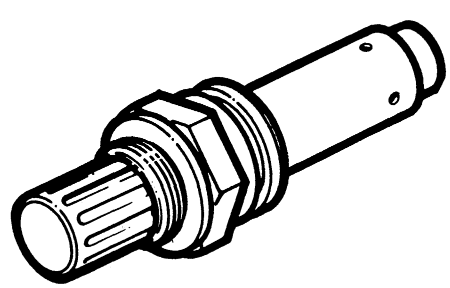
Intake air temperature sensor – temperature versus typical approximate voltage:

Intake air temperature °F	°C	Voltage (measured at ECM Yellow connector pin 20 or sensor pin 1)
14	-10	4.05
32	0	3.64
59	15	2.89
78	25	2.42
86	30	2.20
104	40	1.78
122	50	1.44
140	60	1.17
158	70	0.95
176	80	0.78
193	90	0.65
212	100	0.55

Oxygen Sensor

The oxygen sensor, located in the exhaust down pipe after the first catalyst, is a device that produces voltage by conducting oxygen ions at temperatures above 572°F (300°C). In order to reduce the amount of exhaust gas and resulting emission needed to bring the sensor up to working temperature, an internal electric heater is used. The tip portion of the sensor ceramic element is in contact with the exhaust gas. The remaining portion of the ceramic element is in contact with ambient air via capillary action through the heater electrical wires.

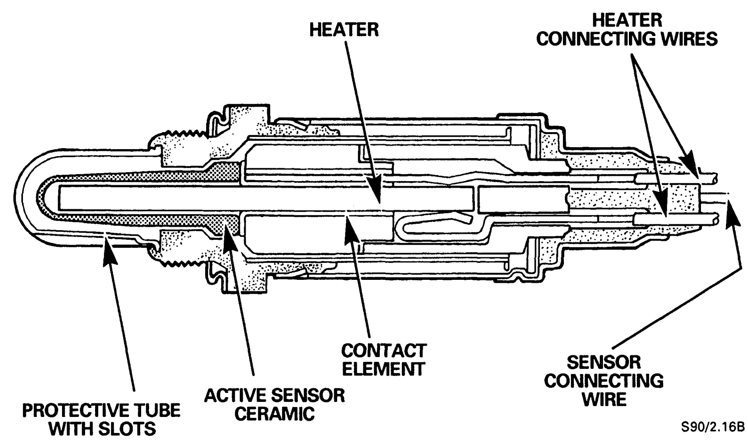
OXYGEN SENSOR



S90/2.16A

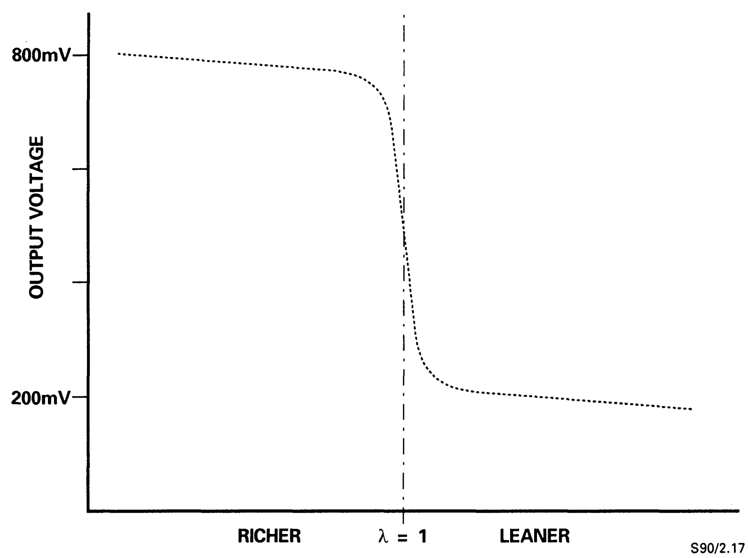
The sensor voltage output switches between approximately 800 millivolts and approximately 200 millivolts depending on the oxygen level differential between ambient air and exhaust gas on either side of the ceramic element. When the air / fuel ratio is richer than 14.7 : 1 (Lambda = 1.0), the voltage output is high; when the air / fuel ratio is leaner than 14.7 : 1 (Lambda = 1.0), the output voltage is low. Only a very small change in air / fuel ratio is required to switch the oxygen sensor.

OXYGEN SENSOR CROSS SECTION



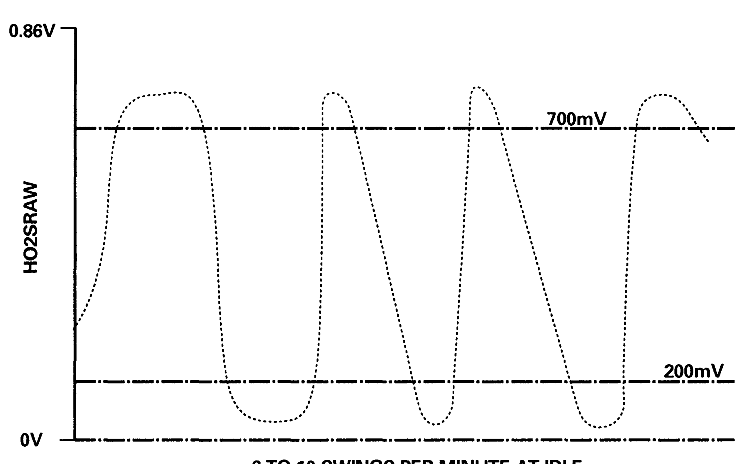
S90/2.16B

OXYGEN SENSOR CHARACTERISTIC



S90/2.17

OXYGEN SENSOR VOLTAGE TRACE: PDU HO2SRAW

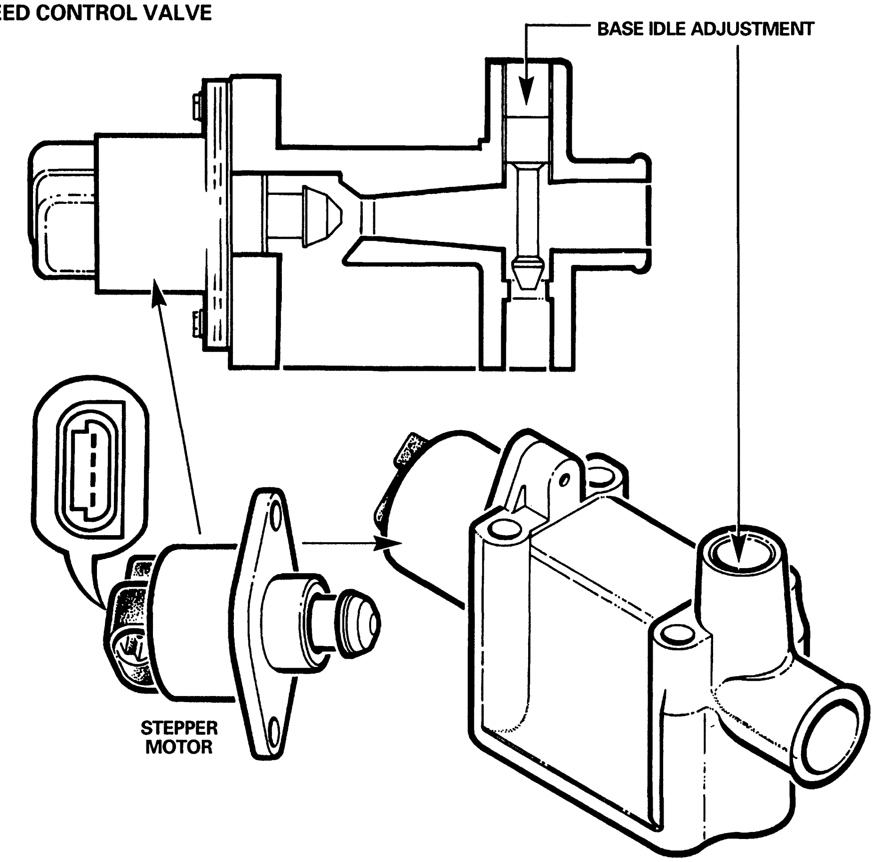


S90/2.18

Idle Speed Control Valve

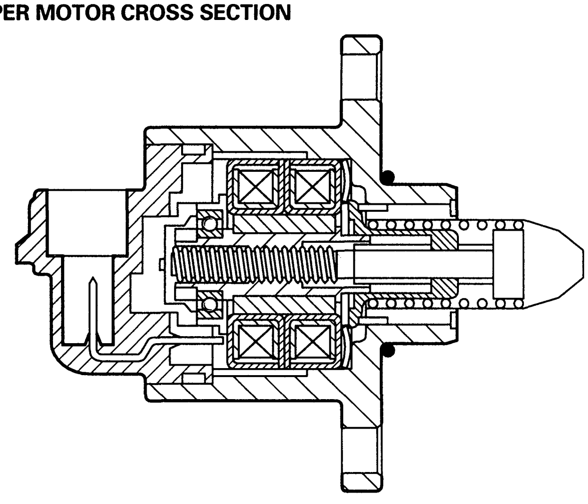
The idle speed control valve assembly, located on the top of the intake manifold, contains a manually adjusted base idle throttle bypass passage and an additional variable bypass passage. The flow of bypass air through the variable passage is regulated by a stepper motor driven by the ECM. The stepper motor has two coils that are pulsed by the ECM. The pulses are phased 90° apart. The order in which the coils are pulsed determines the direction of stepper motor travel. The coil resistance is approximately 50 ohms.

IDLE SPEED CONTROL VALVE



S90/2.19

STEPPER MOTOR CROSS SECTION



S90/2.20

The stepper motor has a total travel from fully opened to fully closed of approximately 230 steps.

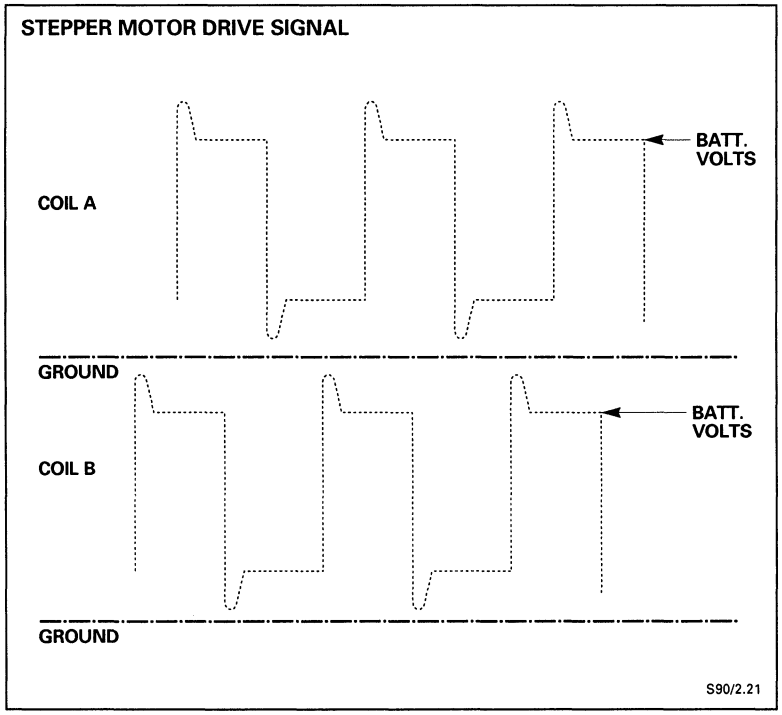
During engine setup (using JDS or PDU), the stepper motor is positioned at 200 steps from fully opened to allow the base idle speed to be set, using the manual air bypass screw. Once the base idle speed is set correctly, the stepper motor will hold the closed loop idle speed within a few rpm of the nominal idle speed (700 rpm in "N" and 580 rpm in "D"; normal operating coolant temperature).

When the ignition is switched off, the control valve indexes to a known "parked" position.

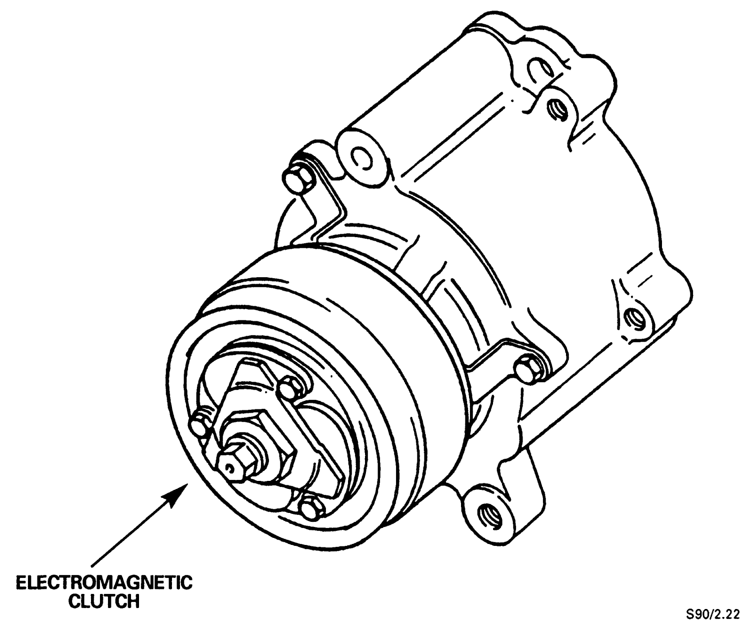
On 1990 model year vehicles, the reference is from the fully opened position. On later vehicles, the reference is from the fully closed position.

On 1993 and later model years, there is a 7-second delay after the ignition is switched off before the control valve closes.

To accurately maintain a correct idle speed, the ECM "learns" the idle stepper position. If the ECM is disconnected from battery power, the idle position must be relearned. The simple way to allow the ECM to relearn the position is to start the engine from cold and allow it to idle until fully warm, then drive the vehicle for a short distance.



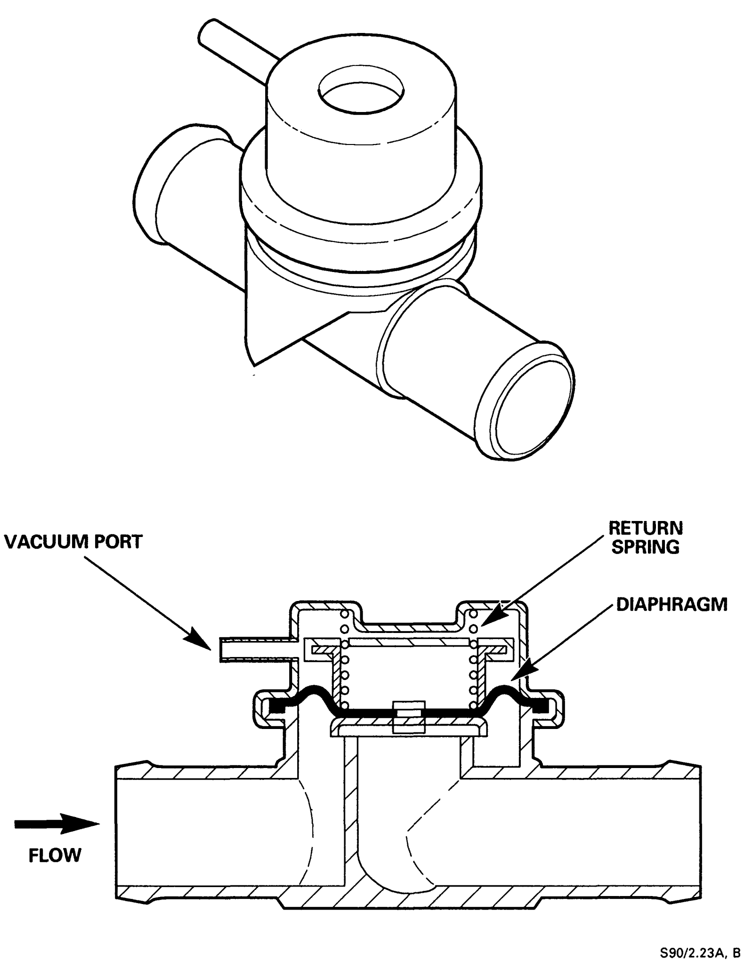
AIR PUMP



Air Pump

The mechanical rotary vane air pump is belt driven through an electromagnetic clutch. The clutch allows the pump to be engaged/disengaged by the ECM (via the air injection relay. If the engine speed exceeds 2500 rpm while air injection is enabled, the ECM will switch off the circuit to prevent over speeding the air pump. Excessive back pressure would damage the pump.

AIR SWITCHING VALVE



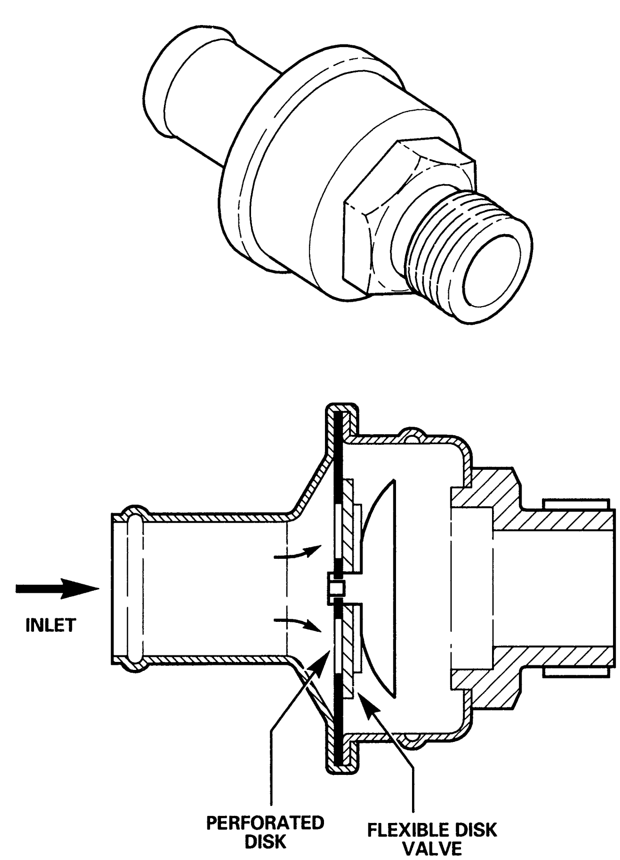
Air Switching Valve

The vacuum actuated air switching valve, located behind the air pump, contains a spring-loaded diaphragm valve resting on a seat. When vacuum is applied, the diaphragm lifts to allow air flow.

Air Injection Check Valve

The check valve, located in the delivery tube behind the air pump, prevents the back-flow of exhaust gas to the air pump.

AIR INJECTION CHECK VALVE

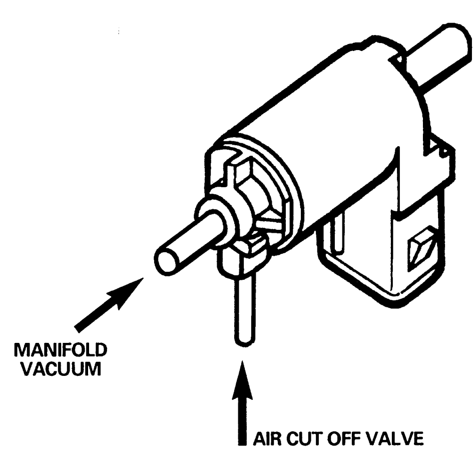


S90/2.24

Air Injection Solenoid Vacuum Valve

The air injection solenoid vacuum valve is located at the left front corner of the engine. When activated via the air injection relay, the normally closed solenoid valve opens to apply intake manifold vacuum to the air switching valve. The resistance of the solenoid coil is approximately 45 ohms.

AIR INJECTION SOLENOID VACUUM VALVE

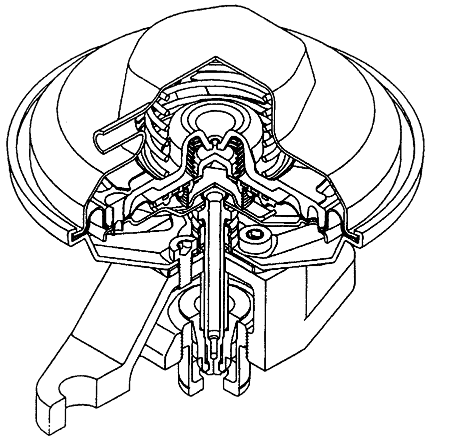


S90/2.25

EGR Valve

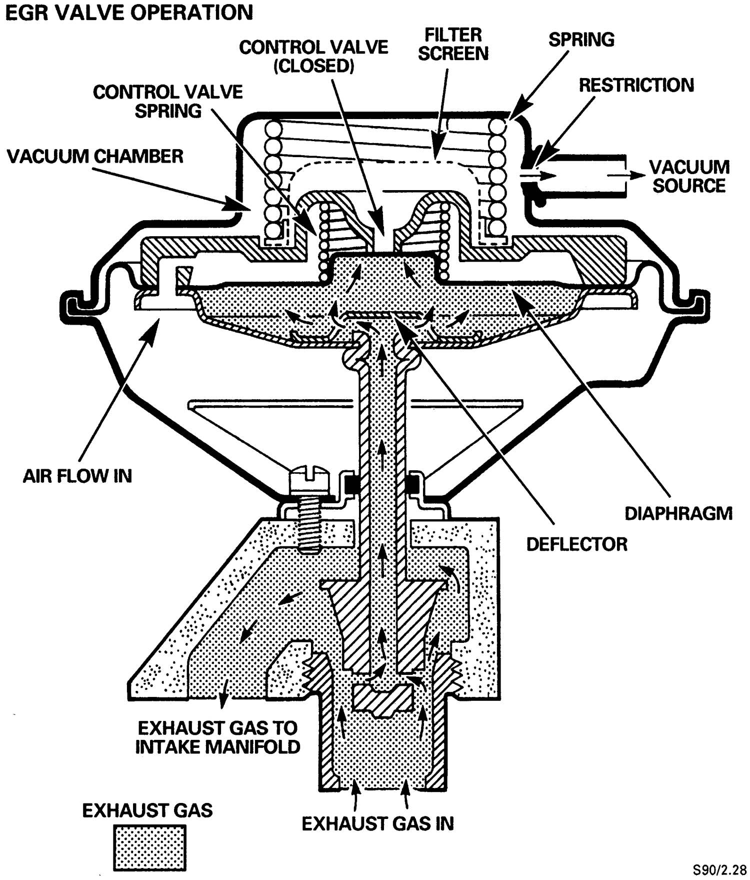
The EGR control valve is a "negative pressure" vacuum operated valve that compensates for exhaust back pressure. The amount of exhaust gas flow into the intake manifold varies depending on intake manifold vacuum and variations in exhaust back pressure. The valve diaphragm has an internal vacuum bleed hole that is held closed by a small spring when no exhaust back pressure exists. When vacuum is applied via the solenoid vacuum valve, the EGR valve opens against the pressure of the large spring. When intake manifold vacuum combines with negative exhaust back pressure, the vacuum bleed hole opens to close the valve.

EGR VALVE



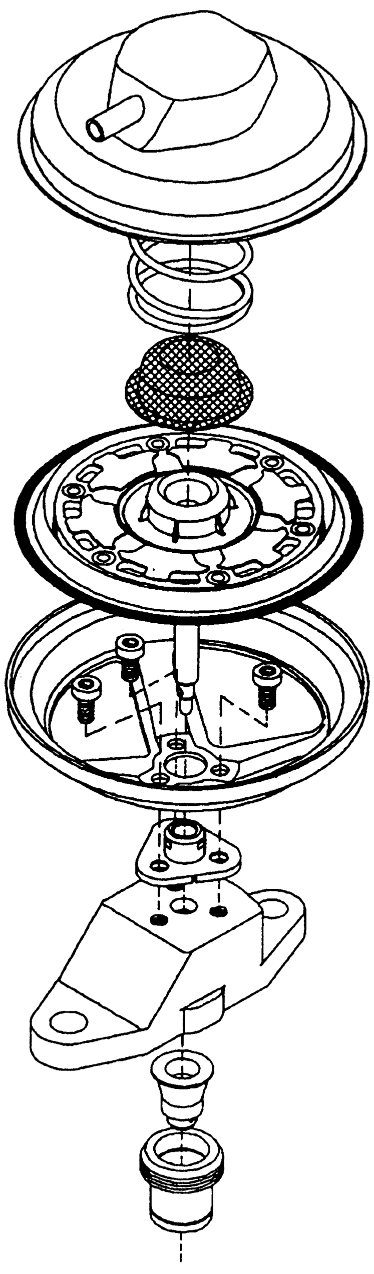
S90/2.27

EGR VALVE OPERATION



S90/2.28

EGR VALVE

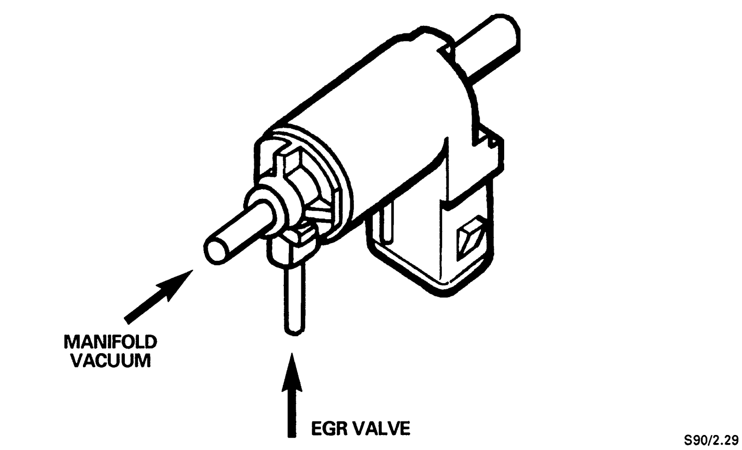


S90/2.26

EGR Solenoid Vacuum Valve

The EGR solenoid vacuum valve is located at the rear of the intake manifold. When activated by the ECM, the normally closed solenoid valve opens to apply intake manifold vacuum to the EGR valve. The resistance of the solenoid coil is approximately 45 ohms.

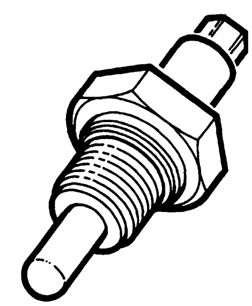
EGR SOLENOID VACUUM VALVE



EGR Temperature Sensor

The EGR sensor is a negative temperature coefficient (NTC) thermistor. NTC means that the resistance of the thermistor decreases as the sensed temperature increases. The ECM applies 5 volts to pin 1 of the sensor and monitors the voltage across the sensor pin to ground. The theoretical full voltage range is from 5 to 0 volts representing maximum cold to maximum hot. Typically, with the engine running at 2000 rpm, the sensor voltage will drop 0.1 volt when the EGR valve is opened.

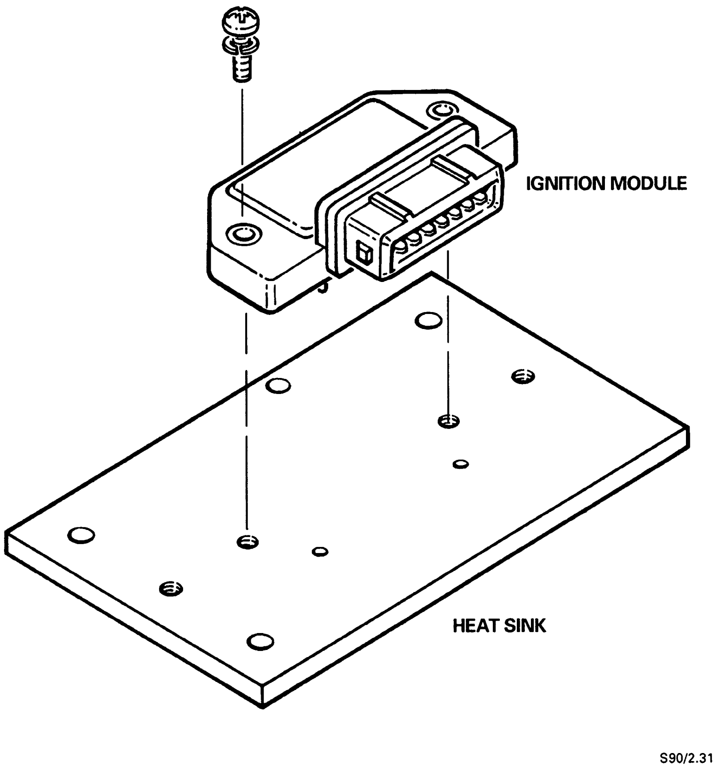
EGR TEMPERATURE SENSOR



EGR temperature sensor – temperature versus resistance :

Intake air temperature		Resistance
°F	°C	(kilo ohms)
122	50	600
212	100	90
302	150	11
392	200	5
482	250	2
572	300	0.8
662	350	0.3
752	400	0.1

IGNITION MODULE



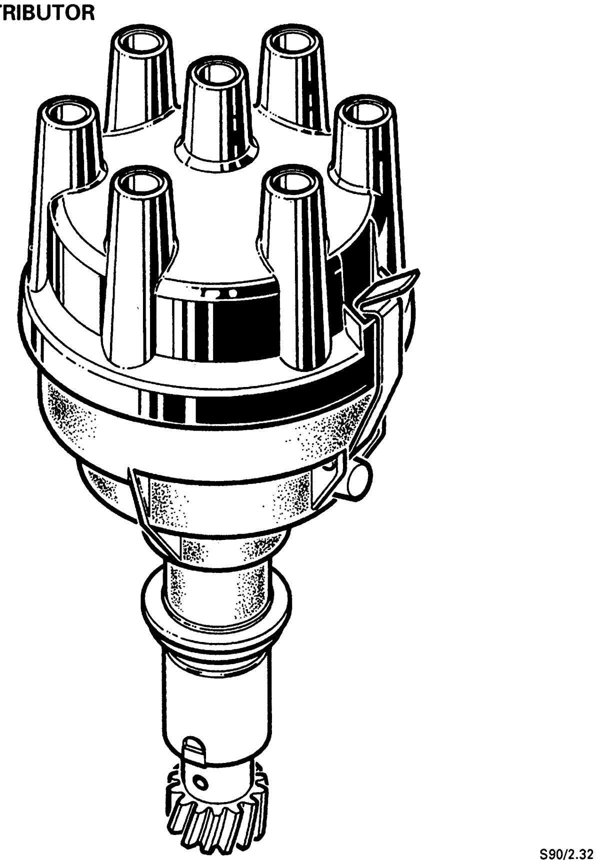
Ignition Module

The ignition module is controlled by the ECM output signal and switches the ignition coil primary circuit. The dwell angle and peak coil current is also controlled by the ignition module. A feature called "stall turn-off" is used to prevent coil overheating and battery discharge if the ignition is left on without the engine running.

NOTE: 1990 model year systems have a four-wire (plus ground) ignition module. 1991 ON model year systems have a three-wire (plus ground) ignition module. The modules are interchangeable.

The module is mounted to an aluminum heat sink plate. If the module and heat sink are separated, heat sink compound must be applied between the components upon reassembly.

IGNITION DISTRIBUTOR



Ignition Distributor

The distributor is a standard unit containing only a rotor arm and cap to distribute high voltage to the spark plugs. The distributor has no effect on ignition timing and can be considered as a simple rotating switch. It is necessary only to position the distributor for correct rotor-to-cap alignment at TDC.

Diagnostics

Diagnostics

Contents

Important Customer Information

Certain engine management faults cannot be successfully diagnosed and repaired without obtaining information about the fault from the customer. If necessary for the diagnosis of intermittent or unusual faults, obtain as much information as possible about the complaint condition using the Engine Management Customer Questionnaire as a guide.

JAGUAR SERVICE

ENGINE MANAGEMENT CUSTOMER QUESTIONNAIRE — S-90

Dealer Name: ____________________ **Service Advisor:** ____________________

Customer's Name:		Date of Repair:
VIN:	Model:	Mileage:

Please describe the conditions and symptoms when the problem occurred:

Date of occurrence:	
How often has the problem occurred?	☐ constantly _____ times per day/month ☐ once only ☐ other:
Ambient Temperature	☐ hot ☐ warm ☐ cool ☐ cold approx. temp. = °F
Weather Conditions	☐ dry ☐ humid ☐ rainy ☐ snow ☐ other:
Type of operation	☐ starting ☐ just after starting ☐ idle ☐ light throttle ☐ cruising ☐ acceleration ☐ deceleration ☐ coming to a stop ☐ pulling away from a stop ☐ other:
Driving conditions	☐ suburbs ☐ rough roads ☐ uphill ☐ downhill ☐ highway ☐ heavy traffic ☐ other:
Engine temperature	☐ cold ☐ normal ☐ warming up ☐ other:
Fuel level in tank	☐ full ☐ 3/4 ☐ 1/2 ☐ 1/4 ☐ very low!
CHECK ENGINE light	☐ was lit after start up ☐ lit while driving ☐ did not light
Does vehicle run well at all other times?	If no, describe other problems that have been experienced:

☐ Does not start	☐ does not crank ☐ cranks - does not fire ☐ fires - does not start
☐ Hard to start	☐ cranks slowly ☐ extended cranking (how long before start?): ☐ repeated starting attempts required (how many before start?):
☐ Bad idle	☐ rough idle ☐ too fast ☐ too slow ☐ incorrect idle RPM ☐ soon after start ☐ after driving ☐ always ☐ other:
☐ Driveability	☐ hesitation ☐ surging ☐ backfire ☐ run-on/detonation ☐ knocking/pinging ☐ low power ☐ other:
☐ Engine stalling	☐ stalls after start up ☐ shifting N to D ☐ during A/C operation ☐ stalls at idle ☐ maneuvering at low speed ☐ loses power then stalls ☐ stalls upon opening throttle ☐ upon closing throttle ☐ stalls at steady throttle: RPM= ☐ restarts immediately ☐ restarts after extended cranking ☐ will not restart ☐ restarts after a wait (how long?):

General Diagnostic Procedure

If the initial inspection and any subsequent repairs do not correct the problem, follow this general diagnostic procedure to determine the fault and correct the problem:

1 Record and clear all EMS DTCs.

Use JDS or PDU to retrieve and note all of the diagnostic trouble codes from the ECM memory. On 1993 and 1994 model year vehicles, JDS will print the number of failures that have been detected, as well as certain fault details (e.g.; intermittent or present, short circuit or open circuit). Record this information.

To clear the codes, use JDS or PDU. If the power supply to the ECM is disconnected, all DTCs are cleared and cannot be retrieved.

If JDS or PDU is not available, DTCs can be retrieved and cleared one by one using the DTC reset connector. Refer to the DTC Manual Reset Procedure on page 6.

2 Operate the vehicle and determine if the fault still exists.

Refer to the Engine Management Problem Questionnaire shown on page 3 and/or any applicable DTC Fault Diagnosis Procedures. Note the "Conditions required for DTC flagging". Operate the vehicle and try to reproduce the conditions that cause the complaint or DTC.

If a fault occurs or if a DTC is reflagged, the fault is still present and can probably be identified quickly using PDU or a DVOM to monitor the system while driving.

If a fault does not occur or if a DTC was originally stored and is not reflagged, the fault is intermittent. Visually inspect the systems and circuits listed as possible faults.

3 Test and repair the systems and circuits.

Refer to the Fault Finding Matrix on page 10 and/or the applicable Fault Diagnosis Procedures. Test the indicated systems or circuits. Use PDU while driving to check for dynamic faults. Determine the required repairs.

If more than one DTC is flagged, investigate the highest priority code first. Refer to the DTC list on page 8.

Test the suspect systems and components using the information provided.

Carry out repairs as necessary.

4 Retest the vehicle.

Upon completion of repairs, retest the vehicle as described in step 3 above.

JDS and PDU

JDS and PDU are diagnostic devices that interface with the engine management ECM through a data link connector. The use of either unit is essential for effective engine management diagnosis. In particular, oxygen sensor feedback can be accessed only using JDS or PDU.

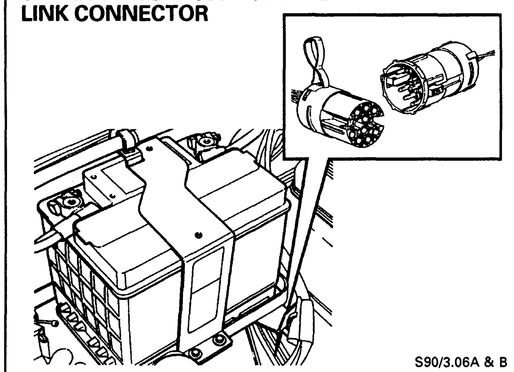
JDS is a stationary unit while PDU is portable. Both units interrogate the ECM and report flagged DTCs, read ECM inputs and outputs, and aid in engine setup and problem diagnosis. PDU includes a dynamic "datalogger" function that will monitor systems, store data and capture faults while driving. For 1993 MY ON vehicles, both units offer "expanded diagnostics", reporting conditions and number of occurrences for DTCs.

Data Link Connector

The data link connector connects the ECM to JDS and PDU for serial communication.

Sedan Range: 1990 – 1992 MY
The data link connector is a brown PM4 type located in the engine compartment, next to the battery.

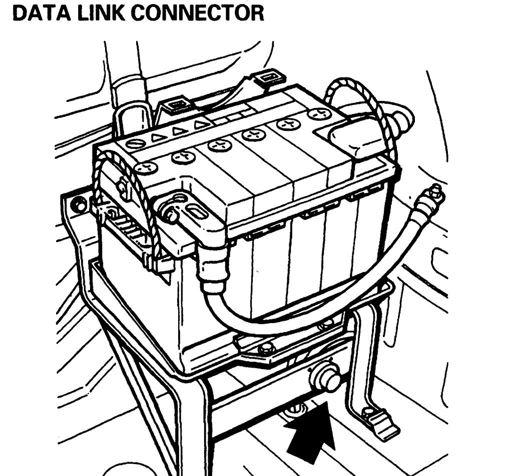
SEDAN RANGE 1990 – 92 MY DATA LINK CONNECTOR



S90/3.06A & B

Sedan Range: 1993 – 1994 MY
A special data link connector is located in the trunk, on the battery tray brace.

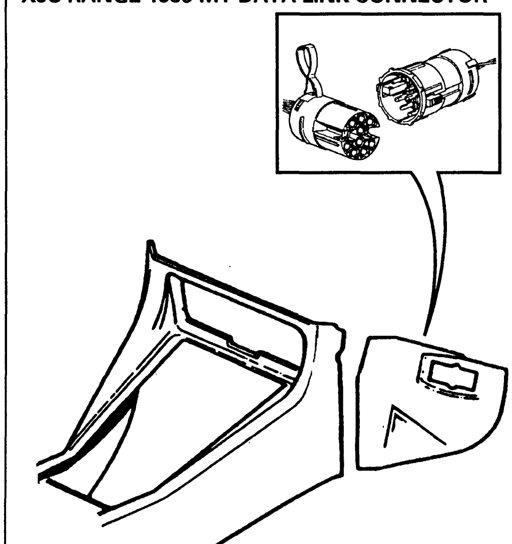
SEDAN RANGE 1993 – 94 MY DATA LINK CONNECTOR



S90/3.07

XJS Range: 1993 MY
The data link connector is a brown PM4 type located in the passenger side footwell, behind the center console panel.

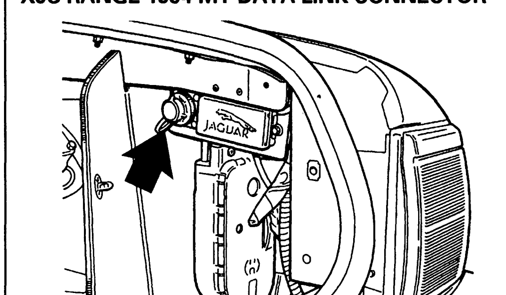
XJS RANGE 1993 MY DATA LINK CONNECTOR



S90/3.08A, B & C

XJS Range: 1994 MY
A special data link connector is located in the trunk, behind the right tail light trim panel.

XJS RANGE 1994 MY DATA LINK CONNECTOR



S90/3.09

CHECK ENGINE MIL

The CHECK ENGINE MIL (malfunction indicator lamp) will light for 5 seconds each time the ignition is switched ON to confirm that the bulb and the circuit are operating.

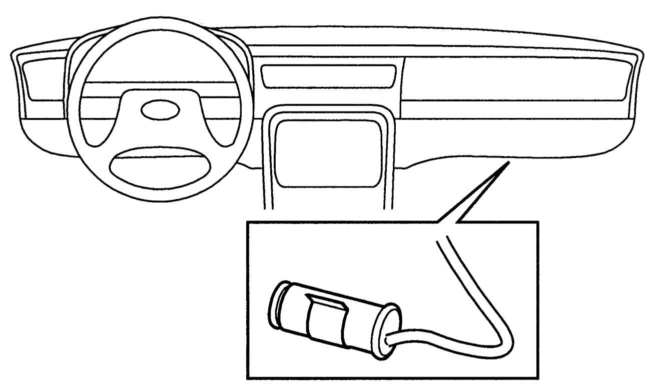
If the on-board diagnostic system detects an engine management fault, the CHECK ENGINE MIL will illuminate and one or more DTC(s) will be flagged by the ECM. The CHECK ENGINE MIL will remain illuminated until the fault is repaired and the ECM memory is cleared.

Only the highest priority DTC can be reported on the instrument pack display. To display the code, switch the ignition OFF; wait 5 seconds, then switch ON the ignition; do not crank the engine. On Sedan Range vehicles, press the VCM button. On XJS Range vehicles, a code is automatically displayed 5 seconds after the ignition is switched ON. If more than one code is flagged, the additional information can be accessed using JDS or PDU or with the DTC manual reset procedure.

DTC Manual Reset Procedure

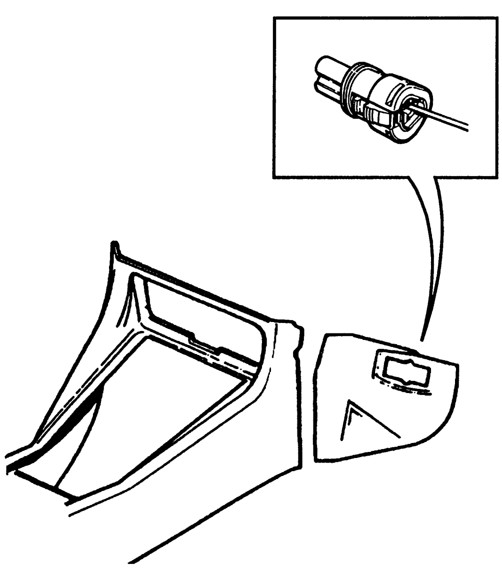
Without JDS or PDU, DTCs can be reported on the instrument pack display and cleared one by one using the following procedure:

SEDAN RANGE DTC RESET CONNECTOR



S90/3.10

XJS RANGE DTC RESET CONNECTOR



S90/3.11A, B & C

1 **Locate the DTC reset connector.**
Sedan Range – red male Econoseal connector with a KR (pink / red) wire, located behind the passenger side under dash panel.
XJS Range – purple male PM5 connector with a YG (yellow / green) wire, located behind the passenger side center console footwell panel.

2 **Record the highest priority DTC.**
Switch On the ignition. On Sedan Range vehicles, press the VCM button. On XJS Range vehicles, a code is automatically displayed 5 seconds after the ignition is switched ON. Record the code.

3 **Clear the highest priority DTC.**
To clear the code from the display and from the ECM memory, connect the wire in the DTC reset connector to ground for 3 seconds.

4 **Check for additional flagged DTCs.**
Check for additional codes by switching the ignition OFF for 5 seconds and repeating steps 2 and 3.

Diagnostic Trouble Codes (DTCs)

The available DTCs are listed in order of priority on the following table. Limp home default is available as indicated. When multiple faults occur, only the highest priority code will be displayed on the vehicle condition monitor.

DTC	Limp Home Default	Fault Area	JDS/PDU Description
29		ECM self test	Lucas injection ECM
44	X	Oxygen sensor circuit	HO2S / circuit
24		Ignition drive circuit	IA drive circuit
12	X	Mass air flow sensor circuit	Mass air flow sensor / circuit
33		Injector drive circuit	Fuel injector / circuit
34		Rich condition during overrun fuel cut-off	Fuel injector leakage
14	X	Coolant temperature sensor circuit	ETC Sensor / Circuit
17	X	Throttle position sensor circuit	TP potentiometer / circuit
18		Throttle position sensor and mass air flow sensor (high throttle pos. voltage; low air flow voltage)	TP / potentiometer / calibration 1
19		Throttle position sensor and mass air flow sensor (low throttle pos. voltage; high air flow voltage)	TP / potentiometer / calibration 2
89		Purge valve drive circuit	EVAP valve / circuit
26		Oxygen sensor feedback (lean)	Air leak
37		EGR drive circuit	EGR valve / circuit
39	X	EGR temperature sensor circuit	Exhaust gas temperature sensor
22		Fuel pump drive circuit	Fuel pump / HO2S relay / circuit
23		Oxygen sensor feedback (rich)	Fuel supply
46		Idle speed control valve (coil 1 drive circuit)	IACV circuit, coil 1
47		Idle speed control valve (coil 2 drive circuit)	IACV circuit, coil 2
48		Idle speed control valve	IACV position error
11	X	Idle fuel trim (1990 – 92 MY XJ6)	
68		Road speed sensor circuit	Vehicle speed sensor / wiring
69		Drive / Neutral input circuit	PNPS / circuit
16	X	Intake air temperature circuit	IAT Sensor / Circuit
66		Air injection pump drive circuit	AIR relay / circuit

Multiple diagnostic trouble codes
If the vehicle battery is disconnected, or the power fuse removed, all stored codes will be cleared from the ECM's memory.

Intermittent Faults

If intermittent faults occur, the primary suspect areas are connectors and wiring harness faults. In low current "sensor" circuits, connector pin corrosion is a particular concern. The simple action of breaking and remaking a connection may be sufficient to correct an intermittent fault. To test for intermittent faults that may be caused by vibration, manually shake wires and connectors, tap or shake components while performing diagnostic checks.

Use the PDU "Datalogger" function to monitor signals and capture faults while driving.

TYPICAL PDU DATALOGGER TRIGGER

PDU DATALOGGER TRIGGER

IT VOLTAGE ↑ **4.0 VOLTS**

Working Practice with a DVOM

Observe the following practices when using a DVOM for engine management diagnostic purposes.

Breaking and making ECM connections
Always switch the ignition OFF before breaking or making the ECM connections..

Resistance measurement
Before taking a resistance measurement, disconnect the component or the vehicle battery. Even a very low quiescent current will result in an incorrect resistance measurement.

Ground connection resistance
The ground connection resistance from a component to a known good chassis ground point should be less than 1 ohm.

Voltage measurements
Voltage measurements are made with the DVOM negative probe connected to a known good chassis ground point, unless noted otherwise.

Back probe when making voltage measurements
When making voltage measurements, do not disconnect components unless noted otherwise. Instead, back probe terminals while they are still connected to the components.

To "back probe" a connector, first pull back the connector cover (if present). Then, insert the DVOM measurement probe into the backside of the terminal block until the probe touches the terminal pin. In a terminal pin is difficult to reach, switch the ignition OFF, unplug the connector and insert the probe to the backside of the terminal block until the probe touches the terminal pin. Then, plug in the connector. A bent paper clip can reach a terminal pin in a tight area. Switch the ignition ON and take the voltage measurement

⚠ CAUTION: Do not probe through wire to connector seals or through wire insulation. Doing so may damage the conductor and/or cause corrosion damage at a later date.

Inspecting connectors
When inspecting block type connectors, unplug the connector and carefully inspect for pins that are bent, pushed back, corroded or spread open. Remove suspect terminals from the connector block for closer inspection.

Inadvertent DTC flagging
If components are disconnected when the ignition is ON, a DTC may be inadvertently flagged.

Fault Finding Matrix: Symptoms and Suspected Problem Areas

When there is a driveability complaint but no DTC, identify suspected problem areas on the following matrix. Investigate the lowest numbered areas first.

SYMPTOM	SUSPECTED PROBLEM AREA														
	STARTER CIRCUIT / BATTERY	SECURITY SYSTEM	PARK / NEUTRAL SIGNALS	EMS ECM POWER / GROUND	FUEL PRESSURE	INJECTOR DELIVERY	CRANKSHAFT SENSOR / CIRCUIT	IGNITION PRIMARY CIRCUIT	IGNITION SECONDARY CIRCUIT	DISTRIBUTOR OR HT LEAD POSITION	IACV SETTING CIRCUIT	TPS SETTING / CIRCUIT	MAF SENSOR/ CIRCUIT	EGR SYSTEM	ENGINE MECHANICAL FAULT*
ENGINE DOES NOT CRANK	1	3	2												4
ENGINE CRANKS / DOES NOT START				2	1	5	3	4		6					7
HARD START: COLD	2 BATTERY				1	4			5		3				6
HARD START: NORMAL					1		4	2	3						5
IDLE FLARE AFTER START	1 BATTERY			2							3				
HIGH IDLE			2								1				3
LOW IDLE			2								1			3	4
ROUGH OR UNSTABLE IDLE						3			5		2		4	1	
STALLS AFTER START				3	1						2				
STALLS WHILE DRIVING**				1	6			2	3		5		4		
LACKS ENGINE BRAKING											2	1			3
SURGING / MISFIRE					1	7	5	6	3	4				2	8
LOW ENGINE POWER					1	5				4				2	3

* Engine mechanical faults: Check throttle valve operation, catalytic converter (blockage), engine compression, crankshaft timing, cylinder pressure leakdown.

** Refer to Diagnostic Procedure: Engine Stalling Condition, page 66.

Vehicle Initial Inspection

The cause of a driveability complaint or Diagnostic Trouble Code (DTC) can often be found and repaired quickly by performing a thorough initial inspection. The initial inspection should include the following:

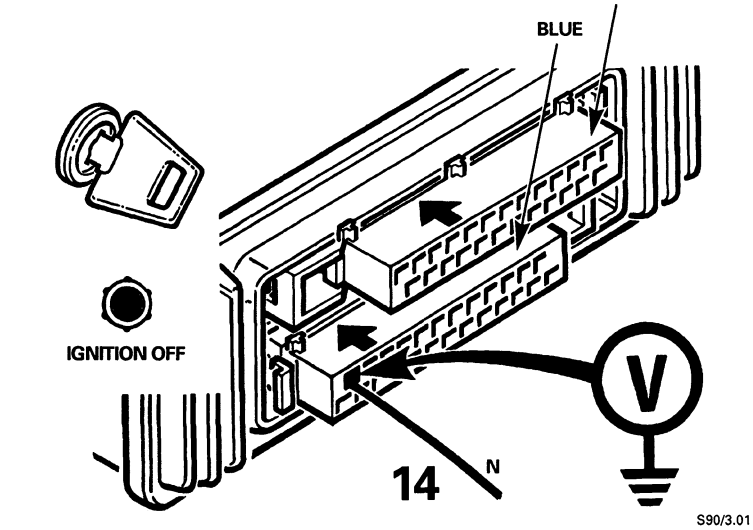
- ☐ Check the battery state of charge; perform a battery load test to ensure that battery performance is satisfactory.

  NOTE: If the CHECK ENGINE MIL is illuminated, DTCs must be retrieved prior to disconnecting the vehicle battery.

- ☐ Check the battery connections; clean and remake as necessary.
- ☐ Visually check for disconnected wires to the engine management input and output components.
- ☐ Visually check the engine management system for chaffed wire insulation or bare wires.
- ☐ Check for loose or corroded ground connections at the bulkhead stud and at the intake manifold stud.
- ☐ Check for loose or corroded engine ground strap connections.
- ☐ Check the ECM connector pins for corrosion. Switch off the ignition and disconnect the yellow and blue ECM connectors. Clean the connector and ECM pins. Spray the ECM pins with JLM 11472. Reconnect the connectors.

Vehicle Initial Inspection (continued)

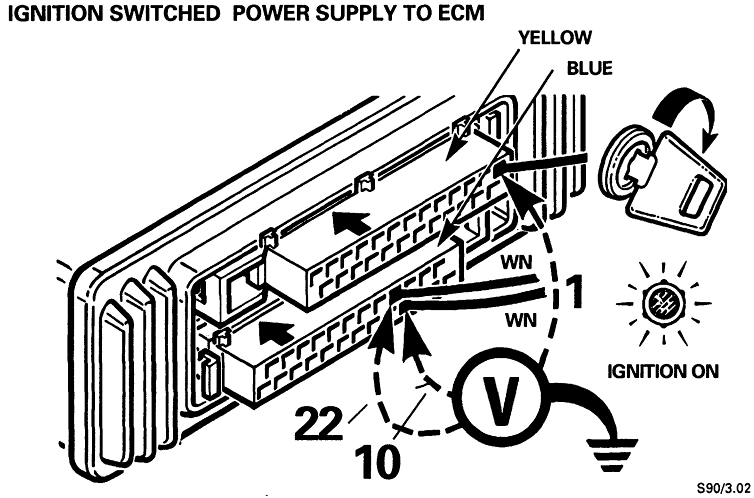
DIRECT BATTERY POWER SUPPLY TO ECM



☐ Test the engine management system ECM power supplies and ground connections:

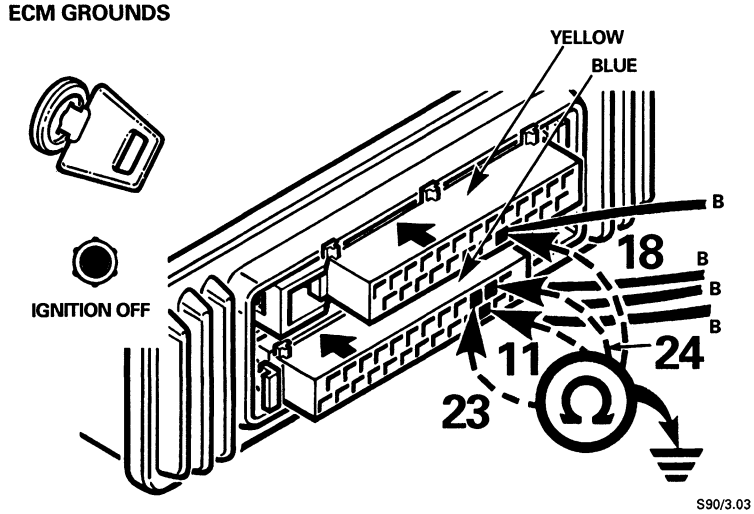
1 Direct battery power is supplied to the ECM through the blue connector pin 14. Test the voltage at pin 14 by back probing the blue connector with a voltmeter. If battery voltage is present, proceed to the next step; if the voltage reading is zero, troubleshoot the circuit between the battery and the ECM. Refer to the wiring diagrams in the REFERENCE section.

IGNITION SWITCHED POWER SUPPLY TO ECM



2 Ignition switched power is supplied to the ECM through the yellow connector pin 1 and through the blue connector pins 10 and 22. Test the voltage at yellow pin 1 and blue pins 10 and 22 by switching ON the ignition and back probing the three pins with a voltmeter. Battery voltage should be present and the readings should be within 200 mV of the reading from Step 1 above. If correct voltage is present, proceed to the next step; if the voltage reading is incorrect, troubleshoot the circuit between the battery, ignition switch and the ECM. Refer to the wiring diagrams in the REFERENCE section.

ECM GROUNDS



3 Ground connection between the ECM, the engine and the chassis varies by the vehicle model year and between the XJ6 Sedan Range and XJS Range models. Refer to the wiring diagrams in the Reference section. The ECM grounds are made at the yellow connector pin 18 and at the blue connector pins 11, 23 and 24. Disconnect the battery and test the ground connections at yellow pin 18 and blue pins 11, 23 and 24 by back probing the four pins with an ohm meter. If the reading is zero ohms, ground connection is complete; if resistance is indicated, troubleshoot the ground circuit.

Additional checks for driveability complaints or DTCs related to fuel metering should include the following:

☐ Check the air filter condition.

☐ Check the fuel pressure:

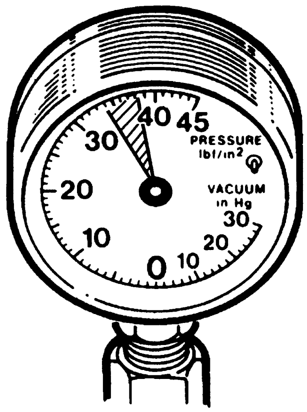
1 Depressurize the fuel delivery system by running the engine and removing the fuel pump relay. When the engine stops, switch OFF the ignition and reinstall the relay. During this step, DTC 22 will flag.

2 "Tee" the fuel pressure gauge into the system at the inlet hose to the fuel rail. Restart the engine and observe the fuel pressure with the manifold vacuum hose connected to and disconnected from the fuel pressure regulator. Normal fuel pressure:

34 – 38 psi at idle	(vacuum connected to fuel pressure regulator)
42 – 45 psi	(vacuum disconnected from fuel pressure regulator)

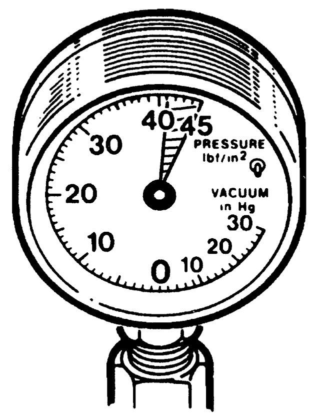
NORMAL FUEL PRESSURE

34 – 38 PSI



IDLE, VACUUM CONNECTED

42 – 45 PSI



VACUUM DESCONNECTED

S90/3.04A & B

3 Switch OFF the ignition and observe the gauge for a drop in fuel pressure.

Maximum pressure drop – 10 psi in the first minute

If the pressure drop exceeds 10 psi in the first minute, suspect the following:

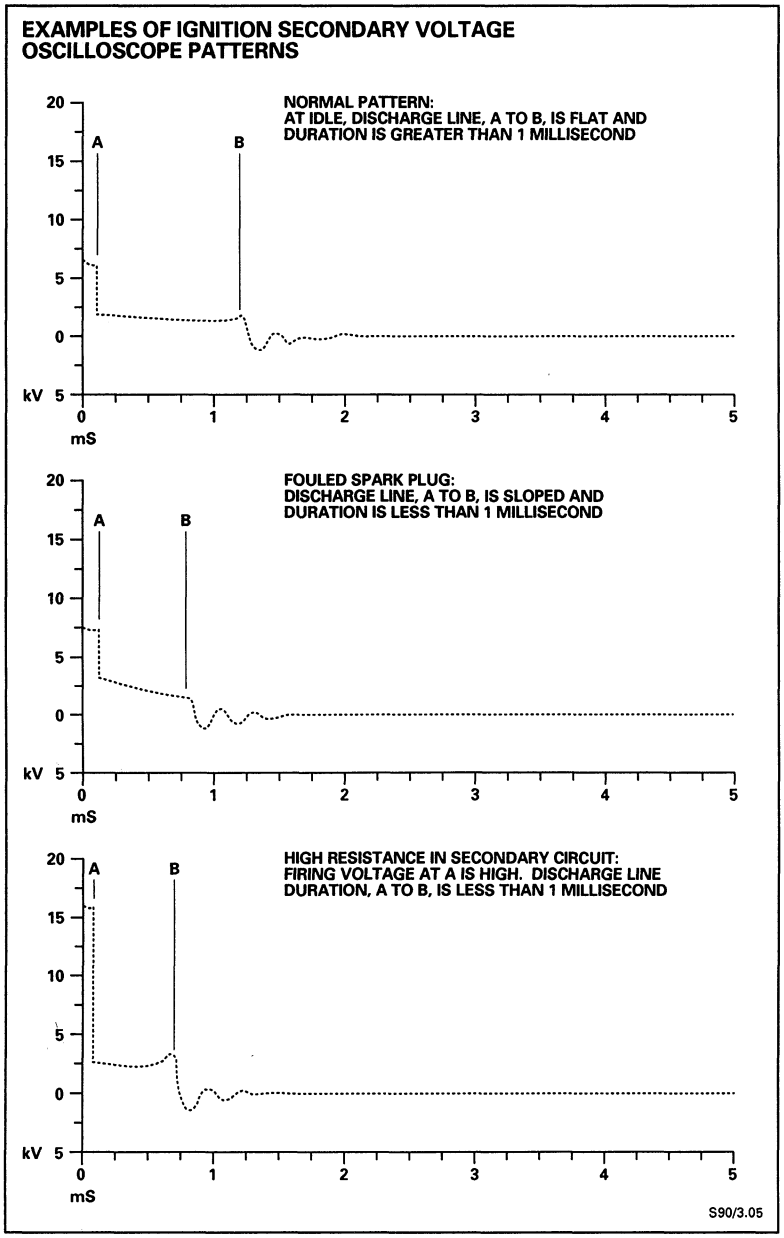
- Fuel pressure regulator
- External fuel pump check valve (1990 MY)
- Fuel tank internal pump hoses and connections (1991 MY ON)
- Injector leakage

4 Clear DTC 22. Refer to GENERAL DIAGNOSTIC PROCEDURE, page 4.

Vehicle Initial Inspection (continued)

☐ Check for water in the fuel.

☐ Check the ignition oscilloscope pattern. A fault in the ignition system secondary circuit will usually cause an engine misfire. Use these examples of ignition secondary voltage oscilloscope patterns as a guide to diagnosing the problem:



☐ Correct, repair and/or replace defective components as necessary, then road test the vehicle to check for a reoccurring problem.

Diagnostic Procedures Directory

DTC 11 IDLE FUEL TRIM POTENTIOMETER AND CIRCUIT

The ECM looks for the idle trim potentiometer signal voltage to be out of the normal operating range.

On 1990 – 92 MY vehicles, the idle trim potentiometer is used to adjust the ECM mapped injector pulse duration at idle. This adjustment enables the feedback system to operate around the same fueling baseline on any particular engine. The trim adjustment is set to obtain an oxygen sensor feedback value of 2 – 3 volts at idle. Typically, the idle trim voltage is between 1 and 4 volts. The potentiometer is located in the mass air flow sensor (MAFS) (air mass meter). The idle trim potentiometer is not used for 1993 ON model years.

CONDITIONS REQUIRED FOR DTC 11 FLAGGING:

Throttle position .... Closed (idle position)

Idle trim potentiometer
signal voltage to ECM .... Greater than 4.0 volts

Monitoring .... Any time during ignition ON

Response time .... 8 milliseconds

LIMP HOME DEFAULT:

If DTC 11 is flagged, no correction is applied to the injector pulse duration at idle.

POSSIBLE FAULTS:

- Open circuit wiring from the ECM to the MAFS
- Open circuit potentiometer within the MAFS
- Incorrect ECM part number
- Incorrect MAFS part number

DIAGNOSTIC NOTES:

1 The idle trim voltage can be monitored and intermittent faults captured using the PDU "Datalogger" function.

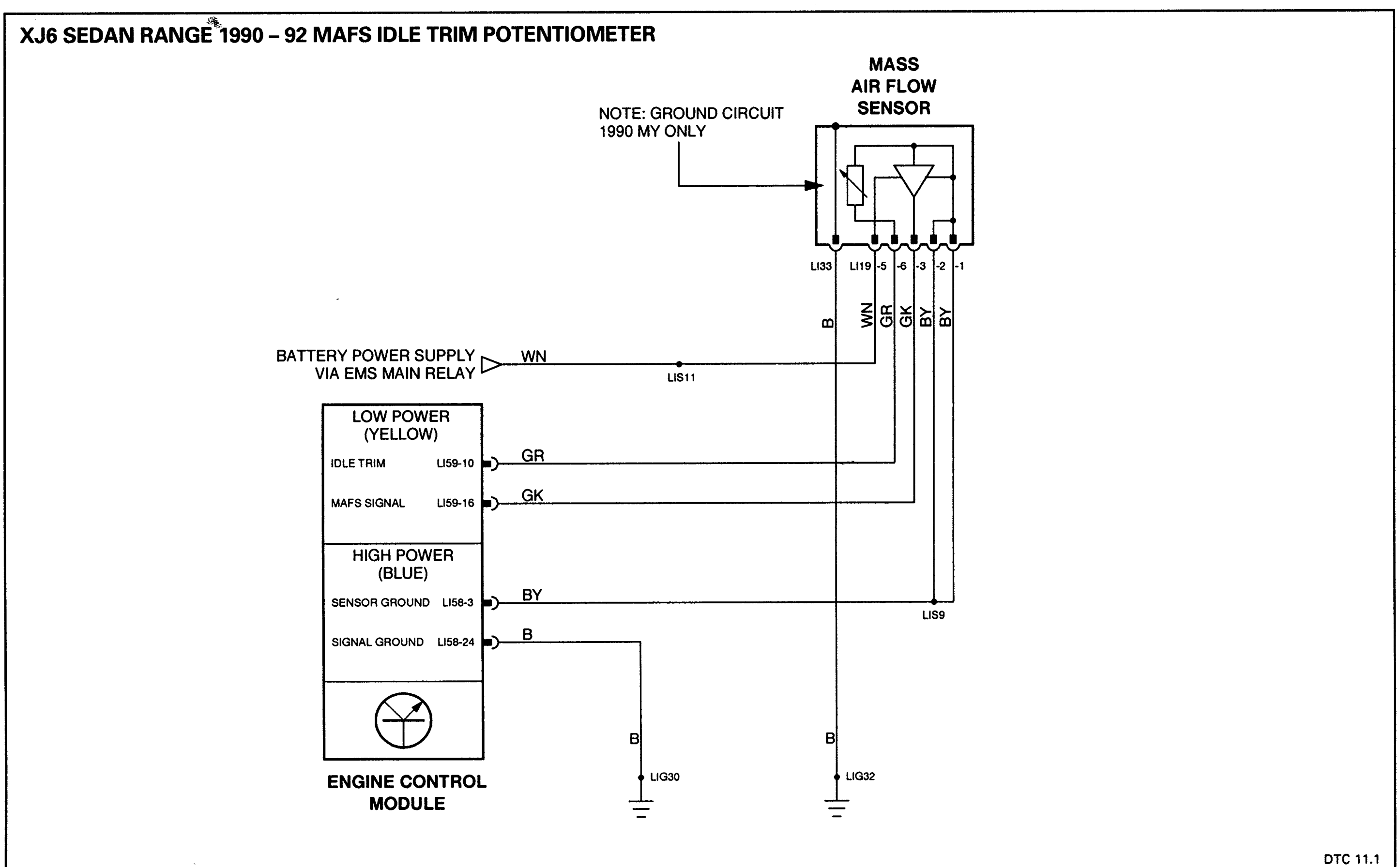
PDU DATALOGGER TRIGGER

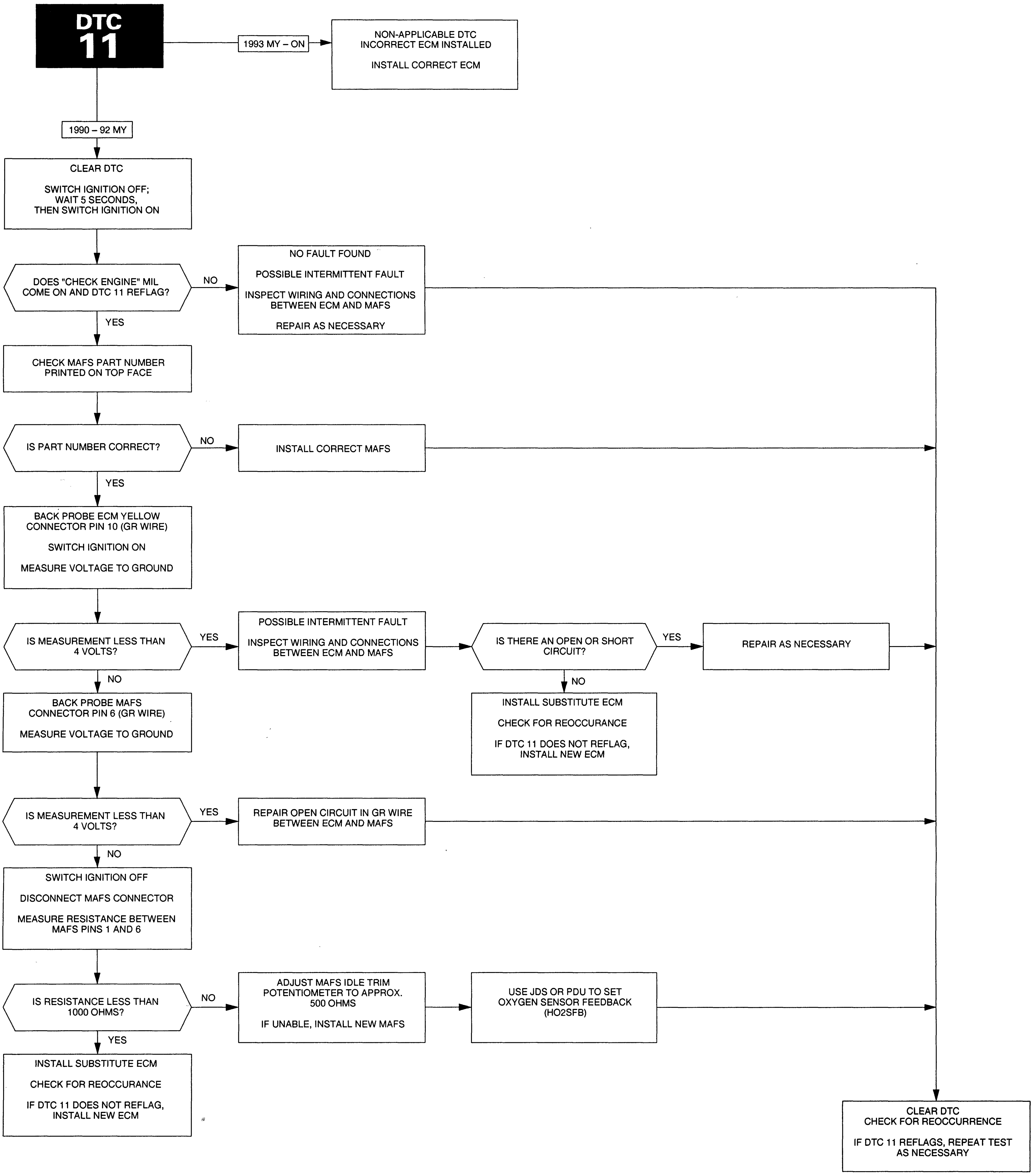
IT VOLTAGE	↑ 4.0 VOLTS

2 If DTC 12, 14, 16, 18, 19 and/or 39 are also flagged, suspect a defective sensor ground circuit to the ECM (BY wire) or defective ECM ground circuit to the front bulkhead ground stud.

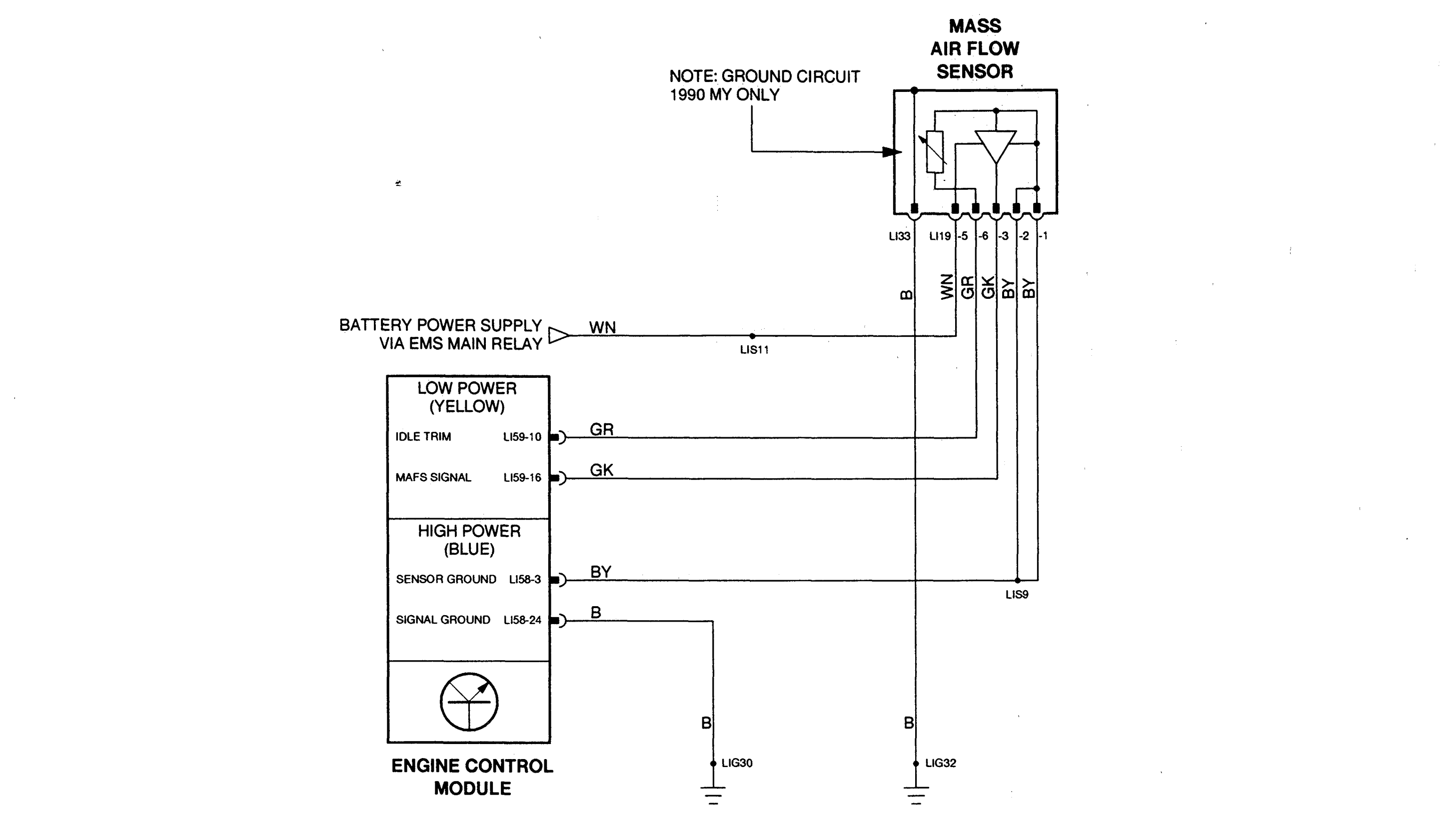
3 The idle trim potentiometer has an adjustable range of approximately 10 to 1000 ohms, measured between pins 1 and 6 on the MAFS. The potentiometer can be adjusted after the anti-tamper plug is removed from the side of the MAFS.

CIRCUIT DIAGRAM



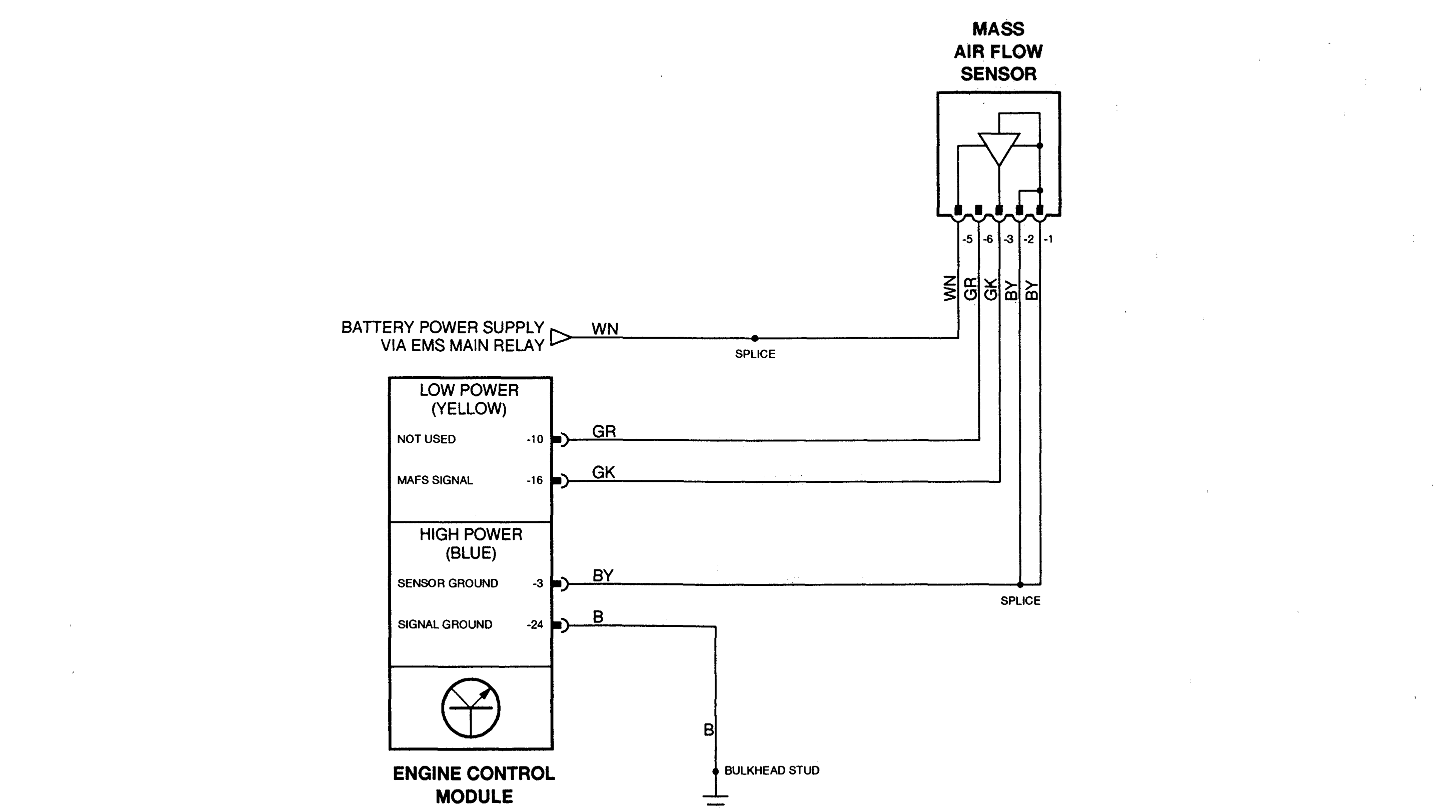

DTC 11
1993 MY – ON
NON-APPLICABLE DTC
INCORRECT ECM INSTALLED
INSTALL CORRECT ECM
1990 – 92 MY
CLEAR DTC
SWITCH IGNITION OFF; WAIT 5 SECONDS, THEN SWITCH IGNITION ON
DOES "CHECK ENGINE" MIL COME ON AND DTC 11 REFLAG?
NO
NO FAULT FOUND
POSSIBLE INTERMITTENT FAULT
INSPECT WIRING AND CONNECTIONS BETWEEN ECM AND MAFS
REPAIR AS NECESSARY
YES
CHECK MAFS PART NUMBER PRINTED ON TOP FACE
IS PART NUMBER CORRECT?
NO
INSTALL CORRECT MAFS
YES
BACK PROBE ECM YELLOW CONNECTOR PIN 10 (GR WIRE)
SWITCH IGNITION ON
MEASURE VOLTAGE TO GROUND
IS MEASUREMENT LESS THAN 4 VOLTS?
YES
POSSIBLE INTERMITTENT FAULT
INSPECT WIRING AND CONNECTIONS BETWEEN ECM AND MAFS
IS THERE AN OPEN OR SHORT CIRCUIT?
YES
REPAIR AS NECESSARY
NO
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 11 DOES NOT REFLAG, INSTALL NEW ECM
NO
BACK PROBE MAFS CONNECTOR PIN 6 (GR WIRE)
MEASURE VOLTAGE TO GROUND
IS MEASUREMENT LESS THAN 4 VOLTS?
YES
REPAIR OPEN CIRCUIT IN GR WIRE BETWEEN ECM AND MAFS
NO
SWITCH IGNITION OFF
DISCONNECT MAFS CONNECTOR
MEASURE RESISTANCE BETWEEN MAFS PINS 1 AND 6
IS RESISTANCE LESS THAN 1000 OHMS?
NO
ADJUST MAFS IDLE TRIM POTENTIOMETER TO APPROX. 500 OHMS
IF UNABLE, INSTALL NEW MAFS
USE JDS OR PDU TO SET OXYGEN SENSOR FEEDBACK (HO2SFB)
YES
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 11 DOES NOT REFLAG, INSTALL NEW ECM
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 11 REFLAGS, REPEAT TEST AS NECESSARY

MASS AIR FLOW SENSOR: 1990 – 92 XJ6 SEDAN RANGE



DTC 12.1

MASS AIR FLOW SENSOR: ALL VEHICLES 1993 – 94 MY



NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION.

DTC 12.2

DTC 12 MASS AIR FLOW SENSOR CIRCUIT

The ECM looks for the mass air flow sensor (MAFS) load signal to be out of the normal operating range.

The mass air flow sensor load signal is used by the ECM as one of the two primary inputs for determining fuel metering and ignition timing. A 12 volt supply to the MAFS provides power for the heated sensor and circuitry. The load signal voltage responds to air flow through the sensor and normally varies between 1 and 4 volts; the higher the voltage, the higher the load.

The ECM will flag DTC 12 if the MAFS signal voltage is not between 0.2 – 4.5 volts in the engine speed range 400 – 3000 rpm.

CONDITIONS REQUIRED FOR DTC 12 FLAGGING:

Engine speed range .... 400 – 3000 rpm
MAFS voltage signal to ECM .... Less than 0.2 or greater than 4.5 volts
Response time .... 5 consecutive engine revolutions

LIMP HOME DEFAULT:

If DTC 12 is flagged, throttle position is substituted for engine load. Throttle position and engine speed become the primary control inputs for fuel metering. A single ignition timing value is used.

POSSIBLE FAULTS:

- Unmodified EMS main relay (1993 MY); Refer to Technical Bulletin 18-36
- Open or short circuit wiring from the ECM to the MAFS
- High resistance circuit wiring or connector from the ECM to the MAFS
- Open circuit wiring from main relay power (splice) to MAFS
- Defective MAFS

DIAGNOSTIC NOTES:

1 The MAFS signal voltage can be monitored and intermittent faults captured using the PDU "Datalogger" function.

PDU DATALOGGER TRIGGERS

MAF VOLTAGE	↑	**4.5 VOLTS**
	↓	**0.2 VOLT**

2 1990 model year vehicles with MAFS part no. EAC 6215 have a black ground wire connected at the stud on the MAFS body. From 1991 model year, the ground wire is not used. If the later MAFS is used on a 1990 model year vehicle, the ground lead can be eliminated.

3 If DTC 11, 14, 16, 18, 19 and/or 39 are also flagged, suspect a defective sensor ground circuit to the ECM (BY wire) or defective ECM ground circuit to the front bulkhead ground stud.

4 1993 MY XJ6 Sedan and XJS vehicles: refer to Technical Bulletin 18-36 for diagnosis of incorrect DTC 12 flagging.

MAFS TEST 1: ENGINE LOAD – IDLE

- Run the engine at normal idle speed; normal operating temperature; select NEUTRAL; air conditioning OFF.
- Use an approved DVOM or monitor the PDU MAF signal to measure the mass air flow sensor signal voltage at the ECM. Use only an approved DVOM to measure the mass air flow sensor signal voltage at the MAFS.
- Back probe the connector pin as directed on the diagnostic flow chart.
- The typical voltage measured should be 1.20 - 1.50 volts.

MAFS TEST 2: ENGINE LOAD – HIGH

This test requires two technicians.

⚠CAUTION: The test must not last longer than 5 seconds. Always allow the engine to idle for at least two minutes between tests to allow the transmission to cool. Do not carry out more than three tests without allowing the engine to cool down for at least half an hour.

- Chock the road wheels and firmly apply both foot and hand brake.
- Run the engine at normal idle speed; select neutral; air conditioning OFF.
- Use an approved DVOM or monitor the PDU MAF signal to measure the mass air flow sensor signal voltage at the ECM. Use only an approved DVOM to measure the mass air flow sensor signal voltage at the MAFS.
- Back probe the connector pin as directed on the diagnostic flow chart.
- Select DRIVE; while firmly pressing the brake pedal, apply full throttle and note the mass air flow sensorsignal voltage at the ECM.

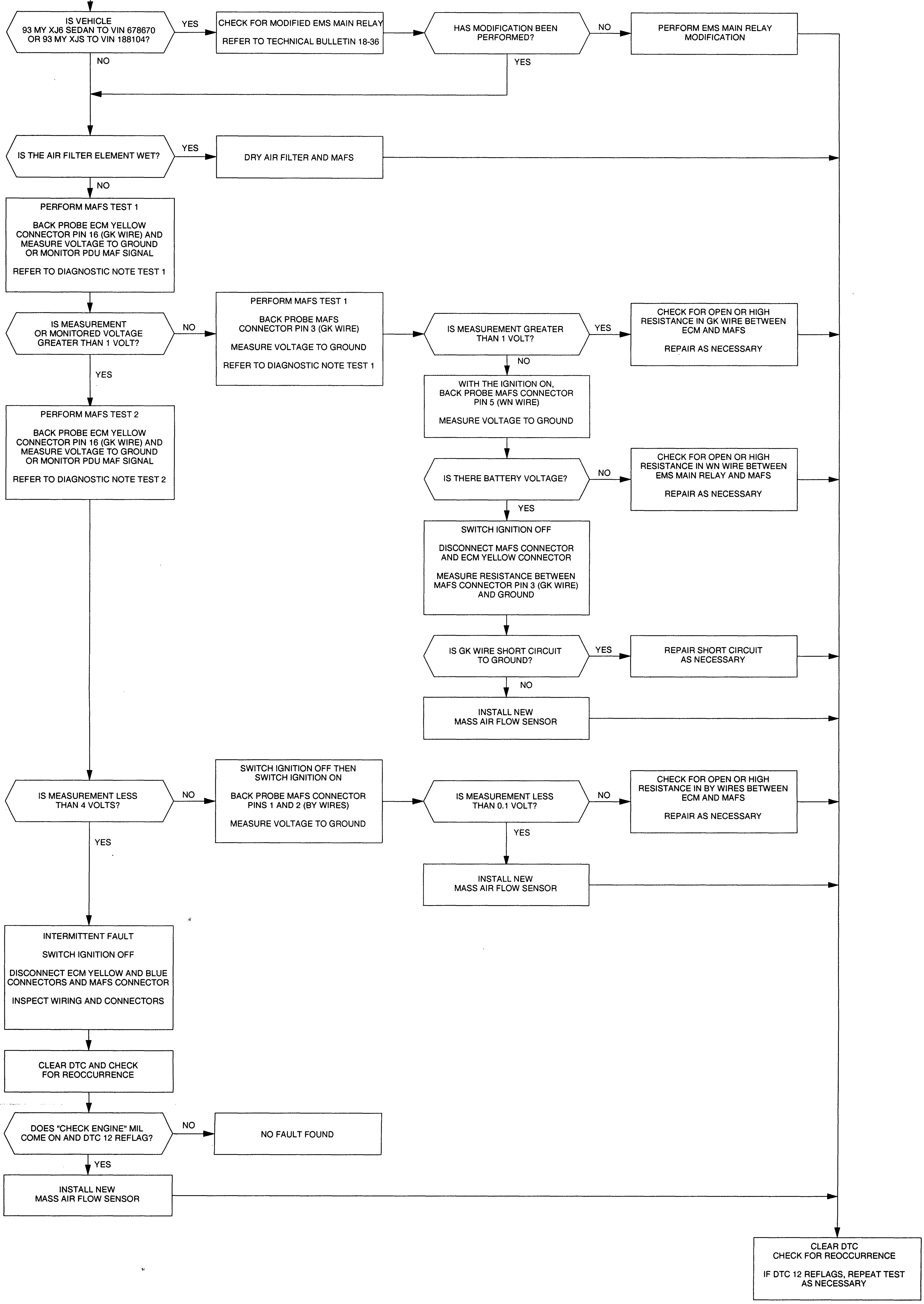
  The typical voltage measured should be 3.00 - 3.30 volts.

NOTE: The voltage readings given are typical for an engine in good condition. Ambient, elevation and/or barometric conditions will effect the readings obtained.

A known good MAFS should be used as a comparison before the MAFS being tested is condemned as defective.

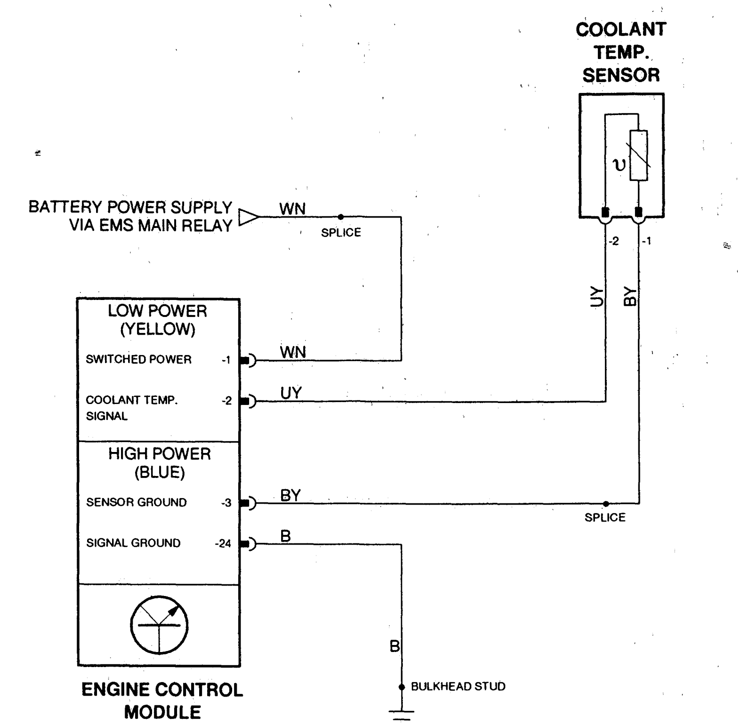
Continued at left on foldout page.

DTC 12



IS VEHICLE
93 MY XJ6 SEDAN TO VIN 678670
OR 93 MY XJS TO VIN 188104?
YES
CHECK FOR MODIFIED EMS MAIN RELAY
REFER TO TECHNICAL BULLETIN 18-36
HAS MODIFICATION BEEN
PERFORMED?
NO
PERFORM EMS MAIN RELAY
MODIFICATION
YES
NO
IS THE AIR FILTER ELEMENT WET?
YES
DRY AIR FILTER AND MAFS
NO
PERFORM MAFS TEST 1
BACK PROBE ECM YELLOW
CONNECTOR PIN 16 (GK WIRE) AND
MEASURE VOLTAGE TO GROUND
OR MONITOR PDU MAF SIGNAL
REFER TO DIAGNOSTIC NOTE TEST 1
IS MEASUREMENT
OR MONITORED VOLTAGE
GREATER THAN 1 VOLT?
NO
PERFORM MAFS TEST 1
BACK PROBE MAFS
CONNECTOR PIN 3 (GK WIRE)
MEASURE VOLTAGE TO GROUND
REFER TO DIAGNOSTIC NOTE TEST 1
IS MEASUREMENT GREATER
THAN 1 VOLT?
YES
CHECK FOR OPEN OR HIGH
RESISTANCE IN GK WIRE BETWEEN
ECM AND MAFS
REPAIR AS NECESSARY
NO
WITH THE IGNITION ON,
BACK PROBE MAFS CONNECTOR
PIN 5 (WN WIRE)
MEASURE VOLTAGE TO GROUND
YES
PERFORM MAFS TEST 2
BACK PROBE ECM YELLOW
CONNECTOR PIN 16 (GK WIRE) AND
MEASURE VOLTAGE TO GROUND
OR MONITOR PDU MAF SIGNAL
REFER TO DIAGNOSTIC NOTE TEST 2
IS THERE BATTERY VOLTAGE?
NO
CHECK FOR OPEN OR HIGH
RESISTANCE IN WN WIRE BETWEEN
EMS MAIN RELAY AND MAFS
REPAIR AS NECESSARY
YES
SWITCH IGNITION OFF
DISCONNECT MAFS CONNECTOR
AND ECM YELLOW CONNECTOR
MEASURE RESISTANCE BETWEEN
MAFS CONNECTOR PIN 3 (GK WIRE)
AND GROUND
IS GK WIRE SHORT CIRCUIT
TO GROUND?
YES
REPAIR SHORT CIRCUIT
AS NECESSARY
NO
INSTALL NEW
MASS AIR FLOW SENSOR
IS MEASUREMENT LESS
THAN 4 VOLTS?
NO
SWITCH IGNITION OFF THEN
SWITCH IGNITION ON
BACK PROBE MAFS CONNECTOR
PINS 1 AND 2 (BY WIRES)
MEASURE VOLTAGE TO GROUND
IS MEASUREMENT LESS
THAN 0.1 VOLT?
NO
CHECK FOR OPEN OR HIGH
RESISTANCE IN BY WIRES BETWEEN
ECM AND MAFS
REPAIR AS NECESSARY
YES
INSTALL NEW
MASS AIR FLOW SENSOR
YES
INTERMITTENT FAULT
SWITCH IGNITION OFF
DISCONNECT ECM YELLOW AND BLUE
CONNECTORS AND MAFS CONNECTOR
INSPECT WIRING AND CONNECTORS
CLEAR DTC AND CHECK
FOR REOCCURRENCE
DOES "CHECK ENGINE" MIL
COME ON AND DTC 12 REFLAG?
NO
NO FAULT FOUND
YES
INSTALL NEW
MASS AIR FLOW SENSOR
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 12 REFLAGS, REPEAT TEST
AS NECESSARY

COOLANT TEMPERATURE SENSOR: ALL VEHICLES AND MODEL YEARS



NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION. DTC 14.1

DTC 14 COOLANT TEMPERATURE SENSOR AND CIRCUIT

The ECM looks for the coolant temperature sensor signal voltage out of range.

The coolant temperature sensor is a negative temperature coefficient sensor; the higher the temperature, the lower the resistance. The sensor is located on top of the thermostat housing.

COOLANT TEMPERATURE SENSOR – TEMPERATURE VERSUS RESISTANCE:

Coolant temperature °F	°C	Resistance (kilo ohms)
14	-10	9.20
32	0	5.90
50	10	3.70
68	20	2.50
86	30	1.70
104	40	1.18
122	50	0.84
140	60	0.60
158	70	0.435
176	80	0.325
193	90	0.25
212	100	0.19

COOLANT TEMPERATURE SENSOR – TEMPERATURE VERSUS TYPICAL APPROXIMATE VOLTAGE:

Coolant temperature °F	°C	Voltage (measured at ECM Yellow connector pin 2 or sensor pin 2)
-18	-30	4.64
-4	-20	4.39
14	-10	4.05
32	0	3.64
59	15	2.89
78	25	2.42
86	30	2.20
95	35	1.98
104	40	1.78
113	45	1.62
122	50	1.44
140	60	1.17
158	70	0.95
176	80	0.78
193	90	0.65
212	100	0.55

The coolant temperature sensor signal is used by the ECM for the control of a number of functions:

- Cranking enrichment
- Warm-up enrichment
- Acceleration enrichment
- Air injection
- Idle speed control
- Exhaust gas recirculation
- Evaporative canister purge

The signal voltage is monitored three ways: (1) Coolant temperature rise after engine cold start; (2) Coolant temperature decrease during engine normal temperature operation; (3) Signal voltage outside the normal coolant temperature sensor operating range.

CONDITIONS REQUIRED FOR DTC 14 FLAGGING:

1 After cold start
   - Engine condition .... After start warm-up
   - Coolant temp. sensor voltage signal to ECM .... 3.53 volts or less
   - Response time .... 6 minutes

2 Normal operating temperature
   - Engine condition .... Normal operating temperature
   - Coolant temp. sensor voltage signal to ECM .... Voltage decrease of 0.7 volt or greater
   - Response time .... 196 milliseconds

3 Normal coolant temperature sensor operating range
   - Coolant temp. sensor voltage signal to ECM .... Less than 0.1 volt or greater than 4.9 volts
   - Conditions monitored .... Any time during ignition ON
   - Response time .... 64 milliseconds

LIMP HOME DEFAULT:

If DTC 14 is flagged, the warm-up strategy defaults to a trim value of 80°F (26°C). Start and after-start values are used that allow the engine to be started over a wide temperature range.

POSSIBLE FAULTS:

- High resistance connection at coolant temperature sensor or ECM
- High resistance or open circuit wiring from the ECM to the coolant temperature sensor
- Short circuit wiring from the ECM to the coolant temperature sensor
- High resistance in ECM ground circuit
- Defective engine coolant thermostat
- Defective coolant temperature sensor

DIAGNOSTIC NOTES:

1 The coolant temperature signal voltage can be monitored and intermittent faults captured using the PDU "Datalogger" function.

PDU DATALOGGER TRIGGERS

(AFTER COLD START)
ECT VOLTAGE (SHOULD OCCUR WITHIN 6 MINUTE PERIOD) ↓ **3.54 VOLTS**

(NORMAL ECT OPERATING RANGE:)
ECT VOLTAGE ↑ **4.9 VOLTS**
ECT VOLTAGE ↓ **0.1 VOLT**

2 If DTC 11, 12, 16, 18, 19 and/or 39 are also flagged, suspect a defective sensor ground circuit to the ECM (BY wire) or defective ECM ground circuit to the front bulkhead ground stud.

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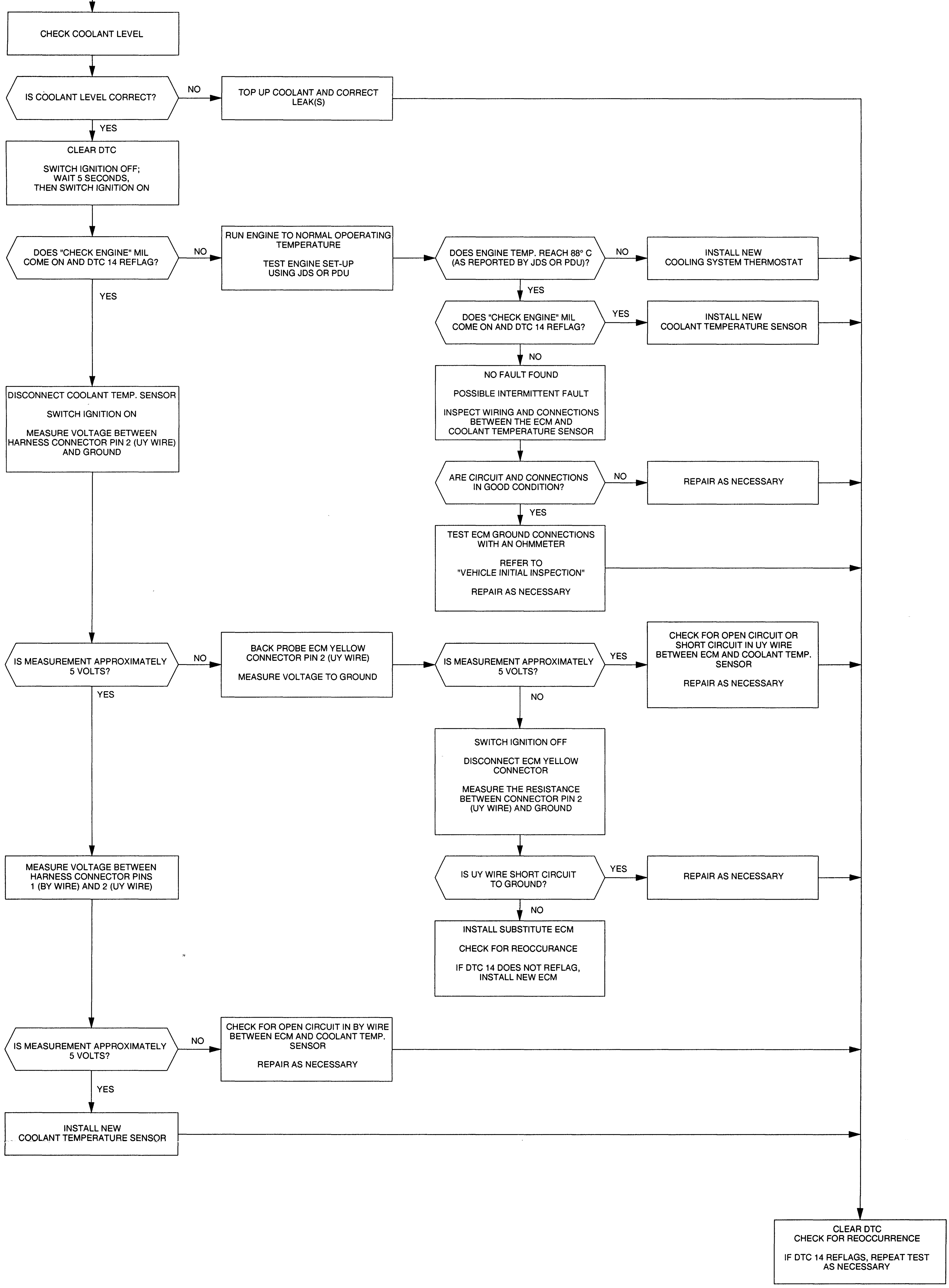
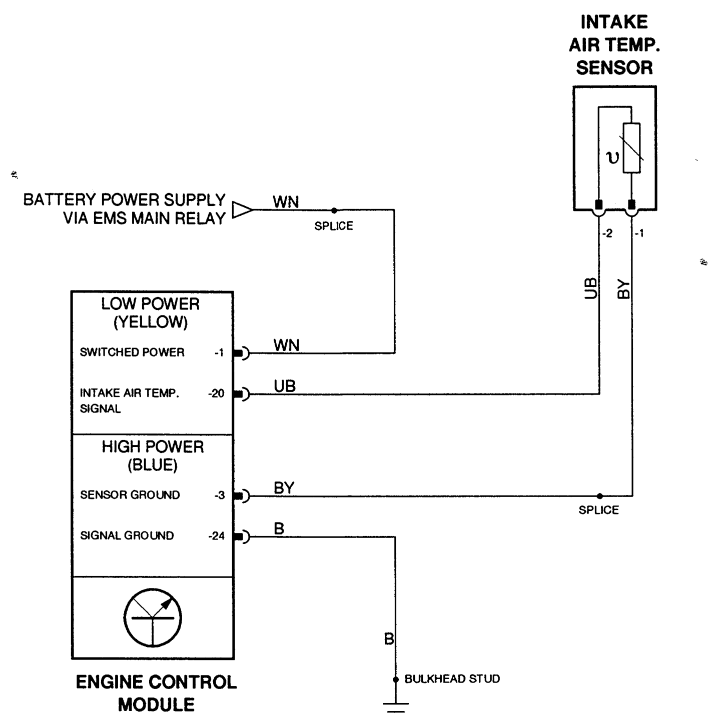
DTC 14


CHECK COOLANT LEVEL
IS COOLANT LEVEL CORRECT?
NO
TOP UP COOLANT AND CORRECT LEAK(S)
YES
CLEAR DTC
SWITCH IGNITION OFF; WAIT 5 SECONDS, THEN SWITCH IGNITION ON
DOES "CHECK ENGINE" MIL COME ON AND DTC 14 REFLAG?
NO
RUN ENGINE TO NORMAL OPOERATING TEMPERATURE
TEST ENGINE SET-UP USING JDS OR PDU
DOES ENGINE TEMP. REACH 88° C (AS REPORTED BY JDS OR PDU)?
NO
INSTALL NEW COOLING SYSTEM THERMOSTAT
YES
DOES "CHECK ENGINE" MIL COME ON AND DTC 14 REFLAG?
YES
INSTALL NEW COOLANT TEMPERATURE SENSOR
NO
NO FAULT FOUND
POSSIBLE INTERMITTENT FAULT
INSPECT WIRING AND CONNECTIONS BETWEEN THE ECM AND COOLANT TEMPERATURE SENSOR
ARE CIRCUIT AND CONNECTIONS IN GOOD CONDITION?
NO
REPAIR AS NECESSARY
YES
TEST ECM GROUND CONNECTIONS WITH AN OHMMETER
REFER TO "VEHICLE INITIAL INSPECTION"
REPAIR AS NECESSARY
YES
DISCONNECT COOLANT TEMP. SENSOR
SWITCH IGNITION ON
MEASURE VOLTAGE BETWEEN HARNESS CONNECTOR PIN 2 (UY WIRE) AND GROUND
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
NO
BACK PROBE ECM YELLOW CONNECTOR PIN 2 (UY WIRE)
MEASURE VOLTAGE TO GROUND
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
YES
CHECK FOR OPEN CIRCUIT OR SHORT CIRCUIT IN UY WIRE BETWEEN ECM AND COOLANT TEMP. SENSOR
REPAIR AS NECESSARY
NO
SWITCH IGNITION OFF
DISCONNECT ECM YELLOW CONNECTOR
MEASURE THE RESISTANCE BETWEEN CONNECTOR PIN 2 (UY WIRE) AND GROUND
IS UY WIRE SHORT CIRCUIT TO GROUND?
YES
REPAIR AS NECESSARY
NO
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 14 DOES NOT REFLAG, INSTALL NEW ECM
YES
MEASURE VOLTAGE BETWEEN HARNESS CONNECTOR PINS 1 (BY WIRE) AND 2 (UY WIRE)
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
NO
CHECK FOR OPEN CIRCUIT IN BY WIRE BETWEEN ECM AND COOLANT TEMP. SENSOR
REPAIR AS NECESSARY
YES
INSTALL NEW COOLANT TEMPERATURE SENSOR
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 14 REFLAGS, REPEAT TEST AS NECESSARY

CIRCUIT DIAGRAM

INTAKE AIR TEMPERATURE SENSOR: ALL VEHICLES AND MODEL YEARS



NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION. DTC 16.1

DTC 16 INTAKE AIR TEMPERATURE SENSOR AND CIRCUIT

The ECM looks for the intake air temperature sensor signal voltage out of the normal operating range.

The intake air temperature sensor is a negative temperature coefficient sensor; the higher the temperature, the lower the resistance. The sensor is located in the air intake elbow.

INTAKE AIR TEMPERATURE SENSOR – TEMPERATURE VERSUS RESISTANCE:

Intake air temperature °F	°C	Resistance (kilo ohms)
14	-10	9.20
32	0	5.90
50	10	3.70
68	20	2.50
86	30	1.70
104	40	1.18
122	50	0.84
140	60	0.60
158	70	0.435
176	80	0.325
193	90	0.25
212	100	0.19

INTAKE AIR TEMPERATURE SENSOR – TEMPERATURE VERSUS TYPICAL APPROXIMATE VOLTAGE:

Intake air temperature °F	°C	Voltage (measured at ECM Yellow connector pin 20 or sensor pin 1)
-18	-30	4.64
-4	-20	4.39
14	-10	4.05
32	0	3.64
59	15	2.89
78	25	2.42
86	30	2.20
95	35	1.98
104	40	1.78
113	45	1.62
122	50	1.44
140	60	1.17
158	70	0.95
176	80	0.78
193	90	0.65
212	100	0.55

The intake air temperature sensor signal is used by the ECM for a correction to the mapped ignition timing. Ignition retard is applied at higher intake air temperatures and higher load sites.

The ECM will flag DTC 16 if the signal voltage is less than 0.1 volt or greater than 4.9 volts any time the ignition is ON.

CONDITIONS REQUIRED FOR DTC 16 FLAGGING:

Intake air temp. sensor voltage
signal to ECM .... Less than 0.1 volt or greater than 4.9 volts
Conditions monitored .... Any time during ignition ON
Response time .... 64 milliseconds

LIMP HOME DEFAULT:

If DTC 16 is flagged, the ignition air temperature strategy defaults to a trim value of 86°F (30°C).

NOTE: If the intake air temperature exceeds 86°F (during default), detonation or pinging may occur.

POSSIBLE FAULTS:

- High resistance connection at the air temperature sensor or ECM
- High resistance or open circuit wiring from the ECM to the intake air temperature sensor
- Short circuit wiring from the ECM to the intake air temperature sensor
- Defective intake air temperature sensor

DIAGNOSTIC NOTES:

1 The air temperature signal voltage can be monitored and intermittent faults captured using the PDU "Datalogger" function.

PDU DATALOGGER TRIGGERS

IAT VOLTAGE	↑ 4.9 VOLTS
	↓ 0.1 VOLT

2 If DTC 11, 12, 14, 18, 19 and/or 39 are also flagged, suspect a defective sensor ground circuit to the ECM (BY wire) or defective ECM ground circuit to the front bulkhead ground stud.

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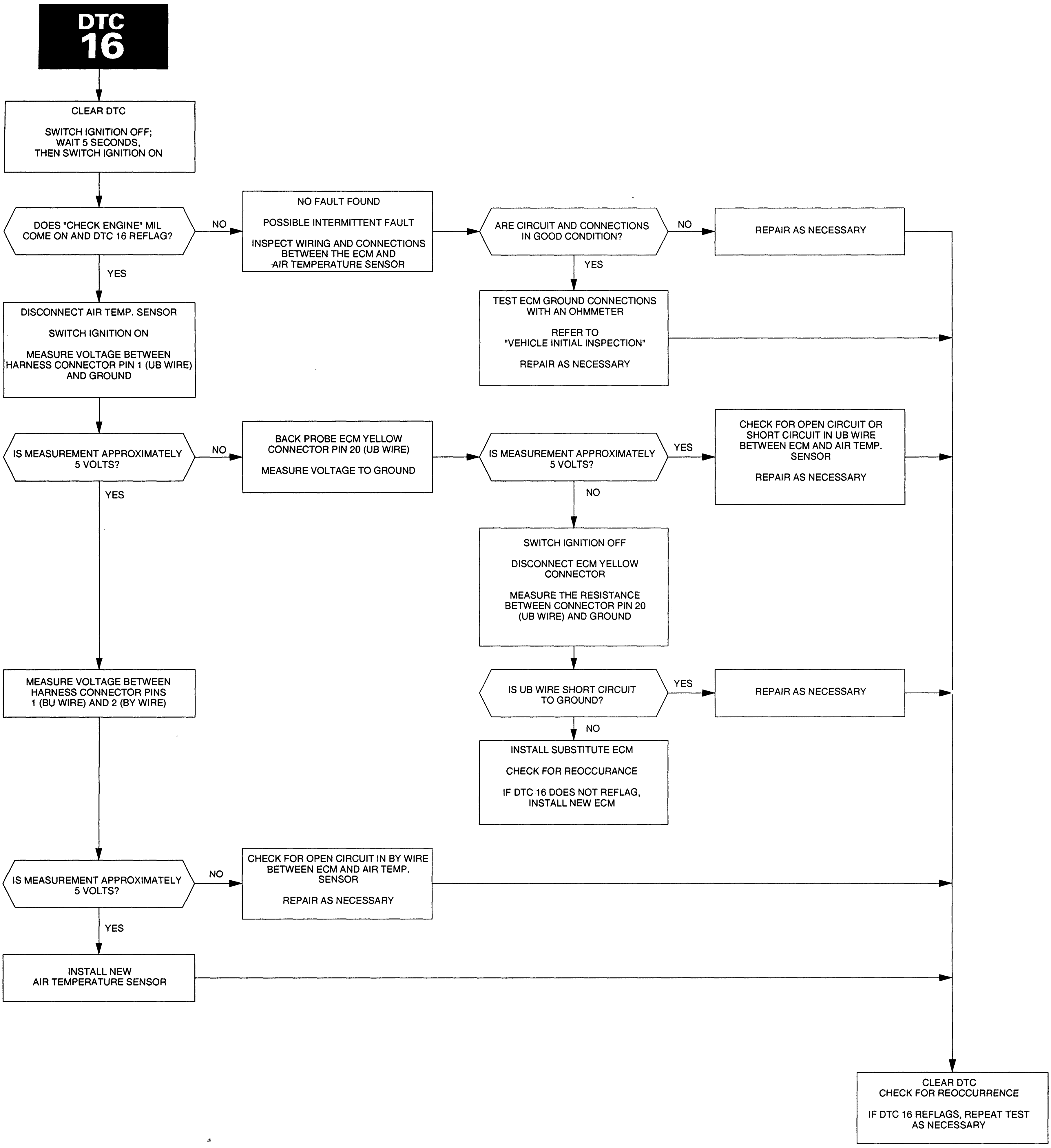

DTC 16
CLEAR DTC
SWITCH IGNITION OFF; WAIT 5 SECONDS, THEN SWITCH IGNITION ON
DOES "CHECK ENGINE" MIL COME ON AND DTC 16 REFLAG?
NO
NO FAULT FOUND
POSSIBLE INTERMITTENT FAULT
INSPECT WIRING AND CONNECTIONS BETWEEN THE ECM AND AIR TEMPERATURE SENSOR
ARE CIRCUIT AND CONNECTIONS IN GOOD CONDITION?
NO
REPAIR AS NECESSARY
YES
TEST ECM GROUND CONNECTIONS WITH AN OHMMETER
REFER TO "VEHICLE INITIAL INSPECTION"
REPAIR AS NECESSARY
YES
DISCONNECT AIR TEMP. SENSOR
SWITCH IGNITION ON
MEASURE VOLTAGE BETWEEN HARNESS CONNECTOR PIN 1 (UB WIRE) AND GROUND
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
NO
BACK PROBE ECM YELLOW CONNECTOR PIN 20 (UB WIRE)
MEASURE VOLTAGE TO GROUND
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
YES
CHECK FOR OPEN CIRCUIT OR SHORT CIRCUIT IN UB WIRE BETWEEN ECM AND AIR TEMP. SENSOR
REPAIR AS NECESSARY
NO
SWITCH IGNITION OFF
DISCONNECT ECM YELLOW CONNECTOR
MEASURE THE RESISTANCE BETWEEN CONNECTOR PIN 20 (UB WIRE) AND GROUND
IS UB WIRE SHORT CIRCUIT TO GROUND?
YES
REPAIR AS NECESSARY
NO
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 16 DOES NOT REFLAG, INSTALL NEW ECM
YES
MEASURE VOLTAGE BETWEEN HARNESS CONNECTOR PINS 1 (BU WIRE) AND 2 (BY WIRE)
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
NO
CHECK FOR OPEN CIRCUIT IN BY WIRE BETWEEN ECM AND AIR TEMP. SENSOR
REPAIR AS NECESSARY
YES
INSTALL NEW AIR TEMPERATURE SENSOR
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 16 REFLAGS, REPEAT TEST AS NECESSARY

DTC 17 THROTTLE POSITION SENSOR CIRCUIT

The ECM looks for the throttle position sensor signal voltage below the low limit for idle recognition.

The throttle position sensor has two tracks; one for engine management and one for transmission control. The ECM monitors the EMS track. The sensor is connected to the throttle valve shaft so that increased throttle opening results in higher voltage. Normal signal voltage at idle is 0.6 volt; normal signal voltage at full throttle is approximately 4.5 volts.

The throttle position sensor signal is used by the ECM for the control of a number of functions:

- Idle speed control
- Ignition idle strategy selection
- Overrun fuel cutoff
- Idle fuel trim (1990 – 92 MY)
- Adaptive idle fueling trim
- Main fuel metering strategy
- Main ignition strategy
- Acceleration enrichment
- Deceleration leaning
- Full load enrichment

NOTE: Other sensor inputs are also required for the above listed functions.

The ECM will flag DTC 17 if the signal voltage is less than 250 millivolts any time the ignition is ON.

CONDITIONS REQUIRED FOR DTC 17 FLAGGING:

Throttle position sensor voltage signal to ECM	Less than 250 millivolts
Conditions monitored	Any time during ignition ON
Response time	64 milliseconds

LIMP HOME DEFAULT:

If DTC 17 is flagged, a fixed part-throttle voltage (1.5 V) is substituted for the missing input. The throttle position functions will not operate.

POSSIBLE FAULTS:

- High resistance connection to ECM or throttle position sensor
- Short circuit or open circuit wiring from the ECM to the throttle position sensor
- Loose or incorrectly adjusted throttle position sensor
- Defective throttle position sensor (worn)

DIAGNOSTIC NOTES:

1 The EMS throttle position sensor signal voltage can be monitored and intermittent faults captured using the PDU "Datalogger" function.

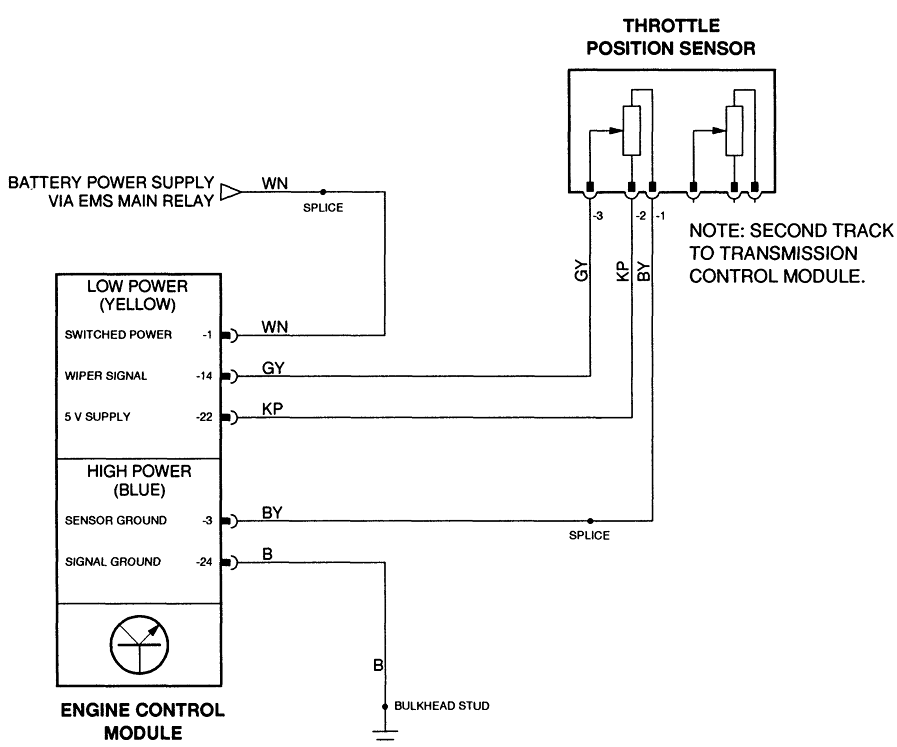
NOTE: JDS displays only the transmission control track voltage.

PDU DATALOGGER TRIGGER

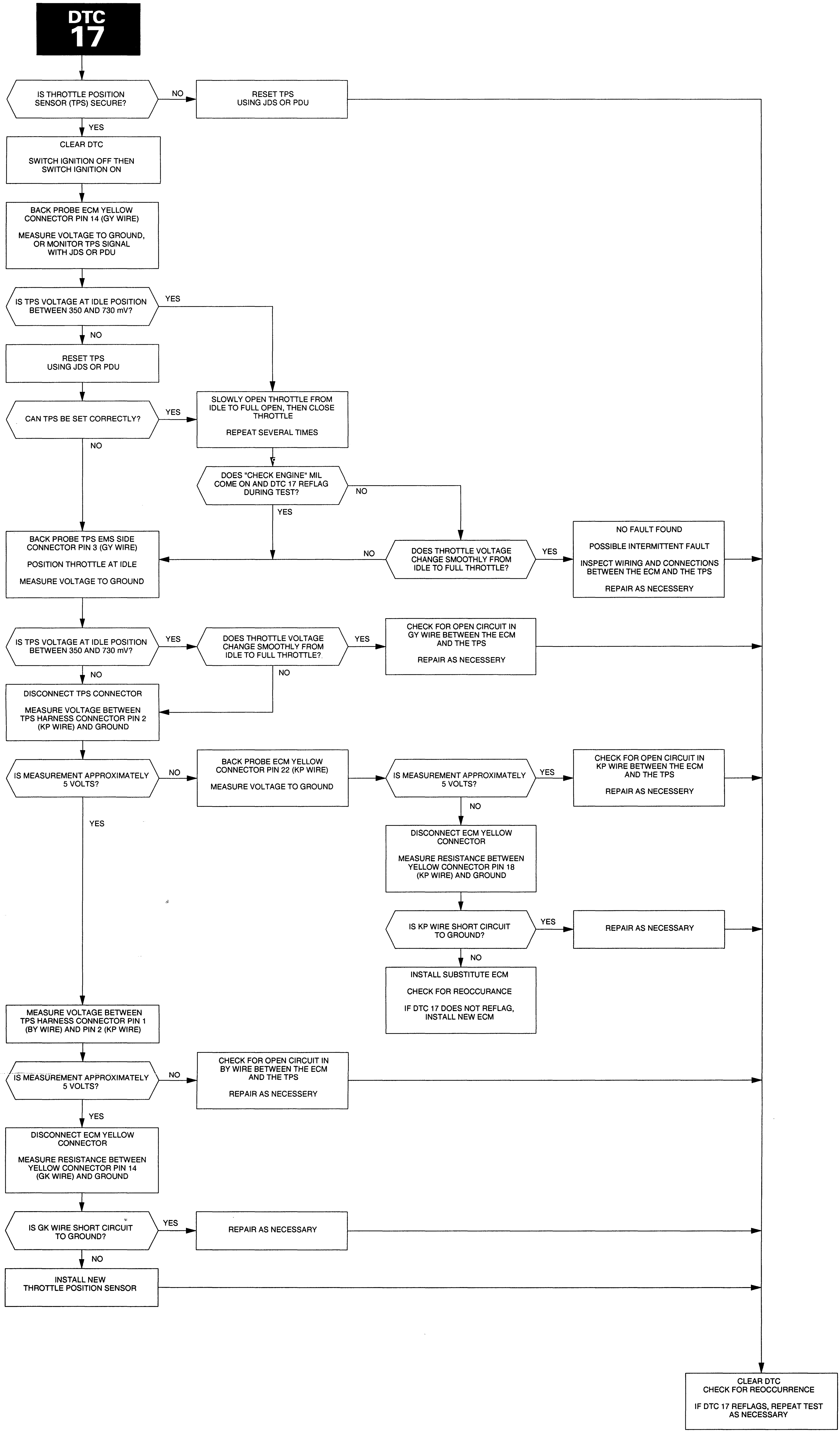
TP VOLTAGE ↓ **0.25 VOLT**

CIRCUIT DIAGRAM

THROTTLE POSITION SENSOR: ALL VEHICLES AND MODEL YEARS

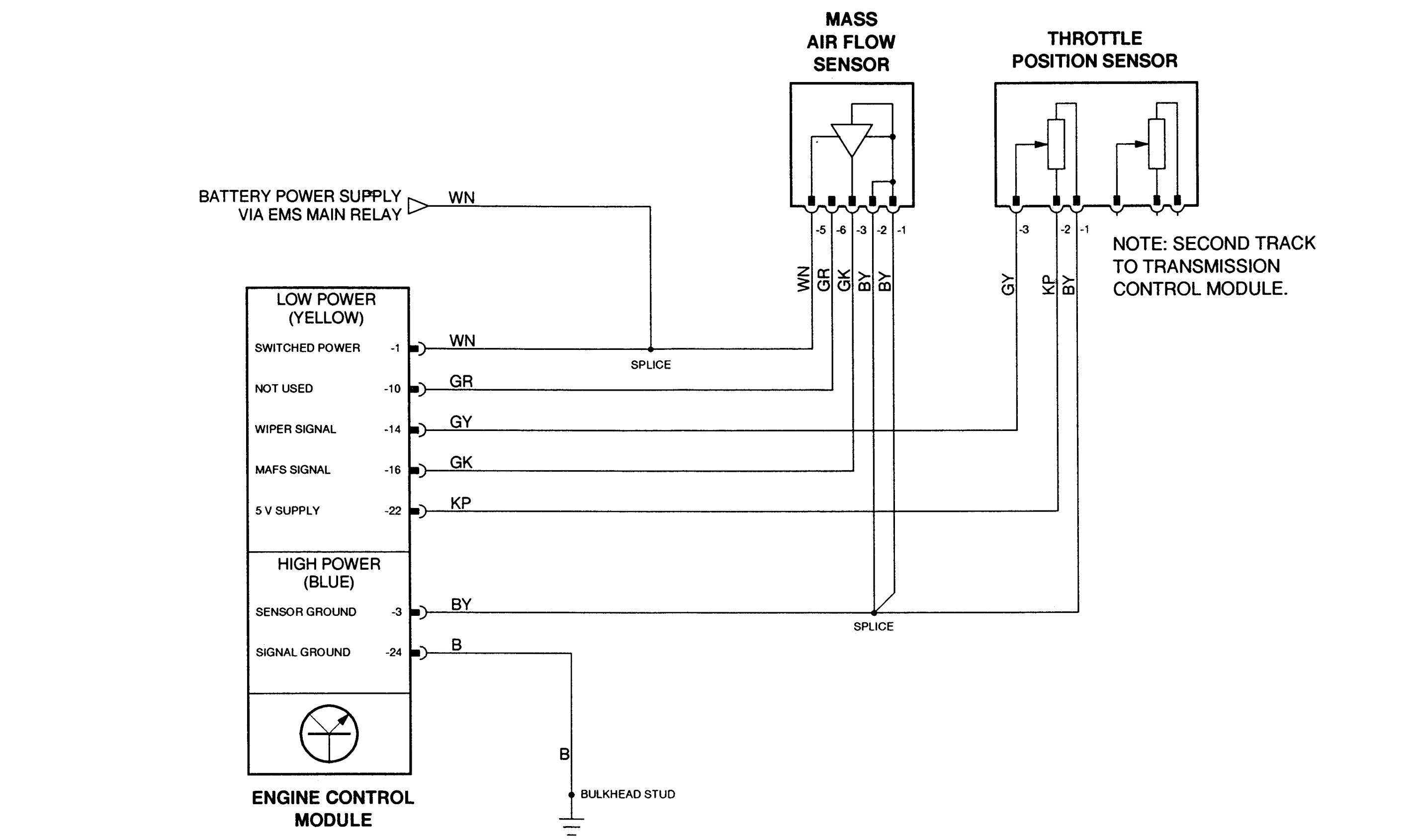


NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION. DTC 17.1


DTC 17
IS THROTTLE POSITION SENSOR (TPS) SECURE?
NO
RESET TPS USING JDS OR PDU
YES
CLEAR DTC
SWITCH IGNITION OFF THEN SWITCH IGNITION ON
BACK PROBE ECM YELLOW CONNECTOR PIN 14 (GY WIRE)
MEASURE VOLTAGE TO GROUND, OR MONITOR TPS SIGNAL WITH JDS OR PDU
IS TPS VOLTAGE AT IDLE POSITION BETWEEN 350 AND 730 mV?
YES
NO
RESET TPS USING JDS OR PDU
CAN TPS BE SET CORRECTLY?
YES
NO
SLOWLY OPEN THROTTLE FROM IDLE TO FULL OPEN, THEN CLOSE THROTTLE
REPEAT SEVERAL TIMES
DOES "CHECK ENGINE" MIL COME ON AND DTC 17 REFLAG DURING TEST?
NO
YES
NO FAULT FOUND
POSSIBLE INTERMITTENT FAULT
INSPECT WIRING AND CONNECTIONS BETWEEN THE ECM AND THE TPS
REPAIR AS NECESSERY
BACK PROBE TPS EMS SIDE CONNECTOR PIN 3 (GY WIRE)
POSITION THROTTLE AT IDLE
MEASURE VOLTAGE TO GROUND
NO
DOES THROTTLE VOLTAGE CHANGE SMOOTHLY FROM IDLE TO FULL THROTTLE?
YES
IS TPS VOLTAGE AT IDLE POSITION BETWEEN 350 AND 730 mV?
YES
DOES THROTTLE VOLTAGE CHANGE SMOOTHLY FROM IDLE TO FULL THROTTLE?
YES
CHECK FOR OPEN CIRCUIT IN GY WIRE BETWEEN THE ECM AND THE TPS
REPAIR AS NECESSERY
NO
NO
DISCONNECT TPS CONNECTOR
MEASURE VOLTAGE BETWEEN TPS HARNESS CONNECTOR PIN 2 (KP WIRE) AND GROUND
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
NO
BACK PROBE ECM YELLOW CONNECTOR PIN 22 (KP WIRE)
MEASURE VOLTAGE TO GROUND
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
YES
CHECK FOR OPEN CIRCUIT IN KP WIRE BETWEEN THE ECM AND THE TPS
REPAIR AS NECESSERY
NO
DISCONNECT ECM YELLOW CONNECTOR
MEASURE RESISTANCE BETWEEN YELLOW CONNECTOR PIN 18 (KP WIRE) AND GROUND
IS KP WIRE SHORT CIRCUIT TO GROUND?
YES
REPAIR AS NECESSARY
NO
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 17 DOES NOT REFLAG, INSTALL NEW ECM
YES
MEASURE VOLTAGE BETWEEN TPS HARNESS CONNECTOR PIN 1 (BY WIRE) AND PIN 2 (KP WIRE)
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
NO
CHECK FOR OPEN CIRCUIT IN BY WIRE BETWEEN THE ECM AND THE TPS
REPAIR AS NECESSERY
YES
DISCONNECT ECM YELLOW CONNECTOR
MEASURE RESISTANCE BETWEEN YELLOW CONNECTOR PIN 14 (GK WIRE) AND GROUND
IS GK WIRE SHORT CIRCUIT TO GROUND?
YES
REPAIR AS NECESSARY
NO
INSTALL NEW THROTTLE POSITION SENSOR
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 17 REFLAGS, REPEAT TEST AS NECESSARY

CIRCUIT DIAGRAM

THROTTLE POSITION SENSOR AND MASS AIR FLOW SENSOR: ALL VEHICLES AND MODEL YEARS



NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION. DTC 18.2

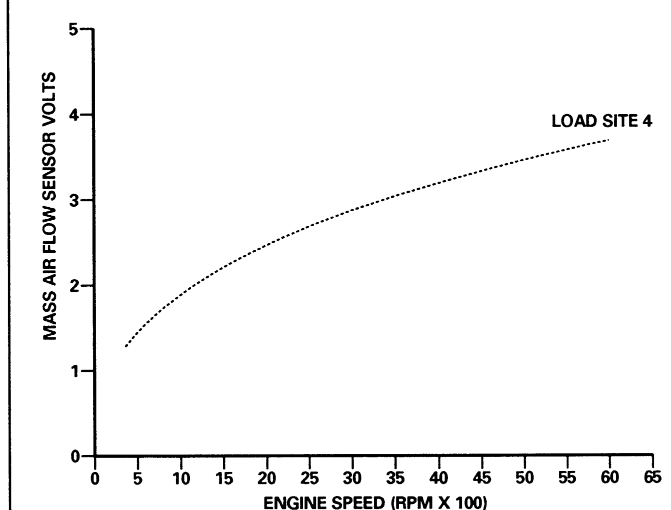
DTC 18 THROTTLE POSITION SENSOR AND MASS AIR FLOW SENSOR (HIGH THROTTLE POS. VOLTAGE; LOW AIR FLOW VOLTAGE)

The ECM looks for a combination of throttle position voltage and mass air flow voltage that cannot occur in a correctly operating system.

The throttle position sensor signal voltage (EMS track) normally varies between 0.6 volt at idle to 4.5 volts at full throttle. The mass air flow sensor load signal voltage normally varies between 1 and 4 volts; the higher the voltage, the higher the load.

The ECM will flag DTC 18 if the throttle position signal voltage shows a large throttle opening when the MAFS signal indicates a low load.

EXAMPLE OF NORMAL SIGNAL: MAFS versus ENGINE SPEED LOAD SITE 4



DTC 18.1

CONDITIONS REQUIRED FOR DTC 18 FLAGGING:

Throttle position sensor voltage signal to ECM	2.25 volts or greater
Engine load site	Load site 3 or lower
Response time	5 engine revolutions

LIMP HOME DEFAULT:

If DTC 18 is flagged, the MAFS signal is accepted as accurate. The throttle position voltage defaults to less than full throttle (1.5 volts) so that full throttle enrichment is disabled.

POSSIBLE FAULTS:

- High resistance connection to ECM or throttle position sensor
- Restricted air intake
- Restricted exhaust
- Low fuel pressure (low engine power)
- Engine mechanical fault (low engine power)
- Ignition fault (low engine power)
- Short circuit or open circuit wiring from the ECM to the mass air flow sensor
- Short circuit or open circuit wiring from the ECM to the throttle position sensor
- Incorrectly adjusted throttle position sensor
- Defective throttle position sensor
- Defective mass air flow sensor

DIAGNOSTIC NOTES:

1 The throttle position sensor and mass air flow sensor signal voltages can be monitored and intermittent faults captured using the PDU "Datalogger" function.

PDU DATALOGGER TRIGGERS

TP VOLTAGE	↑	4.5 VOLTS
MAF VOLTAGE	↓	0.6 VOLT

MAFS TEST 2: ENGINE LOAD – HIGH

This test requires two technicians.

⚠CAUTION: The test must not last longer than 5 seconds. Always allow the engine to idle for at least two minutes between tests to allow the transmission to cool. Do not carry out more than three tests without allowing the engine to cool down for at least half an hour.

- Chock the road wheels and firmly apply both foot and hand brake.
- Run the engine at normal idle speed; select neutral; air conditioning OFF.
- Use an approved DVOM or monitor the PDU MAF signal to measure the mass air flow sensor signal voltage at the ECM. Use only an approved DVOM to measure the mass air flow sensor signal voltage at the MAFS.
- Back probe the connector pin as directed on the diagnostic flow chart.
- Select DRIVE; apply full throttle and note the mass air flow sensor signal voltage at the ECM.

  The typical voltage measured should be 3.00 - 3.30 volts.

NOTE: The voltage readings given are typical for an engine in good condition. Ambient, elevation and/or barometric conditions will effect the readings obtained.

A known good MAFS should be used as a comparison before the MAFS being tested is condemned as defective.

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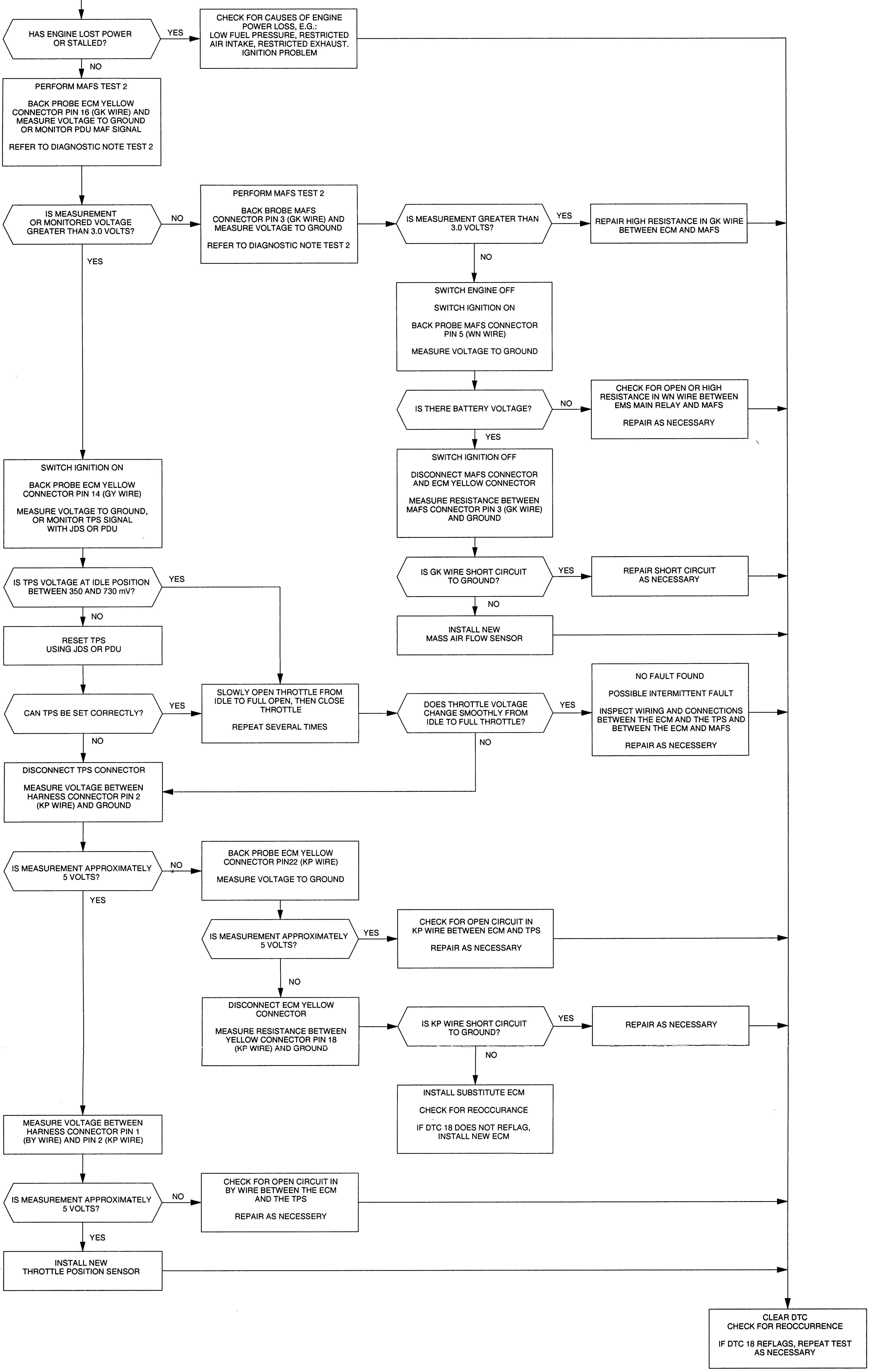
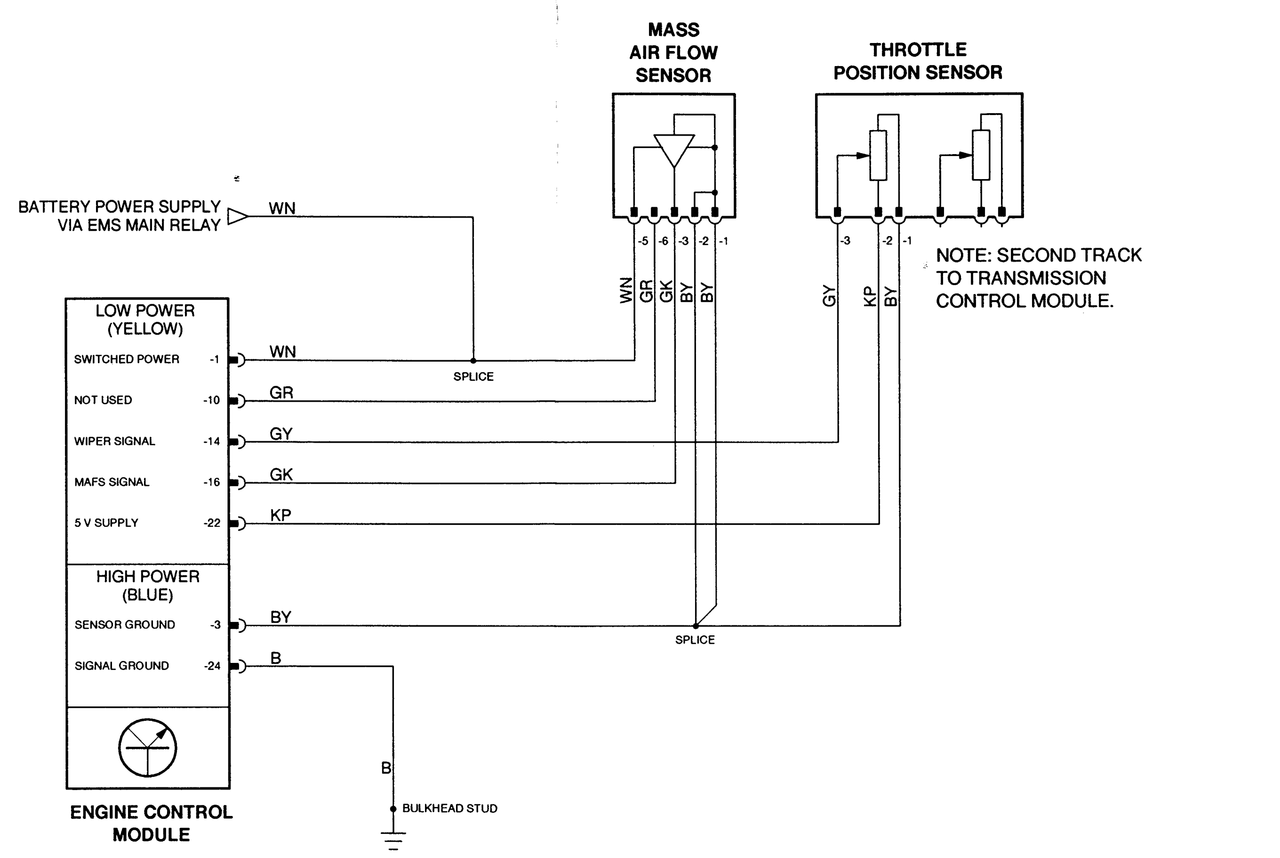
DTC 18


HAS ENGINE LOST POWER OR STALLED?
YES
CHECK FOR CAUSES OF ENGINE POWER LOSS, E.G.: LOW FUEL PRESSURE, RESTRICTED AIR INTAKE, RESTRICTED EXHAUST. IGNITION PROBLEM
NO
PERFORM MAFS TEST 2
BACK PROBE ECM YELLOW CONNECTOR PIN 16 (GK WIRE) AND MEASURE VOLTAGE TO GROUND OR MONITOR PDU MAF SIGNAL
REFER TO DIAGNOSTIC NOTE TEST 2
IS MEASUREMENT OR MONITORED VOLTAGE GREATER THAN 3.0 VOLTS?
NO
PERFORM MAFS TEST 2
BACK BROBE MAFS CONNECTOR PIN 3 (GK WIRE) AND MEASURE VOLTAGE TO GROUND
REFER TO DIAGNOSTIC NOTE TEST 2
IS MEASUREMENT GREATER THAN 3.0 VOLTS?
YES
REPAIR HIGH RESISTANCE IN GK WIRE BETWEEN ECM AND MAFS
NO
SWITCH ENGINE OFF
SWITCH IGNITION ON
BACK PROBE MAFS CONNECTOR PIN 5 (WN WIRE)
MEASURE VOLTAGE TO GROUND
IS THERE BATTERY VOLTAGE?
NO
CHECK FOR OPEN OR HIGH RESISTANCE IN WN WIRE BETWEEN EMS MAIN RELAY AND MAFS
REPAIR AS NECESSARY
YES
SWITCH IGNITION OFF
DISCONNECT MAFS CONNECTOR AND ECM YELLOW CONNECTOR
MEASURE RESISTANCE BETWEEN MAFS CONNECTOR PIN 3 (GK WIRE) AND GROUND
IS GK WIRE SHORT CIRCUIT TO GROUND?
YES
REPAIR SHORT CIRCUIT AS NECESSARY
NO
INSTALL NEW MASS AIR FLOW SENSOR
YES
SWITCH IGNITION ON
BACK PROBE ECM YELLOW CONNECTOR PIN 14 (GY WIRE)
MEASURE VOLTAGE TO GROUND, OR MONITOR TPS SIGNAL WITH JDS OR PDU
IS TPS VOLTAGE AT IDLE POSITION BETWEEN 350 AND 730 mV?
YES
NO
RESET TPS USING JDS OR PDU
CAN TPS BE SET CORRECTLY?
YES
SLOWLY OPEN THROTTLE FROM IDLE TO FULL OPEN, THEN CLOSE THROTTLE
REPEAT SEVERAL TIMES
DOES THROTTLE VOLTAGE CHANGE SMOOTHLY FROM IDLE TO FULL THROTTLE?
YES
NO FAULT FOUND
POSSIBLE INTERMITTENT FAULT
INSPECT WIRING AND CONNECTIONS BETWEEN THE ECM AND THE TPS AND BETWEEN THE ECM AND MAFS
REPAIR AS NECESSERY
NO
NO
DISCONNECT TPS CONNECTOR
MEASURE VOLTAGE BETWEEN HARNESS CONNECTOR PIN 2 (KP WIRE) AND GROUND
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
NO
BACK PROBE ECM YELLOW CONNECTOR PIN22 (KP WIRE)
MEASURE VOLTAGE TO GROUND
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
YES
CHECK FOR OPEN CIRCUIT IN KP WIRE BETWEEN ECM AND TPS
REPAIR AS NECESSARY
NO
DISCONNECT ECM YELLOW CONNECTOR
MEASURE RESISTANCE BETWEEN YELLOW CONNECTOR PIN 18 (KP WIRE) AND GROUND
IS KP WIRE SHORT CIRCUIT TO GROUND?
YES
REPAIR AS NECESSARY
NO
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 18 DOES NOT REFLAG, INSTALL NEW ECM
YES
MEASURE VOLTAGE BETWEEN HARNESS CONNECTOR PIN 1 (BY WIRE) AND PIN 2 (KP WIRE)
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
NO
CHECK FOR OPEN CIRCUIT IN BY WIRE BETWEEN THE ECM AND THE TPS
REPAIR AS NECESSERY
YES
INSTALL NEW THROTTLE POSITION SENSOR
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 18 REFLAGS, REPEAT TEST AS NECESSARY

CIRCUIT DIAGRAM

THROTTLE POSITION SENSOR AND MASS AIR FLOW SENSOR: ALL VEHICLES AND MODEL YEARS



NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION. DTC 19.2

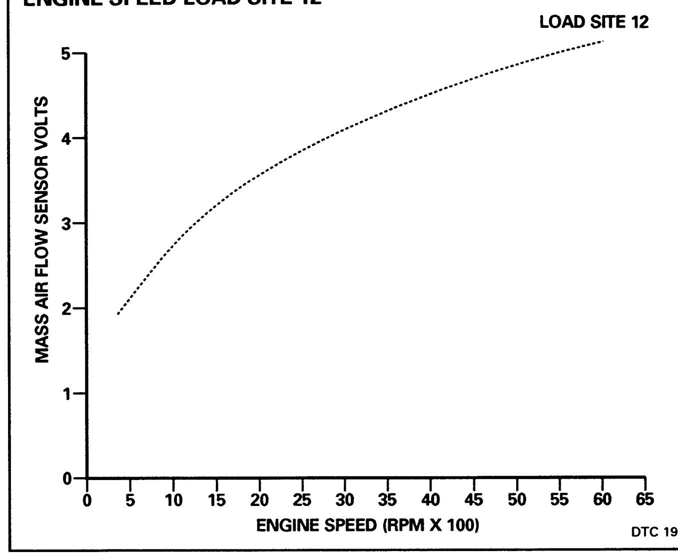
DTC 19 THROTTLE POSITION SENSOR AND MASS AIR FLOW SENSOR (LOW THROTTLE POS. VOLTAGE; HIGH AIR FLOW VOLTAGE)

The ECM looks for a combination of throttle position signal voltage and mass air flow sensor load signal voltage that cannot occur in a correctly operating system.

The throttle position sensor signal voltage (EMS track) normally varies between 0.6 volt at idle to 4.5 volts at full throttle. The mass air flow sensor load signal voltage normally varies between 1 and 4 volts; the higher the voltage, the higher the load.

The ECM will flag DTC 19 if the throttle position signal voltage is at the "adapted idle" value and the engine speed greater than 1000 rpm when MAFS signal indicates a high load.

EXAMPLE OF NORMAL SIGNAL: MAFS versus ENGINE SPEED LOAD SITE 12



DTC 19.1

CONDITIONS REQUIRED FOR DTC 19 FLAGGING:

Throttle position sensor voltage signal to ECM .... On idle

Engine load site .... Load site 13 or higher

Engine speed .... Greater than 1000 rpm

Response time .... 5 engine revolutions

LIMP HOME DEFAULT:

If DTC 19 is flagged, the air flow signal is accepted as accurate. The throttle position voltage defaults to more than idle (1.5 volts) so that idle functions are disabled.

POSSIBLE FAULTS:

- High resistance connection to ECM, MAFS or TPS
- Water in MAFS
- Short circuit or open circuit wiring from the ECM to the mass air flow sensor
- Short circuit or open circuit wiring from the ECM to the throttle position sensor
- Defective throttle position sensor

DIAGNOSTIC NOTES:

1 The throttle position sensor and mass air flow sensor signal voltages can be monitored and intermittent faults captured using the PDU "Datalogger" function.

PDU DATALOGGER TRIGGERS

TP VOLTAGE	↑	4.5 VOLTS
MAF VOLTAGE	↓	0.25 VOLT

MAFS TEST 1: ENGINE LOAD – IDLE

- Run the engine at normal idle speed; normal operating temperature; select NEUTRAL; air conditioning OFF.
- Use an approved DVOM or monitor the PDU MAF signal to measure the mass air flow sensor signal voltage at the ECM. Use only an approved DVOM to measure the mass air flow sensor signal voltage at the MAFS.
- Back probe the connector pin as directed on the diagnostic flow chart.
- The typical voltage measured should be 1.20 - 1.50 volts.

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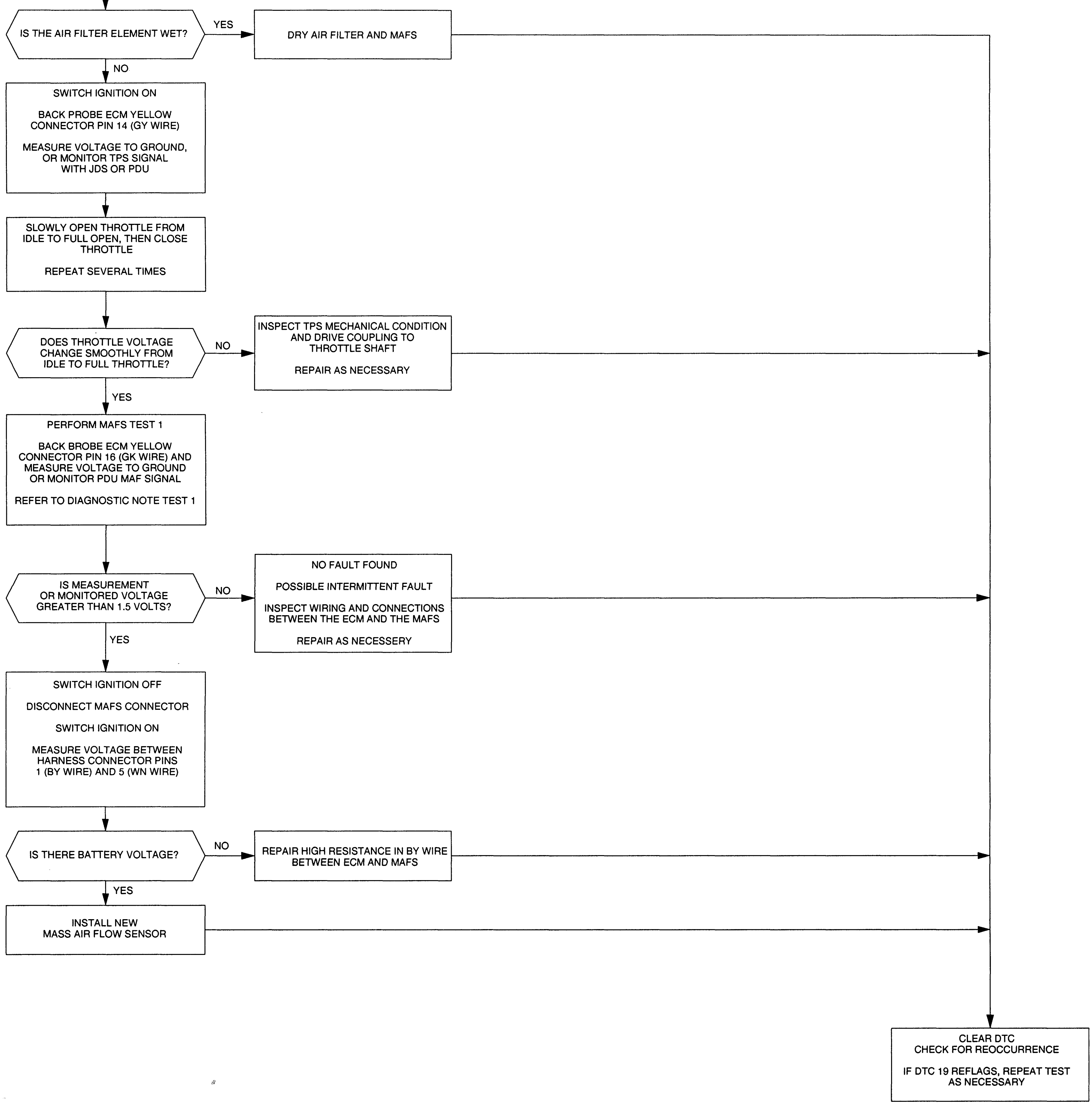
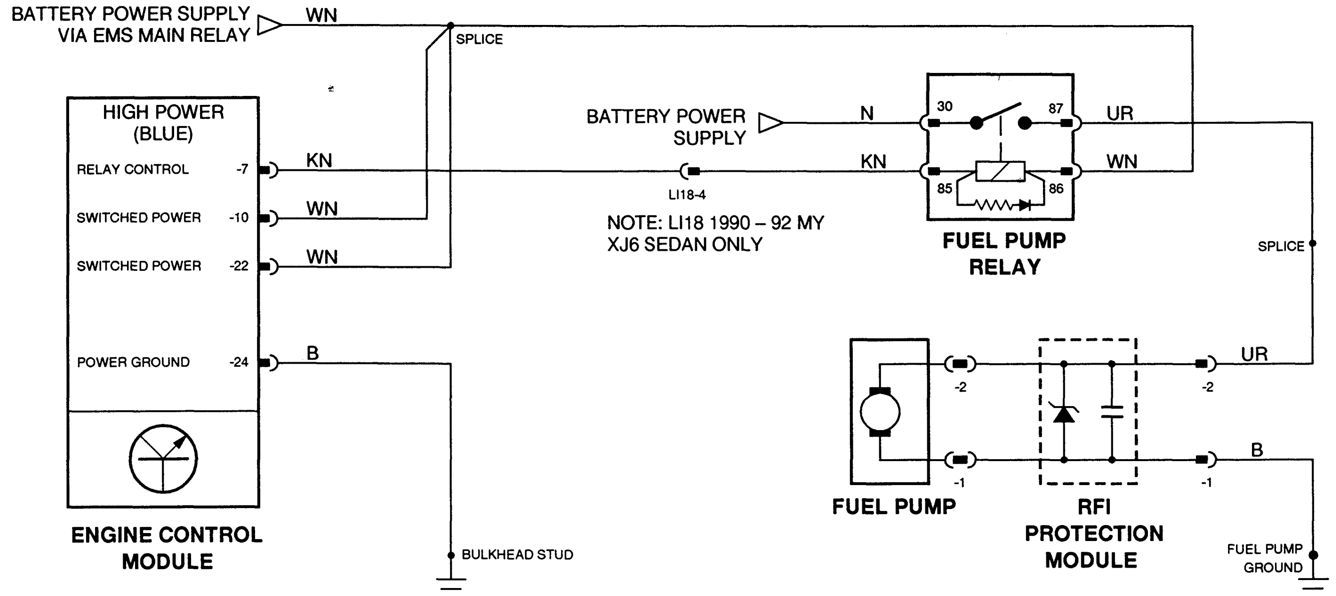
DTC 19

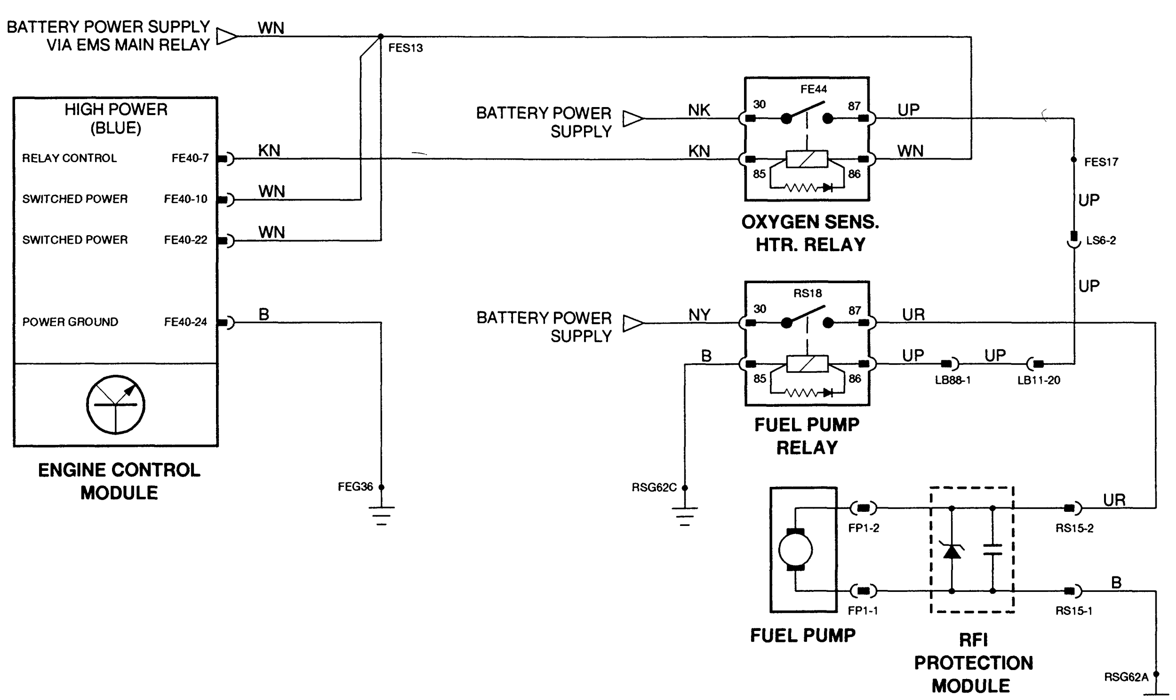

IS THE AIR FILTER ELEMENT WET?
YES
DRY AIR FILTER AND MAFS
NO
SWITCH IGNITION ON
BACK PROBE ECM YELLOW CONNECTOR PIN 14 (GY WIRE)
MEASURE VOLTAGE TO GROUND, OR MONITOR TPS SIGNAL WITH JDS OR PDU
SLOWLY OPEN THROTTLE FROM IDLE TO FULL OPEN, THEN CLOSE THROTTLE
REPEAT SEVERAL TIMES
DOES THROTTLE VOLTAGE CHANGE SMOOTHLY FROM IDLE TO FULL THROTTLE?
NO
INSPECT TPS MECHANICAL CONDITION AND DRIVE COUPLING TO THROTTLE SHAFT
REPAIR AS NECESSARY
YES
PERFORM MAFS TEST 1
BACK BROBE ECM YELLOW CONNECTOR PIN 16 (GK WIRE) AND MEASURE VOLTAGE TO GROUND OR MONITOR PDU MAF SIGNAL
REFER TO DIAGNOSTIC NOTE TEST 1
IS MEASUREMENT OR MONITORED VOLTAGE GREATER THAN 1.5 VOLTS?
NO
NO FAULT FOUND
POSSIBLE INTERMITTENT FAULT
INSPECT WIRING AND CONNECTIONS BETWEEN THE ECM AND THE MAFS
REPAIR AS NECESSERY
YES
SWITCH IGNITION OFF
DISCONNECT MAFS CONNECTOR
SWITCH IGNITION ON
MEASURE VOLTAGE BETWEEN HARNESS CONNECTOR PINS 1 (BY WIRE) AND 5 (WN WIRE)
IS THERE BATTERY VOLTAGE?
NO
REPAIR HIGH RESISTANCE IN BY WIRE BETWEEN ECM AND MAFS
YES
INSTALL NEW MASS AIR FLOW SENSOR
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 19 REFLAGS, REPEAT TEST AS NECESSARY

FUEL PUMP CONTROL: 1990 – 92 XJ6 SEDAN RANGE, ALL XJS RANGE



NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION. DTC 22.1

FUEL PUMP CONTROL: 1993 – 94 MY XJ6 SEDAN RANGE



NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION. DTC 22.2

DTC 22 FUEL PUMP CONTROL CIRCUIT

The ECM looks for an incorrect internal circuit voltage that indicates the state of the fuel pump relay coil switching circuit (oxygen sensor heater relay: 1993 MY ON XJ6). This internal voltage cannot be measured.

The ECM switches on the fuel pump by grounding the fuel pump relay coil circuit (85 pin) (all XJS and 1990 – 92 MY XJ6). On 1993 MY ON XJ6, the ECM switches on the fuel pump by grounding the oxygen sensor heater relay, which in turn switches the fuel pump relay. The fuel pump is switched on for approximately 1 second after the ignition is switched ON, and when an engine speed signal is present.

The ECM will flag DTC 22 if the fuel pump control circuit is open or short circuit while the fuel pump is operating.

CONDITIONS REQUIRED FOR DTC 22 FLAGGING:

Ignition .... Ignition ON

Fuel pump .... Fuel pump operating

ECM internal circuit .... Indicates that the fuel pump control circuit is open or short circuit.

Response time .... 600 milliseconds

LIMP HOME DEFAULT:

NONE

POSSIBLE FAULTS:

- Low battery voltage
- Poor ECM power feed or ground connections
- Short circuit or open circuit wiring from the ECM to the fuel pump relay (all XJS and 1990 – 92 MY XJ6)
- Short circuit or open circuit wiring from the ECM to the oxygen sensor heater relay (1993 MY ON XJ6)
- Short circuit or open circuit wiring in ignition switched power to above relays pin 86
- Loose connector pins (LI18) – 6-way PM4 yellow connector under air cleaner (1991 – 92 MY XJ6)
- Faulty relay
- Air pump relay circuit fault

DIAGNOSTIC NOTES:

1 If DTC 66 is also flagged, first investigate the cause of the air injection relay control circuit.

2 If the fuel pump is inoperative but DTC is not flagged, investigate the fuel pump switched power supply (relay), fuel pump ground and the fuel pump mechanical condition.

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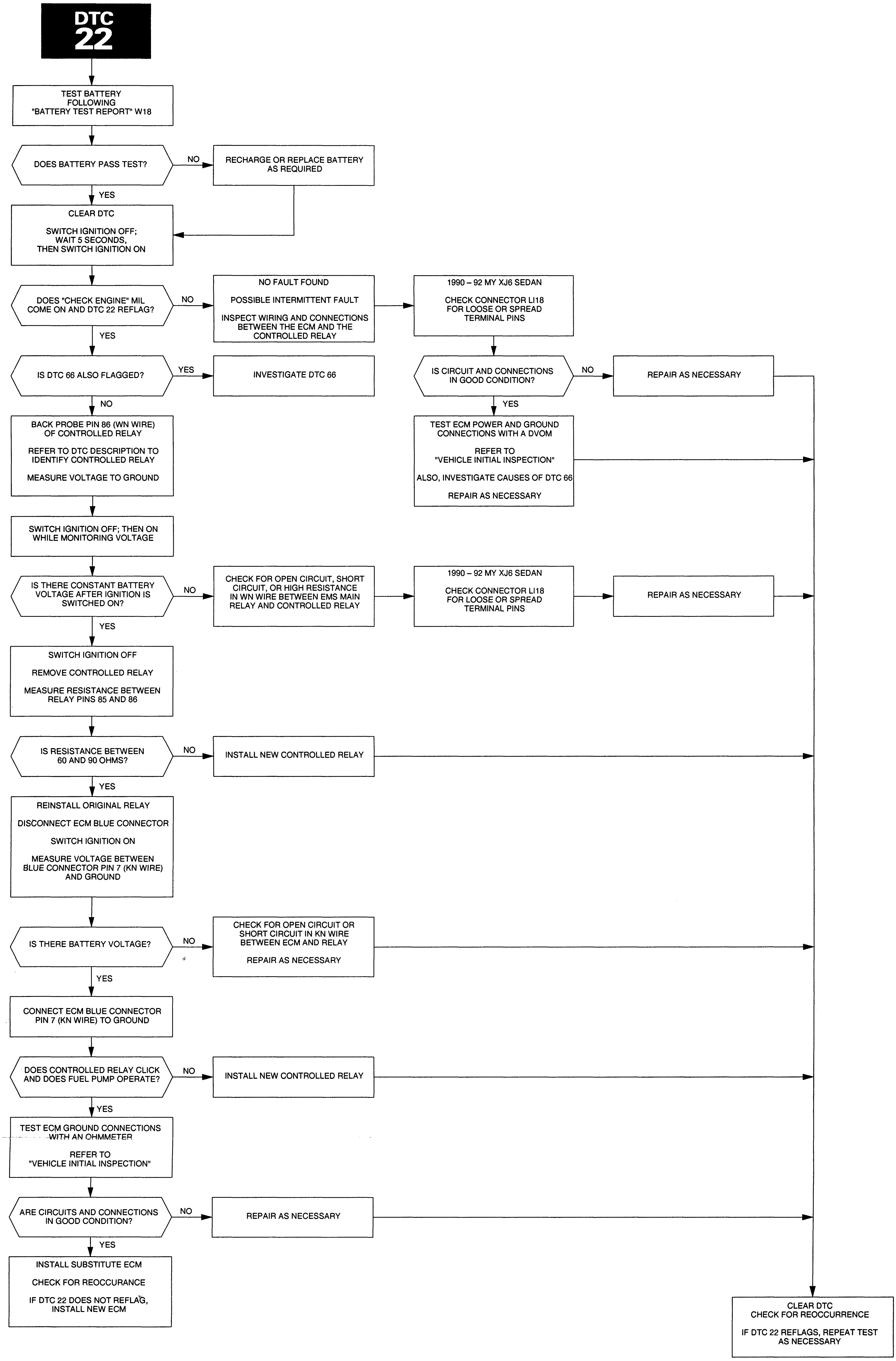
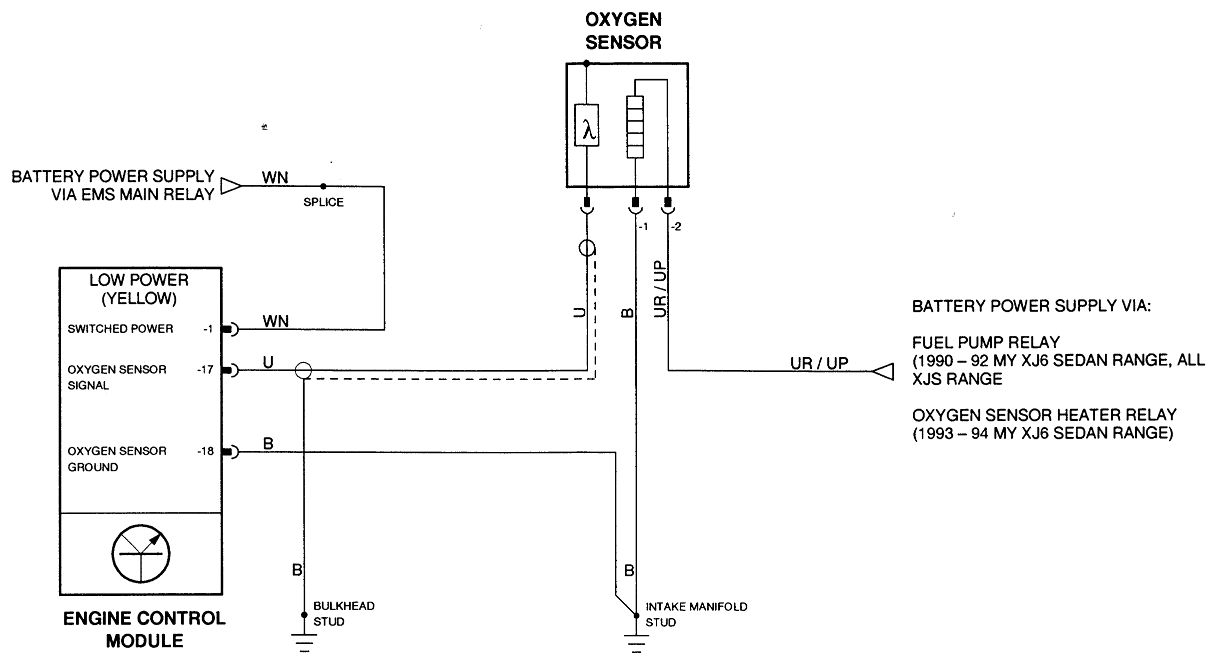

DTC 22
TEST BATTERY FOLLOWING "BATTERY TEST REPORT" W18
DOES BATTERY PASS TEST?
NO
RECHARGE OR REPLACE BATTERY AS REQUIRED
YES
CLEAR DTC
SWITCH IGNITION OFF; WAIT 5 SECONDS, THEN SWITCH IGNITION ON
DOES "CHECK ENGINE" MIL COME ON AND DTC 22 REFLAG?
NO
NO FAULT FOUND
POSSIBLE INTERMITTENT FAULT
INSPECT WIRING AND CONNECTIONS BETWEEN THE ECM AND THE CONTROLLED RELAY
1990 – 92 MY XJ6 SEDAN
CHECK CONNECTOR LI18 FOR LOOSE OR SPREAD TERMINAL PINS
IS CIRCUIT AND CONNECTIONS IN GOOD CONDITION?
NO
REPAIR AS NECESSARY
YES
TEST ECM POWER AND GROUND CONNECTIONS WITH A DVOM
REFER TO "VEHICLE INITIAL INSPECTION"
ALSO, INVESTIGATE CAUSES OF DTC 66
REPAIR AS NECESSARY
YES
IS DTC 66 ALSO FLAGGED?
YES
INVESTIGATE DTC 66
NO
BACK PROBE PIN 86 (WN WIRE) OF CONTROLLED RELAY
REFER TO DTC DESCRIPTION TO IDENTIFY CONTROLLED RELAY
MEASURE VOLTAGE TO GROUND
SWITCH IGNITION OFF; THEN ON WHILE MONITORING VOLTAGE
IS THERE CONSTANT BATTERY VOLTAGE AFTER IGNITION IS SWITCHED ON?
NO
CHECK FOR OPEN CIRCUIT, SHORT CIRCUIT, OR HIGH RESISTANCE IN WN WIRE BETWEEN EMS MAIN RELAY AND CONTROLLED RELAY
1990 – 92 MY XJ6 SEDAN
CHECK CONNECTOR LI18 FOR LOOSE OR SPREAD TERMINAL PINS
REPAIR AS NECESSARY
YES
SWITCH IGNITION OFF
REMOVE CONTROLLED RELAY
MEASURE RESISTANCE BETWEEN RELAY PINS 85 AND 86
IS RESISTANCE BETWEEN 60 AND 90 OHMS?
NO
INSTALL NEW CONTROLLED RELAY
YES
REINSTALL ORIGINAL RELAY
DISCONNECT ECM BLUE CONNECTOR
SWITCH IGNITION ON
MEASURE VOLTAGE BETWEEN BLUE CONNECTOR PIN 7 (KN WIRE) AND GROUND
IS THERE BATTERY VOLTAGE?
NO
CHECK FOR OPEN CIRCUIT OR SHORT CIRCUIT IN KN WIRE BETWEEN ECM AND RELAY
REPAIR AS NECESSARY
YES
CONNECT ECM BLUE CONNECTOR PIN 7 (KN WIRE) TO GROUND
DOES CONTROLLED RELAY CLICK AND DOES FUEL PUMP OPERATE?
NO
INSTALL NEW CONTROLLED RELAY
YES
TEST ECM GROUND CONNECTIONS WITH AN OHMMETER
REFER TO "VEHICLE INITIAL INSPECTION"
ARE CIRCUITS AND CONNECTIONS IN GOOD CONDITION?
NO
REPAIR AS NECESSARY
YES
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 22 DOES NOT REFLAG, INSTALL NEW ECM
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 22 REFLAGS, REPEAT TEST AS NECESSARY

CIRCUIT DIAGRAM

HEATED OXYGEN SENSOR: ALL VEHICLES AND MODEL YEARS



NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION. DTC 23.2

DTC 23 OXYGEN SENSOR FEEDBACK (RICH)

The ECM looks for poor closed loop fuel metering control while correcting for a rich mixture condition.

The ECM shortens the injector pulse duration in response to high oxygen sensor voltage indicating rich fuel metering. The fuel metering can vary by ± 12.5 % without flagging a code. If the fuel metering cannot be corrected by the ECM, the oxygen sensor feedback voltage (monitor with JDS or PDU) falls to 0 volt and DTC 23 will be flagged.

CONDITIONS REQUIRED FOR DTC 23 FLAGGING:

Engine coolant temperature .... Greater than 167°F

Closed loop fuel metering .... Not in control (rich) – feedback = 0 volt (oxygen sensor feedback)

Response time .... 660 consecutive engine revolutions

LIMP HOME DEFAULT:

NONE

POSSIBLE FAULTS:

- High fuel pressure
- Oxygen sensor heater ground loose or engine ground loose
- ECM ground connection at bulkhead stud loose or corroded
- Engine coolant thermostat stuck open
- Purge valve stuck open
- High resistance in MAFS connector
- Incorrect mass air flow sensor calibration
- 1993 MY ON vehicles (with adaptive idle fueling trim): Intake system air leak – especially between the MAFS and the throttle valve
- "Lazy" or defective oxygen sensor

DIAGNOSTIC NOTES:

1 Engine fueling correction (dynamic) can be monitored by using JDS or PDU to read the oxygen sensor feedback voltage (HO2SFB). If the feedback voltage is between 1 and 4 volts, the fueling is normal and the problem is intermittent. If the feedback voltage stays below 1 volt, look for causes of rich running (DTC 23). The PDU Datalogger can be set to trigger on flagging DTC 23.

PDU DATALOGGER TRIGGER

FF 23 ↑ 1

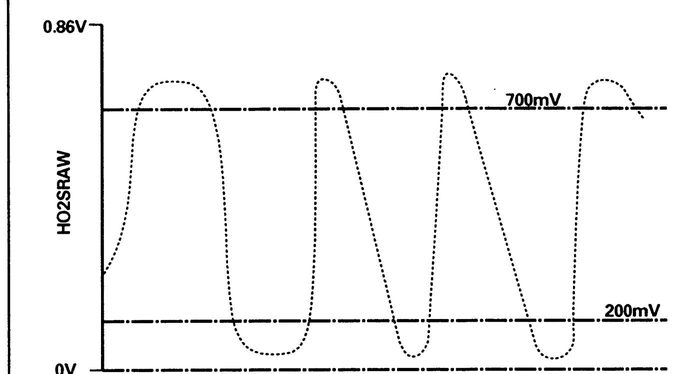
2 1993 MY ON vehicles (with adaptive idle fueling trim) The ECM automatically corrects for small fueling errors by adding to or subtracting from the "base line" injector pulse duration. To determine if a base line correction has occurred, first monitor the oxygen sensor feedback voltage and record the value. Then disconnect and reconnect the ECM and recheck the oxygen sensor feedback voltage. A change in the feedback voltage indicates that a correction had been applied. (Disconnecting the ECM erases the correction.)

3 A rich mixture condition can be caused by the engine coolant thermostat sticking open. At high road speed, the coolant temperature decreases, causing enriching from the coolant temperature sensor input to the ECM. To test the thermostat, check the engine setup using JDS or PDU. If the coolant temperature does not reach 190°F (88°C) (as monitored by JDS or PDU), replace the thermostat.

4 1993 MY ON vehicles (with adaptive idle fueling trim) DTC 23 can be caused by an unmeasured air leak, especially between the MAFS and the throttle valve. The base line correction, automatically applied for the lean mixture condition at idle, can create a rich mixture condition while driving.

5 During closed loop fueling, the oxygen sensor "raw" voltage (signal voltage to the ECM) normally swings between 0.2 and 0.8 volt. If the oxygen sensor becomes contaminated or the heater is inoperative, the sensor can be "lazy". A lazy sensor may show a voltage swing of 0.3 – 0.7 volt or even less. The oxygen sensor raw voltage can be monitored using PDU (HO2 S RAW).

OXYGEN SENSOR VOLTAGE TRACE: PDU HO2S RAW



6 TO 10 SWINGS PER MINUTE AT IDLE

DTC 23.1

FUEL PRESSURE CHECK

42 – 45 psi	(vacuum disconnected from fuel pressure regulator)
34 – 38 psi at idle	(vacuum connected to fuel pressure regulator)

PURGE VALVE TEST

To test for a sticking purge valve:

- Disconnect the purge hose at the intake manifold adapter.
- Switch ignition ON; do not start the engine.
- Apply vacuum to purge hose; vacuum should hold. If the vacuum does not hold, the purge valve is stuck and should be replaced.
- Switch ignition OFF; vacuum should release after a few seconds. If the vacuum does not release, the purge valve is stuck and should be replaced.

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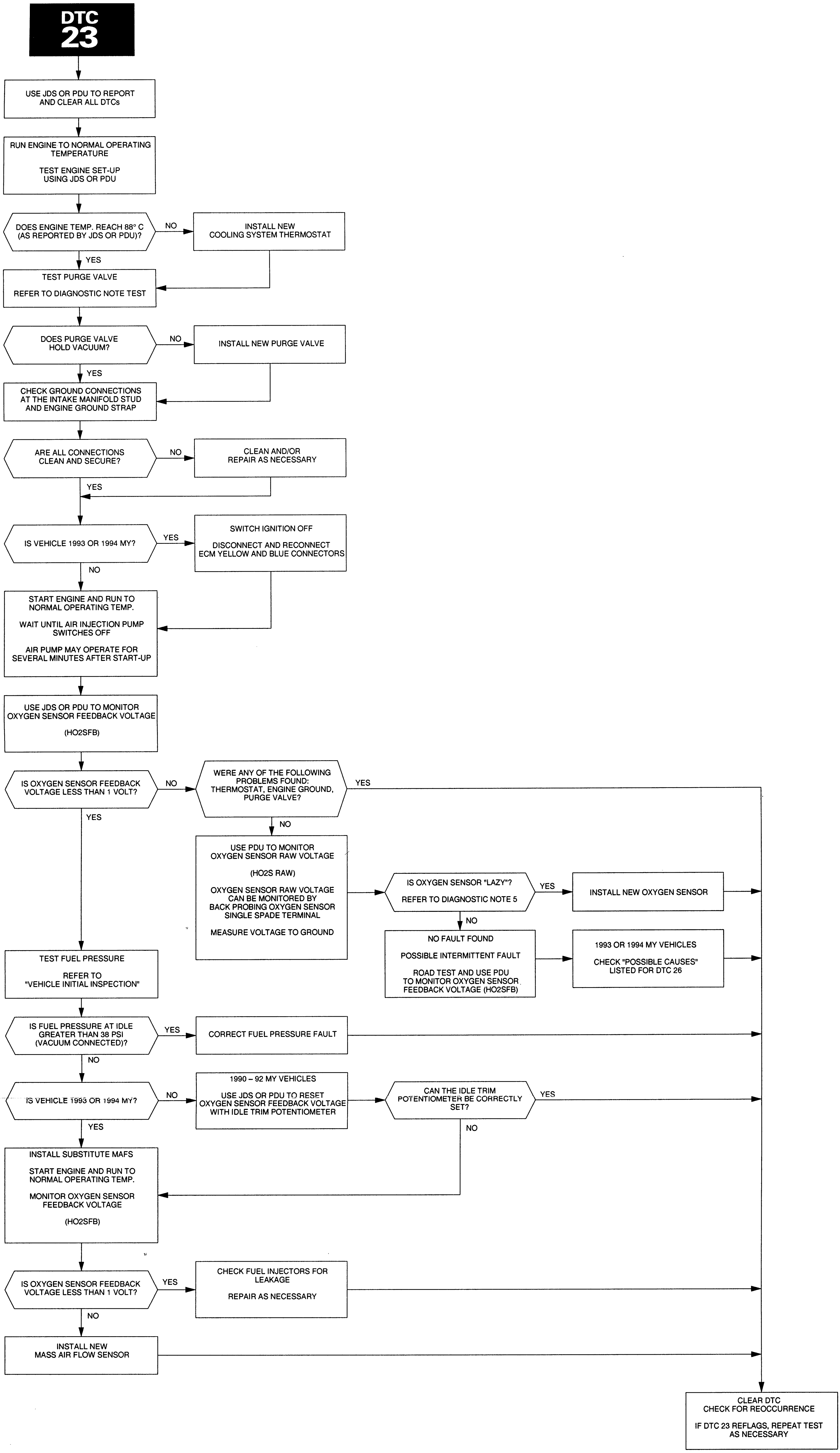

DTC 23
USE JDS OR PDU TO REPORT AND CLEAR ALL DTCs
RUN ENGINE TO NORMAL OPERATING TEMPERATURE
TEST ENGINE SET-UP USING JDS OR PDU
DOES ENGINE TEMP. REACH 88° C (AS REPORTED BY JDS OR PDU)?
NO
INSTALL NEW COOLING SYSTEM THERMOSTAT
YES
TEST PURGE VALVE
REFER TO DIAGNOSTIC NOTE TEST
DOES PURGE VALVE HOLD VACUUM?
NO
INSTALL NEW PURGE VALVE
YES
CHECK GROUND CONNECTIONS AT THE INTAKE MANIFOLD STUD AND ENGINE GROUND STRAP
ARE ALL CONNECTIONS CLEAN AND SECURE?
NO
CLEAN AND/OR REPAIR AS NECESSARY
YES
IS VEHICLE 1993 OR 1994 MY?
YES
SWITCH IGNITION OFF
DISCONNECT AND RECONNECT ECM YELLOW AND BLUE CONNECTORS
NO
START ENGINE AND RUN TO NORMAL OPERATING TEMP.
WAIT UNTIL AIR INJECTION PUMP SWITCHES OFF
AIR PUMP MAY OPERATE FOR SEVERAL MINUTES AFTER START-UP
USE JDS OR PDU TO MONITOR OXYGEN SENSOR FEEDBACK VOLTAGE
(HO2SFB)
IS OXYGEN SENSOR FEEDBACK VOLTAGE LESS THAN 1 VOLT?
NO
WERE ANY OF THE FOLLOWING PROBLEMS FOUND: THERMOSTAT, ENGINE GROUND, PURGE VALVE?
YES
NO
USE PDU TO MONITOR OXYGEN SENSOR RAW VOLTAGE
(HO2S RAW)
OXYGEN SENSOR RAW VOLTAGE CAN BE MONITORED BY BACK PROBING OXYGEN SENSOR SINGLE SPADE TERMINAL
MEASURE VOLTAGE TO GROUND
IS OXYGEN SENSOR "LAZY"?
REFER TO DIAGNOSTIC NOTE 5
YES
INSTALL NEW OXYGEN SENSOR
NO
NO FAULT FOUND
POSSIBLE INTERMITTENT FAULT
ROAD TEST AND USE PDU TO MONITOR OXYGEN SENSOR FEEDBACK VOLTAGE (HO2SFB)
1993 OR 1994 MY VEHICLES
CHECK "POSSIBLE CAUSES" LISTED FOR DTC 26
YES
TEST FUEL PRESSURE
REFER TO "VEHICLE INITIAL INSPECTION"
IS FUEL PRESSURE AT IDLE GREATER THAN 38 PSI (VACUUM CONNECTED)?
YES
CORRECT FUEL PRESSURE FAULT
NO
IS VEHICLE 1993 OR 1994 MY?
NO
1990 – 92 MY VEHICLES
USE JDS OR PDU TO RESET OXYGEN SENSOR FEEDBACK VOLTAGE WITH IDLE TRIM POTENTIOMETER
CAN THE IDLE TRIM POTENTIOMETER BE CORRECTLY SET?
YES
NO
YES
INSTALL SUBSTITUTE MAFS
START ENGINE AND RUN TO NORMAL OPERATING TEMP.
MONITOR OXYGEN SENSOR FEEDBACK VOLTAGE
(HO2SFB)
IS OXYGEN SENSOR FEEDBACK VOLTAGE LESS THAN 1 VOLT?
YES
CHECK FUEL INJECTORS FOR LEAKAGE
REPAIR AS NECESSARY
NO
INSTALL NEW MASS AIR FLOW SENSOR
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 23 REFLAGS, REPEAT TEST AS NECESSARY

DTC 23

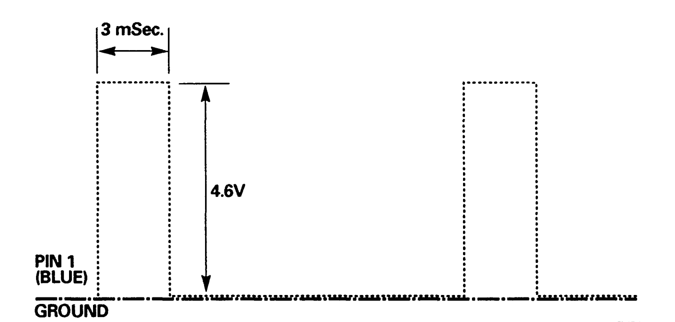
DTC 24 IGNITION DRIVE CIRCUIT

The ECM looks for the ignition drive output levels to be outside the normal range for both the ON and the OFF signal.

The ECM ignition drive output controls the ignition module switching of the low tension circuit. The drive signal is a square wave output that can be monitored with an oscilloscope.

The ECM will flag DTC 24 if the drive ON signal voltage is less than 4.5 volts; or if the OFF signal voltage is greater than 0.1 volt.

ECM IGNITION OUTPUT SIGNAL TO IGNITION MODULE



DTC 24.1

CONDITIONS REQUIRED FOR DTC 24 FLAGGING:

Ignition .... Ignition ON

Ignition drive ON signal voltage .... Voltage less than 4.5 volts

Ignition drive OFF signal voltage .... Voltage greater than 0.1 volt

Response time .... 600 milliseconds

LIMP HOME DEFAULT:

NONE

POSSIBLE FAULTS:

- Low battery voltage
- Poor connection at ECM or ignition module
- Water ingress at ECM blue connector (WR wire)
- Short circuit in WR wire between ECM and ignition module
- Defective ignition module
- Defective ECM

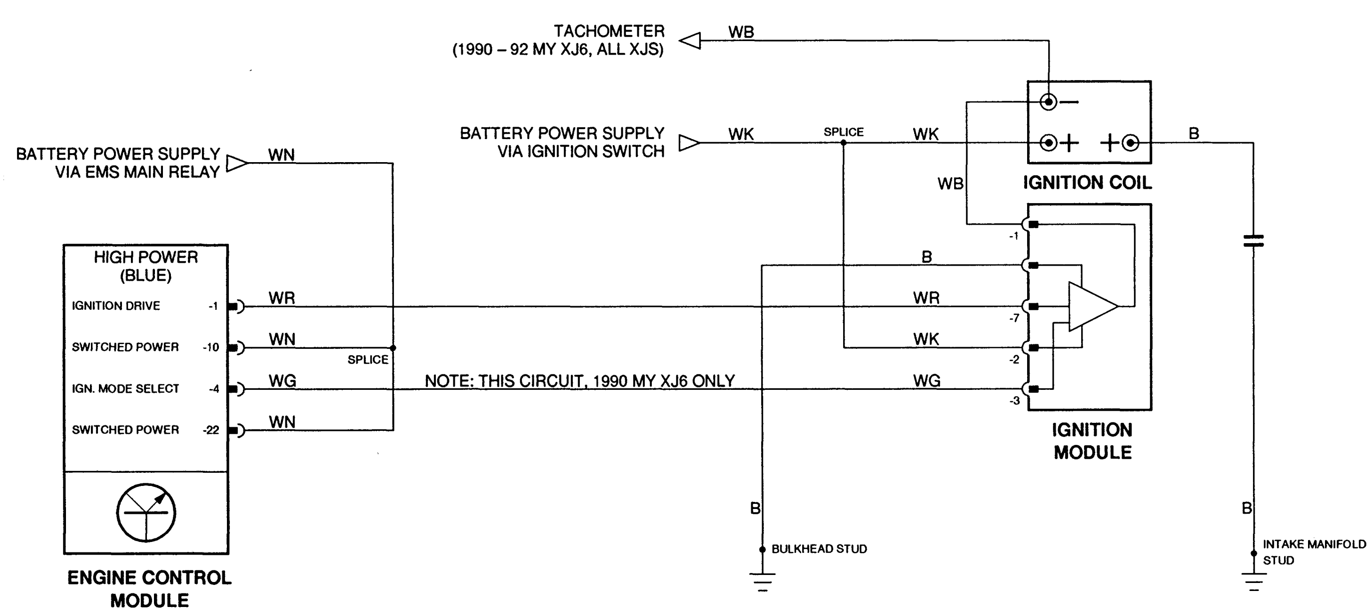
DIAGNOSTIC NOTES:

1 The ignition module in 1990 MY XJ6 vehicles has 4 wires plus a ground; all later vehicles have 3 wires plus ground. The 3-wire module can be used to replace the 4-wire module without modification.

2 The ignition module and heat sink plate are replaced as a unit. If the module and heat sink plate are separated, use heat sink compound during reassembly.

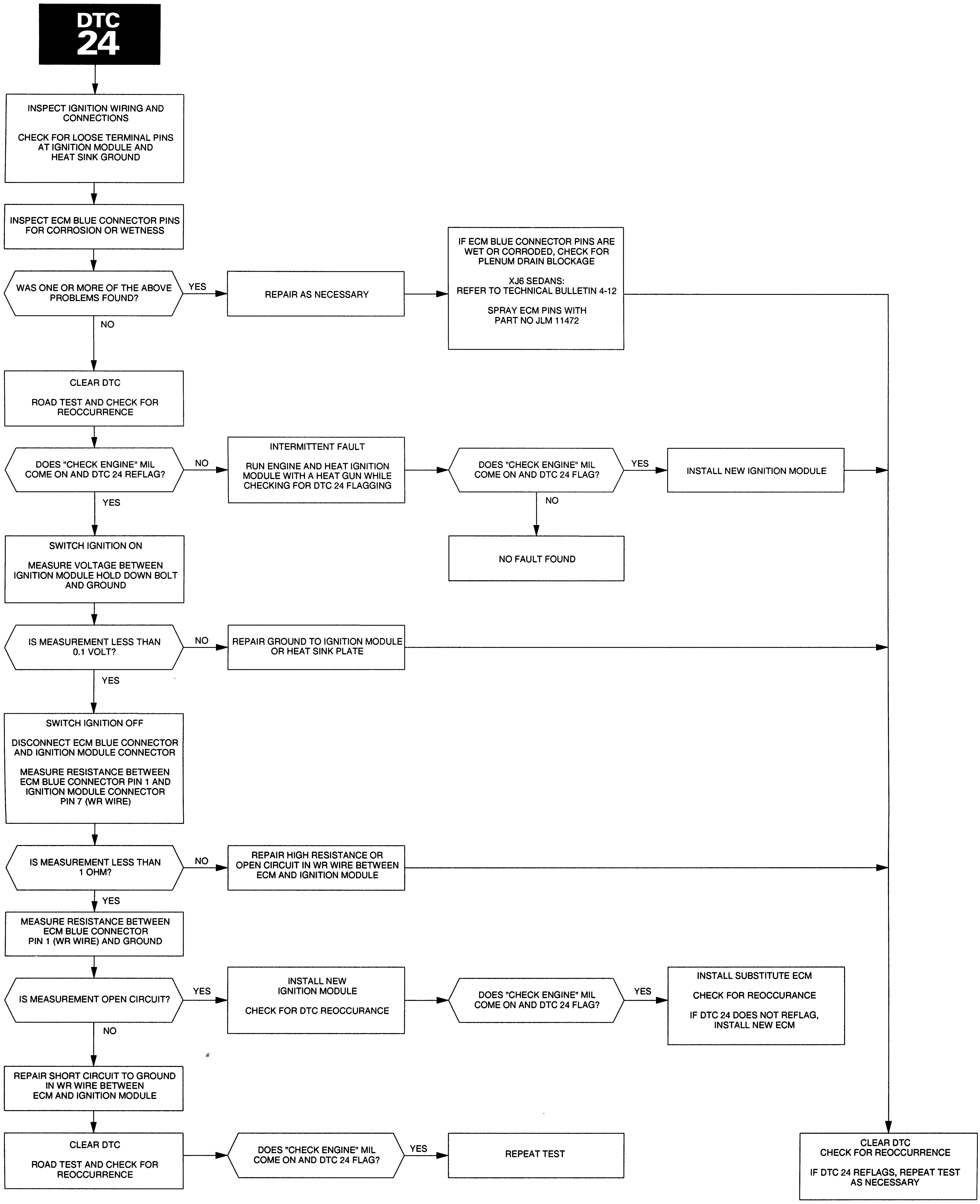
CIRCUIT DIAGRAM

IGNITION DRIVE: ALL VEHICLES AND MODEL YEARS



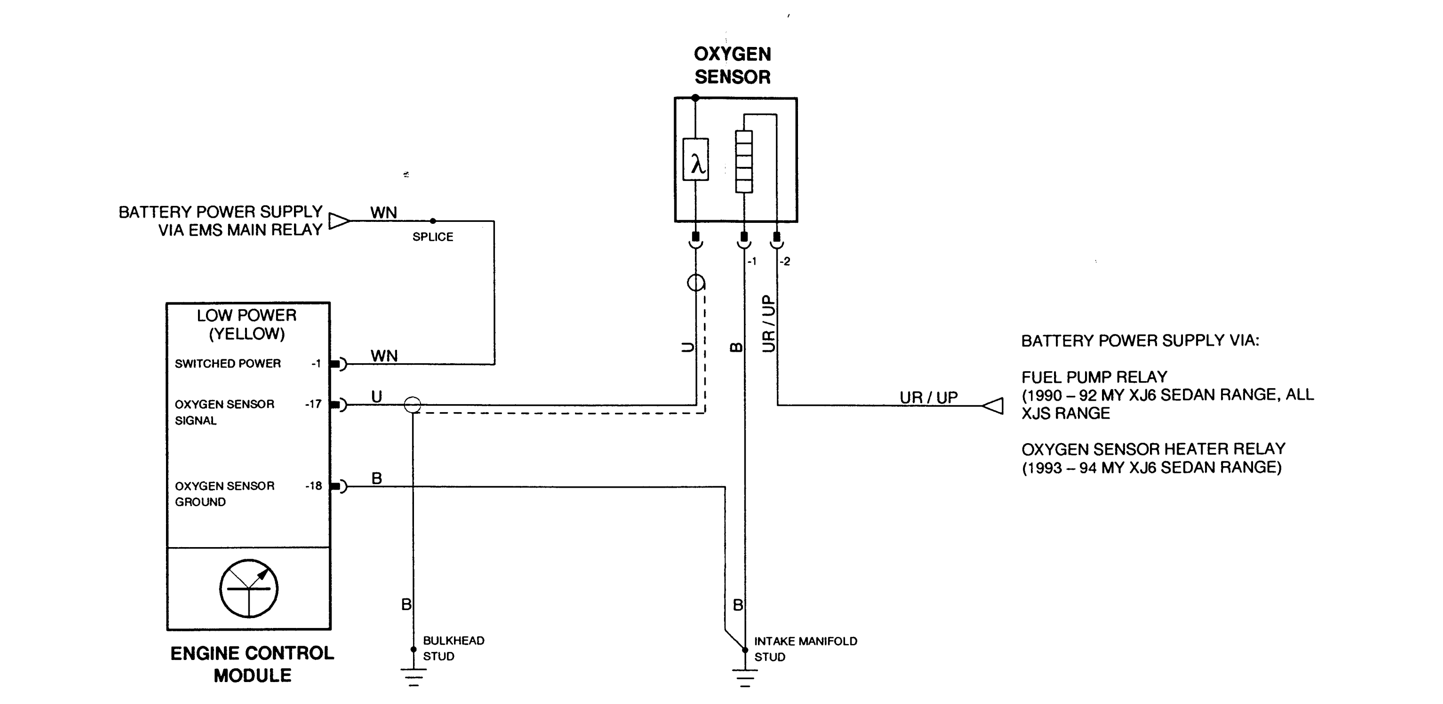
NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION.

DTC 24.2


DTC 24
INSPECT IGNITION WIRING AND CONNECTIONS
CHECK FOR LOOSE TERMINAL PINS AT IGNITION MODULE AND HEAT SINK GROUND
INSPECT ECM BLUE CONNECTOR PINS FOR CORROSION OR WETNESS
WAS ONE OR MORE OF THE ABOVE PROBLEMS FOUND?
YES
REPAIR AS NECESSARY
IF ECM BLUE CONNECTOR PINS ARE WET OR CORRODED, CHECK FOR PLENUM DRAIN BLOCKAGE
XJ6 SEDANS: REFER TO TECHNICAL BULLETIN 4-12
SPRAY ECM PINS WITH PART NO JLM 11472
NO
CLEAR DTC
ROAD TEST AND CHECK FOR REOCCURRENCE
DOES "CHECK ENGINE" MIL COME ON AND DTC 24 REFLAG?
NO
INTERMITTENT FAULT
RUN ENGINE AND HEAT IGNITION MODULE WITH A HEAT GUN WHILE CHECKING FOR DTC 24 FLAGGING
DOES "CHECK ENGINE" MIL COME ON AND DTC 24 FLAG?
YES
INSTALL NEW IGNITION MODULE
NO
NO FAULT FOUND
YES
SWITCH IGNITION ON
MEASURE VOLTAGE BETWEEN IGNITION MODULE HOLD DOWN BOLT AND GROUND
IS MEASUREMENT LESS THAN 0.1 VOLT?
NO
REPAIR GROUND TO IGNITION MODULE OR HEAT SINK PLATE
YES
SWITCH IGNITION OFF
DISCONNECT ECM BLUE CONNECTOR AND IGNITION MODULE CONNECTOR
MEASURE RESISTANCE BETWEEN ECM BLUE CONNECTOR PIN 1 AND IGNITION MODULE CONNECTOR PIN 7 (WR WIRE)
IS MEASUREMENT LESS THAN 1 OHM?
NO
REPAIR HIGH RESISTANCE OR OPEN CIRCUIT IN WR WIRE BETWEEN ECM AND IGNITION MODULE
YES
MEASURE RESISTANCE BETWEEN ECM BLUE CONNECTOR PIN 1 (WR WIRE) AND GROUND
IS MEASUREMENT OPEN CIRCUIT?
YES
INSTALL NEW IGNITION MODULE
CHECK FOR DTC REOCCURANCE
DOES "CHECK ENGINE" MIL COME ON AND DTC 24 FLAG?
YES
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 24 DOES NOT REFLAG, INSTALL NEW ECM
NO
REPAIR SHORT CIRCUIT TO GROUND IN WR WIRE BETWEEN ECM AND IGNITION MODULE
CLEAR DTC
ROAD TEST AND CHECK FOR REOCCURRENCE
DOES "CHECK ENGINE" MIL COME ON AND DTC 24 FLAG?
YES
REPEAT TEST
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 24 REFLAGS, REPEAT TEST AS NECESSARY

CIRCUIT DIAGRAM

HEATED OXYGEN SENSOR: ALL VEHICLES AND MODEL YEARS



NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION. DTC 26.2

DTC 26 OXYGEN SENSOR FEEDBACK (LEAN)

The ECM looks for poor closed loop fuel metering control while correcting for a lean mixture condition.

The ECM lengthens the injector pulse duration in response to low oxygen sensor voltage indicating lean fuel metering. The fuel metering can vary ± 12.5 % without flagging a code. If the fuel metering cannot be corrected by the ECM, the oxygen sensor feedback voltage (monitor with JDS or PDU) rises to 5 volts and DTC 26 will be flagged.

CONDITIONS REQUIRED FOR DTC 26 FLAGGING:

Engine coolant temperature ...... Greater than 167°F

Closed loop fuel metering .... Not in control (lean) – feedback = 5 volts (oxygen sensor feedback)

Response time .... 660 consecutive engine revolutions

LIMP HOME DEFAULT:

NONE

POSSIBLE FAULTS:

- Low fuel pressure
- Intake manifold air leak
- Ignition misfire
- Purge valve stuck open
- Fuel injectors blocked or sticking
- Incorrect injectors (3.6 L injectors instead of 4.0 L injectors)
- Air injection pump running continuously
- Oxygen sensor circuit fault
- Oxygen sensor heater ground loose
- Engine ground loose
- High resistance connection to MAFS
- Incorrect mass air flow sensor calibration
- "Lazy" or defective oxygen sensor

DIAGNOSTIC NOTES:

1 Engine fueling correction (dynamic) can be monitored by using JDS or PDU to read the oxygen sensor feedback voltage (HO2SFB). If the feedback voltage is between 1 and 4 volts, the fueling is normal and the problem is intermittent. If the feedback voltage stays above 4 volts, look for causes of lean running (DTC 26). The PDU Datalogger can be set to trigger on flagging DTC 26.

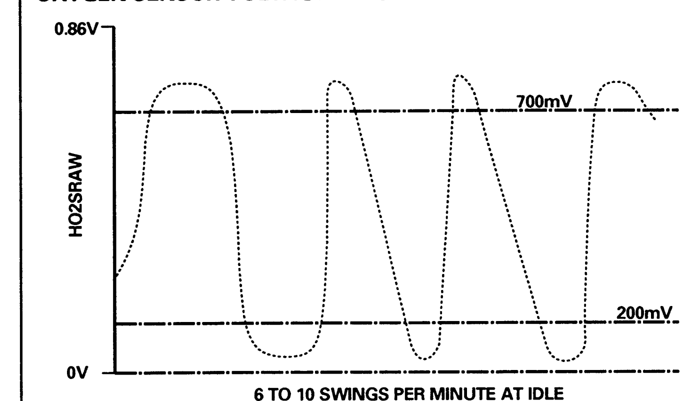
PDU DATALOGGER TRIGGER

FF 26 ↑ 1

2 1993 MY ON vehicles (with adaptive idle fueling trim) The ECM automatically corrects for small fueling errors by adding to or subtracting from the "base line" injector pulse duration. To determine if a base line correction has occurred, first monitor the oxygen sensor feedback voltage and record the value. Then disconnect and reconnect the ECM and recheck the oxygen sensor feedback voltage. A change in the feedback voltage indicates that a correction had been applied. (Disconnecting the ECM erases the correction.)

3 During closed loop fueling, the oxygen sensor "raw" voltage (signal voltage to the ECM) normally swings between 0.2 and 0.8 volt. If the oxygen sensor becomes contaminated or the heater is inoperative, the sensor can be "lazy". A lazy sensor may show a voltage swing of 0.3 – 0.7 volt or even less. The oxygen sensor raw voltage can be monitored using PDU (HO2 S RAW).

OXYGEN SENSOR VOLTAGE TRACE: PDU H02SRAW



DTC 26.1

4 1992 MY ON vehicles (ECM part number DBC 9622 ON): DTC 26 and 44 are inhibited when the fuel level is below approximately 2.5 gallons. A fuel level signal is input to the ECM on the yellow connector–pin 6 from the fuel level sensor circuit. When the voltage is above 5.7 volts, the codes cannot be flagged.

FUEL PRESSURE CHECK

42 – 45 psi	(vacuum disconnected from fuel pressure regulator)
34 – 38 psi at idle	(vacuum connected to fuel pressure regulator)

PURGE VALVE TEST

To test for a sticking purge valve:

- Disconnect the purge hose at the intake manifold adapter.
- Switch ignition ON; do not start the engine.
- Apply vacuum to purge hose; vacuum should hold. If the vacuum does not hold, the purge valve is stuck and should be replaced.
- Switch ignition OFF; vacuum should release after a few seconds. If the vacuum does not release, the purge valve is stuck and should be replaced.

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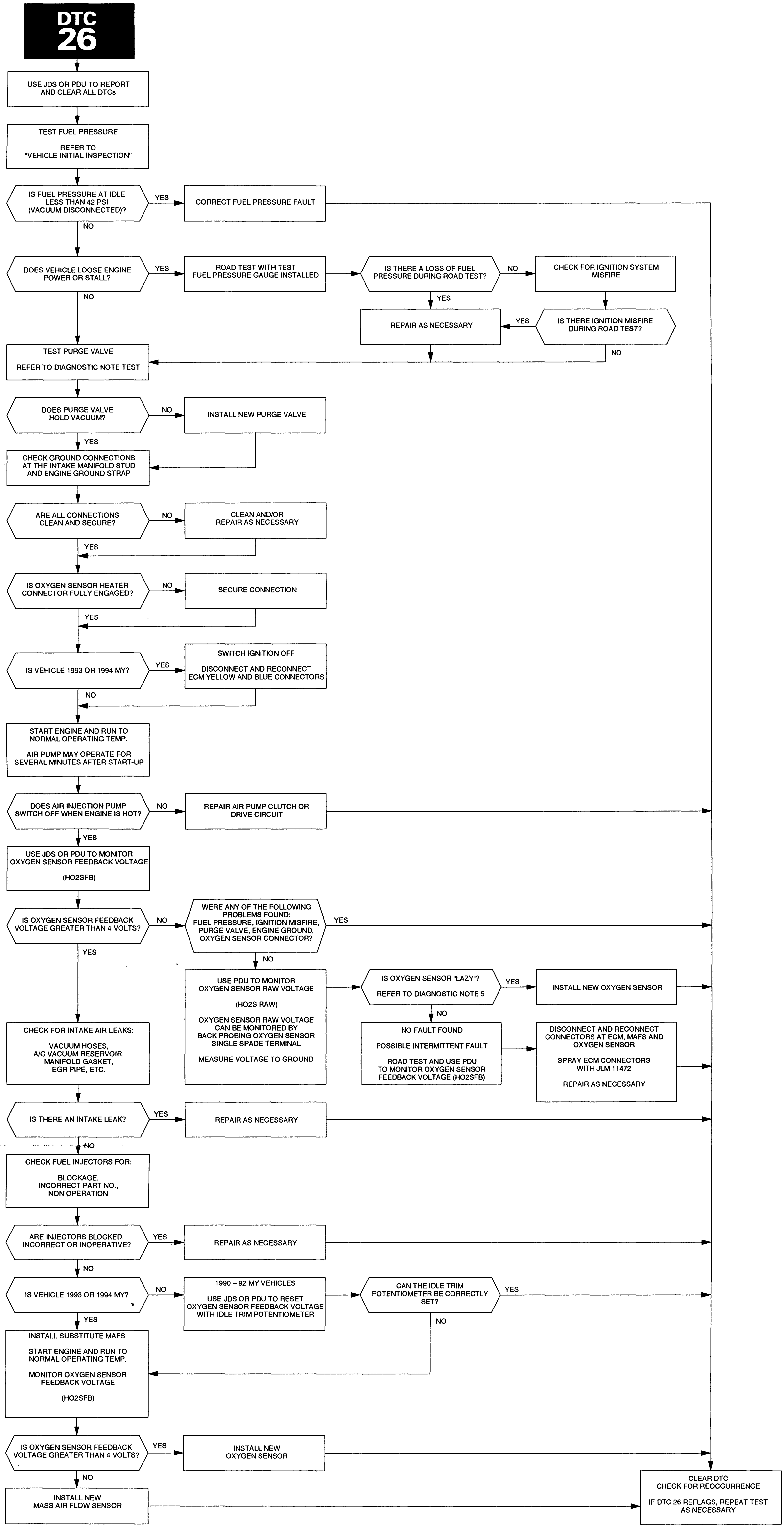

DTC 26
USE JDS OR PDU TO REPORT AND CLEAR ALL DTCs
TEST FUEL PRESSURE
REFER TO "VEHICLE INITIAL INSPECTION"
IS FUEL PRESSURE AT IDLE LESS THAN 42 PSI (VACUUM DISCONNECTED)?
YES
CORRECT FUEL PRESSURE FAULT
NO
DOES VEHICLE LOOSE ENGINE POWER OR STALL?
YES
ROAD TEST WITH TEST FUEL PRESSURE GAUGE INSTALLED
IS THERE A LOSS OF FUEL PRESSURE DURING ROAD TEST?
NO
CHECK FOR IGNITION SYSTEM MISFIRE
YES
REPAIR AS NECESSARY
YES
IS THERE IGNITION MISFIRE DURING ROAD TEST?
NO
NO
TEST PURGE VALVE
REFER TO DIAGNOSTIC NOTE TEST
DOES PURGE VALVE HOLD VACUUM?
NO
INSTALL NEW PURGE VALVE
YES
CHECK GROUND CONNECTIONS AT THE INTAKE MANIFOLD STUD AND ENGINE GROUND STRAP
ARE ALL CONNECTIONS CLEAN AND SECURE?
NO
CLEAN AND/OR REPAIR AS NECESSARY
YES
IS OXYGEN SENSOR HEATER CONNECTOR FULLY ENGAGED?
NO
SECURE CONNECTION
YES
IS VEHICLE 1993 OR 1994 MY?
YES
SWITCH IGNITION OFF
DISCONNECT AND RECONNECT ECM YELLOW AND BLUE CONNECTORS
NO
START ENGINE AND RUN TO NORMAL OPERATING TEMP.
AIR PUMP MAY OPERATE FOR SEVERAL MINUTES AFTER START-UP
DOES AIR INJECTION PUMP SWITCH OFF WHEN ENGINE IS HOT?
NO
REPAIR AIR PUMP CLUTCH OR DRIVE CIRCUIT
YES
USE JDS OR PDU TO MONITOR OXYGEN SENSOR FEEDBACK VOLTAGE
(HO2SFB)
IS OXYGEN SENSOR FEEDBACK VOLTAGE GREATER THAN 4 VOLTS?
NO
WERE ANY OF THE FOLLOWING PROBLEMS FOUND: FUEL PRESSURE, IGNITION MISFIRE, PURGE VALVE, ENGINE GROUND, OXYGEN SENSOR CONNECTOR?
YES
YES
NO
USE PDU TO MONITOR OXYGEN SENSOR RAW VOLTAGE
(HO2S RAW)
OXYGEN SENSOR RAW VOLTAGE CAN BE MONITORED BY BACK PROBING OXYGEN SENSOR SINGLE SPADE TERMINAL
MEASURE VOLTAGE TO GROUND
IS OXYGEN SENSOR "LAZY"?
REFER TO DIAGNOSTIC NOTE 5
YES
INSTALL NEW OXYGEN SENSOR
NO
NO FAULT FOUND
POSSIBLE INTERMITTENT FAULT
ROAD TEST AND USE PDU TO MONITOR OXYGEN SENSOR FEEDBACK VOLTAGE (HO2SFB)
DISCONNECT AND RECONNECT CONNECTORS AT ECM, MAFS AND OXYGEN SENSOR
SPRAY ECM CONNECTORS WITH JLM 11472
REPAIR AS NECESSARY
CHECK FOR INTAKE AIR LEAKS:
VACUUM HOSES, A/C VACUUM RESERVOIR, MANIFOLD GASKET, EGR PIPE, ETC.
IS THERE AN INTAKE LEAK?
YES
REPAIR AS NECESSARY
NO
CHECK FUEL INJECTORS FOR:
BLOCKAGE, INCORRECT PART NO., NON OPERATION
ARE INJECTORS BLOCKED, INCORRECT OR INOPERATIVE?
YES
REPAIR AS NECESSARY
NO
IS VEHICLE 1993 OR 1994 MY?
NO
1990 – 92 MY VEHICLES
USE JDS OR PDU TO RESET OXYGEN SENSOR FEEDBACK VOLTAGE WITH IDLE TRIM POTENTIOMETER
CAN THE IDLE TRIM POTENTIOMETER BE CORRECTLY SET?
YES
NO
YES
INSTALL SUBSTITUTE MAFS
START ENGINE AND RUN TO NORMAL OPERATING TEMP.
MONITOR OXYGEN SENSOR FEEDBACK VOLTAGE
(HO2SFB)
IS OXYGEN SENSOR FEEDBACK VOLTAGE GREATER THAN 4 VOLTS?
YES
INSTALL NEW OXYGEN SENSOR
NO
INSTALL NEW MASS AIR FLOW SENSOR
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 26 REFLAGS, REPEAT TEST AS NECESSARY

DTC 29 ECM SELF-TEST

The ECM runs an internal self-test routine each time the ignition is switched ON.

The engine management program and data are stored within the ECM as a continuous list of numbers. When the ECM checks itself, it adds all the numbers together and compares the result to a programmed value (Checksum). If they are not the same, then some corruption of the data or program has taken place.

The ECM will flag DTC 29 if the self-test result does not equal the checksum.

CONDITIONS REQUIRED FOR DTC 29 FLAGGING:

Ignition .... Ignition ON
ECM self-test .... Checksum fail

LIMP HOME DEFAULT:

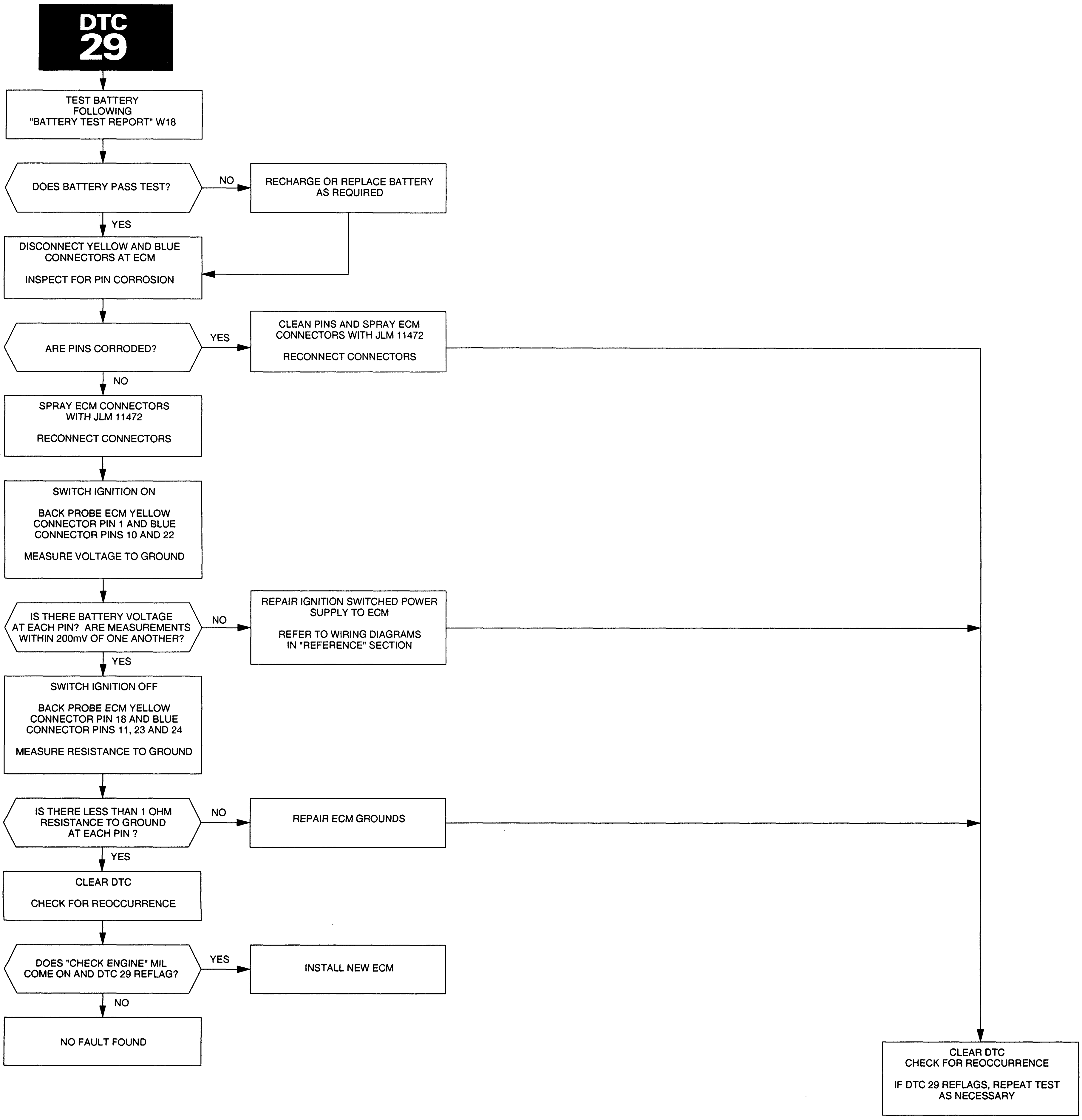
NONE

POSSIBLE FAULTS:

- Low battery voltage
- Poor connection to ECM power supplies
- Poor ECM ground connections
- ECM

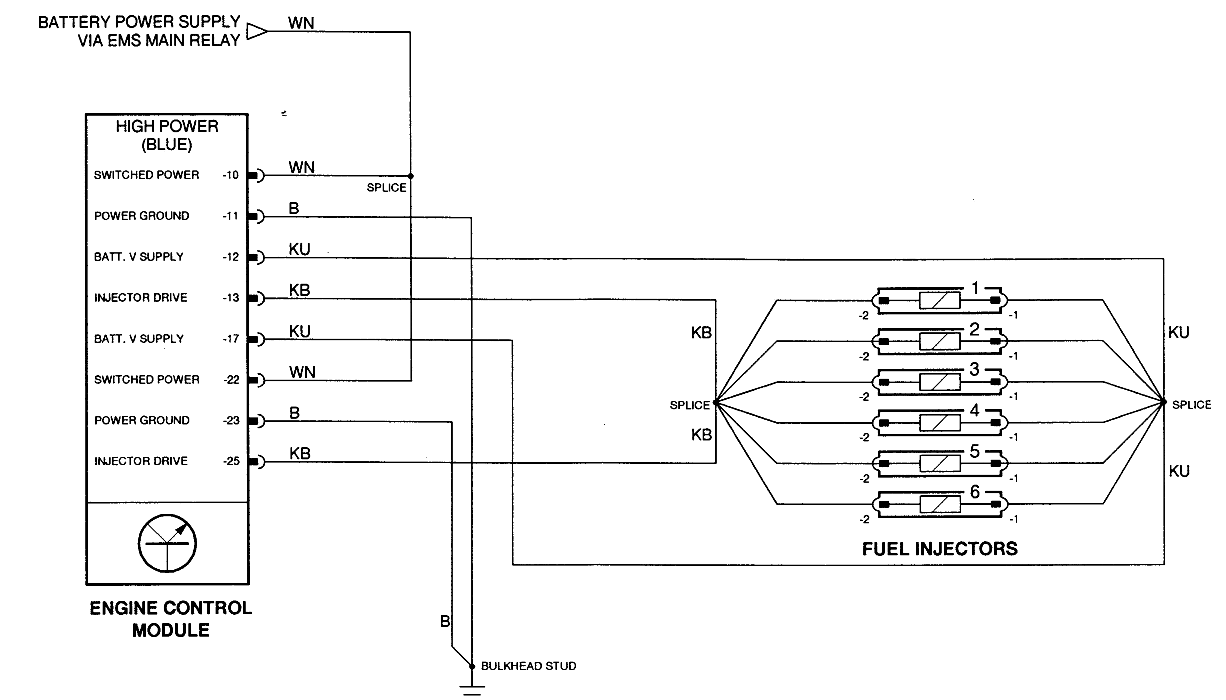
DIAGNOSTIC NOTES:

1 Check the battery condition (load test). If necessary, recharge or replace the battery. Clear the code and check for a reoccurrence. If DTC 29 does not reflag, the code may have been flagged during a previous period of low battery voltage. Do not replace an ECM if DTC does not reflag.


DTC 29
TEST BATTERY FOLLOWING "BATTERY TEST REPORT" W18
DOES BATTERY PASS TEST?
NO
RECHARGE OR REPLACE BATTERY AS REQUIRED
YES
DISCONNECT YELLOW AND BLUE CONNECTORS AT ECM
INSPECT FOR PIN CORROSION
ARE PINS CORRODED?
YES
CLEAN PINS AND SPRAY ECM CONNECTORS WITH JLM 11472
RECONNECT CONNECTORS
NO
SPRAY ECM CONNECTORS WITH JLM 11472
RECONNECT CONNECTORS
SWITCH IGNITION ON
BACK PROBE ECM YELLOW CONNECTOR PIN 1 AND BLUE CONNECTOR PINS 10 AND 22
MEASURE VOLTAGE TO GROUND
IS THERE BATTERY VOLTAGE AT EACH PIN? ARE MEASUREMENTS WITHIN 200mV OF ONE ANOTHER?
NO
REPAIR IGNITION SWITCHED POWER SUPPLY TO ECM
REFER TO WIRING DIAGRAMS IN "REFERENCE" SECTION
YES
SWITCH IGNITION OFF
BACK PROBE ECM YELLOW CONNECTOR PIN 18 AND BLUE CONNECTOR PINS 11, 23 AND 24
MEASURE RESISTANCE TO GROUND
IS THERE LESS THAN 1 OHM RESISTANCE TO GROUND AT EACH PIN ?
NO
REPAIR ECM GROUNDS
YES
CLEAR DTC
CHECK FOR REOCCURRENCE
DOES "CHECK ENGINE" MIL COME ON AND DTC 29 REFLAG?
YES
INSTALL NEW ECM
NO
NO FAULT FOUND
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 29 REFLAGS, REPEAT TEST AS NECESSARY

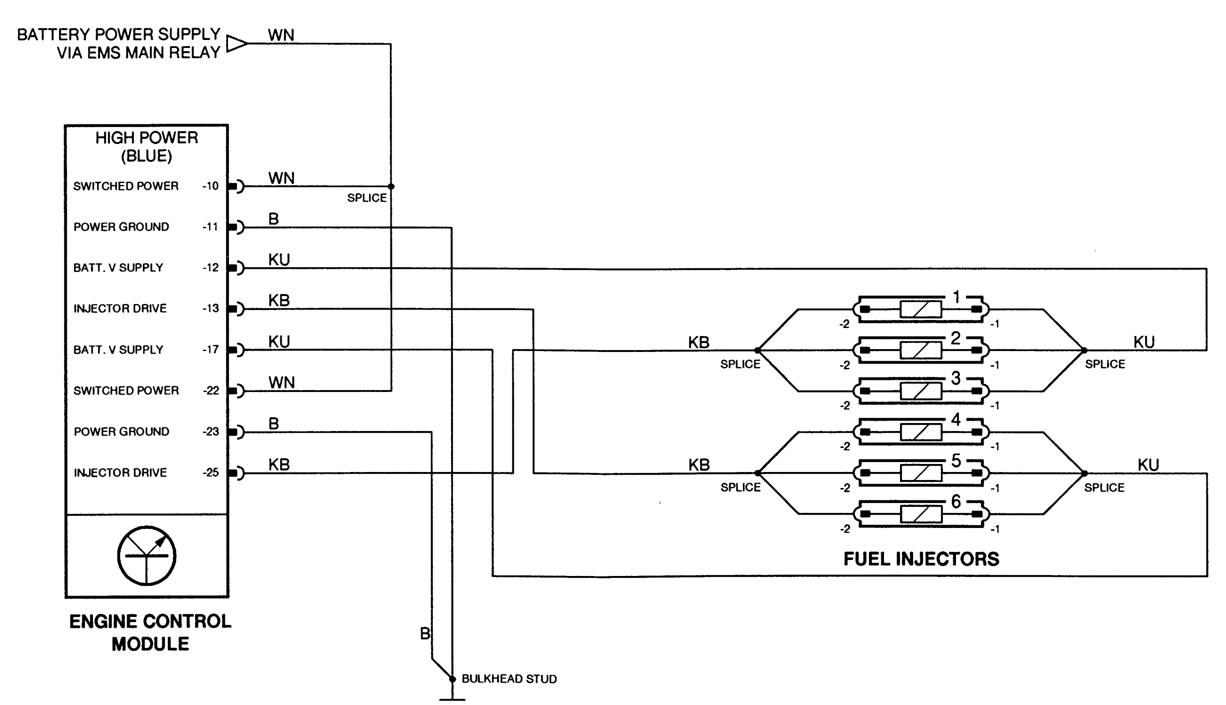
DTC 29

FUEL INJECTOR DRIVE: 1990 – 92 XJ6 SEDAN RANGE



NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION. DTC 33.2

FUEL INJECTOR DRIVE: 1993 – 94 MY XJ6 SEDAN RANGE, ALL XJS RANGE



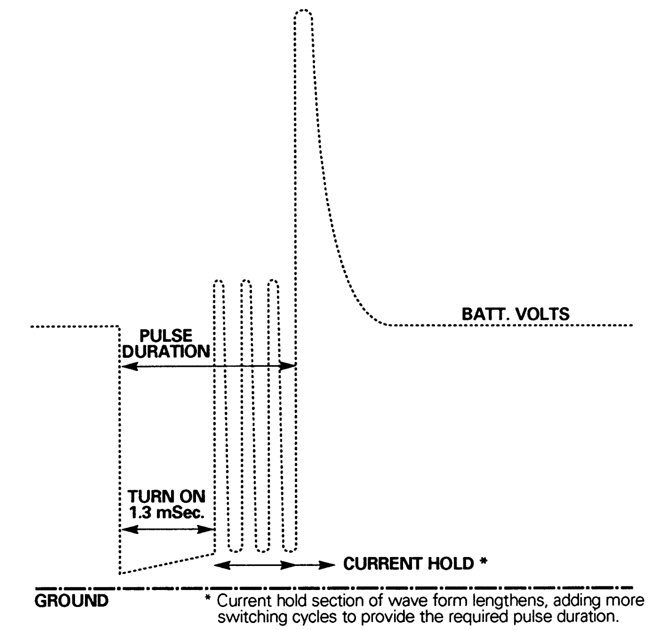
NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION. DTC 33.3

DTC 33 INJECTOR DRIVE CIRCUIT

The ECM looks for a low electrical load on the fuel injector drive circuit when the injectors are switched on.

The fuel injectors are supplied with 12 volts and are triggered on the ground side by the ECM. To reduce power consumption, the current drawn by the injectors is controlled by the ECM. The injectors are opened by a relatively large "turn on" electrical pulse and are held open for the required pulse duration by a series of smaller "hold on" pulses. All six injectors are connected in parallel and operate simultaneously.

INJECTOR WAVE FORM



DTC 33.1

The ECM will flag DTC 33 if the fuel injector drive circuit voltage is 1.2 volts or greater when the injectors are on.

CONDITIONS REQUIRED FOR DTC 33 FLAGGING:

Injector drive ON .... 1.2 volts or greater

Response time .... 600 milliseconds

LIMP HOME DEFAULT:

NONE

POSSIBLE FAULTS:

- Poor connection at the fuel injectors or the ECM
- Open circuit or short circuit in injector harness
- Poor power ground connection to the ECM (blue pins 11 and 23)
- Defective (open circuit) fuel injector(s)

DIAGNOSTIC NOTES:

1 The two injector supply pins on the ECM, blue 12 and 17, are connected together with pins 10 and 22 to supply 12 volts to the injectors.

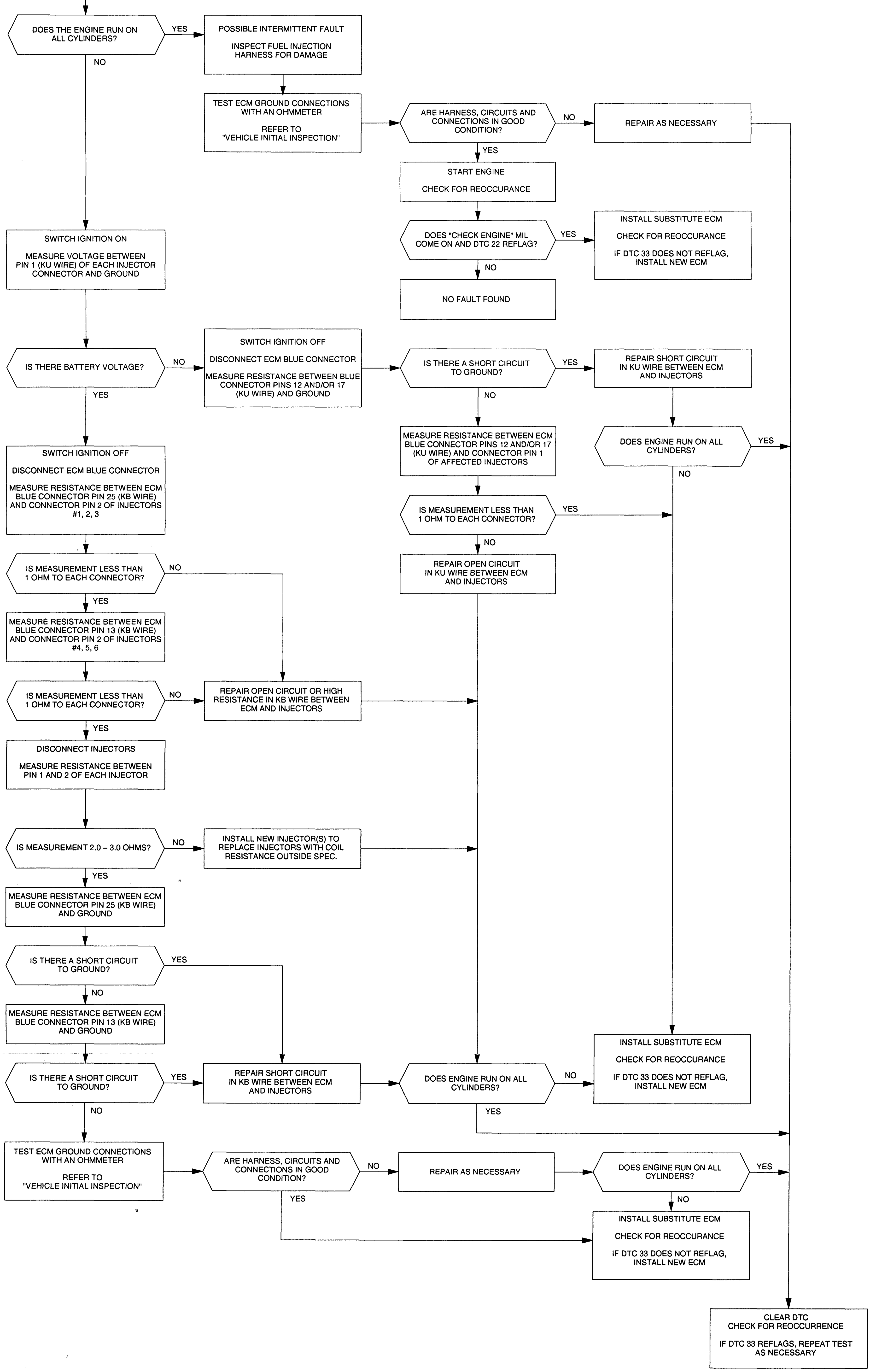
2 The two injector drive pins on the ECM, blue 13 and 25, are connected together to provide the pulsed ground.

3 If one or two injectors are not operating, the fault is likely to be located in the fuel rail area of the harness.

4 The individual injector coil resistance is 2.2 – 3 ohms.

Continued at left on foldout page.

DTC 33



DOES THE ENGINE RUN ON ALL CYLINDERS?
YES
NO
POSSIBLE INTERMITTENT FAULT
INSPECT FUEL INJECTION HARNESS FOR DAMAGE
TEST ECM GROUND CONNECTIONS WITH AN OHMMETER
REFER TO "VEHICLE INITIAL INSPECTION"
ARE HARNESS, CIRCUITS AND CONNECTIONS IN GOOD CONDITION?
NO
REPAIR AS NECESSARY
YES
START ENGINE
CHECK FOR REOCCURANCE
DOES "CHECK ENGINE" MIL COME ON AND DTC 22 REFLAG?
YES
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 33 DOES NOT REFLAG, INSTALL NEW ECM
NO
NO FAULT FOUND
SWITCH IGNITION ON
MEASURE VOLTAGE BETWEEN PIN 1 (KU WIRE) OF EACH INJECTOR CONNECTOR AND GROUND
IS THERE BATTERY VOLTAGE?
NO
SWITCH IGNITION OFF
DISCONNECT ECM BLUE CONNECTOR
MEASURE RESISTANCE BETWEEN BLUE CONNECTOR PINS 12 AND/OR 17 (KU WIRE) AND GROUND
IS THERE A SHORT CIRCUIT TO GROUND?
YES
REPAIR SHORT CIRCUIT IN KU WIRE BETWEEN ECM AND INJECTORS
DOES ENGINE RUN ON ALL CYLINDERS?
YES
NO
NO
MEASURE RESISTANCE BETWEEN ECM BLUE CONNECTOR PINS 12 AND/OR 17 (KU WIRE) AND CONNECTOR PIN 1 OF AFFECTED INJECTORS
IS MEASUREMENT LESS THAN 1 OHM TO EACH CONNECTOR?
YES
NO
REPAIR OPEN CIRCUIT IN KU WIRE BETWEEN ECM AND INJECTORS
YES
SWITCH IGNITION OFF
DISCONNECT ECM BLUE CONNECTOR
MEASURE RESISTANCE BETWEEN ECM BLUE CONNECTOR PIN 25 (KB WIRE) AND CONNECTOR PIN 2 OF INJECTORS #1, 2, 3
IS MEASUREMENT LESS THAN 1 OHM TO EACH CONNECTOR?
NO
YES
MEASURE RESISTANCE BETWEEN ECM BLUE CONNECTOR PIN 13 (KB WIRE) AND CONNECTOR PIN 2 OF INJECTORS #4, 5, 6
IS MEASUREMENT LESS THAN 1 OHM TO EACH CONNECTOR?
NO
REPAIR OPEN CIRCUIT OR HIGH RESISTANCE IN KB WIRE BETWEEN ECM AND INJECTORS
YES
DISCONNECT INJECTORS
MEASURE RESISTANCE BETWEEN PIN 1 AND 2 OF EACH INJECTOR
IS MEASUREMENT 2.0 – 3.0 OHMS?
NO
INSTALL NEW INJECTOR(S) TO REPLACE INJECTORS WITH COIL RESISTANCE OUTSIDE SPEC.
YES
MEASURE RESISTANCE BETWEEN ECM BLUE CONNECTOR PIN 25 (KB WIRE) AND GROUND
IS THERE A SHORT CIRCUIT TO GROUND?
YES
NO
MEASURE RESISTANCE BETWEEN ECM BLUE CONNECTOR PIN 13 (KB WIRE) AND GROUND
IS THERE A SHORT CIRCUIT TO GROUND?
YES
REPAIR SHORT CIRCUIT IN KB WIRE BETWEEN ECM AND INJECTORS
DOES ENGINE RUN ON ALL CYLINDERS?
NO
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 33 DOES NOT REFLAG, INSTALL NEW ECM
YES
NO
TEST ECM GROUND CONNECTIONS WITH AN OHMMETER
REFER TO "VEHICLE INITIAL INSPECTION"
ARE HARNESS, CIRCUITS AND CONNECTIONS IN GOOD CONDITION?
NO
REPAIR AS NECESSARY
DOES ENGINE RUN ON ALL CYLINDERS?
YES
NO
YES
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 33 DOES NOT REFLAG, INSTALL NEW ECM
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 33 REFLAGS, REPEAT TEST AS NECESSARY

DTC 34 AIR / FUEL RATIO "RICH" DURING OVERRUN FUEL CUTOFF

The ECM looks for the oxygen sensor feedback voltage to indicate a "rich" condition during overrun fuel cutoff.

During overrun fuel cutoff, the ECM checks the oxygen sensor raw voltage three times per engine revolution. Fuel cutoff occurs when the throttle is closed, engine speed is above 1100 rpm, and the coolant temperature is greater than 86°F (30°C).

The ECM will flag DTC 34 if the oxygen sensor feedback voltage indicates "rich" during overrun fuel cutoff for more than 32 consecutive checks.

CONDITIONS REQUIRED FOR DTC 34 FLAGGING:

Throttle position	At idle
Engine speed	Greater than 2000 rpm
Engine coolant temperature	94°F (34°C) or greater
Oxygen sensor feedback voltage	32 or more "rich" responses
Response time	5 seconds

LIMP HOME DEFAULT:

NONE

POSSIBLE FAULTS:

- Leaking fuel injector(s)
- Leaking / stuck purge valve
- Leaking vacuum/pressure relief valve ("Rochester valve") diaphragm

DIAGNOSTIC NOTES:

1 The oxygen sensor feedback voltage can be monitored and intermittent faults captured using the PDU "Datalogger" function. The PDU Datalogger can be set to trigger on flagging DTC 34.

PDU DATALOGGER TRIGGER

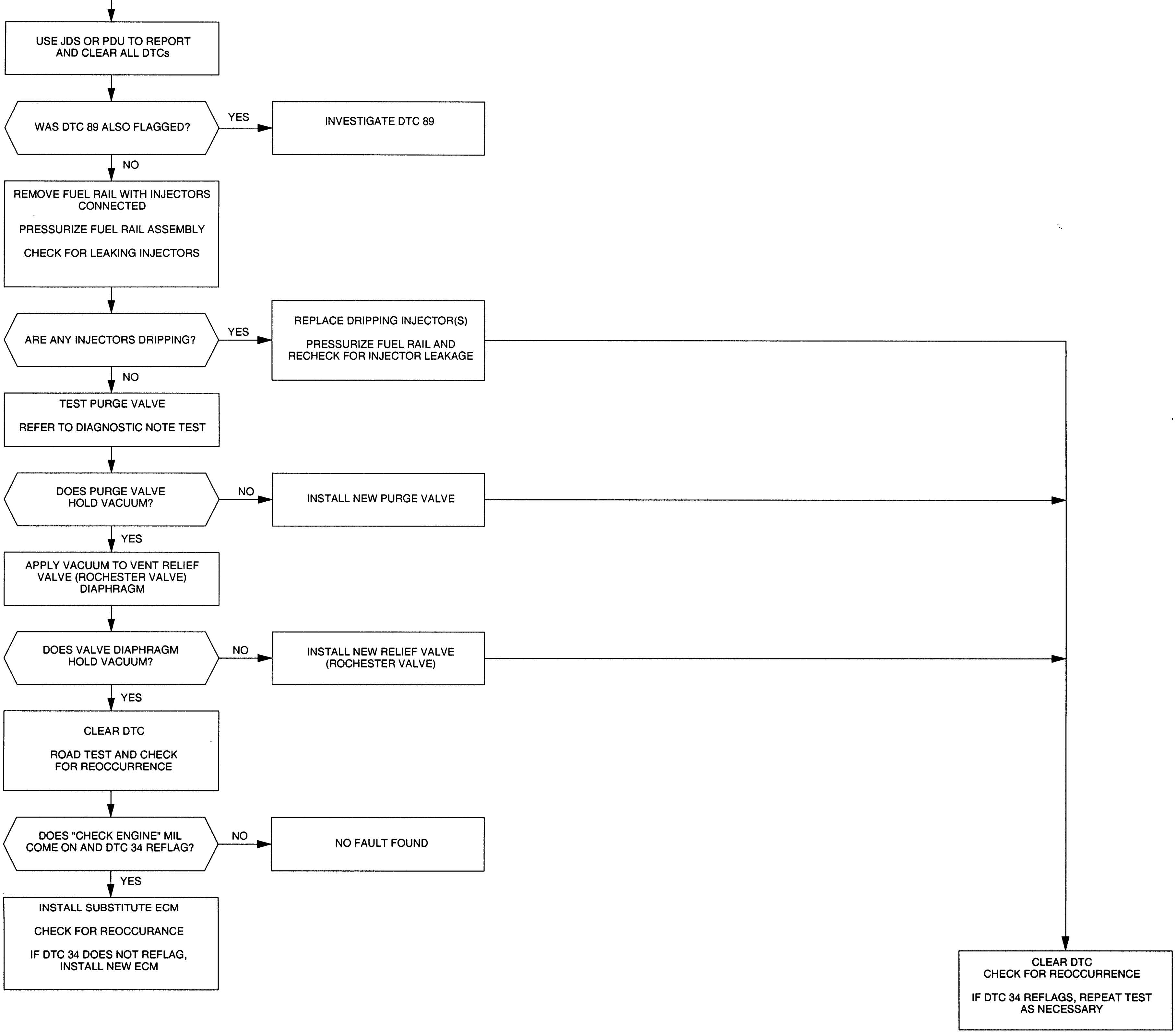
FF 34 ↑ **1**

PURGE VALVE TEST

To test for a sticking purge valve:

- Disconnect the purge hose at the intake manifold adapter.
- Switch ignition ON; do not start the engine.
- Apply vacuum to purge hose; vacuum should hold.
  If the vacuum does not hold, the purge valve is stuck and should be replaced.
- Switch ignition OFF; vacuum should release after a few seconds.
  If the vacuum does not release, the purge valve is stuck and should be replaced.

DTC 34

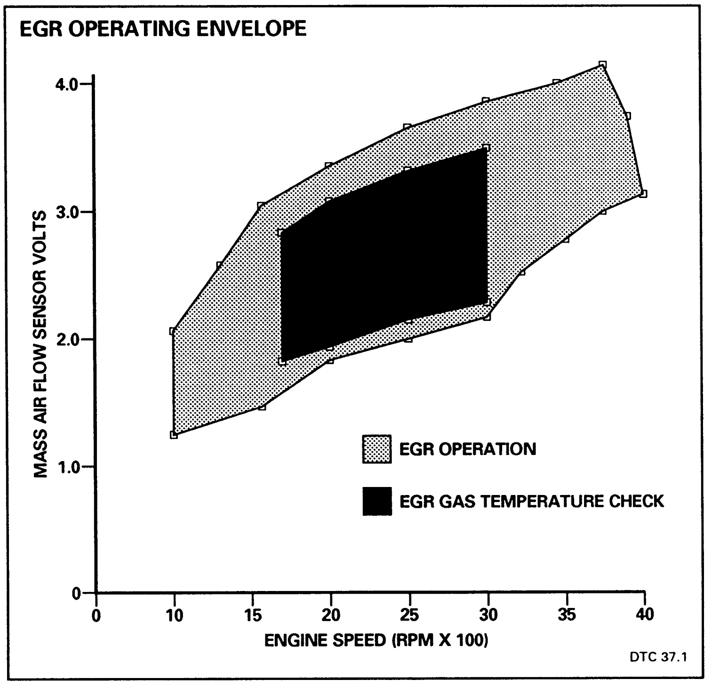


USE JDS OR PDU TO REPORT AND CLEAR ALL DTCs
WAS DTC 89 ALSO FLAGGED?
YES
INVESTIGATE DTC 89
NO
REMOVE FUEL RAIL WITH INJECTORS CONNECTED
PRESSURIZE FUEL RAIL ASSEMBLY
CHECK FOR LEAKING INJECTORS
ARE ANY INJECTORS DRIPPING?
YES
REPLACE DRIPPING INJECTOR(S)
PRESSURIZE FUEL RAIL AND RECHECK FOR INJECTOR LEAKAGE
NO
TEST PURGE VALVE
REFER TO DIAGNOSTIC NOTE TEST
DOES PURGE VALVE HOLD VACUUM?
NO
INSTALL NEW PURGE VALVE
YES
APPLY VACUUM TO VENT RELIEF VALVE (ROCHESTER VALVE) DIAPHRAGM
DOES VALVE DIAPHRAGM HOLD VACUUM?
NO
INSTALL NEW RELIEF VALVE (ROCHESTER VALVE)
YES
CLEAR DTC
ROAD TEST AND CHECK FOR REOCCURRENCE
DOES "CHECK ENGINE" MIL COME ON AND DTC 34 REFLAG?
NO
NO FAULT FOUND
YES
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 34 DOES NOT REFLAG, INSTALL NEW ECM
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 34 REFLAGS, REPEAT TEST AS NECESSARY

DTC 37 EGR CONTROL CIRCUIT

When the ignition is switched ON, the ECM looks for an incorrect internal circuit voltage that indicates the state of the EGR solenoid vacuum valve switching circuit. This internal voltage cannot be measured.

The EGR solenoid vacuum valve has a 12-volt power supply from the EMS main relay and is switched ON by the ECM by completing the circuit to ground. When energized, the solenoid valve directs manifold vacuum to the EGR valve. EGR is activated when the engine coolant temperature is above 140°F (60°C), the transmission is in a driving gear, and the engine is operating within the envelope.



The ECM will flag DTC 37 if the EGR solenoid vacuum valve control circuit is open or short circuit.

CONDITIONS REQUIRED FOR DTC 37 FLAGGING:

Engine .... Engine operating

ECM internal circuit .... Indicates that the EGR solenoid vacuum valve control circuit is open or short circuit

Response time .... 100 milliseconds

LIMP HOME DEFAULT:

NONE

POSSIBLE FAULTS:

- Low battery voltage
- Poor ground connection to ECM
- Short circuit or open circuit wiring from the ECM to the EGR solenoid vacuum valve
- Defective EGR solenoid vacuum valve

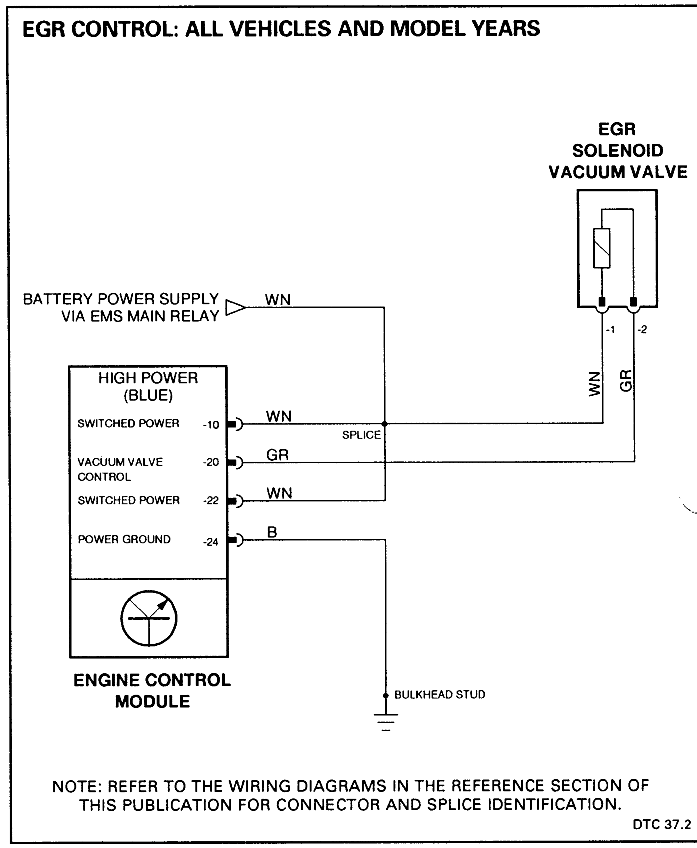
DIAGNOSTIC NOTES:

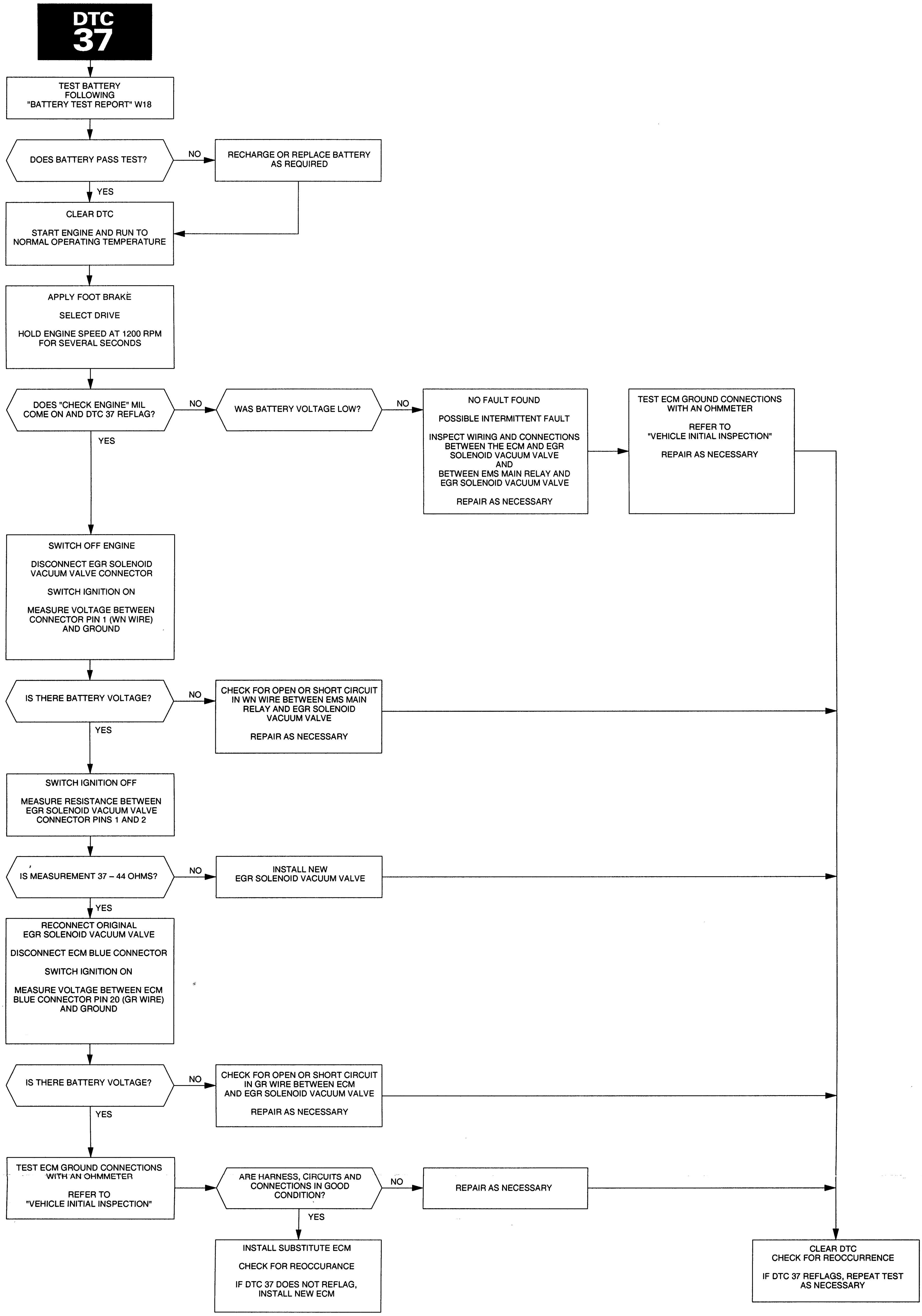
1 The EGR solenoid vacuum valve coil resistance should be 37 – 44 ohms.

2 With the ignition ON and the engine off, there should be approximately 12 volts at pins 1 and 2 on the solenoid vacuum valve.

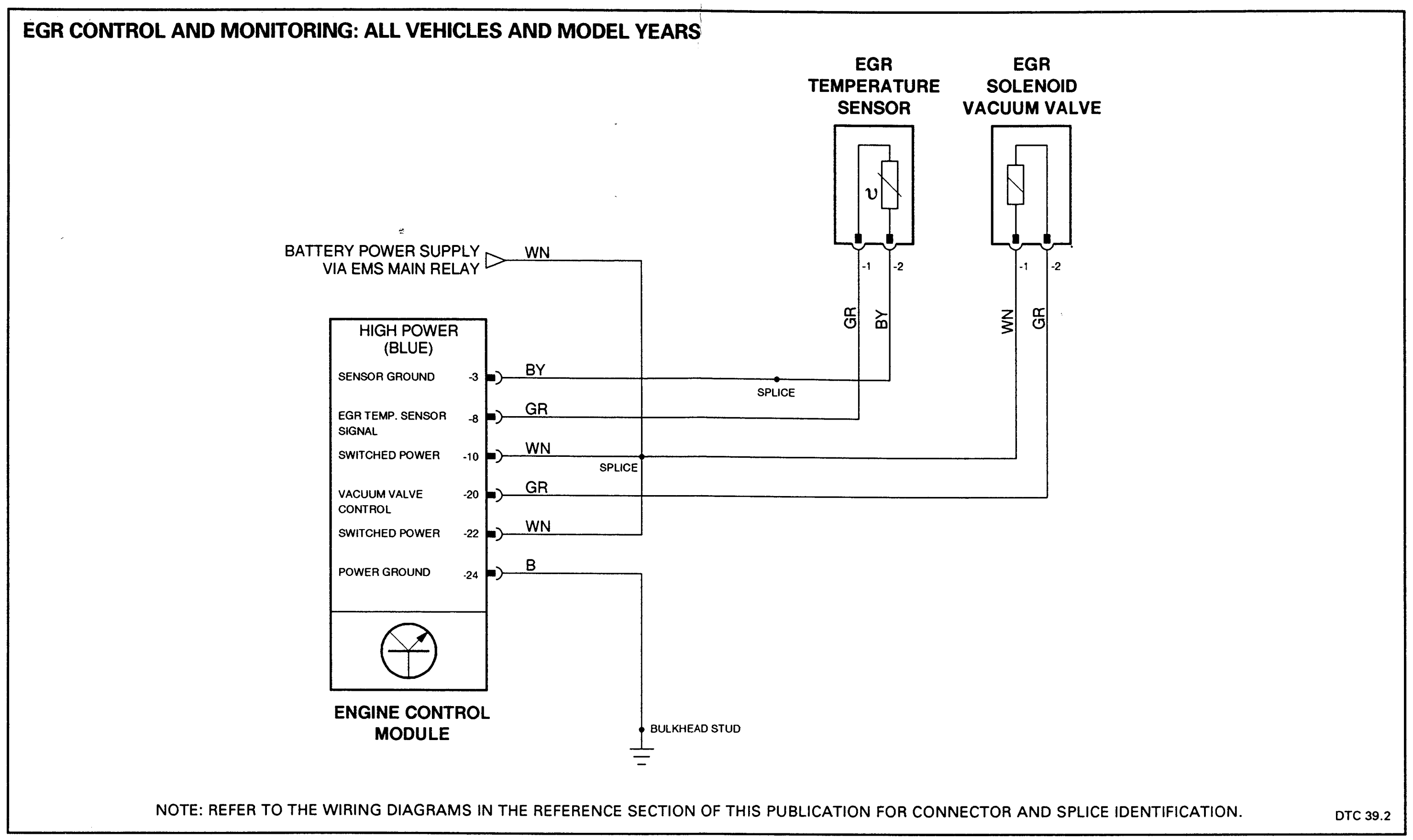
3 During EGR operation, there should approximately 2 volts at pin 2 on the solenoid vacuum valve.

CIRCUIT DIAGRAM




DTC 37
TEST BATTERY FOLLOWING "BATTERY TEST REPORT" W18
DOES BATTERY PASS TEST?
NO
RECHARGE OR REPLACE BATTERY AS REQUIRED
YES
CLEAR DTC
START ENGINE AND RUN TO NORMAL OPERATING TEMPERATURE
APPLY FOOT BRAKE
SELECT DRIVE
HOLD ENGINE SPEED AT 1200 RPM FOR SEVERAL SECONDS
DOES "CHECK ENGINE" MIL COME ON AND DTC 37 REFLAG?
NO
WAS BATTERY VOLTAGE LOW?
NO
NO FAULT FOUND
POSSIBLE INTERMITTENT FAULT
INSPECT WIRING AND CONNECTIONS BETWEEN THE ECM AND EGR SOLENOID VACUUM VALVE AND BETWEEN EMS MAIN RELAY AND EGR SOLENOID VACUUM VALVE
REPAIR AS NECESSARY
TEST ECM GROUND CONNECTIONS WITH AN OHMMETER
REFER TO "VEHICLE INITIAL INSPECTION"
REPAIR AS NECESSARY
YES
SWITCH OFF ENGINE
DISCONNECT EGR SOLENOID VACUUM VALVE CONNECTOR
SWITCH IGNITION ON
MEASURE VOLTAGE BETWEEN CONNECTOR PIN 1 (WN WIRE) AND GROUND
IS THERE BATTERY VOLTAGE?
NO
CHECK FOR OPEN OR SHORT CIRCUIT IN WN WIRE BETWEEN EMS MAIN RELAY AND EGR SOLENOID VACUUM VALVE
REPAIR AS NECESSARY
YES
SWITCH IGNITION OFF
MEASURE RESISTANCE BETWEEN EGR SOLENOID VACUUM VALVE CONNECTOR PINS 1 AND 2
IS MEASUREMENT 37 – 44 OHMS?
NO
INSTALL NEW EGR SOLENOID VACUUM VALVE
YES
RECONNECT ORIGINAL EGR SOLENOID VACUUM VALVE
DISCONNECT ECM BLUE CONNECTOR
SWITCH IGNITION ON
MEASURE VOLTAGE BETWEEN ECM BLUE CONNECTOR PIN 20 (GR WIRE) AND GROUND
IS THERE BATTERY VOLTAGE?
NO
CHECK FOR OPEN OR SHORT CIRCUIT IN GR WIRE BETWEEN ECM AND EGR SOLENOID VACUUM VALVE
REPAIR AS NECESSARY
YES
TEST ECM GROUND CONNECTIONS WITH AN OHMMETER
REFER TO "VEHICLE INITIAL INSPECTION"
ARE HARNESS, CIRCUITS AND CONNECTIONS IN GOOD CONDITION?
NO
REPAIR AS NECESSARY
YES
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 37 DOES NOT REFLAG, INSTALL NEW ECM
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 37 REFLAGS, REPEAT TEST AS NECESSARY

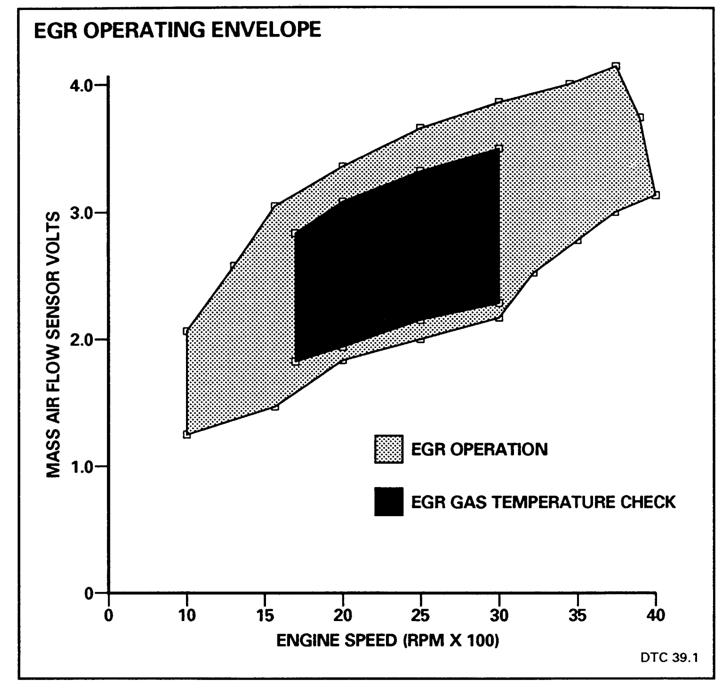
CIRCUIT DIAGRAM



DTC 39 EGR TEMPERATURE SENSOR CIRCUIT

The ECM looks for a low EGR temperature signal when the EGR solenoid vacuum valve is open and a high EGR temperature signal when the EGR solenoid vacuum valve is closed. In addition, the ECM looks for an over-temperature condition when EGR is enabled.

The ECM monitors the temperature at the intake manifold EGR adapter to determine if exhaust gas is flowing when the engine is operating within the EGR operating envelope. When EGR is disabled by the ECM, 5 minutes are allowed for the system to cool down.



The EGR temperature sensor is a "negative temperature coefficient" (NTC) thermister in which the resistance decreases as the temperature increases. The ECM applies 5 volts to the sensor and monitors for a voltage decrease when exhaust gas flows.

The ECM will flag DTC 39 if the EGR temperature signal is outside a limit (higher or lower) when EGR is enabled or disabled.

CONDITIONS REQUIRED FOR DTC 39 FLAGGING:

Engine coolant temp. .... Greater than 180°F (82°C)
Throttle position .... Within the expected range for the engine speed
Engine speed .... 1700 – 3000
Load site range............. 2 – 7 (requires road test)

EGR enabled .... EGR temperature greater than 525°F (275°C) (temp. sensor voltage signal less than 0.95 V)
Response time .... 64 Milliseconds

EGR enabled .... EGR temperature less than 212°F (100°C) (temp. sensor voltage signal greater than 4.72 V)
Response time .... 1 minute

EGR disabled .... EGR temperature greater than 122°F (50°C) (temp. sensor voltage less than 4.96 V)
Response time .... 5 minutes

LIMP HOME DEFAULT:

If DTC 39 is flagged, EGR is disabled.

POSSIBLE FAULTS:

- Blockage in EGR transfer pipe between EGR valve and intake manifold
- Blockage in intake manifold EGR adapter
- Disconnected, leaking or blocked vacuum hose to EGR solenoid vacuum valve or EGR valve
- Defective EGR solenoid vacuum valve
- Defective EGR valve
- Defective EGR temperature sensor
- Open or short circuit wiring

DIAGNOSTIC NOTES:

1. The EGR temperature sensor signal voltage can be monitored and the signals stored using the PDU Datalogger. There is no PDU Datalogger trigger.
2. Test for a DTC reoccurrence by road testing the vehicle at highway speed. Maintain a steady throttle position and engine speed between 1700 and 3000 rpm for more than 1 minute.
3. Test for EGR transfer pipe or intake manifold adapter blockage by manually lifting the EGR valve diaphragm while the engine is running at 1000 rpm. If the engine speed decreases when the diaphragm is lifted, exhaust gas is flowing to the intake manifold. **WARNING: THE EGR VALVE IS HOT WHEN THE ENGINE IS RUNNING AND WILL BURN UNPROTECTED SKIN.**
4. EGR Temperature Sensor resistance versus temperature:

Temperature	Resistance (kilo ohms)
122°F (50°C)	560 – 710
212°F (100°C)	76 – 94

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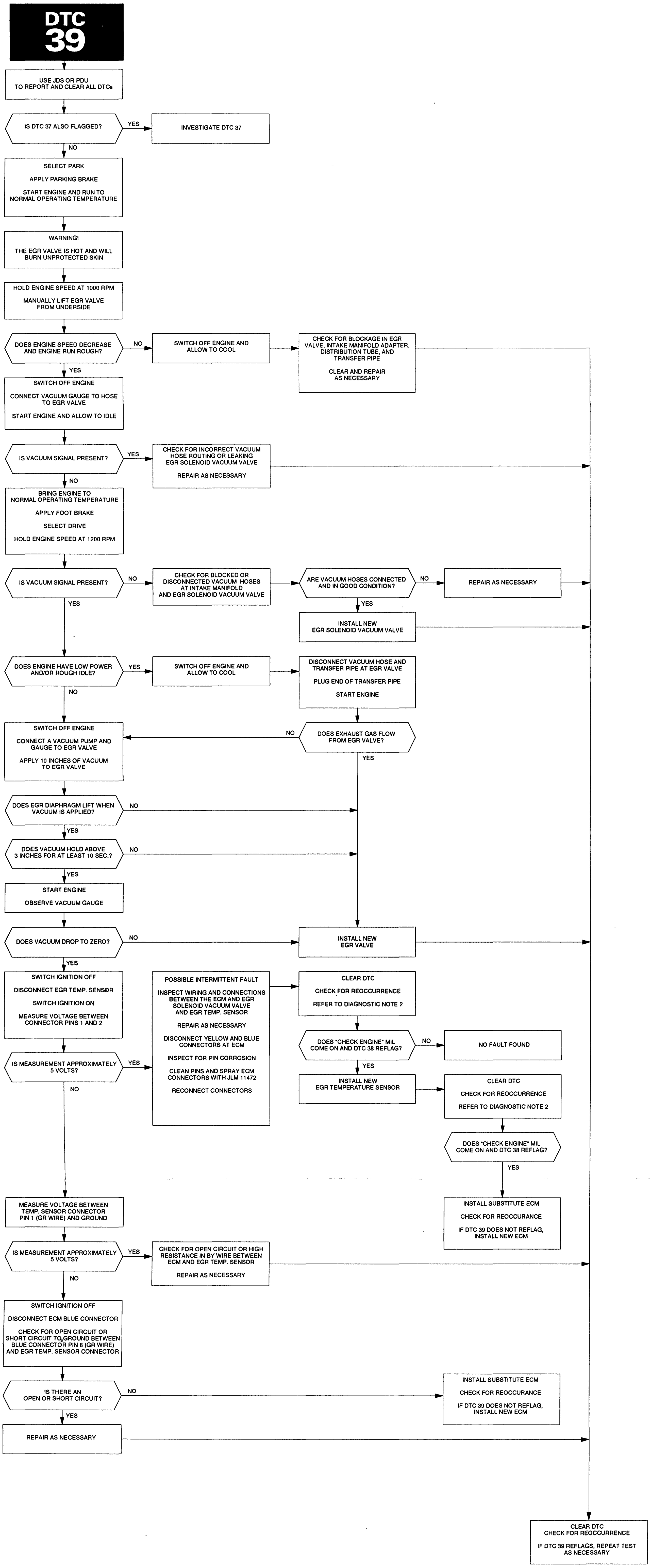

USE JDS OR PDU TO REPORT AND CLEAR ALL DTCs
IS DTC 37 ALSO FLAGGED?
YES
INVESTIGATE DTC 37
NO
SELECT PARK
APPLY PARKING BRAKE
START ENGINE AND RUN TO NORMAL OPERATING TEMPERATURE
WARNING!
THE EGR VALVE IS HOT AND WILL BURN UNPROTECTED SKIN
HOLD ENGINE SPEED AT 1000 RPM
MANUALLY LIFT EGR VALVE FROM UNDERSIDE
DOES ENGINE SPEED DECREASE AND ENGINE RUN ROUGH?
NO
SWITCH OFF ENGINE AND ALLOW TO COOL
CHECK FOR BLOCKAGE IN EGR VALVE, INTAKE MANIFOLD ADAPTER, DISTRIBUTION TUBE, AND TRANSFER PIPE
CLEAR AND REPAIR AS NECESSARY
YES
SWITCH OFF ENGINE
CONNECT VACUUM GAUGE TO HOSE TO EGR VALVE
START ENGINE AND ALLOW TO IDLE
IS VACUUM SIGNAL PRESENT?
YES
CHECK FOR INCORRECT VACUUM HOSE ROUTING OR LEAKING EGR SOLENOID VACUUM VALVE
REPAIR AS NECESSARY
NO
BRING ENGINE TO NORMAL OPERATING TEMPERATURE
APPLY FOOT BRAKE
SELECT DRIVE
HOLD ENGINE SPEED AT 1200 RPM
IS VACUUM SIGNAL PRESENT?
NO
CHECK FOR BLOCKED OR DISCONNECTED VACUUM HOSES AT INTAKE MANIFOLD AND EGR SOLENOID VACUUM VALVE
ARE VACUUM HOSES CONNECTED AND IN GOOD CONDITION?
NO
REPAIR AS NECESSARY
YES
INSTALL NEW EGR SOLENOID VACUUM VALVE
YES
DOES ENGINE HAVE LOW POWER AND/OR ROUGH IDLE?
YES
SWITCH OFF ENGINE AND ALLOW TO COOL
DISCONNECT VACUUM HOSE AND TRANSFER PIPE AT EGR VALVE
PLUG END OF TRANSFER PIPE
START ENGINE
DOES EXHAUST GAS FLOW FROM EGR VALVE?
NO
YES
NO
SWITCH OFF ENGINE
CONNECT A VACUUM PUMP AND GAUGE TO EGR VALVE
APPLY 10 INCHES OF VACUUM TO EGR VALVE
DOES EGR DIAPHRAGM LIFT WHEN VACUUM IS APPLIED?
NO
YES
DOES VACUUM HOLD ABOVE 3 INCHES FOR AT LEAST 10 SEC.?
NO
YES
START ENGINE
OBSERVE VACUUM GAUGE
DOES VACUUM DROP TO ZERO?
NO
INSTALL NEW EGR VALVE
YES
SWITCH IGNITION OFF
DISCONNECT EGR TEMP. SENSOR
SWITCH IGNITION ON
MEASURE VOLTAGE BETWEEN CONNECTOR PINS 1 AND 2
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
YES
POSSIBLE INTERMITTENT FAULT
INSPECT WIRING AND CONNECTIONS BETWEEN THE ECM AND EGR SOLENOID VACUUM VALVE AND EGR TEMP. SENSOR
REPAIR AS NECESSARY
DISCONNECT YELLOW AND BLUE CONNECTORS AT ECM
INSPECT FOR PIN CORROSION
CLEAN PINS AND SPRAY ECM CONNECTORS WITH JLM 11472
RECONNECT CONNECTORS
CLEAR DTC
CHECK FOR REOCCURRENCE
REFER TO DIAGNOSTIC NOTE 2
DOES "CHECK ENGINE" MIL COME ON AND DTC 38 REFLAG?
NO
NO FAULT FOUND
YES
INSTALL NEW EGR TEMPERATURE SENSOR
CLEAR DTC
CHECK FOR REOCCURRENCE
REFER TO DIAGNOSTIC NOTE 2
DOES "CHECK ENGINE" MIL COME ON AND DTC 38 REFLAG?
YES
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 39 DOES NOT REFLAG, INSTALL NEW ECM
NO
MEASURE VOLTAGE BETWEEN TEMP. SENSOR CONNECTOR PIN 1 (GR WIRE) AND GROUND
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
YES
CHECK FOR OPEN CIRCUIT OR HIGH RESISTANCE IN BY WIRE BETWEEN ECM AND EGR TEMP. SENSOR
REPAIR AS NECESSARY
NO
SWITCH IGNITION OFF
DISCONNECT ECM BLUE CONNECTOR
CHECK FOR OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND BETWEEN BLUE CONNECTOR PIN 8 (GR WIRE) AND EGR TEMP. SENSOR CONNECTOR
IS THERE AN OPEN OR SHORT CIRCUIT?
NO
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 39 DOES NOT REFLAG, INSTALL NEW ECM
YES
REPAIR AS NECESSARY
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 39 REFLAGS, REPEAT TEST AS NECESSARY

DIAGNOSTIC NOTES (CONTINUED)

6 XJ6 Sedan Range vehicles up to VIN 664940 – When replacing an oxygen sensor, install a splash shield (P/N C33139/4). All vehicles after this VIN, including XJS, are equipped with splash shields.

7 1992 MY ON vehicles (ECM part number DBC 9622 ON): DTC 26 and 44 are inhibited when the fuel level is below approximately 2.5 gallons. A fuel level signal is input to the ECM on the yellow connector–pin 6 from the fuel level sensor circuit. When the voltage is above 5.7 volts, the codes cannot be flagged.

FUEL PRESSURE CHECK

— 42 – 45 psi (vacuum disconnected from fuel pressure regulator)

— 34 – 38 psi at idle (vacuum connected to fuel pressure regulator)

PURGE VALVE TEST

To test for a sticking purge valve:

— Disconnect the purge hose at the intake manifold adapter.

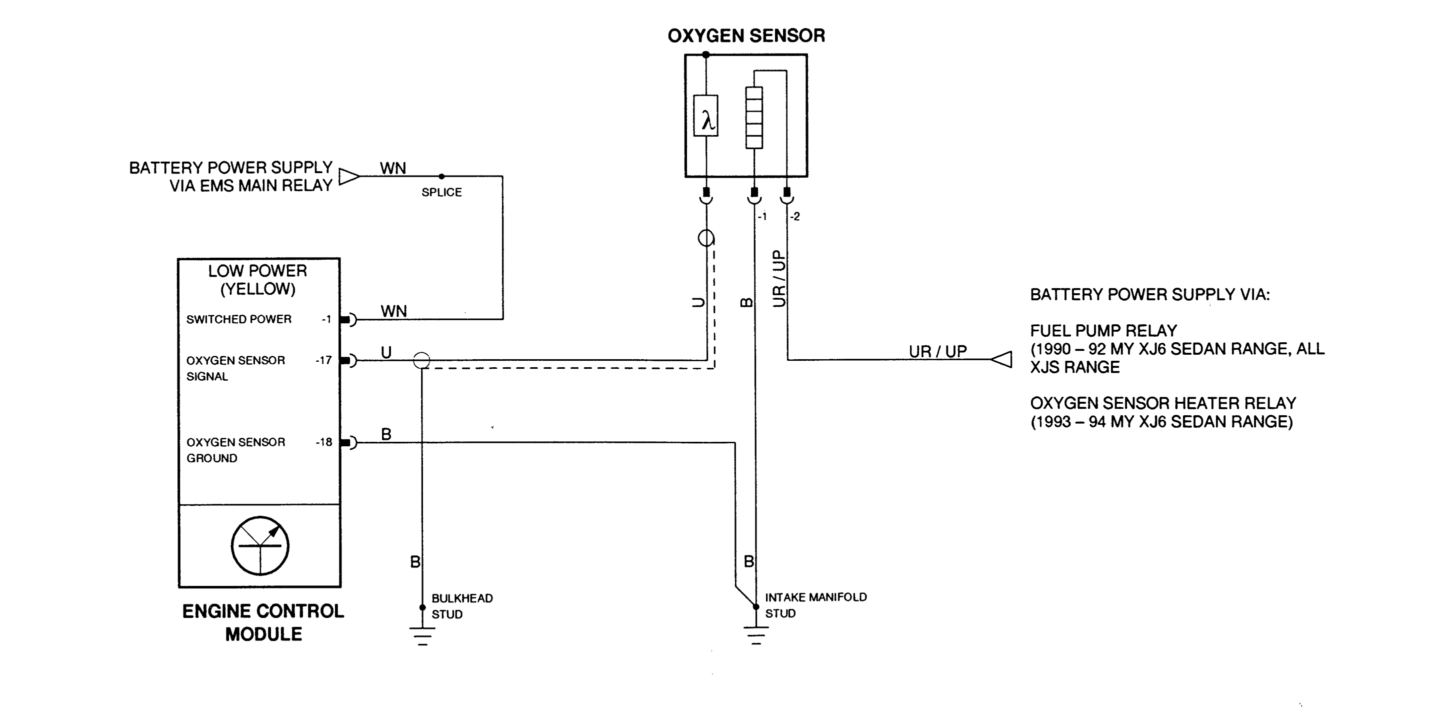
— Switch ignition ON; do not start the engine.

— Apply vacuum to purge hose; vacuum should hold.
If the vacuum does not hold, the purge valve is stuck and should be replaced.

— Switch ignition OFF; vacuum should release after a few seconds.
If the vacuum does not release, the purge valve is stuck and should be replaced.

CIRCUIT DIAGRAM

HEATED OXYGEN SENSOR: ALL VEHICLES AND MODEL YEARS



NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION. DTC 44.2

DTC 44 OXYGEN SENSOR CIRCUIT

The ECM looks for poor closed loop fuel metering control while correcting for a rich or lean mixture condition.

The heated oxygen sensor, located in the exhaust gas stream, compares exhaust oxygen content to ambient air that is drawn through the heater wires. The heater is powered by the fuel pump relay (1990 – 92 MY vehicles) or oxygen sensor heater relay (1993 MY ON vehicles)

The ECM lengthens or shortens the injector pulse duration in response to the oxygen sensor detecting a rich or a lean mixture. The fuel metering can vary ± 12.5 % without flagging a code. If a rich mixture cannot be corrected by the ECM, the oxygen sensor feedback voltage (monitor with JDS or PDU) falls to 0 volt; if a lean mixture cannot be corrected by the ECM, the oxygen sensor feedback voltage (monitor with JDS or PDU) rises to 5 volts. A further 37.5 % fuel metering adjustment is then made. If the oxygen sensor signal voltage does not respond, DTC 44 is flagged. In addition, the ECM will flag DTC 44 if the oxygen sensor signal voltage (raw) is not sensed at the ECM (open or short circuit).

CONDITIONS REQUIRED FOR DTC 44 FLAGGING

Throttle position	Less than 3 volts
Engine coolant temperature	Greater than 167° F
Closed loop fuel metering (oxygen sensor feedback)	Not in control (rich and/or lean)
Oxygen sensor signal voltage (raw)	Not switching
Condition monitored for	450 consecutive engine revolutions

LIMP HOME DEFAULT

If DTC 44 is flagged, closed loop fuel metering is canceled and no dynamic fueling correction is applied to the fuel metering strategy. The oxygen sensor feedback voltage will remain stationary at the mid point (2.5 volts).

POSSIBLE FAULTS

- Fuel pressure fault
- Stuck open purge valve
- Poor ground connections
- Poor oxygen sensor connection
- Open or short circuit oxygen sensor wiring
- Open or short circuit oxygen sensor heater wiring
- "Lazy" or defective oxygen sensor
- Defective air injection pump or circuit
- Intake air leak
- Blocked or inoperative fuel injectors
- Defective mass air flow sensor

DIAGNOSTIC NOTES

1 Engine fueling correction (dynamic) can be monitored by using JDS or PDU to read the oxygen sensor feedback voltage (HO2SFB). If the feedback voltage is between 1 and 4 volts, the fueling is normal and the problem is intermittent. If the feedback voltage stays below 1 volt, look for causes of rich running (DTC 23); if the feedback voltage stays above 4 volts, look for causes of lean running (DTC 26). The PDU Datalogger can be set to trigger upon DTC 44 being flagged.

PDU DATALOGGER TRIGGER

FF 44 ↑ 1

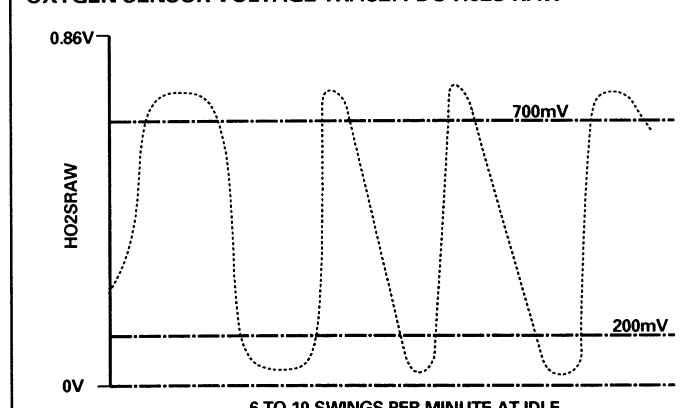
2 Test for a DTC reoccurrence by bringing the engine to normal operating temperature then holding the speed at 2000 rpm for 1 minute.

3 1993 MY ON vehicles (with adaptive idle fueling trim) The ECM automatically corrects for small fueling errors by adding to or subtracting from the "base line" injector pulse duration. To determine if a base line correction has occurred, first monitor the oxygen sensor feedback voltage and record the value. Then disconnect and reconnect the ECM and recheck the oxygen sensor feedback voltage. A change in the feedback voltage indicates that a correction had been applied. (Disconnecting the ECM erases the correction.)

4 A rich mixture condition can be caused by the engine coolant thermostat sticking open. At high road speed, the coolant temperature decreases, causing enriching from the coolant temperature sensor input to the ECM. To test the thermostat, check the engine setup using JDS or PDU. If the coolant temperature does not reach 190° F (88° C) (as monitored by JDS or PDU), replace the thermostat.

5 During closed loop fueling, the oxygen sensor "raw" voltage (signal voltage to the ECM) normally swings between 0.2 and 0.8 volt. If the oxygen sensor becomes contaminated or the heater is inoperative, the sensor can be "lazy". A lazy sensor may show a voltage swing of 0.3 – 0.7 volt or even less. The oxygen sensor raw voltage can be monitored using PDU (HO2 S RAW).

OXYGEN SENSOR VOLTAGE TRACE: PDU H02S RAW



DTC 44.1

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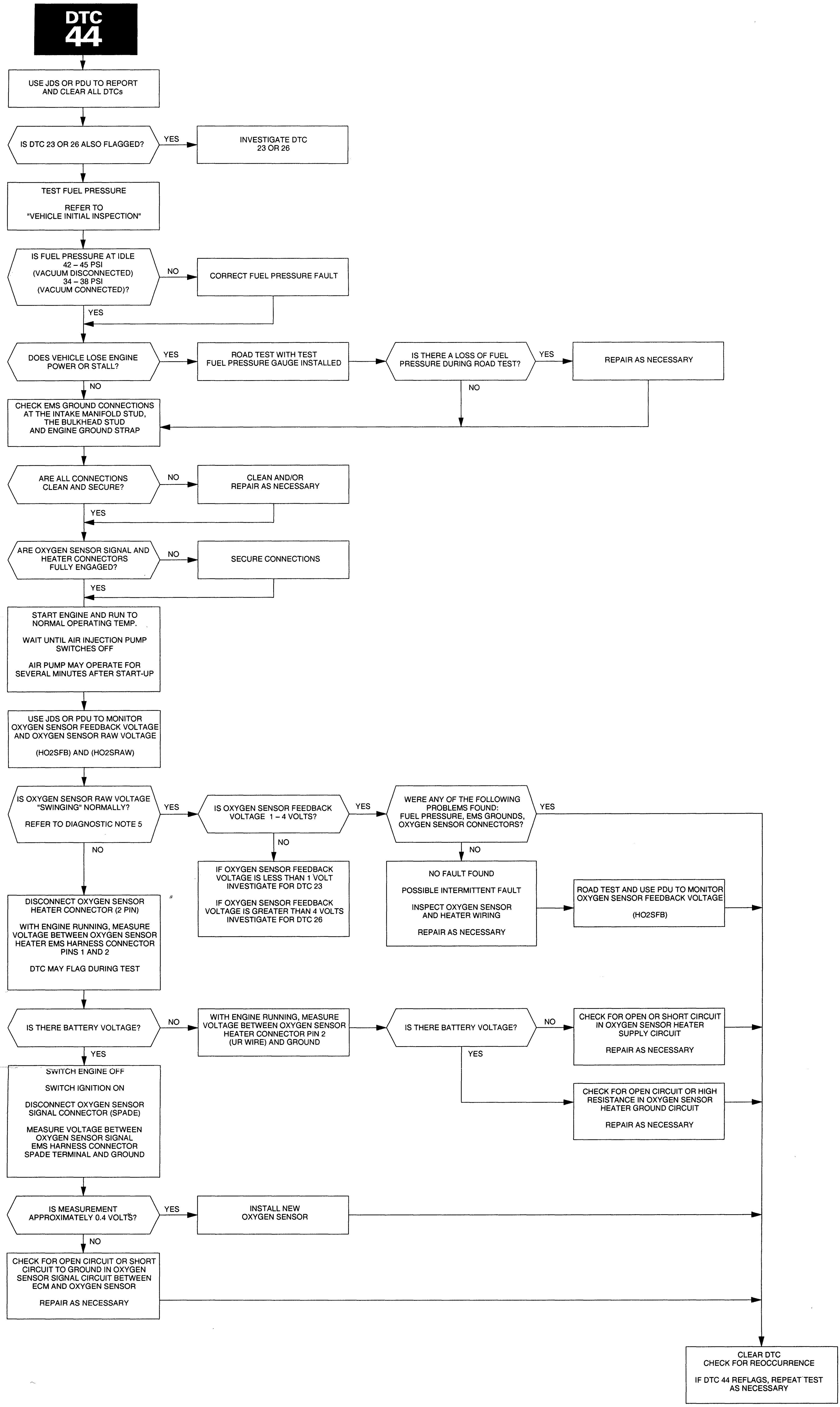
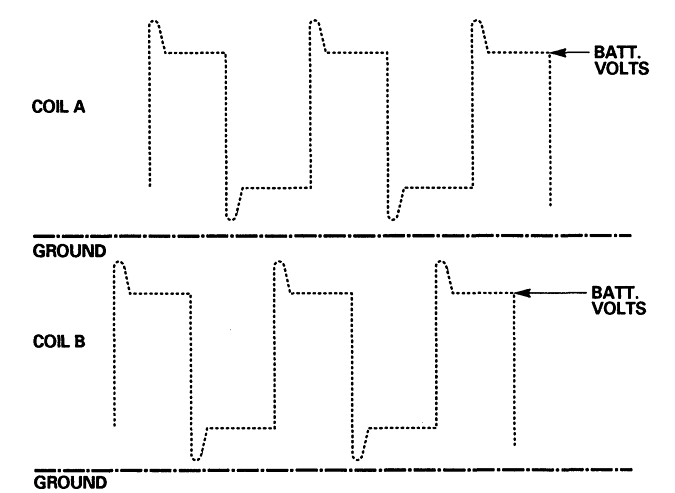

DTC 44
USE JDS OR PDU TO REPORT AND CLEAR ALL DTCs
IS DTC 23 OR 26 ALSO FLAGGED?
YES
INVESTIGATE DTC 23 OR 26
TEST FUEL PRESSURE
REFER TO "VEHICLE INITIAL INSPECTION"
IS FUEL PRESSURE AT IDLE 42 – 45 PSI (VACUUM DISCONNECTED) 34 – 38 PSI (VACUUM CONNECTED)?
NO
CORRECT FUEL PRESSURE FAULT
YES
DOES VEHICLE LOSE ENGINE POWER OR STALL?
YES
ROAD TEST WITH TEST FUEL PRESSURE GAUGE INSTALLED
IS THERE A LOSS OF FUEL PRESSURE DURING ROAD TEST?
YES
REPAIR AS NECESSARY
NO
NO
CHECK EMS GROUND CONNECTIONS AT THE INTAKE MANIFOLD STUD, THE BULKHEAD STUD AND ENGINE GROUND STRAP
ARE ALL CONNECTIONS CLEAN AND SECURE?
NO
CLEAN AND/OR REPAIR AS NECESSARY
YES
ARE OXYGEN SENSOR SIGNAL AND HEATER CONNECTORS FULLY ENGAGED?
NO
SECURE CONNECTIONS
YES
START ENGINE AND RUN TO NORMAL OPERATING TEMP.
WAIT UNTIL AIR INJECTION PUMP SWITCHES OFF
AIR PUMP MAY OPERATE FOR SEVERAL MINUTES AFTER START-UP
USE JDS OR PDU TO MONITOR OXYGEN SENSOR FEEDBACK VOLTAGE AND OXYGEN SENSOR RAW VOLTAGE
(HO2SFB) AND (HO2SRAW)
IS OXYGEN SENSOR RAW VOLTAGE "SWINGING" NORMALLY?
REFER TO DIAGNOSTIC NOTE 5
YES
IS OXYGEN SENSOR FEEDBACK VOLTAGE 1 – 4 VOLTS?
YES
WERE ANY OF THE FOLLOWING PROBLEMS FOUND: FUEL PRESSURE, EMS GROUNDS, OXYGEN SENSOR CONNECTORS?
YES
NO
IF OXYGEN SENSOR FEEDBACK VOLTAGE IS LESS THAN 1 VOLT INVESTIGATE FOR DTC 23
IF OXYGEN SENSOR FEEDBACK VOLTAGE IS GREATER THAN 4 VOLTS INVESTIGATE FOR DTC 26
NO
NO FAULT FOUND
POSSIBLE INTERMITTENT FAULT
INSPECT OXYGEN SENSOR AND HEATER WIRING
REPAIR AS NECESSARY
ROAD TEST AND USE PDU TO MONITOR OXYGEN SENSOR FEEDBACK VOLTAGE
(HO2SFB)
NO
DISCONNECT OXYGEN SENSOR HEATER CONNECTOR (2 PIN)
WITH ENGINE RUNNING, MEASURE VOLTAGE BETWEEN OXYGEN SENSOR HEATER EMS HARNESS CONNECTOR PINS 1 AND 2
DTC MAY FLAG DURING TEST
IS THERE BATTERY VOLTAGE?
NO
WITH ENGINE RUNNING, MEASURE VOLTAGE BETWEEN OXYGEN SENSOR HEATER CONNECTOR PIN 2 (UR WIRE) AND GROUND
IS THERE BATTERY VOLTAGE?
NO
CHECK FOR OPEN OR SHORT CIRCUIT IN OXYGEN SENSOR HEATER SUPPLY CIRCUIT
REPAIR AS NECESSARY
YES
CHECK FOR OPEN CIRCUIT OR HIGH RESISTANCE IN OXYGEN SENSOR HEATER GROUND CIRCUIT
REPAIR AS NECESSARY
YES
SWITCH ENGINE OFF
SWITCH IGNITION ON
DISCONNECT OXYGEN SENSOR SIGNAL CONNECTOR (SPADE)
MEASURE VOLTAGE BETWEEN OXYGEN SENSOR SIGNAL EMS HARNESS CONNECTOR SPADE TERMINAL AND GROUND
IS MEASUREMENT APPROXIMATELY 0.4 VOLTS?
YES
INSTALL NEW OXYGEN SENSOR
NO
CHECK FOR OPEN CIRCUIT OR SHORT CIRCUIT TO GROUND IN OXYGEN SENSOR SIGNAL CIRCUIT BETWEEN ECM AND OXYGEN SENSOR
REPAIR AS NECESSARY
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 44 REFLAGS, REPEAT TEST AS NECESSARY

DTC 46, 47 IDLE SPEED CONTROL VALVE (COIL 1 DRIVE CIRCUIT) IDLE SPEED CONTROL VALVE (COIL 2 DRIVE CIRCUIT)

The ECM looks for the idle speed control valve coil drive voltage outside the normal range for valve operation.

The idle speed actuator is a stepper motor that adjusts the flow of air bypassing the throttle valve to control idle speed. The ECM drives the idle speed actuator toward open or close by pulsing coil 1 and coil 2. The coil pulses are phased 90° apart. To reverse the valve direction (e.g. from opening to closing), the phasing is reversed. The idle speed control valve signal can be monitored with an oscilloscope. Loss of one coil will cause the stepper motor to be inoperative.

STEPPER MOTOR DRIVE SIGNAL



DTC 46/47.1

The ECM will flag DTC 46 or 47 if the drive circuit voltage is less than 0.85 volt when OFF or less than 12.25 volts when ON.

CONDITIONS REQUIRED FOR DTC 46 FLAGGING:

Ignition .... ON
Coil 1 circuit voltage – OFF .... Less than 0.85 volt
Coil 1 circuit voltage – ON .... Less than 12.25 volts
Response time .... 100 milliseconds

CONDITIONS REQUIRED FOR DTC 47 FLAGGING:

Ignition .... ON
Coil 2 circuit voltage – OFF .... Less than 0.85 volt
Coil 2 circuit voltage – ON .... Less than 12.25 volts
Response time .... 100 milliseconds

LIMP HOME DEFAULT:

NONE

POSSIBLE FAULTS:

- Low battery voltage
- Poor ECM power feed or ground connections
- Open or short circuit in coil 1 or coil 2 drive circuit wiring
- Open or short circuit in coil 1 or coil 2 ground circuit wiring
- Water ingress to ECM connector
- Defective idle speed actuator

DIAGNOSTIC NOTES:

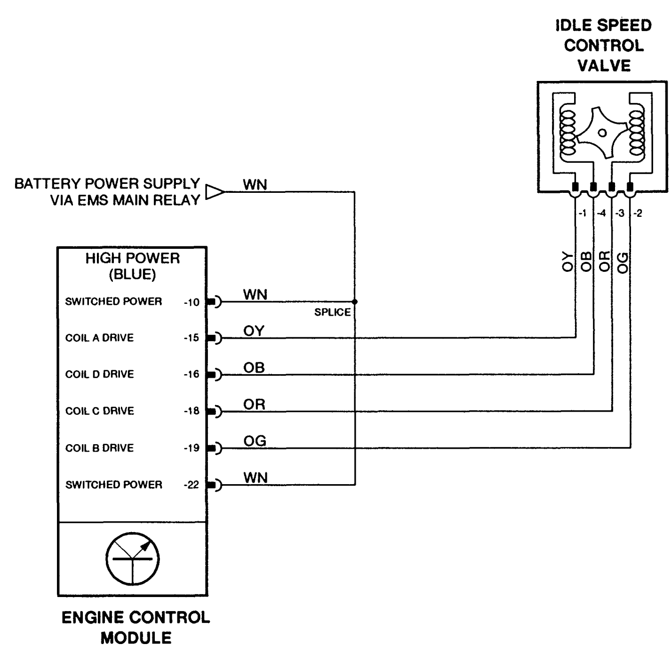
1 DTC 46 applies only to coil 1 (idle speed control valve pins 1 and 4). DTC 47 applies only to coil 2 (idle speed control valve pins 2 and 3).

2 The idle speed control valve coil resistance should be 40 – 60 ohms.

3 Drive the idle speed control valve by switching OFF the ignition, waiting 10 seconds, then switching ON the ignition.

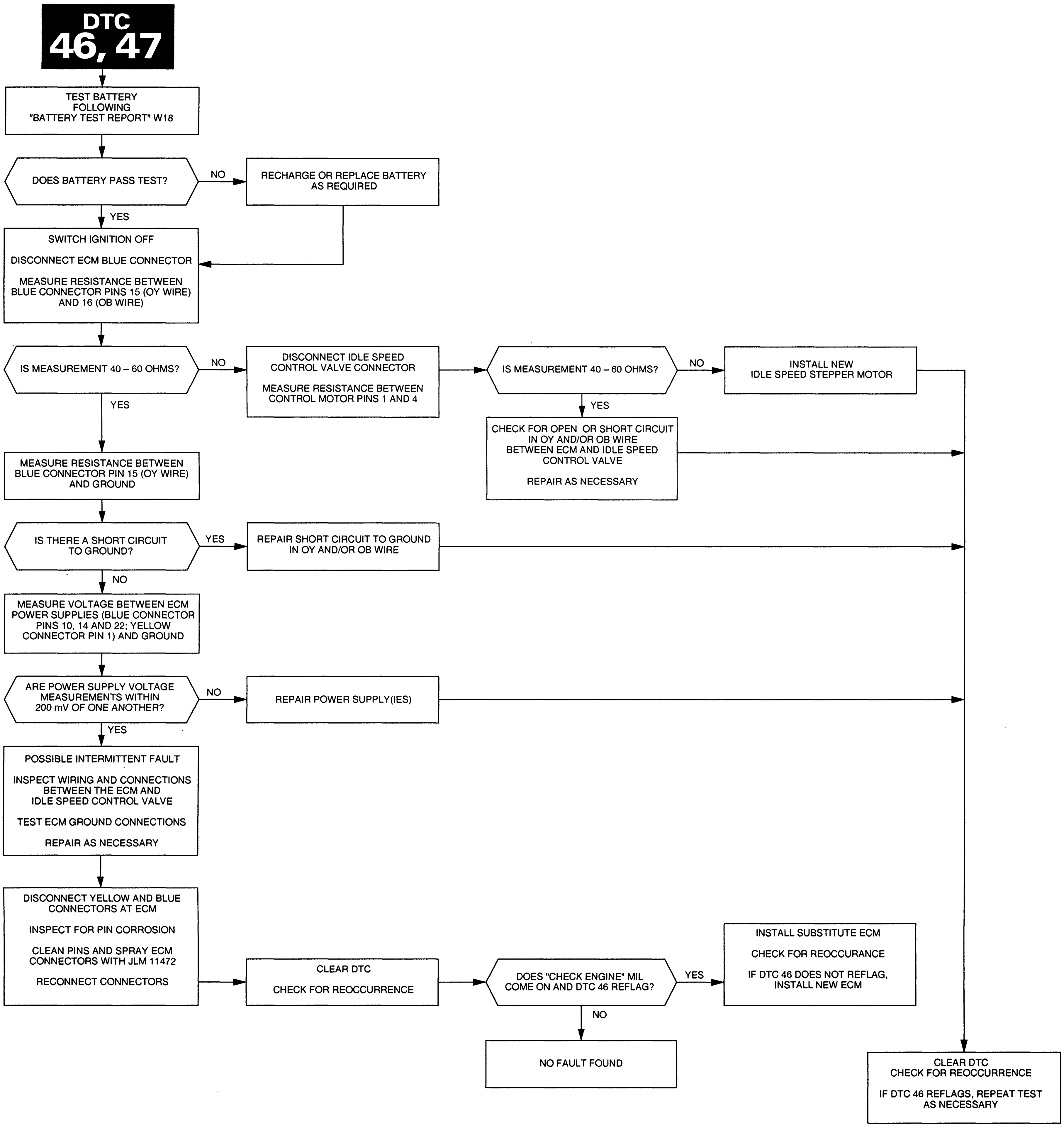
CIRCUIT DIAGRAM

IDLE SPEED CONTROL VALVE: ALL VEHICLES AND MODEL YEARS



NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION.

DTC 46/47.2


DTC 46, 47
TEST BATTERY FOLLOWING "BATTERY TEST REPORT" W18
DOES BATTERY PASS TEST?
NO
RECHARGE OR REPLACE BATTERY AS REQUIRED
YES
SWITCH IGNITION OFF
DISCONNECT ECM BLUE CONNECTOR
MEASURE RESISTANCE BETWEEN BLUE CONNECTOR PINS 15 (OY WIRE) AND 16 (OB WIRE)
IS MEASUREMENT 40 – 60 OHMS?
NO
DISCONNECT IDLE SPEED CONTROL VALVE CONNECTOR
MEASURE RESISTANCE BETWEEN CONTROL MOTOR PINS 1 AND 4
IS MEASUREMENT 40 – 60 OHMS?
NO
INSTALL NEW IDLE SPEED STEPPER MOTOR
YES
CHECK FOR OPEN OR SHORT CIRCUIT IN OY AND/OR OB WIRE BETWEEN ECM AND IDLE SPEED CONTROL VALVE
REPAIR AS NECESSARY
YES
MEASURE RESISTANCE BETWEEN BLUE CONNECTOR PIN 15 (OY WIRE) AND GROUND
IS THERE A SHORT CIRCUIT TO GROUND?
YES
REPAIR SHORT CIRCUIT TO GROUND IN OY AND/OR OB WIRE
NO
MEASURE VOLTAGE BETWEEN ECM POWER SUPPLIES (BLUE CONNECTOR PINS 10, 14 AND 22; YELLOW CONNECTOR PIN 1) AND GROUND
ARE POWER SUPPLY VOLTAGE MEASUREMENTS WITHIN 200 mV OF ONE ANOTHER?
NO
REPAIR POWER SUPPLY(IES)
YES
POSSIBLE INTERMITTENT FAULT
INSPECT WIRING AND CONNECTIONS BETWEEN THE ECM AND IDLE SPEED CONTROL VALVE
TEST ECM GROUND CONNECTIONS
REPAIR AS NECESSARY
DISCONNECT YELLOW AND BLUE CONNECTORS AT ECM
INSPECT FOR PIN CORROSION
CLEAN PINS AND SPRAY ECM CONNECTORS WITH JLM 11472
RECONNECT CONNECTORS
CLEAR DTC
CHECK FOR REOCCURRENCE
DOES "CHECK ENGINE" MIL COME ON AND DTC 46 REFLAG?
YES
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 46 DOES NOT REFLAG, INSTALL NEW ECM
NO
NO FAULT FOUND
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 46 REFLAGS, REPEAT TEST AS NECESSARY

DTC 48 IDLE SPEED CONTROL VALVE

The ECM looks for the idle speed actuator far out of position at idle.

The idle speed control valve is opened or closed by the ECM to maintain engine idle speed. Once the base idle speed has been correctly set using the air bypass adjustment screw, the idle speed control valve will hold the idle speed to within a few rpm of the nominal controlled idle speed.

Typical controlled engine idle speeds:

Cold engine (68°F [20°C]) – Neutral	800 rpm
Cold engine (68°F [20°C]) – Drive	650 rpm
Warm engine (193°F [90°C]) – Neutral	700 rpm
Warm engine (193°F [90°C]) – Drive	580 rpm

The ECM will flag DTC 48 if the idle speed actuator is full open when the engine coolant temperature is greater than 168°F (75°C) or the idle speed actuator is full closed when the engine coolant temperature is less than 94°F (35°C) and the nominal idle speed cannot be maintained.

CONDITIONS REQUIRED FOR DTC 48 FLAGGING:

Throttle position .... At idle

Engine coolant temperature .... Greater than 168°F (75°C)
(Idle speed actuator position .... Full open
Engine speed .... Less than nominal idle speed

Engine coolant temperature .... Less than 94°F (35°C)
Idle speed actuator position .... Full closed
Engine speed .... Greater than nominal idle speed

Response time .... 64 milliseconds

LIMP HOME DEFAULT:

NONE

POSSIBLE FAULTS:

- Low battery voltage
- Loss of ECM memory power supply (blue connector, pin 14)
- Loss of ECM ground connection (bulkhead stud)
- Badly misadjusted idle air bypass screw
- Badly misadjusted throttle valve
- Air leak past idle speed control valve or throttle valve
- Low engine power at idle when hot
- Inoperative idle speed control valve
- Blocked idle air bypass hose or valve

DIAGNOSTIC NOTES:

1 The idle speed control valve motions are as follows: ignition ON – the valve moves to a mapped position; ignition OFF (1990 MY vehicles) – the valve fully opens, then moves to a "park" position; ignition OFF (1991 MY ON vehicles) – after a 7 second delay, the valve fully closes, then moves to a "park" position.

2 If battery voltage is disconnected from the ECM, the learned stepper motor positions ("run line") will be erased and may result in engine speed flare-up upon starting and possible reflagging of DTC 48.

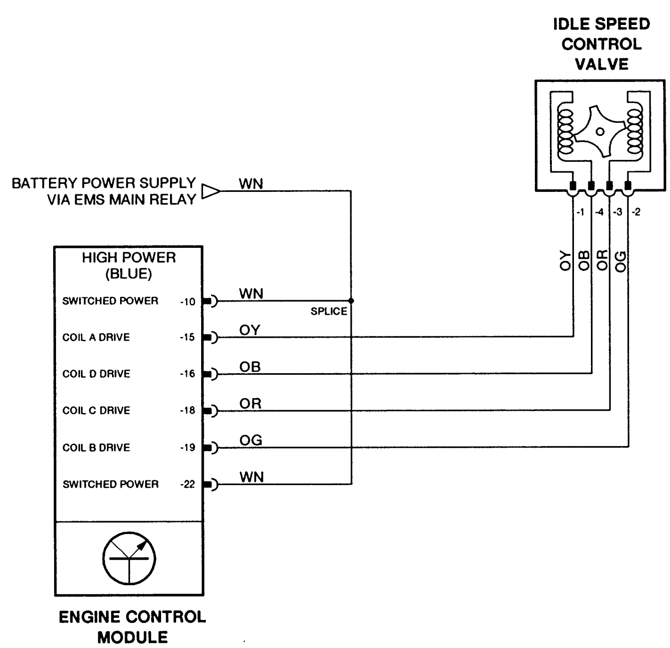
3 To enable the ECM to relearn the "run line", start the engine from cold and allow it to reach normal operating temperature at idle. Then, drive the vehicle for at least 50 yards above 3 mph.

4 The throttle valve clearance is adjusted for minimum air flow without sticking closed. Adjustment is required only if the base idle speed is too high and cannot be corrected, or if the throttle sticks in the closed position.

Throttle valve clearance: 0.001 – 0.004 in.

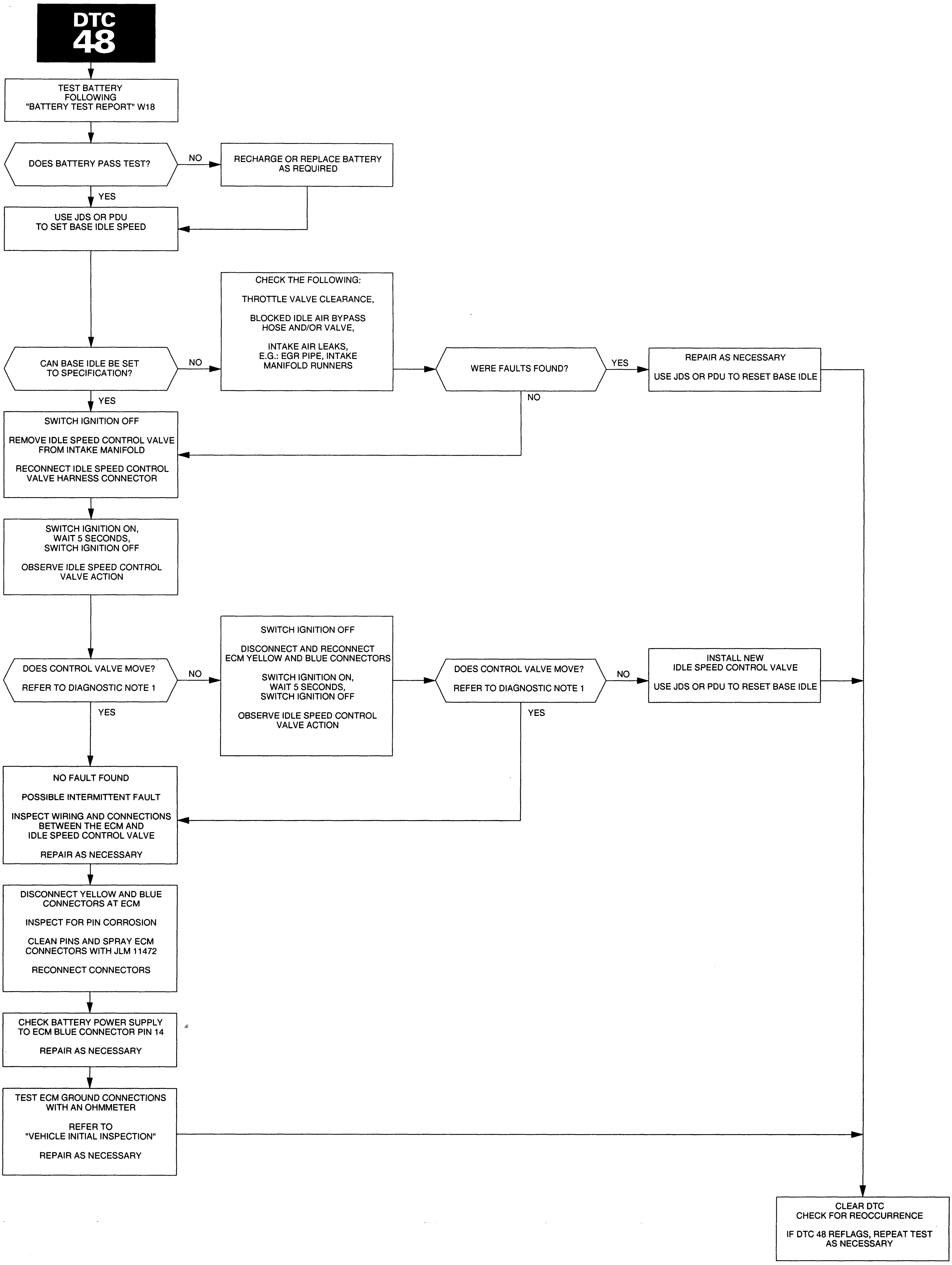
CIRCUIT DIAGRAM

IDLE SPEED CONTROL VALVE: ALL VEHICLES AND MODEL YEARS

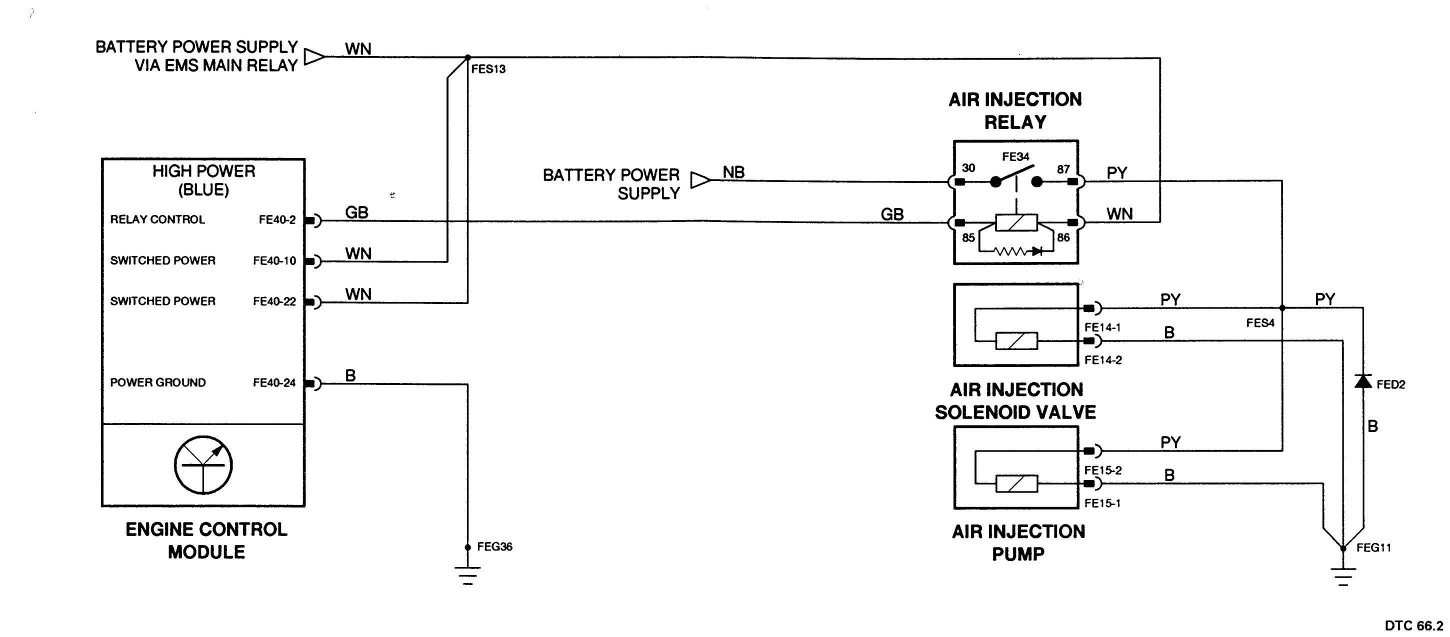


NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION.

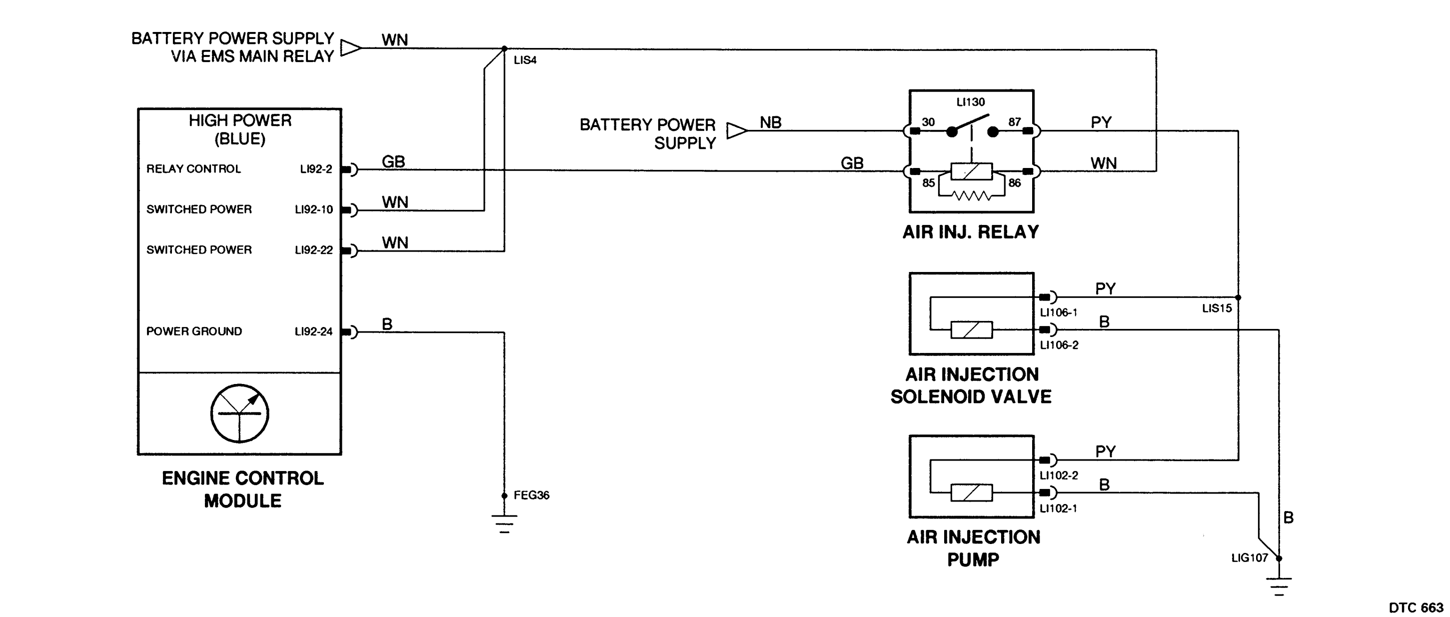
DTC 48.1


DTC 48
TEST BATTERY FOLLOWING "BATTERY TEST REPORT" W18
DOES BATTERY PASS TEST?
NO
RECHARGE OR REPLACE BATTERY AS REQUIRED
YES
USE JDS OR PDU TO SET BASE IDLE SPEED
CHECK THE FOLLOWING:
THROTTLE VALVE CLEARANCE,
BLOCKED IDLE AIR BYPASS HOSE AND/OR VALVE,
INTAKE AIR LEAKS, E.G.: EGR PIPE, INTAKE MANIFOLD RUNNERS
CAN BASE IDLE BE SET TO SPECIFICATION?
NO
WERE FAULTS FOUND?
YES
REPAIR AS NECESSARY
USE JDS OR PDU TO RESET BASE IDLE
NO
YES
SWITCH IGNITION OFF
REMOVE IDLE SPEED CONTROL VALVE FROM INTAKE MANIFOLD
RECONNECT IDLE SPEED CONTROL VALVE HARNESS CONNECTOR
SWITCH IGNITION ON, WAIT 5 SECONDS, SWITCH IGNITION OFF
OBSERVE IDLE SPEED CONTROL VALVE ACTION
SWITCH IGNITION OFF
DISCONNECT AND RECONNECT ECM YELLOW AND BLUE CONNECTORS
SWITCH IGNITION ON, WAIT 5 SECONDS, SWITCH IGNITION OFF
OBSERVE IDLE SPEED CONTROL VALVE ACTION
DOES CONTROL VALVE MOVE?
REFER TO DIAGNOSTIC NOTE 1
NO
DOES CONTROL VALVE MOVE?
REFER TO DIAGNOSTIC NOTE 1
NO
INSTALL NEW IDLE SPEED CONTROL VALVE
USE JDS OR PDU TO RESET BASE IDLE
YES
YES
NO FAULT FOUND
POSSIBLE INTERMITTENT FAULT
INSPECT WIRING AND CONNECTIONS BETWEEN THE ECM AND IDLE SPEED CONTROL VALVE
REPAIR AS NECESSARY
DISCONNECT YELLOW AND BLUE CONNECTORS AT ECM
INSPECT FOR PIN CORROSION
CLEAN PINS AND SPRAY ECM CONNECTORS WITH JLM 11472
RECONNECT CONNECTORS
CHECK BATTERY POWER SUPPLY TO ECM BLUE CONNECTOR PIN 14
REPAIR AS NECESSARY
TEST ECM GROUND CONNECTIONS WITH AN OHMMETER
REFER TO "VEHICLE INITIAL INSPECTION"
REPAIR AS NECESSARY
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 48 REFLAGS, REPEAT TEST AS NECESSARY

AIR INJECTION CONTROL: 1993 – 94 MY XJ6 SEDAN RANGE



AIR INJECTION CONTROL: 1993 – 94 MY XJS RANGE



DTC 66 AIR INJECTION CONTROL CIRCUIT

The ECM looks for an incorrect internal circuit voltage that indicates the state of the air injection relay coil switching circuit. This internal voltage cannot be measured.

The ECM switches on the air injection pump by grounding the air injection relay coil circuit (85 pin). Air injection is enabled after engine start up and remains on until the coolant temperature reaches 95°F (34°C). On 1993 MY ON vehicles, air injection is enabled after each engine start for a mapped period. Air injection is disabled above 2500 rpm engine speed.

The ECM will flag DTC 66 if the air injection control circuit is open or short circuit.

CONDITIONS REQUIRED FOR DTC 66 FLAGGING:

Ignition .... Ignition ON

ECM internal circuit .... Indicates that the air injection control circuit is open or short circuit

Response time .... 100 milliseconds

LIMP HOME DEFAULT:

NONE

POSSIBLE FAULTS:

- Low battery voltage
- Poor ECM power feed or ground connections
- Short circuit or open circuit wiring from the ECM to the air injection relay
- Short circuit or open circuit in ignition switched power supply to the air injection relay pin 86
- Defective relay

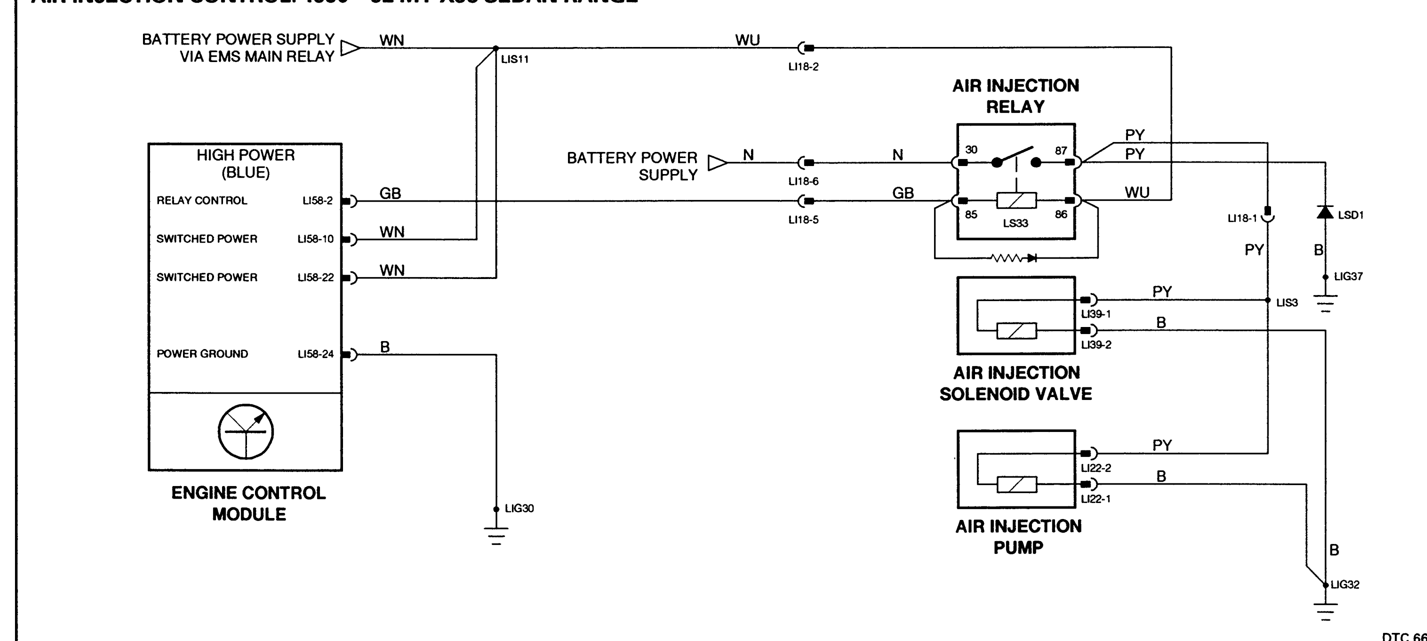
DIAGNOSTIC NOTES:

1 If the air injection pump is inoperative but DTC 66 is not flagged, investigate the air injection pump switched power supply (relay), air injection clutch circuit and the air injection pump mechanical condition.

2 If an air injection control circuit fault is present when the ignition is switched ON, both DTC 66 and 22 will be flagged.

CIRCUIT DIAGRAMS

AIR INJECTION CONTROL: 1990 – 92 MY XJ6 SEDAN RANGE



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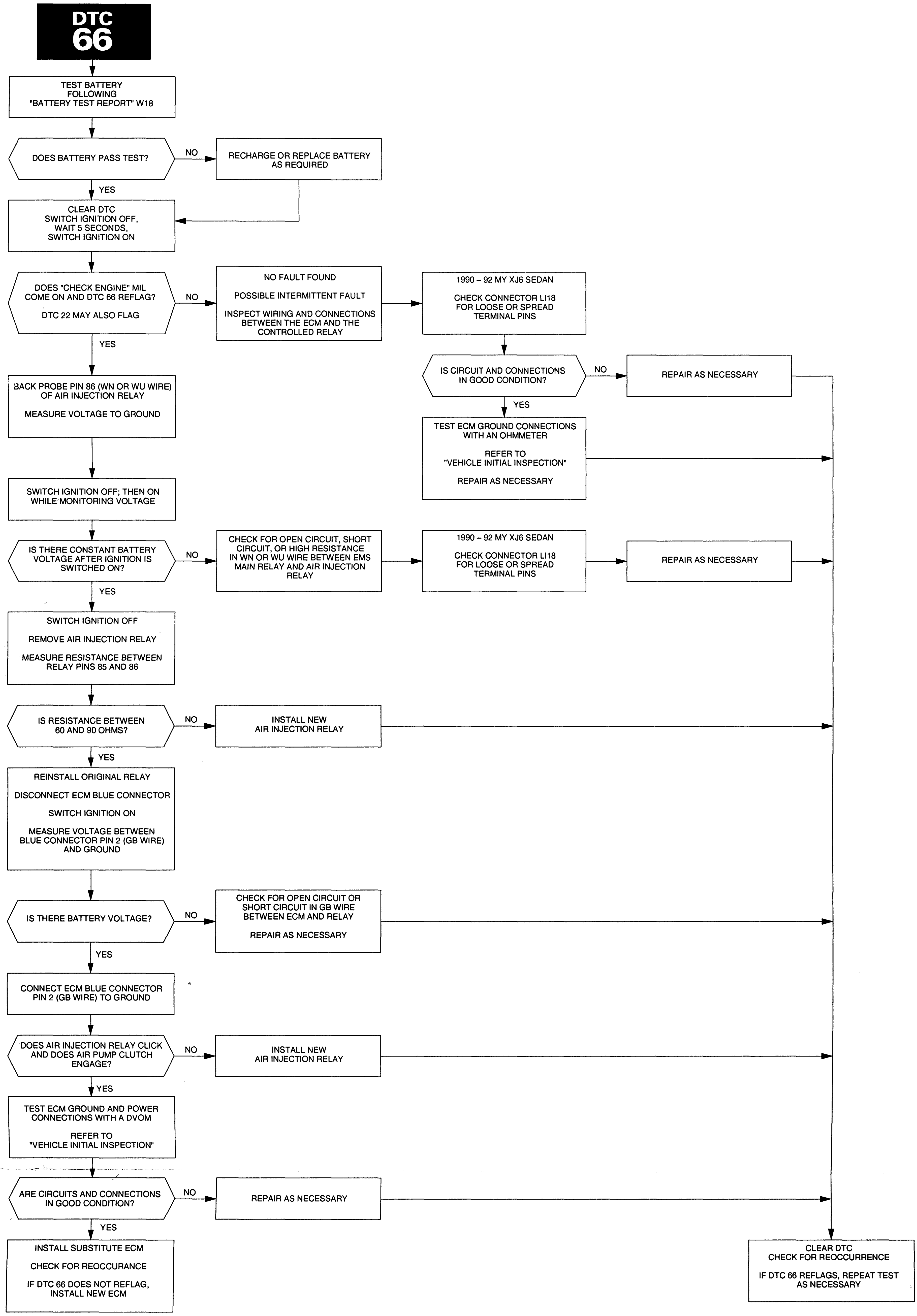

DTC 66
TEST BATTERY FOLLOWING "BATTERY TEST REPORT" W18
DOES BATTERY PASS TEST?
NO
RECHARGE OR REPLACE BATTERY AS REQUIRED
YES
CLEAR DTC SWITCH IGNITION OFF, WAIT 5 SECONDS, SWITCH IGNITION ON
DOES "CHECK ENGINE" MIL COME ON AND DTC 66 REFLAG? DTC 22 MAY ALSO FLAG
NO
NO FAULT FOUND
POSSIBLE INTERMITTENT FAULT
INSPECT WIRING AND CONNECTIONS BETWEEN THE ECM AND THE CONTROLLED RELAY
1990 – 92 MY XJ6 SEDAN
CHECK CONNECTOR LI18 FOR LOOSE OR SPREAD TERMINAL PINS
IS CIRCUIT AND CONNECTIONS IN GOOD CONDITION?
NO
REPAIR AS NECESSARY
YES
TEST ECM GROUND CONNECTIONS WITH AN OHMMETER
REFER TO "VEHICLE INITIAL INSPECTION"
REPAIR AS NECESSARY
YES
BACK PROBE PIN 86 (WN OR WU WIRE) OF AIR INJECTION RELAY
MEASURE VOLTAGE TO GROUND
SWITCH IGNITION OFF; THEN ON WHILE MONITORING VOLTAGE
IS THERE CONSTANT BATTERY VOLTAGE AFTER IGNITION IS SWITCHED ON?
NO
CHECK FOR OPEN CIRCUIT, SHORT CIRCUIT, OR HIGH RESISTANCE IN WN OR WU WIRE BETWEEN EMS MAIN RELAY AND AIR INJECTION RELAY
1990 – 92 MY XJ6 SEDAN
CHECK CONNECTOR LI18 FOR LOOSE OR SPREAD TERMINAL PINS
REPAIR AS NECESSARY
YES
SWITCH IGNITION OFF
REMOVE AIR INJECTION RELAY
MEASURE RESISTANCE BETWEEN RELAY PINS 85 AND 86
IS RESISTANCE BETWEEN 60 AND 90 OHMS?
NO
INSTALL NEW AIR INJECTION RELAY
YES
REINSTALL ORIGINAL RELAY
DISCONNECT ECM BLUE CONNECTOR
SWITCH IGNITION ON
MEASURE VOLTAGE BETWEEN BLUE CONNECTOR PIN 2 (GB WIRE) AND GROUND
IS THERE BATTERY VOLTAGE?
NO
CHECK FOR OPEN CIRCUIT OR SHORT CIRCUIT IN GB WIRE BETWEEN ECM AND RELAY
REPAIR AS NECESSARY
YES
CONNECT ECM BLUE CONNECTOR PIN 2 (GB WIRE) TO GROUND
DOES AIR INJECTION RELAY CLICK AND DOES AIR PUMP CLUTCH ENGAGE?
NO
INSTALL NEW AIR INJECTION RELAY
YES
TEST ECM GROUND AND POWER CONNECTIONS WITH A DVOM
REFER TO "VEHICLE INITIAL INSPECTION"
ARE CIRCUITS AND CONNECTIONS IN GOOD CONDITION?
NO
REPAIR AS NECESSARY
YES
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 66 DOES NOT REFLAG, INSTALL NEW ECM
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 66 REFLAGS, REPEAT TEST AS NECESSARY

DTC 68 ROAD SPEED SENSOR CIRCUIT

The ECM looks for a low road speed signal when the engine load and speed are high.

The engine management ECM receives a road speed signal (5 volt square wave) from the instrument pack. The ECM uses the road speed signal to determine idle speed control functions. The idle speed is controlled when the road speed is less than 3 mph.

The ECM will flag DTC 68 if the road speed is 1.5 mph or less when the engine speed is greater than 2800 rpm and the mass air flow sensor signal voltage is greater than 3 volts.

CONDITIONS REQUIRED FOR DTC 68 FLAGGING:

Road speed .... 1.5 mph or less

Engine speed .... 2800 or greater

Mass air flow signal voltage .... Greater than 3 volts

Response time .... 8 seconds

LIMP HOME DEFAULT:

NONE

POSSIBLE FAULTS:

- Open circuit or short road speed output:

  1990 – 92 MY XJ6 Sedan Range –
  Instrument pack output to EMS ECM and Cruise Control Module;

  1993 – 94 MY XJ6 Sedan Range –
  Instrument pack output to EMS ECM, Cruise Control Module and Central Microprocessor;

  1993 – 94 XJS Range –
  Speed interface unit output to speedometer, EMS ECM and Cruise Control
- Defective instrument pack
- 1990 – 92 MY XJ6 Sedan Range and XJS vehicles –
  Defective road speed sensor, or short circuit or open circuit between road speed sensor and instrument pack
- 1993 MY ON vehicles –
  Defective ABS control module, or short circuit or open circuit between ABS control module sensor and instrument pack. Defective wheel speed sensor, or short circuit or open circuit between wheel speed sensor and ABS control module
- Defective Engine Control Module

DIAGNOSTIC NOTES:

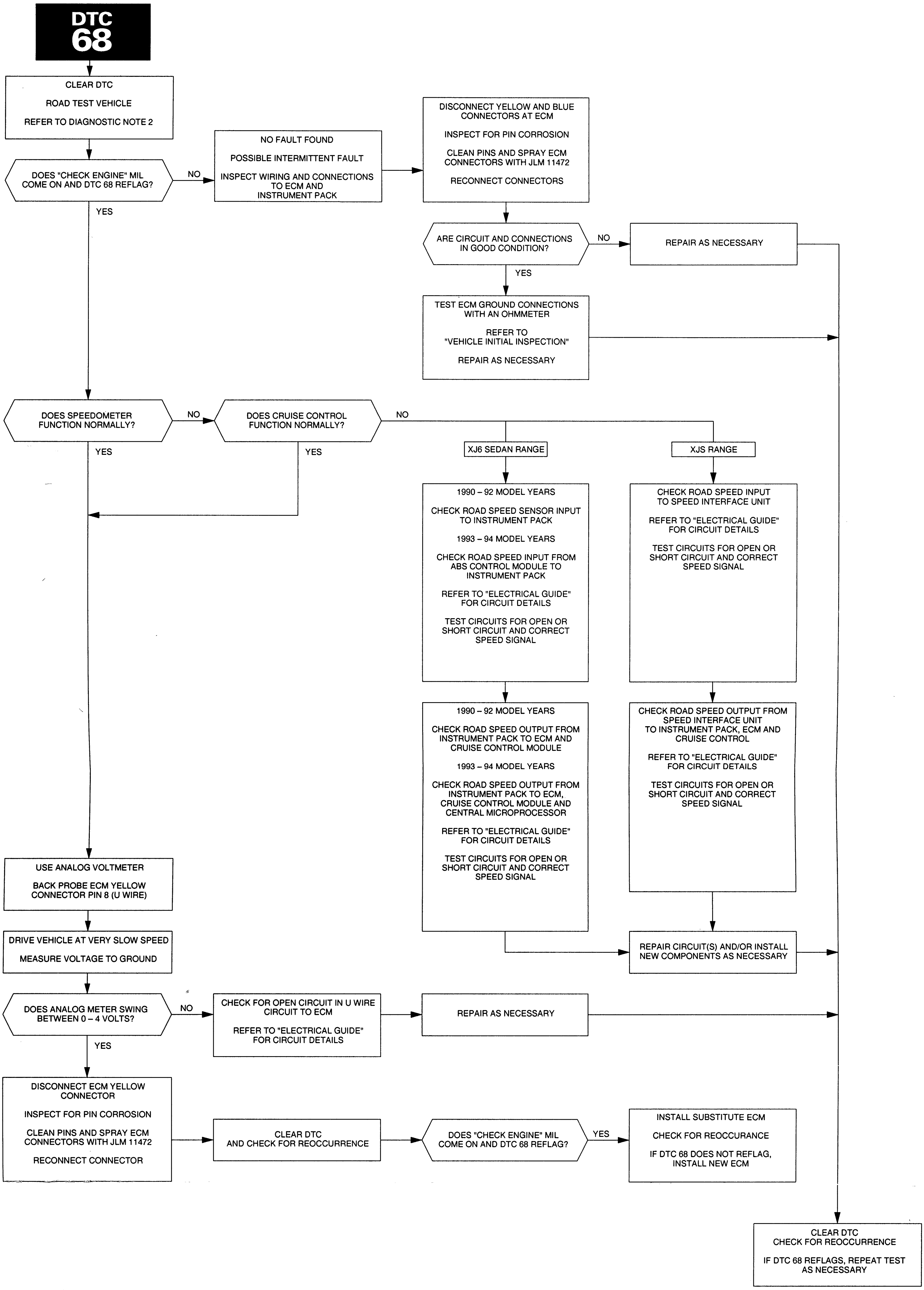
1 The road speed input can be monitored as a logic input using the PDU Datalogger (0 = no signal; 1 = signal)

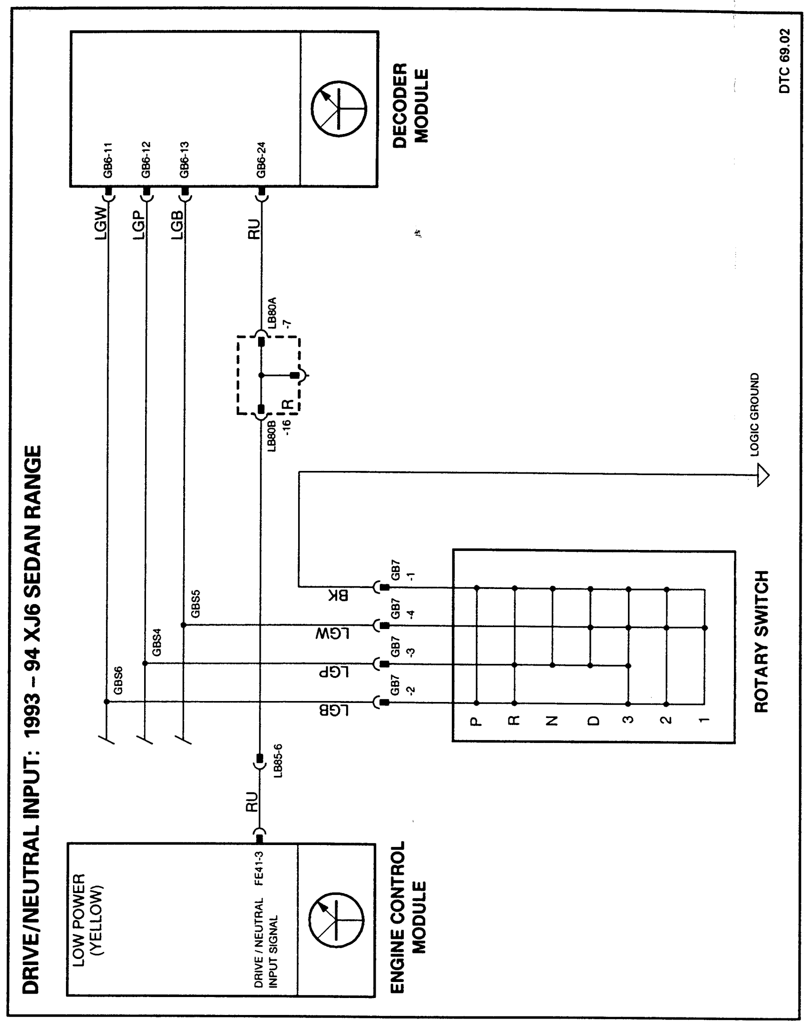
2 Test for a DTC reoccurrence by road testing the vehicle. Drive the vehicle under load with the engine speed above 2800 rpm for more than 8 seconds.

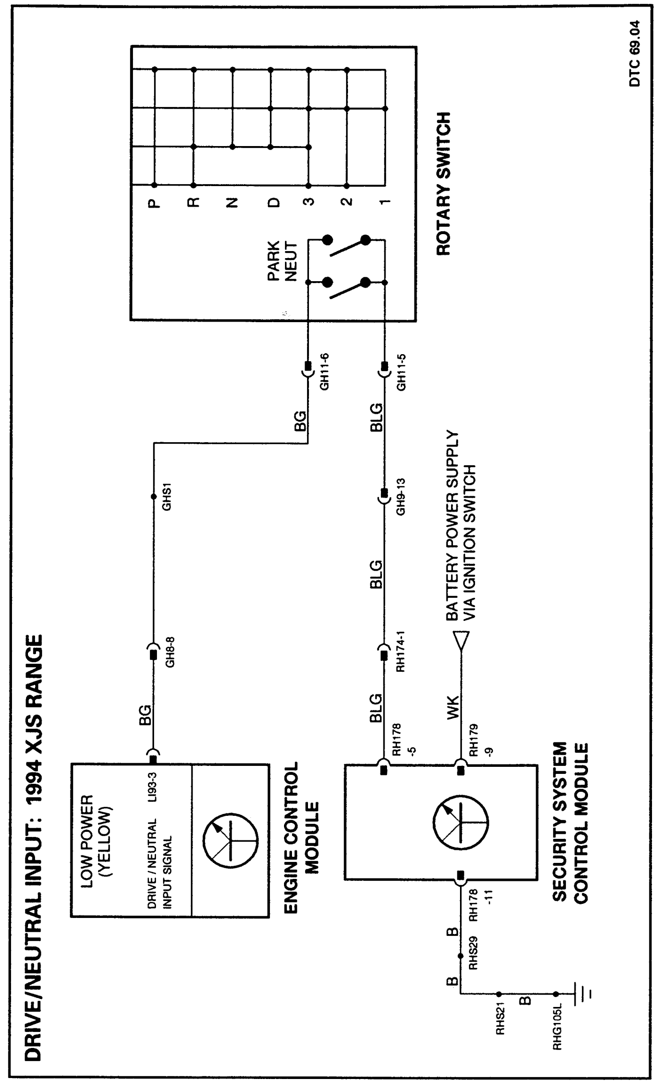
3 The instrument pack provides a road speed signal for the engine management system and the cruise control system. If DTC 68 is flagged and the speedometer operates correctly, suspect a wiring or connection fault between the instrument pack and the ECM. If DTC 68 is flagged and the speedometer does not operate correctly, suspect a signal fault to the instrument pack.

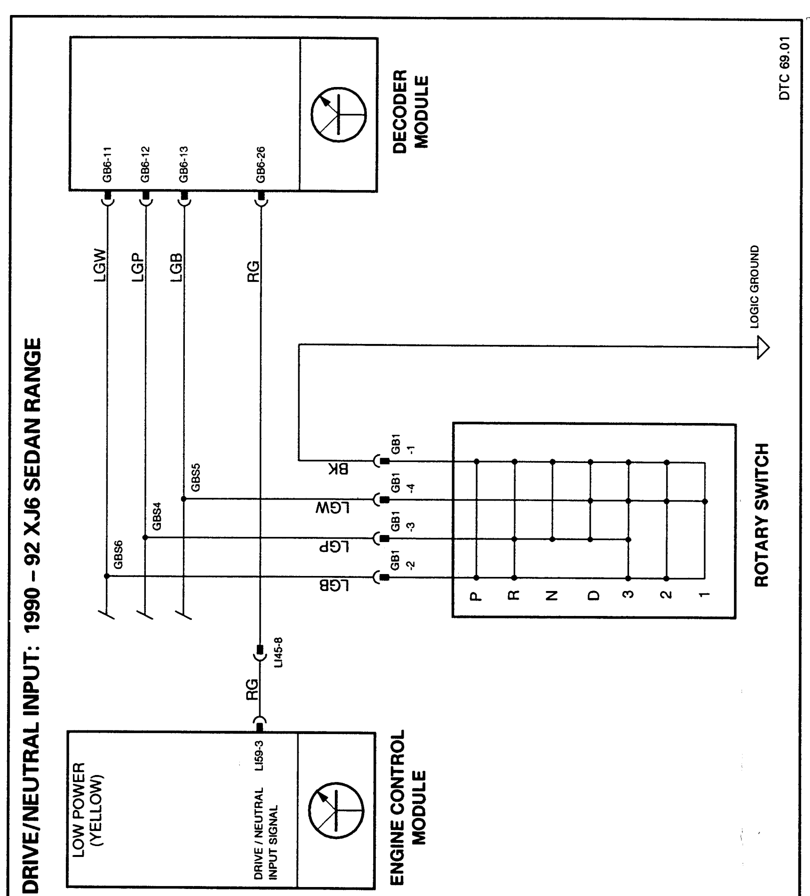
4 To test the road speed sensor (1990 – 92 MY vehicles), back probe the road speed connector in the trunk. Measure the AC voltage between the red and the blue wires. At 30 mph, the voltage is approximately 1.4V AC.

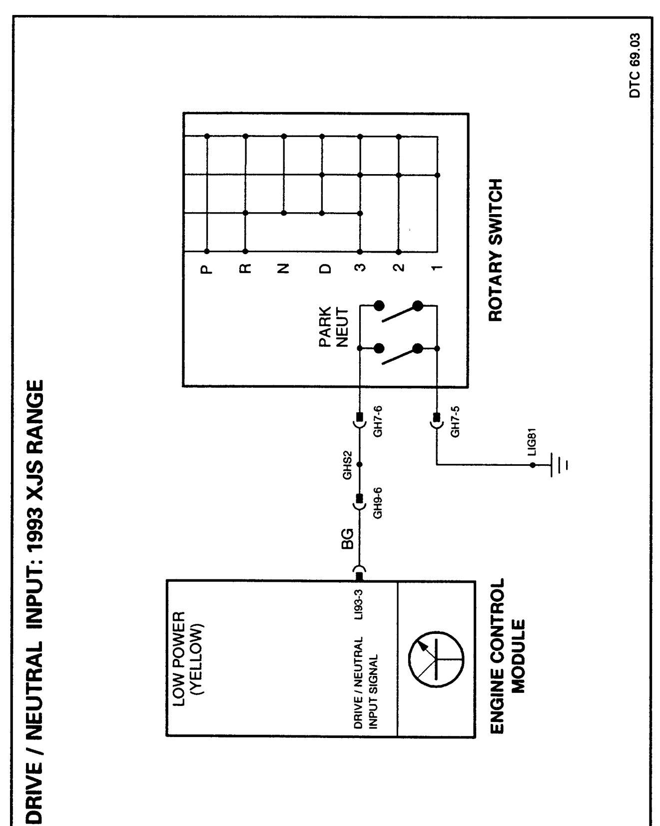
NOTE: The voltage level is not critical as the speedometer is a frequency counter.


DTC 68
CLEAR DTC
ROAD TEST VEHICLE
REFER TO DIAGNOSTIC NOTE 2
DOES "CHECK ENGINE" MIL COME ON AND DTC 68 REFLAG?
NO
NO FAULT FOUND
POSSIBLE INTERMITTENT FAULT
INSPECT WIRING AND CONNECTIONS TO ECM AND INSTRUMENT PACK
DISCONNECT YELLOW AND BLUE CONNECTORS AT ECM
INSPECT FOR PIN CORROSION
CLEAN PINS AND SPRAY ECM CONNECTORS WITH JLM 11472
RECONNECT CONNECTORS
ARE CIRCUIT AND CONNECTIONS IN GOOD CONDITION?
NO
REPAIR AS NECESSARY
YES
TEST ECM GROUND CONNECTIONS WITH AN OHMMETER
REFER TO "VEHICLE INITIAL INSPECTION"
REPAIR AS NECESSARY
YES
DOES SPEEDOMETER FUNCTION NORMALLY?
NO
DOES CRUISE CONTROL FUNCTION NORMALLY?
NO
YES
YES
XJ6 SEDAN RANGE
1990 – 92 MODEL YEARS
CHECK ROAD SPEED SENSOR INPUT TO INSTRUMENT PACK
1993 – 94 MODEL YEARS
CHECK ROAD SPEED INPUT FROM ABS CONTROL MODULE TO INSTRUMENT PACK
REFER TO "ELECTRICAL GUIDE" FOR CIRCUIT DETAILS
TEST CIRCUITS FOR OPEN OR SHORT CIRCUIT AND CORRECT SPEED SIGNAL
1990 – 92 MODEL YEARS
CHECK ROAD SPEED OUTPUT FROM INSTRUMENT PACK TO ECM AND CRUISE CONTROL MODULE
1993 – 94 MODEL YEARS
CHECK ROAD SPEED OUTPUT FROM INSTRUMENT PACK TO ECM, CRUISE CONTROL MODULE AND CENTRAL MICROPROCESSOR
REFER TO "ELECTRICAL GUIDE" FOR CIRCUIT DETAILS
TEST CIRCUITS FOR OPEN OR SHORT CIRCUIT AND CORRECT SPEED SIGNAL
XJS RANGE
CHECK ROAD SPEED INPUT TO SPEED INTERFACE UNIT
REFER TO "ELECTRICAL GUIDE" FOR CIRCUIT DETAILS
TEST CIRCUITS FOR OPEN OR SHORT CIRCUIT AND CORRECT SPEED SIGNAL
CHECK ROAD SPEED OUTPUT FROM SPEED INTERFACE UNIT TO INSTRUMENT PACK, ECM AND CRUISE CONTROL
REFER TO "ELECTRICAL GUIDE" FOR CIRCUIT DETAILS
TEST CIRCUITS FOR OPEN OR SHORT CIRCUIT AND CORRECT SPEED SIGNAL
REPAIR CIRCUIT(S) AND/OR INSTALL NEW COMPONENTS AS NECESSARY
USE ANALOG VOLTMETER
BACK PROBE ECM YELLOW CONNECTOR PIN 8 (U WIRE)
DRIVE VEHICLE AT VERY SLOW SPEED
MEASURE VOLTAGE TO GROUND
DOES ANALOG METER SWING BETWEEN 0 – 4 VOLTS?
NO
CHECK FOR OPEN CIRCUIT IN U WIRE CIRCUIT TO ECM
REFER TO "ELECTRICAL GUIDE" FOR CIRCUIT DETAILS
REPAIR AS NECESSARY
YES
DISCONNECT ECM YELLOW CONNECTOR
INSPECT FOR PIN CORROSION
CLEAN PINS AND SPRAY ECM CONNECTORS WITH JLM 11472
RECONNECT CONNECTOR
CLEAR DTC AND CHECK FOR REOCCURRENCE
DOES "CHECK ENGINE" MIL COME ON AND DTC 68 REFLAG?
YES
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 68 DOES NOT REFLAG, INSTALL NEW ECM
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 68 REFLAGS, REPEAT TEST AS NECESSARY









DTC 69 DRIVE / NEUTRAL INPUT CIRCUIT

The ECM looks for an incorrect gear position (DRIVE; NEUTRAL) input signal. The ECM uses the gear position input for idle control functions. The controlled idle speed in DRIVE is lower than in NEUTRAL.

The ECM outputs a 5 volt gear position sensor signal on the low power (yellow) connector, pin 3. When the gear selector is in PARK or NEUTRAL, the voltage signal is switched to ground by an external device and pin 3 voltage becomes zero.

On XJ6 Sedan Range vehicles, the gear position sensor signal is switched to ground by the decoder module, which receives gear position information from the transmission rotary switch. On 1990 – 92 MY vehicles, the decoder module is located above the component panel behind the right side under dash panel. On 1993 MY ON vehicles, the decoder module is located on the "J" gate assembly.

On XJS vehicles, the gear position sensor signal is switched to ground by the transmission rotary switch.

The ECM will flag DTC 69 if the gear position is not PARK or NEUTRAL when the engine is started. DTC 69 will also flag if the gear position is PARK or NEUTRAL when the engine load and speed are high.

CONDITIONS REQUIRED FOR DTC 69 FLAGGING:

Engine speed .... Greater than 3550 rpm
Engine load site .... Load site 12 or higher
Gear position voltage signal .... Less than 1 volt (PARK / NEUTRAL)

Engine speed .... Less than 200 rpm
Gear position voltage signal .... 5 volts (DRIVE GEAR)

Response time .... 83 engine revolutions

LIMP HOME DEFAULT:

NONE

POSSIBLE FAULTS:

- Low battery voltage
- Ignition switched too quickly from OFF to START (XJ6 Sedan Range up to VIN 645802)
- Gear shift cable incorrectly adjusted
- Transmission rotary switch incorrectly adjusted
- Open circuit or short circuit wiring between the ECM and the decoder module (XJ6 Sedan Range)
- Open circuit or short circuit wiring between the ECM and the transmission rotary switch (XJS Range)
- Defective ECM

DIAGNOSTIC NOTES:

1 The gear position sensor signal can be monitored using the PDU "Datalogger" function. In PARK and NEUTRAL, the signal is 0; in all other gear positions, the signal is 1. The PDU Datalogger can be set to trigger on flagging DTC 69.

PDU DATALOGGER TRIGGER

FF 69 ↑ 1

2 Test for a DTC reoccurrence by road testing the vehicle. Accelerate at full throttle to above 3550 rpm.

3 A revised decoder module was introduced on XJ6 Sedan Range vehicles at VIN 645803 to prevent false flagging of DTC 69 caused by switching of the ignition too quickly from OFF to START.

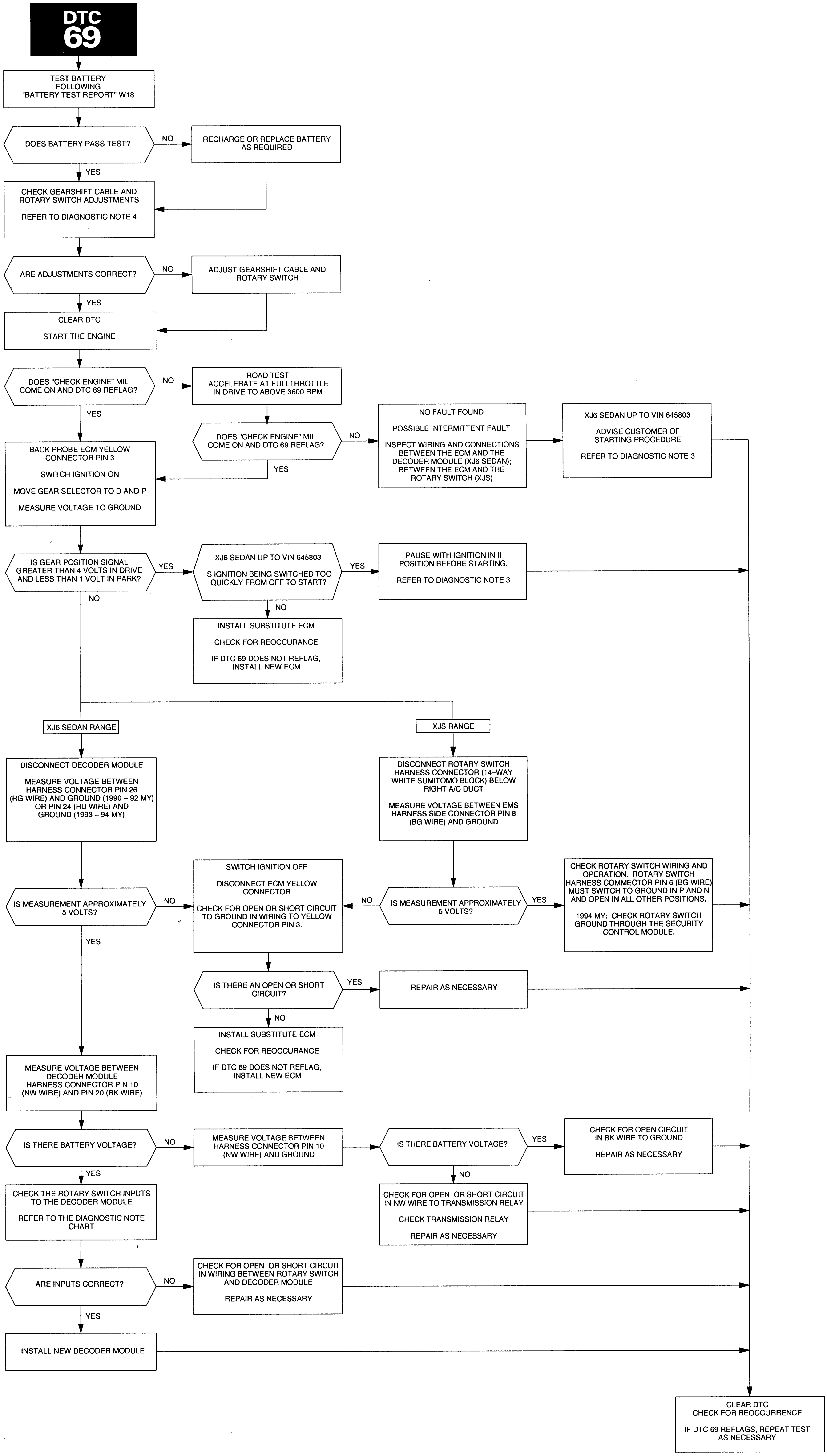
4 When checking the gear shift cable and rotary switch adjustment, check the gear shift cable adjustment first. When the manual valve selector shaft is held in the NEUTRAL position by the detent, the gear selector must be centered in the NEUTRAL gate notch. Check the rotary switch adjustment using special tool JD 161.

DECODER MODULE INPUTS

Gear position	Pin number (wire color) 11 (LGP)	12 (LGW)	13 (LGB)
P	1	1	0
R	0	1	0
N	0	1	1
D	0	0	1
3	0	0	0
2	1	0	0

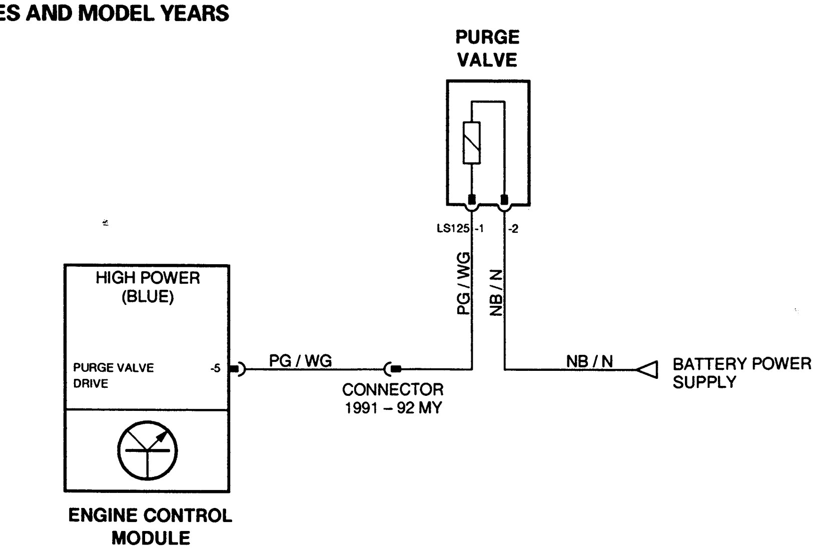
0 = switch closed circuit to ground
1 = switch open circuit to ground

Continued at left on foldout page.


DTC 69
TEST BATTERY FOLLOWING "BATTERY TEST REPORT" W18
DOES BATTERY PASS TEST?
NO
RECHARGE OR REPLACE BATTERY AS REQUIRED
YES
CHECK GEARSHIFT CABLE AND ROTARY SWITCH ADJUSTMENTS
REFER TO DIAGNOSTIC NOTE 4
ARE ADJUSTMENTS CORRECT?
NO
ADJUST GEARSHIFT CABLE AND ROTARY SWITCH
YES
CLEAR DTC
START THE ENGINE
DOES "CHECK ENGINE" MIL COME ON AND DTC 69 REFLAG?
NO
ROAD TEST
ACCELERATE AT FULLTHROTTLE IN DRIVE TO ABOVE 3600 RPM
DOES "CHECK ENGINE" MIL COME ON AND DTC 69 REFLAG?
NO
NO FAULT FOUND
POSSIBLE INTERMITTENT FAULT
INSPECT WIRING AND CONNECTIONS BETWEEN THE ECM AND THE DECODER MODULE (XJ6 SEDAN); BETWEEN THE ECM AND THE ROTARY SWITCH (XJS)
XJ6 SEDAN UP TO VIN 645803
ADVISE CUSTOMER OF STARTING PROCEDURE
REFER TO DIAGNOSTIC NOTE 3
YES
YES
BACK PROBE ECM YELLOW CONNECTOR PIN 3
SWITCH IGNITION ON
MOVE GEAR SELECTOR TO D AND P
MEASURE VOLTAGE TO GROUND
IS GEAR POSITION SIGNAL GREATER THAN 4 VOLTS IN DRIVE AND LESS THAN 1 VOLT IN PARK?
YES
XJ6 SEDAN UP TO VIN 645803
IS IGNITION BEING SWITCHED TOO QUICKLY FROM OFF TO START?
YES
PAUSE WITH IGNITION IN II POSITION BEFORE STARTING.
REFER TO DIAGNOSTIC NOTE 3
NO
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 69 DOES NOT REFLAG, INSTALL NEW ECM
NO
XJ6 SEDAN RANGE
XJS RANGE
DISCONNECT DECODER MODULE
MEASURE VOLTAGE BETWEEN HARNESS CONNECTOR PIN 26 (RG WIRE) AND GROUND (1990 – 92 MY) OR PIN 24 (RU WIRE) AND GROUND (1993 – 94 MY)
DISCONNECT ROTARY SWITCH HARNESS CONNECTOR (14–WAY WHITE SUMITOMO BLOCK) BELOW RIGHT A/C DUCT
MEASURE VOLTAGE BETWEEN EMS HARNESS SIDE CONNECTOR PIN 8 (BG WIRE) AND GROUND
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
NO
SWITCH IGNITION OFF
DISCONNECT ECM YELLOW CONNECTOR
CHECK FOR OPEN OR SHORT CIRCUIT TO GROUND IN WIRING TO YELLOW CONNECTOR PIN 3.
NO
IS MEASUREMENT APPROXIMATELY 5 VOLTS?
YES
CHECK ROTARY SWITCH WIRING AND OPERATION. ROTARY SWITCH HARNESS COMMECTOR PIN 6 (BG WIRE) MUST SWITCH TO GROUND IN P AND N AND OPEN IN ALL OTHER POSITIONS.
1994 MY: CHECK ROTARY SWITCH GROUND THROUGH THE SECURITY CONTROL MODULE.
YES
IS THERE AN OPEN OR SHORT CIRCUIT?
YES
REPAIR AS NECESSARY
NO
INSTALL SUBSTITUTE ECM
CHECK FOR REOCCURANCE
IF DTC 69 DOES NOT REFLAG, INSTALL NEW ECM
MEASURE VOLTAGE BETWEEN DECODER MODULE HARNESS CONNECTOR PIN 10 (NW WIRE) AND PIN 20 (BK WIRE)
IS THERE BATTERY VOLTAGE?
NO
MEASURE VOLTAGE BETWEEN HARNESS CONNECTOR PIN 10 (NW WIRE) AND GROUND
IS THERE BATTERY VOLTAGE?
YES
CHECK FOR OPEN CIRCUIT IN BK WIRE TO GROUND
REPAIR AS NECESSARY
NO
CHECK FOR OPEN OR SHORT CIRCUIT IN NW WIRE TO TRANSMISSION RELAY
CHECK TRANSMISSION RELAY
REPAIR AS NECESSARY
YES
CHECK THE ROTARY SWITCH INPUTS TO THE DECODER MODULE
REFER TO THE DIAGNOSTIC NOTE CHART
ARE INPUTS CORRECT?
NO
CHECK FOR OPEN OR SHORT CIRCUIT IN WIRING BETWEEN ROTARY SWITCH AND DECODER MODULE
REPAIR AS NECESSARY
YES
INSTALL NEW DECODER MODULE
CLEAR DTC
CHECK FOR REOCCURRENCE
IF DTC 69 REFLAGS, REPEAT TEST AS NECESSARY

CIRCUIT DIAGRAM

PURGE VALVE: ALL VEHICLES AND MODEL YEARS



NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR IDENTIFICATION.

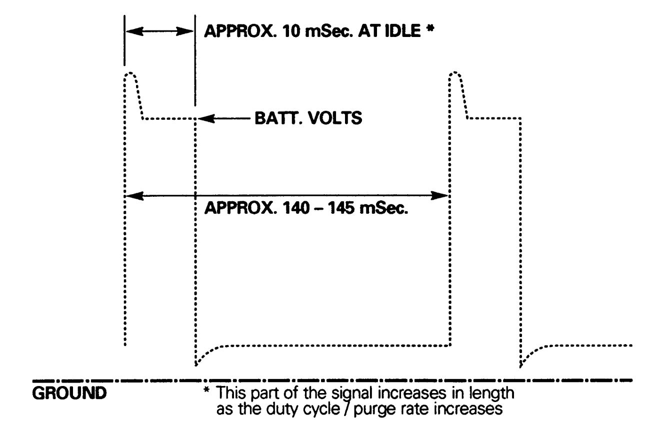
DTC 89.2

DTC 89 PURGE VALVE DRIVE CIRCUIT

The ECM looks for the purge valve drive circuit voltage to be outside the expected range when the valve is switched ON and OFF.

The ECM drives the purge valve by grounding the purge valve solenoid coil. The drive signal (pulse width modulated) is a square wave that is mapped in the ECM to provide optimum purge rates. When purge is enabled, the frequency of the drive signal is constant, but the dwell ("valve open" time) changes with engine load and speed. If the oxygen sensor detects excess air in the exhaust, the ECM closes the purge valve for up to 20 minutes, allowing the canister to collect more vapor.

PURGE VALVE SIGNAL



DTC 89.1

The ECM monitors the purge valve drive signal and checks that when the valve is closed, the drive signal is close to ground and when the valve is opened, the signal is near battery voltage. The exact voltage levels vary depending upon battery voltage.

The ECM will flag DTC 89 if the drive circuit voltage is greater than approximately 2.5 volts when the purge valve is driven closed, or if the drive circuit voltage is less than approximately 10.5 volts when the purge valve is driven open.

CONDITIONS REQUIRED FOR DTC 89 FLAGGING:

Purge drive signal .... ON (valve closed)
Drive circuit voltage .... Greater than 2.5 volts (approximate)

Purge drive .... OFF (valve open)
Drive circuit voltage .... Less than 10.5 volts (approximate)

LIMP HOME DEFAULT:

NONE

POSSIBLE FAULTS:

- Low battery voltage
- Poor ECM power feed or ground connections
- Open or short circuit wiring in the purge valve drive circuit
- Open circuit wiring in the purge valve power supply circuit
- XJ6 Sedan Range vehicles (1990 – 1992 MY) – Loose terminal pins in connector LI18 (yellow PM4 below air cleaner housing)
- Defective purge valve

DIAGNOSTIC NOTES:

1 The purge drive signal can be monitored with an oscilloscope.
2 The purge valve coil resistance should be approximately 42 ohms.
3 Intermittent power loss will flag DTC 89. Check the security of the connections to the left and right bulkhead power studs (passenger side – XJ6 Sedan Range vehicles; engine side – XJS Range vehicles).
4 1990 – 92 MY XJ6 Sedan Range vehicles – Intermittent faults can be caused by loose terminal pins in connector LI18 (yellow PM4) located below the air cleaner housing. Remove the female pins from the connector block and inspect for a loose condition. The contact tangs must bent toward the inside of the female terminal.

PURGE VALVE TEST

To test for an inoperative or sticking purge valve:

— Disconnect the purge hose at the intake manifold adapter.

— Switch ignition ON; do not start the engine.

— Apply vacuum to purge hose; vacuum should hold. If the vacuum does not hold, the purge valve is stuck and should be replaced.

— Switch ignition OFF; vacuum should release after a few seconds. If the vacuum does not release, the purge valve is stuck and should be replaced.

Continued at left on foldout page.

DTC 89

TEST BATTERY FOLLOWING "BATTERY TEST REPORT" W18

DOES BATTERY PASS TEST?

- NO → RECHARGE OR REPLACE BATTERY AS REQUIRED → (continue to next step)
- YES ↓

CHECK CONNECTIONS TO BULKHEAD POWER STUDS FOR LOOSENESS OR CORROSION

REFER TO DIAGNOSTIC NOTE 3

REPAIR AS NECESSARY

↓

TEST ECM POWER AND GROUND CONNECTIONS WITH A DVOM

REFER TO "VEHICLE INITIAL INSPECTION"

REPAIR AS NECESSARY

↓

1990 – 92 MY XJ6 SEDAN RANGE: CHECK CONNECTOR LI18 PINS

REFER TO DIAGNOSTIC NOTE 4

REPAIR AS NECESSARY

↓

CLEAR DTC

START ENGINE AND RUN TO NORMAL OPERATING TEMPERATURE

↓

DOES "CHECK ENGINE" MIL COME ON AND DTC 89 REFLAG?

- NO → NO FAULT FOUND

  POSSIBLE INTERMITTENT FAULT

  INSPECT WIRING AND CONNECTIONS BETWEEN ECM AND PURGE VALVE

  REPAIR AS NECESSARY
- YES ↓

DISCONNECT THE PURGE VALVE

MEASURE THE RESISTANCE BETWEEN PURGE VALVE PINS 1 AND 2

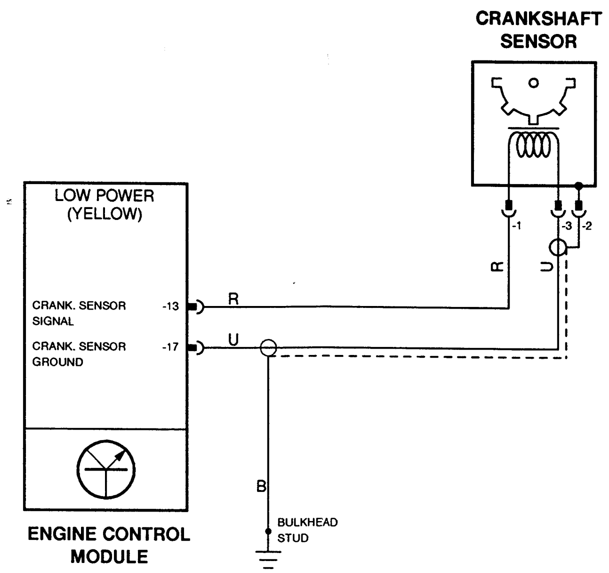
↓

IS THE RESISTANCE OF THE PURGE VALVE COIL 25 – 50 OHMS?

- NO → INSTALL NEW PURGE VALVE

CIRCUIT DIAGRAM

CRANKSHAFT SENSOR: ALL VEHICLES AND MODEL YEARS



NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND IDENTIFICATION.

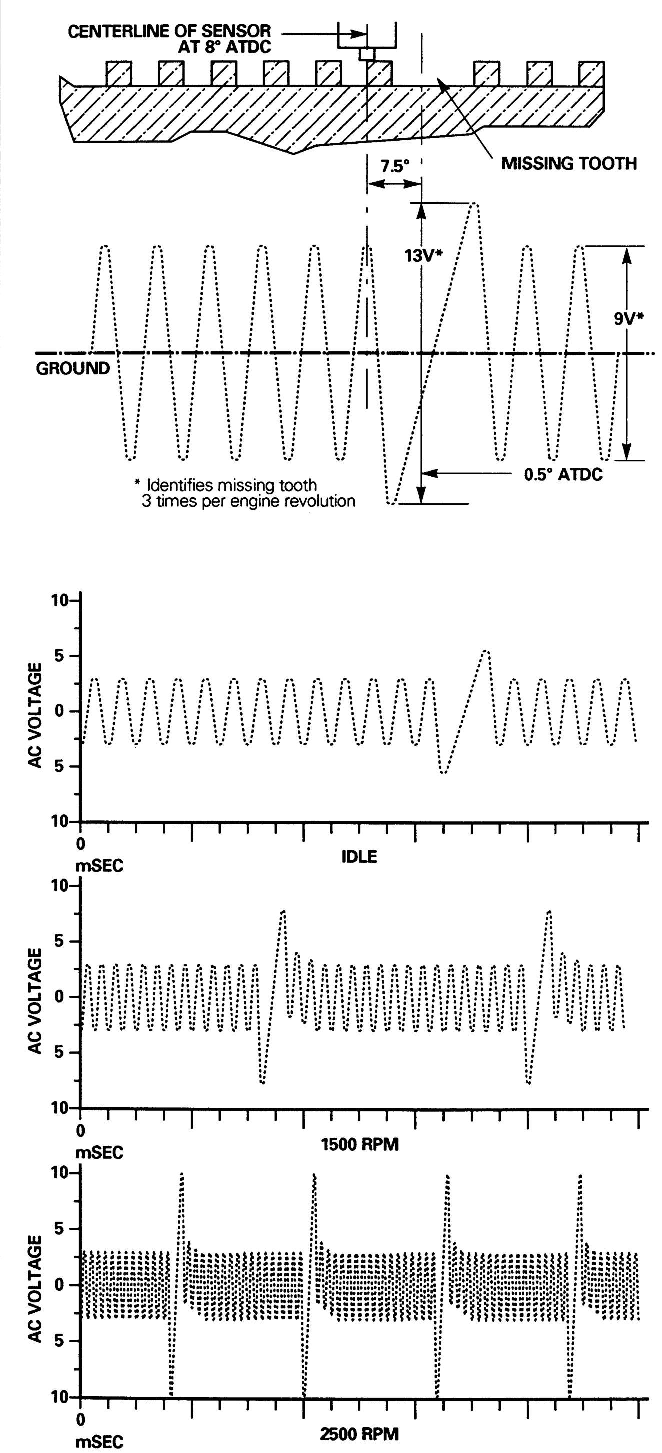
DTC N1.02

NO DTC CRANKSHAFT SENSOR CIRCUIT

There is no ECM OBD monitoring of this circuit. Intermittent loss of the signal will cause engine misfire and/or stalling. Total loss will stop the engine completely.

The crankshaft sensor, located on the engine front timing cover, produces an AC voltage. The sensor output voltage to the ECM will increase rapidly as engine speed increases from cranking to running.

CRANKSHAFT SENSOR SIGNAL



DTC N1.01

POSSIBLE FAULTS:

- Incorrect sensor core gap
- Open circuit or short circuit wiring between ECM and crankshaft sensor
- Poor ground connection between the sensor shielding and bulkhead ground stud
- Defective crankshaft sensor
- Damaged toothed wheel

DIAGNOSTIC NOTES:

1. The crankshaft sensor signal can be monitored with an oscilloscope.
2. The crankshaft AC voltage output can be measured between ECM yellow connector pins 13 and 24:
   - 2.5 volts AC @ 1000 rpm (approximate)
   - 5.0 volts AC @ 3000 rpm (approximate)
3. The sensor coil resistance should be 1.25 to 1.45 kilo ohms at 70°F. Replace the sensor if the resistance is incorrect.
4. The sensor air gap should be 0.020 – 0.040 in. If the gap is incorrect, remove the mounting bracket from the engine and the crankshaft sensor from the mounting bracket. File the mounting bracket to reduce the core gap. Install the assembly and recheck the gap.
5. To check the crankshaft sensor circuit, disconnect the ECM yellow connector and the crankshaft sensor connector. Check for an open circuit or a short circuit to ground between the ECM yellow connector pin 13 (RED wire) and the crankshaft sensor connector, and the ECM yellow connector pin 24 (BLUE wire) and the crankshaft sensor connector.
6. Check the crankshaft sensor shield connection to ground at the harness side of the crankshaft sensor connector pin 2.
7. If an engine misfire is accompanied by erratic tachometer readings, suspect a poor crankshaft sensor output.

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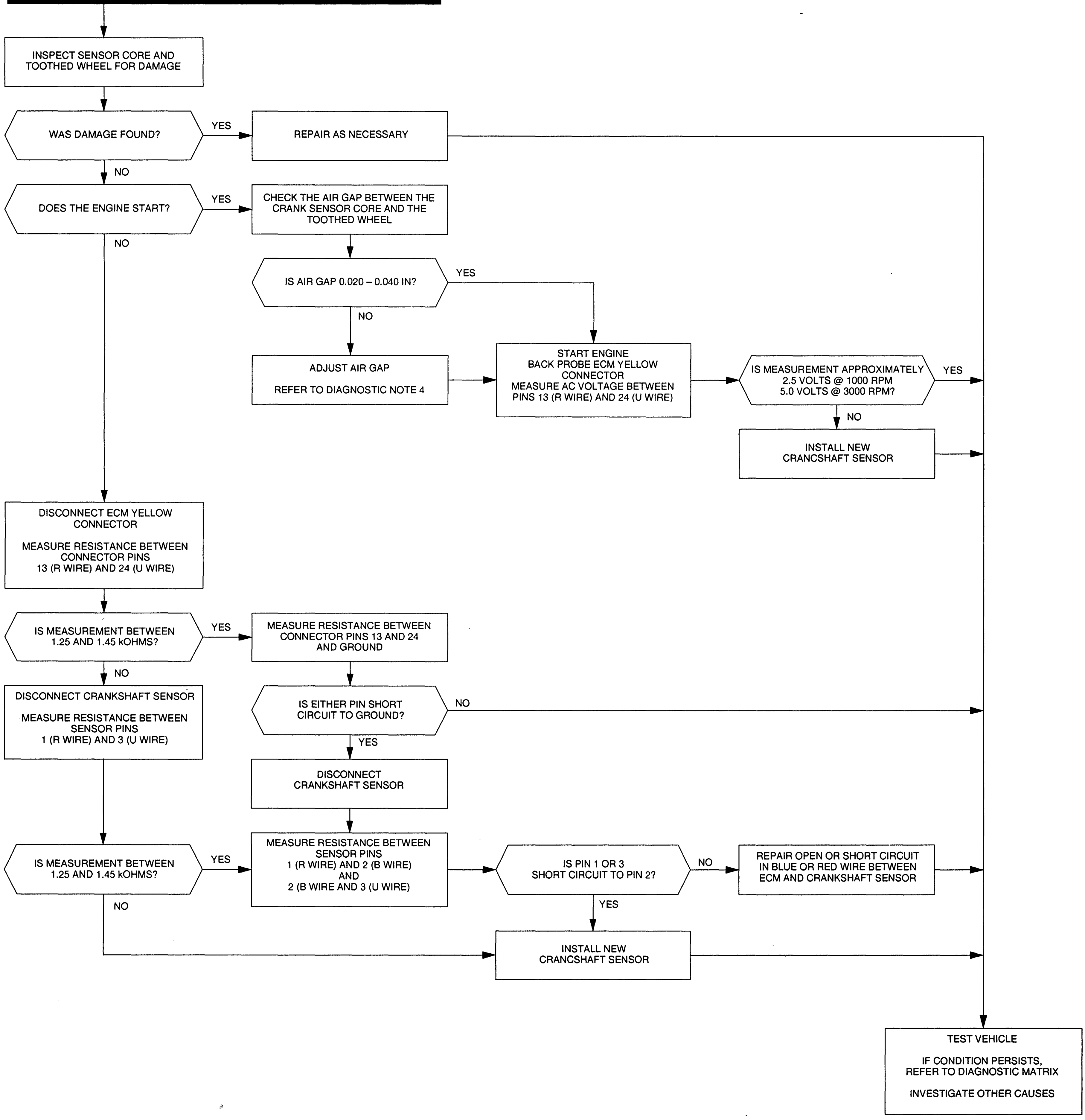
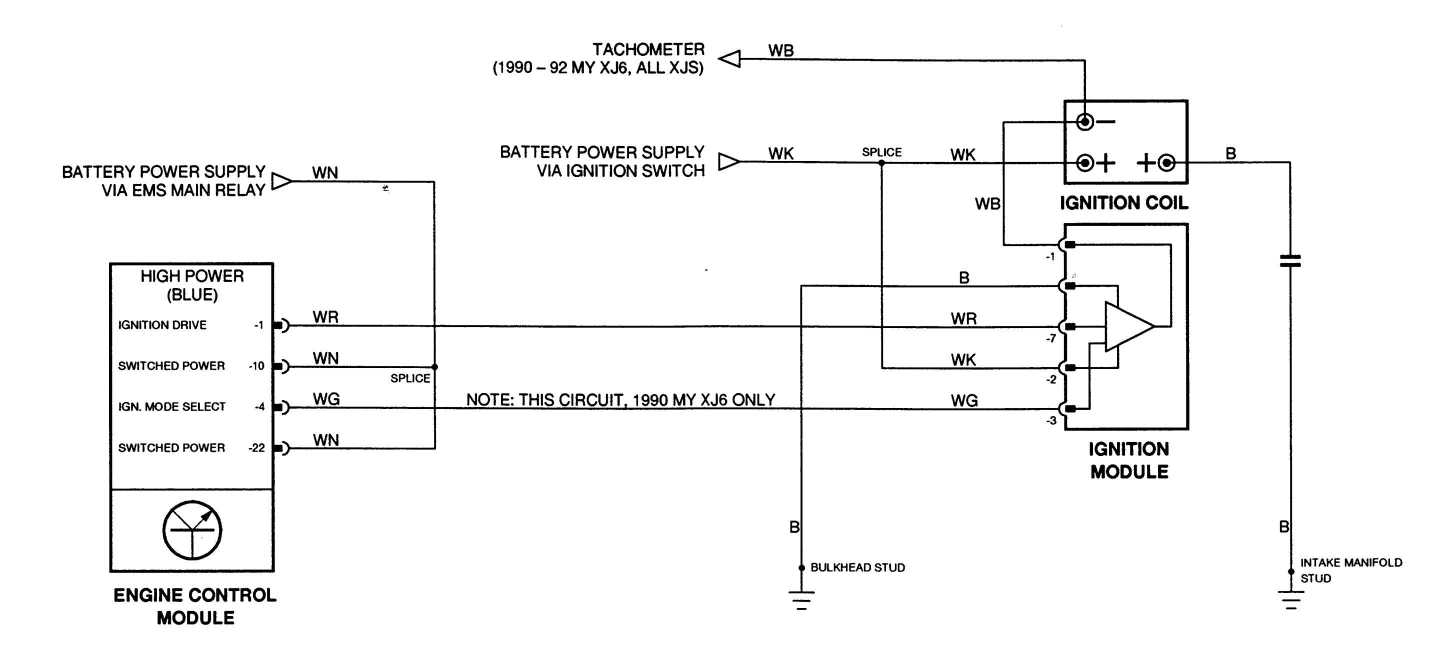
CRANKSHAFT SENSOR CIRCUIT



CIRCUIT DIAGRAM

CRANKSHAFT SENSOR: ALL VEHICLES AND MODEL YEARS



NOTE: REFER TO THE WIRING DIAGRAMS IN THE REFERENCE SECTION OF THIS PUBLICATION FOR CONNECTOR AND SPLICE IDENTIFICATION.

DTC N1.02

NO DTC IGNITION PRIMARY AND SECONDARY CIRCUITS

The ignition module is controlled by the ECM. This function is monitored by the ECM and faults are flagged as DTC 24. There are no diagnostic trouble codes for the remainder of the system; however, DTC 26 can be flagged if there is a severe ignition misfire, resulting in excess oxygen in the exhaust.

The ignition module switches the ignition coil primary circuit to ground. The coil saturation period (dwell) and peak coil current are also controlled by the ignition module. A function called "stall turnoff" prevents the coil overheating and battery discharge if the ignition is left ON without the engine running. The coil current is discharged slowly to avoid causing a spark.

The ignition secondary system uses a standard distributor rotor arm and cap. The distributor has no affect on ignition timing; it is simply a rotating switch for the secondary current.

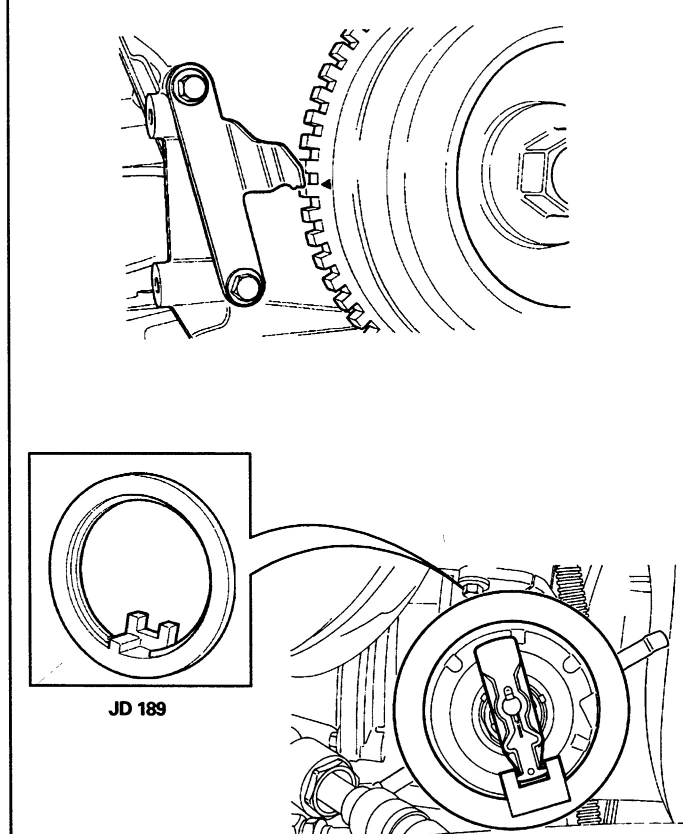
DIAGNOSTIC NOTES:

1 The ignition secondary circuit can be monitored with a standard ignition oscilloscope.

2 The ignition module in 1990 MY XJ6 vehicles has 4 wires plus a ground; all later vehicles have 3 wire plus ground module. The 3-wire module can be used to replace the 4-wire module without modification.

3 If misfiring occurs at high engine speed or load, check the distributor position in relation to the engine position. The distributor position is set using special tool JD 189 with the number 1 cylinder at TDC on the compression stroke.

SET DISTRIBUTOR POSITION WITH NUMBER 1 CYLINDER AT TDC ON COMPRESSION STROKE

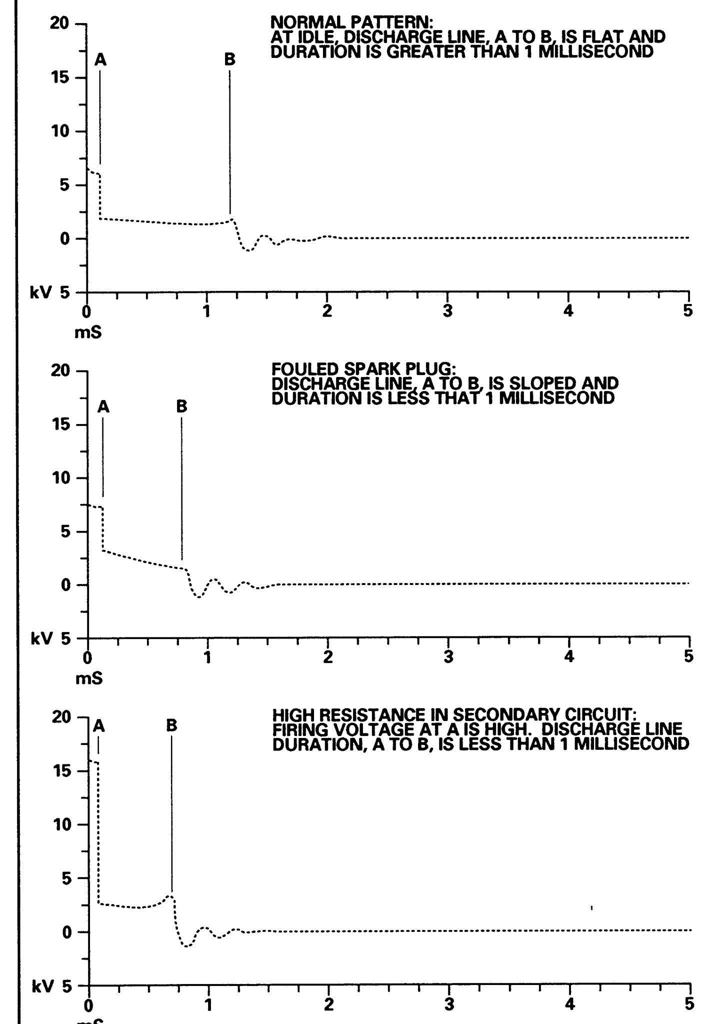


DTC N2.02, 2.03A, B & C

4 A fault in the ignition system primary circuit will cause stalling or a "no start" condition. If there is no spark, use the diagnostic procedure shown on the opposite page.

5 A fault in the ignition system secondary circuit will usually cause an engine misfire. Use these examples of ignition secondary voltage oscilloscope patterns as a guide to diagnosing the problem:

EXAMPLES OF IGNITION SECONDARY VOLTAGE OSCILLOSCOPE PATTERNS



DTC N2.01

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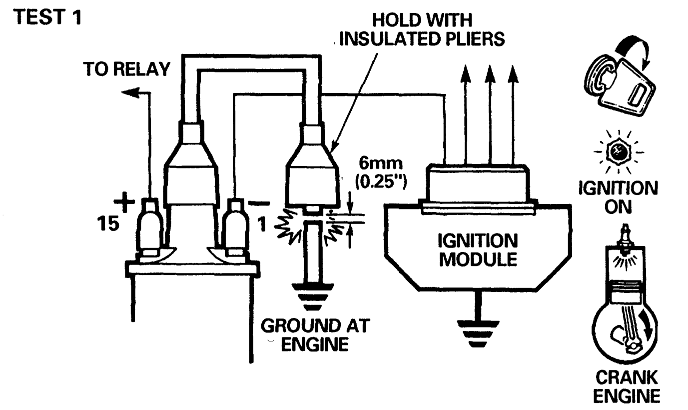
IGNITION PRIMARY AND SECONDARY CIRCUITS

CONDITION: NO START CAUSED BY IGNITION FAULT

CHECK IGNITION MODULE CONNECTOR FOR FULL ENGAGEMENT / LOOSE PINS

OK

TEST 1

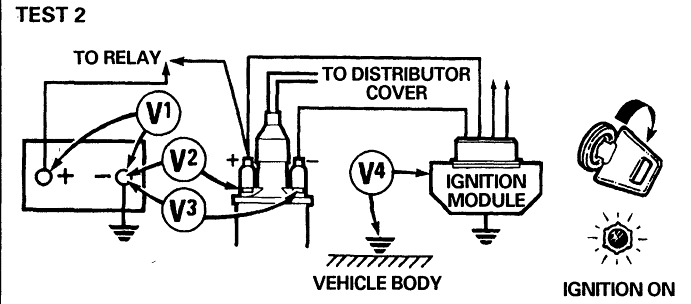


CRANK ENGINE. CHECK FOR SPARK. SHOULD HAVE REGULAR SPARK.

OK → CHECK IGNITION ROTOR. (GO TO TEST 5)

WEAK OR NO SPARK

TEST 2

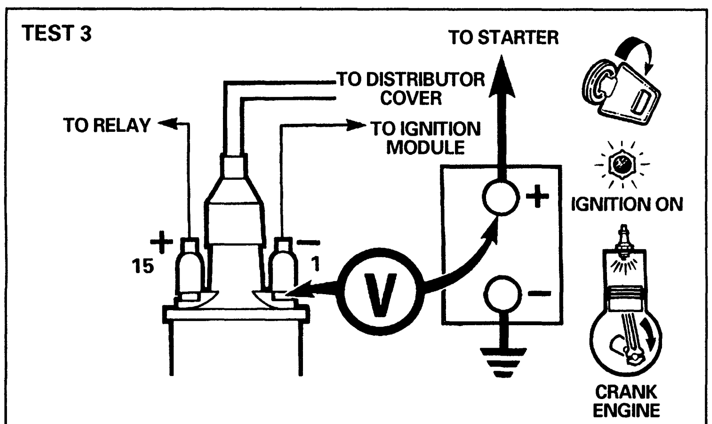


SWITCH IGNITION ON. MEASURE VOLTAGES V1 TO V4.

TEST	EXPECTED MEASUREMENT	ACTION IF INCORRECT
V1	MORE THAN 12 VOLTS	RECHARGE BATTERY
V2	1 VOLT MAX. BELOW V1	CHECK WIRING FROM IGNITION ON RELAY
V3	1 VOLT MAX. BELOW V1	IF V2 IS INCORRECT, REPAIR V2 FIRST. IF V2 IS OK, DISCONNECT WIRE FROM IGNITION COIL NEGATIVE TERMINAL AND REPEAT V3 MEASUREMENT. IF V3 IS STILL LOW, INSTALL NEW IGNITION COIL.
V4	0.0 TO 0.1 VOLTS	CHECK GROUND CONNECTION TO IGNITION MODULE AND HEAT SINK PLATE.

ALL MEASUREMENTS CORRECT

TEST 3

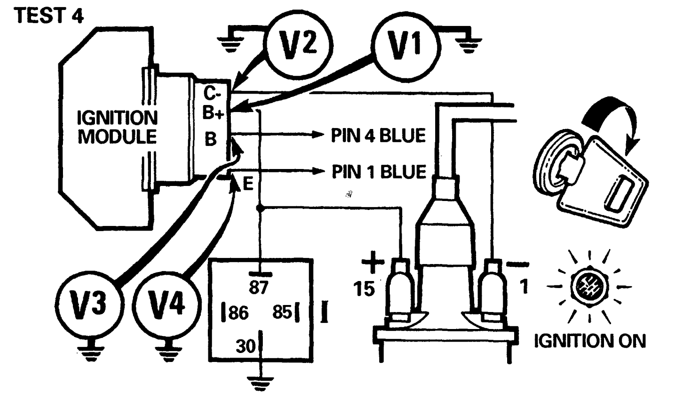


CRANK ENGINE. VOLTAGE SHOULD INCREASE FROM 0.0 UPON CRANKING.

VOLTAGE INCREASES → REPLACE IGNITION COIL AND RETEST.

VOLTAGE DOES NOT INCREASE

TEST 4

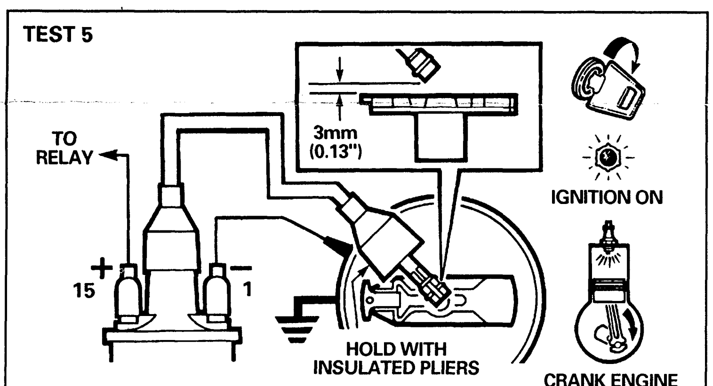


SWITCH IGNITION ON. MEASURE VOLTAGES V1 TO V4.

TEST	EXPECTED MEASUREMENT	ACTION IF INCORRECT
V1	1 VOLT MAX. BELOW BATTERY VOLTAGE	CHECK WIRING TO IGNITION MODULE FROM IGNITION ON RELAY.
V2	1 VOLT MAX. BELOW BATTERY VOLTAGE	CHECK WIRING TO IGNITION MODULE FROM COIL NEGATIVE TERMINAL. IF WIRING IS OK, REPLACE IGNITION MODULE.
V3	APPROXIMATELY 5 VOLTS (1990 MY ONLY)	INSTALL 3-WIRE IGNITION MODULE.
V4	WHEN ENGINE IS CRANKED, VOLTAGE SHOULD RISE FROM NEAR 0 TO APPROX. 0.3 VOLTS.	CHECK WIRING FROM EMS ECM BLUE PLUG PIN 1 TO IGNITION MODULE (WR WIRE). IF WIRING IS OK, DISCONNECT IGNITION MODULE. MEASURE VOLTAGE BETWEEN EMS ECM BLUE PLUG PIN 1 AND GROUND. CRANK ENGINE. VOLTAGE SHOULD RISE FROM NEAR 0 UPON CRANKING. IF VOLTAGE NOW RISES, REPLACE IGNITION MODULE. IF VOLTAGE STILL DOES NOT RISE, CHECK CRANKSHAFT SENSOR.

ALL MEASUREMENTS CORRECT

TEST 5



CRANK ENGINE. CHECK FOR SPARK TO ROTOR CONTACT.

SPARK JUMPS TO ROTOR. → INSTALL NEW ROTOR.

SPARK DOES NOT JUMP (ROTOR OK).

VISUALLY INSPECT THE HIGH TENSION SYSTEM:

DISTRIBUTOR CAP	SHOULD BE CLEAN, DRY AND HAVE NO CRACKS OR TRACKING MARKS.
ROTOR ARM	RESISTOR MUST BE INTACT. SHOULD HAVE NO CRACKS OR TRACKING MARKS. MUST BE CORRECTLY POSITIONED WITH REFERENCE TO THE DISTRIBUTOR BODY. CHECK POSITION USING TOOL JD 189 WITH ENGINE AT TDC ON COMPRESSION STROKE OF NUMBER 1 CYLINDER. REFER TO FIG 2 ON OPPOSITE PAGE.
IGNITION COIL	SHOULD BE CLEAN, DRY AND HAVE NO CRACKS OR TRACKING MARKS. PRIMARY LEADS MUST BE POINTED AWAY FROM HIGH TENSION TOWER.
HT LEAD INSULATION	MUST NOT BE CRACKED, CHAFED OR DETERIORATED.
HT LEAD CONTINUITY	MUST NOT BE OPEN CIRCUIT.
SPARK PLUGS	MUST BE GAPPED TO .035"

IF ALL OK, SUSPECT FUEL INJECTION OR ENGINE MECHANICAL PROBLEM.

NO DTC ENGINE STALLING CONDITION

SYMPTOM:

A momentary loss of engine power, or stalling; the engine restarts immediately. The CHECK ENGINE MIL remains off and no DTC is flagged.

Use this procedure to diagnose and repair the stalling condition. All of the steps in the procedure must be completed.

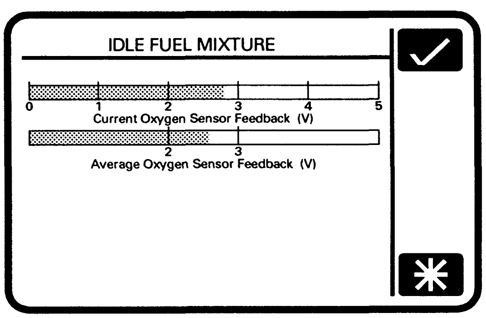
DIAGNOSTIC NOTES:

1 Stalling can occur from high tension tracking caused by dirt accumulating on the ignition coil high tension (HT) tower.

2 1993 MY vehicles – Hella relays are marked with a manufacturing date code. The first two digits indicate the week; the last digit indicates the year. Code 183 indicates the 18th week of 1993.

3 Engine fueling correction (dynamic) can be monitored by using JDS or PDU to read the oxygen sensor feedback voltage (HO2SFB). If the feedback voltage is between 1 and 4 volts, the fueling is normal. If the feedback voltage stays below 1 volt, look for causes of rich running (DTC 23); if the feedback voltage stays above 4 volts, look for causes of lean running (DTC 26).

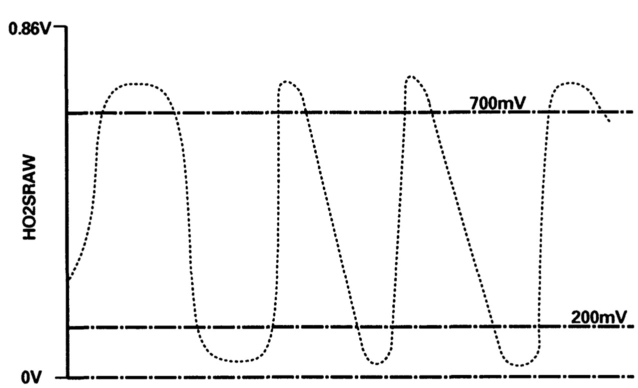
OXYGEN SENSOR FEEDBACK



DTC N3.01

During closed loop fueling, the oxygen sensor "raw" voltage (signal voltage to the ECM) normally swings between 0.2 and 0.8 volt. If the oxygen sensor becomes contaminated or the heater is inoperative, the sensor can be "lazy". A lazy sensor may show a voltage swing of 0.3 – 0.7 volt or even less. The oxygen sensor raw voltage can be monitored using PDU (HO2 S RAW).

OXYGEN SENSOR VOLTAGE TRACE: PDU H02S RAW



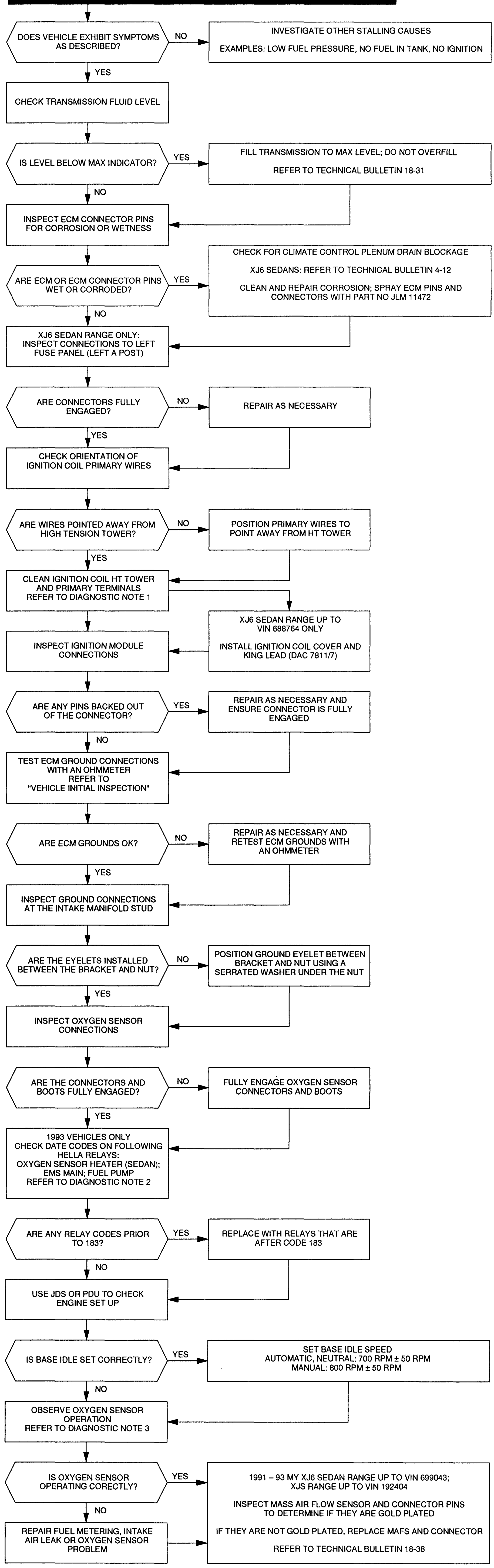
6 TO 10 SWINGS PER MINUTE AT IDLE

DTC N3.02

4 During 1994 MY, gold-plated connector pins were introduced to prevent corrosion and resistance build-up. The gold-plated pins can be identified by their color.

⚠ CAUTION! Tin-plated pins and gold-plated pins must not be matched; they are not compatible.

ENGINE STALLING CONDITION



Reference

Reference

Contents

AJ6 4.0 Litre Engine Test Specifications

Engine Management (fuel injection; ignition; fuel delivery; evaporative emission control)	Microprocessor controlled engine management system (15 CU)
Valve clearance (intake and exhaust)	0.012 – 0.014 in.
Spark plugs and gap	Champion RC9YC 0.035 in.
Ignition coil resistance (measures at 68° F)	Primary winding: 0.5 Ohm ± 10% Secondary winding: 6 kOhm ± 10%
Ignition coil power consumption	Engine stationary: 5 – 6.5 amps Engine running: 2.5 – 3 amps
Firing order (Distributor)	Firing order: 1,5,3,6,2,4; Rotation: clockwise (viewed from above)
Ignition high tension wire resistance	Coil lead (King lead): 1.8 – 4.1 kOhms Plug 1: 5.6 – 13.2 kOhms Plug 2: 6.0 – 14.0 kOhms Plug 3: 6.6 – 15.5 kOhms Plug 4: 7.7 – 18.2 kOhms Plug 5: 9.5 – 22.3 kOhms Plug 6: 9.1 – 21.4 kOhms
Fuel pressure	34 – 38 psi at idle (vacuum connected to fuel pressure regulator) 42 – 45 psi (vacuum disconnected from fuel pressure regulator)
Idle speed (normal operating temperature)	Automatic NEUTRAL 700 ± 50 rpm (automatic) Manual 800 ± 50 rpm (manual)
Compression pressure	160 – 170 psi (max 10 psi differential between cylinders) **Note:** Compression pressure should be checked under the following conditions: • all spark plugs removed • throttle full open • engine at normal operating temperature • vehicle battery fully charged

CONNECTORS

CODE	DESCRIPTION	LOCATION / INTERFACE
LB28	6-WAY PM 4 (YELLOW)	RIGHT DASH UNDER PANEL / LI HARNESS
LI4	RELAY BASE (RED)	RIGHT DASH UNDER PANEL / EMS MAIN RELAY
LI5	RELAY BASE (YELLOW)	RIGHT DASH UNDER PANEL / FUEL PUMP RELAY
LI8	2-WAY RWC SOCKET (GREY)	ENGINE COMPARTMENT / INJECTOR 6
LI9	2-WAY RWC SOCKET (GREY)	ENGINE COMPARTMENT / INJECTOR 5
LI10	2-WAY RWC SOCKET (GREY)	ENGINE COMPARTMENT / INJECTOR 4
LI11	2-WAY RWC SOCKET (GREY)	ENGINE COMPARTMENT / INJECTOR 3
LI12	2-WAY RWC SOCKET (GREY)	ENGINE COMPARTMENT / INJECTOR 2
LI13	2-WAY RWC SOCKET (GREY)	ENGINE COMPARTMENT / INJECTOR 1
LI14	SPADE (WHITE)	ENGINE COMPARTMENT, RIGHT / OXYGEN SENSOR
LI18	6-WAY PM 4 (YELLOW)	UNDER AIR CLEANER HOUSING / LS HARNESS
LI19	6-WAY BOSCH SOCKET (BLACK)	ENGINE COMPARTMENT, LEFT / MASS AIR FLOW SENSOR
LI20	2-WAY BOSCH SOCKET (BLACK)	THERMOSTAT HOUSING / COOLANT TEMP. SENSOR
LI21	PM 5 (BLACK)	ENGINE COMPARTMENT, FRONT OF ENGINE / CRANKSHAFT SENSOR
LI22	PM 5 (BLACK)	ENGINE COMPARTMENT, LEFT FRONT / AIR INJECTION PUMP
LI26	EYELET (RED)	ENGINE COMPARTMENT, RIGHT / IGNITION COIL
LI27	EYELET (BLACK)	ENGINE COMPARTMENT, RIGHT / IGNITION COIL
LI28	EYELET	IGNITION MODULE BASE PLATE / POWER GROUND
LI33	EYELET	MASS AIR FLOW SENSOR STUD / POWER GROUND
LI37	2-WAY BOSCH SOCKET (BLACK)	ENGINE COMPARTMENT / OXYGEN SENSOR HEATER
LI39	2-WAY BOSCH SOCKET (BLACK)	ENGINE, LEFT FRONT / AIR INJECTION SOLENOID VALVE
LI42	2-WAY BOSCH SOCKET (BLACK)	AIR INTAKE ELBOW / AIR TEMPERATURE SENSOR
LI45	24-WAY PM HD (GREEN)	PASSENGER FOOTWELL // GB HARNESS
LI47	2-WAY BOSCH (BLACK)	BELOW INTAKE MANIFOLD / EGR TEMPERATURE SENSOR
LI48	2-WAY BOSCH (BLACK)	LEFT REAR OF ENGINE / EGR SOLENOID VACUUM VALVE
LI55	6-WAY PM 4 (BLUE)	BELOW INTAKE MANIFOLD / THROTTLE POSITION SENSOR
LI56	4-WAY PACKARD (BLACK)	INTAKE MANIFOLD, TOP / THROTTLE POSITION SENSOR
LI58	25-WAY AMP SOCKET (BLACK)	DRIVER FOOTWELL / ENGINE MANAGEMENT ECM
LI59	25-WAY AMP SOCKET (YELLOW)	DRIVER FOOTWELL / ENGINE MANAGEMENT ECM
LI125	7-WAY BOSCH (BLACK)	RIGHT FRONT BULKHEAD / IGNITION MODULE
LS3	9-WAY PM 4 (BLACK)	LEFT 'A' POST, UNDER DASH PANEL / LB HARNESS
LS10	3-WAY PM 4 (BLACK)	LEFT CAVITY, REAR SEAT PAN / FUEL PUMP HARNESS
LS33	RELAY BASE (GREEN)	LEFT RADIATOR SUPPORT / AIR INJECTION RELAY
RS7	9-WAY PM 4 (YELLOW)	ENGINE COMPARTMENT, ABOVE IGNITION COIL / LI HARNESS

GROUNDS

CODE	DESCRIPTION	LOCATION / INTERFACE
LBG72	EYELET	DRIVER FOOTWELL, LEFT 'A' POST / POWER GROUND
LIG30	EYELET	ENGINE COMPARTMENT BULKHEAD, RIGHT / POWER GROUND
LIG31	EYELET	ENGINE COMPARTMENT BULKHEAD, RIGHT / POWER GROUND
LIG32	EYELET	INLET MANIFOLD, #2 CYLINDER FIRING STUD / POWER GROUND
LSG121	EYELET	TRUNK TRIM PANEL, LEFT REAR / POWER GROUND

INPUTS / OUTPUTS

ENGINE CONTROL MODULE

CODE	IN / OUT	CIRCUIT	ACTIVE	INACTIVE
LI58-1	OUTPUT	IGNITION DRIVE	PULSED DRIVE: 0.5V CRANKING; APPROX. 0.6V @1000 RPM; 1.5V @2000 RPM	
LI58-2	OUTPUT	AIR INJECTION RELAY	GROUND	12V
LI58-3	OUTPUT	MASS AIR FLOW SENSOR	GROUND	GROUND
LI58-4	OUTPUT	IGNITION MODULE	KEY ON: 5V	KEY OFF: 0V
LI58-5	OUTPUT	PURGE VALVE CONTROL	GROUND	12V
LI58-6	NOT USED			
LI58-7	OUTPUT	FUEL PUMP RELAY	GROUND	KEY ON, ENGINE OFF:
LI58-8	INPUT	EGR TEMP. SENSOR — IGNITION ON, ENGINE OFF	4 - 6V APPROX.	
LI58-9	OUTPUT	TRANSMISSION ECM (INJECTOR PULSE, ENGINE LOAD)	PULSED SIGNAL	0V
LI58-10	INPUT	IGNITION SWITCHED POWER	12V	0V
LI58-11	OUTPUT	LOGIC GROUND	GROUND	GROUND
LI58-12	OUTPUT	INJECTORS (SUPPLY)	PULSED SIGNAL	12V
LI58-13	OUTPUT	INJECTORS (DRIVE)	PULSED SIGNAL	12V
LI58-14	INPUT	BATTERY POWER	12V	12V
LI58-15	OUTPUT	IDLE SPEED ACTUATOR	PULSED SIGNAL	KEY ON, ENGINE OFF: 10V
LI58-16	OUTPUT	IDLE SPEED ACTUATOR	PULSED SIGNAL	KEY ON, ENGINE OFF: LESS THAN 1V
LI58-17	OUTPUT	INJECTORS (SUPPLY)	PULSED SIGNAL	12V
LI58-18	OUTPUT	IDLE SPEED ACTUATOR	PULSED SIGNAL	KEY ON, ENGINE OFF: 10V
LI58-19	OUTPUT	IDLE SPEED ACTUATOR	PULSED SIGNAL	KEY ON, ENGINE OFF: LESS THAN 1V
LI58-20	OUTPUT	EGR SOLENOID VACUUM VALVE	GROUND	KEY ON, ENGINE OFF: 12V
LI58-21	INPUT	A/C COMPRESSOR	12V	0V
LI58-22	INPUT	IGNITION SWITCHED POWER	12V	0V
LI58-23	OUTPUT	LOGIC GROUND	GROUND	GROUND
LI58-24	OUTPUT	LOGIC GROUND	GROUND	GROUND
LI58-25	OUTPUT	INJECTORS (DRIVE)	PULSED SIGNAL	12V
LI59-1	INPUT	IGNITION SWITCHED POWER	12V	0V
LI59-2	INPUT	COOLANT TEMP. SENSOR	APPROX. 2.06V @30°C	0V
LI59-3	INPUT	TRANSMISSION DECODER (IDLE FUEL)	"P", "N": GROUND; "R", "D", "3", "2": 5V	
LI59-4	INPUT	SERIAL COMMUNICATIONS DATA LINK CONNECTOR	GEOUND	GROUND
LI59-5	INPUT	TRANSMISSION ECM (IGNITION TIMING CONTROL)	PULSED SIGNAL	0V
LI59-6	INOT USED			
LI59-7	OUTPUT	TRANSMISSION ECM (IGNITION TIMING SELECT)	PULSED SIGNAL	0V
LI59-8	INPUT	SPEEDOMETER (ROAD SPEED SIGNAL)	GROUND	GROUND
LI59-9	NOT USED			
LI59-10	INPUT	MASS AIR FLOW METER IDLE TRIM ADJUSTMENT	RANGE: 0 – 5V	KEY OFF: 0V
LI59-11	OUTPUT	ENGINE SPEED SIGNAL	PULSED SIGNAL	0V
LI59-12	OUTPUT	FUELING FAULT (CHECK ENGINE)	GROUND	12V
LI59-13	INPUT	CRANKSHAFT SENSOR	PULSED SIGNAL	GROUND
LI59-14	INPUT	THROTTLE POSITION SENSOR WIPER	240MV – 4.9V	
LI59-15	OUTPUT	FUEL USED	PULSED SIGNAL	0V
LI59-16	INPUT	MASS AIR FLOW SENSOR LOAD	IDLE IN "N": APPROX. 1.4V	0V
LI59-17	INPUT	OXYGEN SENSOR	0 – 1V SWING	ENGINE OFF: 0V
LI59-18	INPUT	OXYGEN SENSOR GROUND	GROUND	GROUND
LI59-19	OUTPUT	SERIAL COMMUNICATIONS DATA LINK CONNECTOR	GROUND	GROUND
LI59-20	INPUT	AIR TEMPERATURE SENSOR	SENSED VOLTAGE: 2.3V @ 24°C	0V
LI59-21	INPUT	A/C COMPRESSOR (IDLE STEP)	12V	0V
LI59-22	OUTPUT	THROTTLE POSITION SENSOR POWER	5V	0V
LI59-23	NOT USED			
LI59-24	OUTPUT	CRANKSHAFT SENSOR GROUND	GROUND	GROUND
LI59-25	NOT USED			

CONNECTORS

CODE	DESCRIPTION	LOCATION / INTERFACE
LB27	6-WAY PMHD (YELLOW)	PASSENGER FOOTWELL / LB HARNESS
LB28	6-WAY PM 4 (YELLOW)	RIGHT DASH UNDER PANEL / LI HARNESS
LI4	RELAY BASE (RED)	RIGHT DASH UNDER PANEL / EMS MAIN RELAY
LI8	2-WAY RWC SOCKET (GREY)	ENGINE COMPARTMENT / INJECTOR 6
LI9	2-WAY RWC SOCKET (GREY)	ENGINE COMPARTMENT / INJECTOR 5
LI10	2-WAY RWC SOCKET (GREY)	ENGINE COMPARTMENT / INJECTOR 4
LI11	2-WAY RWC SOCKET (GREY)	ENGINE COMPARTMENT / INJECTOR 3
LI12	2-WAY RWC SOCKET (GREY)	ENGINE COMPARTMENT / INJECTOR 2
LI13	2-WAY RWC SOCKET (GREY)	ENGINE COMPARTMENT / INJECTOR 1
LI14	SPADE (WHITE)	ENGINE COMPARTMENT, RIGHT / OXYGEN SENSOR
LI18	6-WAY PM 4 (YELLOW)	UNDER AIR CLEANER HOUSING / LS HARNESS
LI19	6-WAY BOSCH SOCKET (BLACK)	ENGINE COMPARTMENT, LEFT / MASS AIR FLOW SENSOR
LI20	2-WAY BOSCH SOCKET (BLACK)	THERMOSTAT HOUSING / COOLANT TEMP. SENSOR
LI21	PM 5 (BLACK)	ENGINE COMPARTMENT, FRONT OF ENGINE / CRANKSHAFT SENSOR
LI22	PM 5 (BLACK)	ENGINE COMPARTMENT, LEFT FRONT / AIR INJECTION PUMP
LI26	EYELET (RED)	ENGINE COMPARTMENT, RIGHT / IGNITION COIL
LI27	EYELET (BLACK)	ENGINE COMPARTMENT, RIGHT / IGNITION COIL
LI28	EYELET	IGNITION MODULE BASE PLATE / POWER GROUND
LI33	EYELET	MASS AIR FLOW SENSOR STUD / POWER GROUND
LI37	2-WAY BOSCH SOCKET (BLACK)	ENGINE COMPARTMENT / OXYGEN SENSOR HEATER
LI39	2-WAY BOSCH SOCKET (BLACK)	ENGINE, LEFT FRONT / AIR INJECTION SOLENOID VALVE
LI42	2-WAY BOSCH SOCKET (BLACK)	AIR INTAKE ELBOW / AIR TEMPERATURE SENSOR
LI45	24-WAY PM HD (GREEN)	PASSENGER FOOTWELL // GB HARNESS
LI47	2-WAY BOSCH (BLACK)	BELOW INTAKE MANIFOLD / EGR TEMPERATURE SENSOR
LI48	2-WAY BOSCH (BLACK)	LEFT REAR OF ENGINE / EGR SOLENOID VACUUM VALVE
LI55	6-WAY PM 4 (BLUE)	BELOW INTAKE MANIFOLD / THROTTLE POSITION SENSOR
LI56	4-WAY PACKARD (BLACK)	INTAKE MANIFOLD, TOP / THROTTLE POSITION SENSOR
LI58	25-WAY AMP SOCKET (BLACK)	DRIVER FOOTWELL / ENGINE MANAGEMENT ECM
LI59	25-WAY AMP SOCKET (YELLOW)	DRIVER FOOTWELL / ENGINE MANAGEMENT ECM
LI125	7-WAY BOSCH (BLACK)	RIGHT FRONT BULKHEAD / IGNITION MODULE
LS3	9-WAY PM 4 (BLACK)	LEFT 'A' POST, UNDER DASH PANEL / LB HARNESS
LS10	3-WAY PM 4 (BLACK)	LEFT CAVITY, REAR SEAT PAN / FUEL PUMP HARNESS
LS33	RELAY BASE (GREEN)	LEFT RADIATOR SUPPORT / AIR INJECTION RELAY
LS140	RELAY BASE (YELLOW)	ENGINE COMPARTMENT, ON ENGINE BOOSTER BRACKET / FUEL PUMP RELAY
LS143	2-WAY ECONOSEAL (BLACK)	TRUNK, FRONT, BY FUEL TRANSMITTER / FUEL PUMP HARNESS
RS7	9-WAY PM 4 (YELLOW)	ENGINE COMPARTMENT, ABOVE IGNITION COIL / LI HARNESS

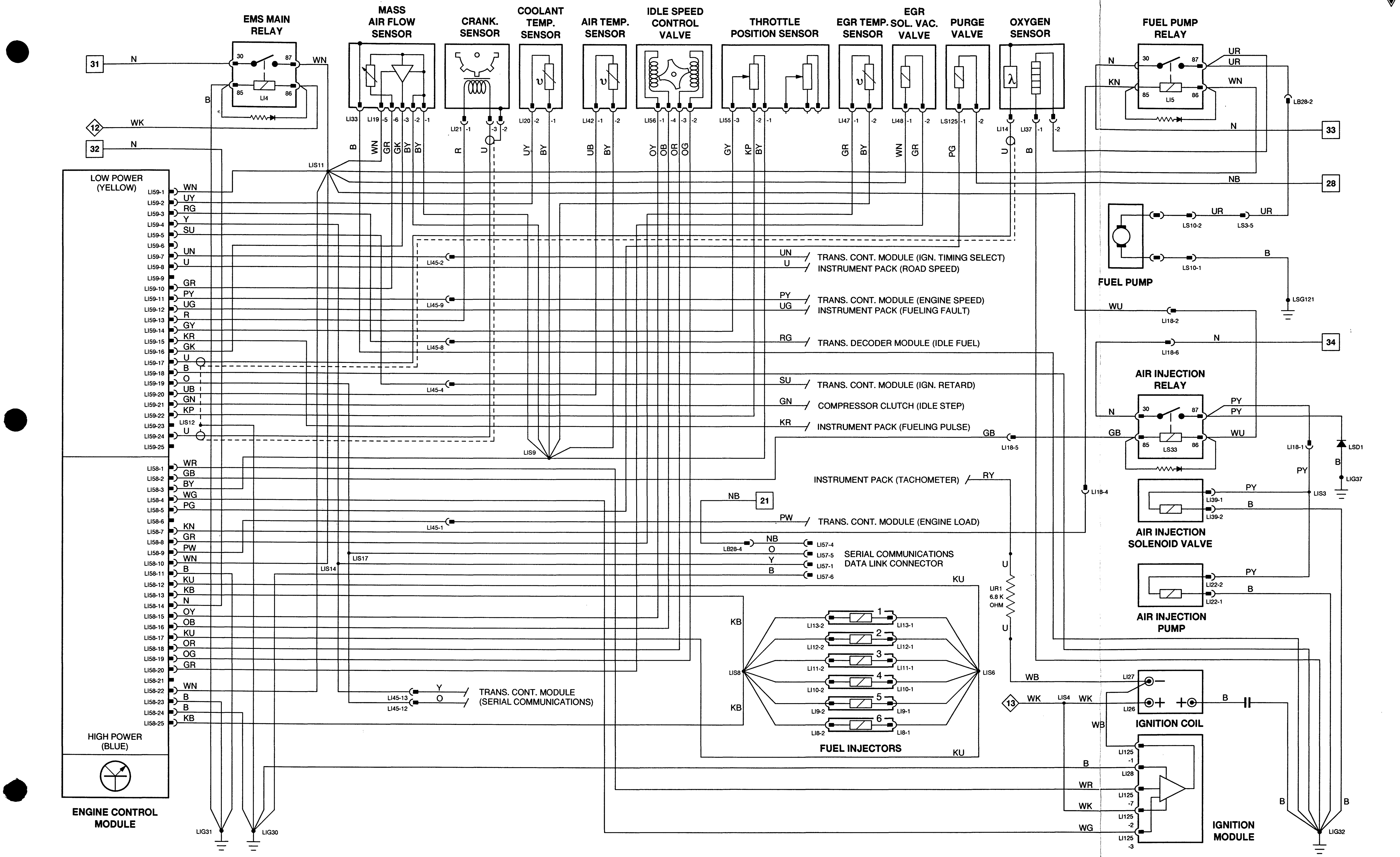
GROUNDS

CODE	DESCRIPTION	LOCATION / INTERFACE
LBG72	EYELET	DRIVER FOOTWELL, LEFT 'A' POST / POWER GROUND
LIG30	EYELET	ENGINE COMPARTMENT BULKHEAD, RIGHT / POWER GROUND
LIG31	EYELET	ENGINE COMPARTMENT BULKHEAD, RIGHT / POWER GROUND
LIG32	EYELET	INLET MANIFOLD, #2 CYLINDER FIRING STUD / POWER GROUND
LSG121	EYELET	TRUNK TRIM PANEL, LEFT REAR / POWER GROUND

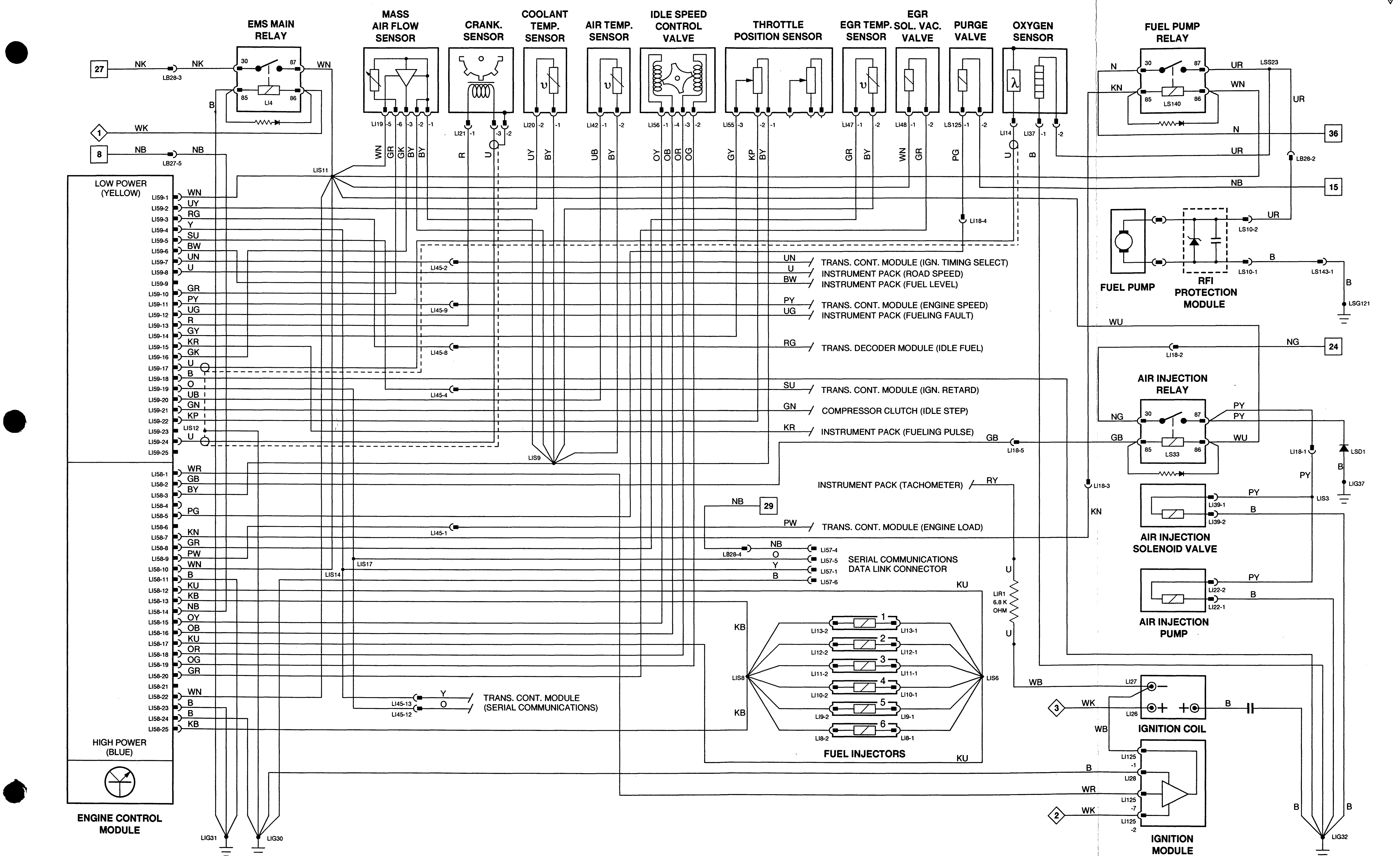
INPUTS / OUTPUTS

ENGINE CONTROL MODULE

CODE	IN / OUT	CIRCUIT	ACTIVE	INACTIVE
LI58-1	OUTPUT	IGNITION DRIVE	PULSED DRIVE: 0.5V CRANKING; APPROX. 0.6V @1000 RPM; 1.5V @2000 RPM	
LI58-2	OUTPUT	AIR INJECTION RELAY	GROUND	12V
LI58-3	OUTPUT	MASS AIR FLOW SENSOR	GROUND	GROUND
LI58-4	NOT USED			
LI58-5	OUTPUT	PURGE VALVE CONTROL	GROUND	12V
LI58-6	NOT USED			
LI58-7	OUTPUT	FUEL PUMP RELAY	GROUND	KEY ON, ENGINE OFF:
LI58-8	INPUT	EGR TEMP. SENSOR — IGNITION ON, ENGINE OFF	4 - 6V APPROX.	
LI58-9	OUTPUT	TRANSMISSION ECM (INJECTOR PULSE, ENGINE LOAD)	PULSED SIGNAL	0V
LI58-10	INPUT	IGNITION SWITCHED POWER	12V	0V
LI58-11	OUTPUT	LOGIC GROUND	GROUND	GROUND
LI58-12	OUTPUT	INJECTORS (SUPPLY)	PULSED SIGNAL	12V
LI58-13	OUTPUT	INJECTORS (DRIVE)	PULSED SIGNAL	12V
LI58-14	INPUT	BATTERY POWER	12V	12V
LI58-15	OUTPUT	IDLE SPEED ACTUATOR	PULSED SIGNAL	KEY ON, ENGINE OFF: 10V
LI58-16	OUTPUT	IDLE SPEED ACTUATOR	PULSED SIGNAL	KEY ON, ENGINE OFF: LESS THAN 1V
LI58-17	OUTPUT	INJECTORS (SUPPLY)	PULSED SIGNAL	12V
LI58-18	OUTPUT	IDLE SPEED ACTUATOR	PULSED SIGNAL	KEY ON, ENGINE OFF: 10V
LI58-19	OUTPUT	IDLE SPEED ACTUATOR	PULSED SIGNAL	KEY ON, ENGINE OFF: LESS THAN 1V
LI58-20	OUTPUT	EGR SOLENOID VACUUM VALVE	GROUND	KEY ON, ENGINE OFF: 12V
LI58-21	NOT USED			
LI58-22	INPUT	IGNITION SWITCHED POWER	12V	0V
LI58-23	OUTPUT	LOGIC GROUND	GROUND	GROUND
LI58-24	OUTPUT	LOGIC GROUND	GROUND	GROUND
LI58-25	OUTPUT	INJECTORS (DRIVE)	PULSED SIGNAL	12V
LI59-1	INPUT	IGNITION SWITCHED POWER	12V	0V
LI59-2	INPUT	COOLANT TEMP. SENSOR	APPROX. 2.06V @30°C	0V
LI59-3	INPUT	TRANSMISSION DECODER (IDLE FUEL)	"P", "N": GROUND; "R", "D", "3", "2": 5V	
LI59-4	INPUT	SERIAL COMMUNICATIONS DATA LINK CONNECTOR	GEOUND	GROUND
LI59-5	INPUT	TRANSMISSION ECM (IGNITION TIMING CONTROL)	PULSED SIGNAL	0V
LI59-6	INPUT	FUEL LEVEL TRANSMITTER	PULSED SIGNAL	0V
LI59-7	OUTPUT	TRANSMISSION ECM (IGNITION TIMING SELECT)	PULSED SIGNAL	0V
LI59-8	INPUT	SPEEDOMETER (ROAD SPEED SIGNAL)	GROUND	GROUND
LI59-9	NOT USED			
LI59-10	INPUT	MASS AIR FLOW METER IDLE TRIM ADJUSTMENT	RANGE: 0 – 5V	KEY OFF: 0V
LI59-11	OUTPUT	ENGINE SPEED SIGNAL	PULSED SIGNAL	0V
LI59-12	OUTPUT	FUELING FAULT (CHECK ENGINE)	GROUND	12V
LI59-13	INPUT	CRANKSHAFT SENSOR	PULSED SIGNAL	GROUND
LI59-14	INPUT	THROTTLE POSITION SENSOR WIPER	240MV – 4.9V	
LI59-15	OUTPUT	FUEL USED	PULSED SIGNAL	0V
LI59-16	INPUT	MASS AIR FLOW SENSOR LOAD	IDLE IN "N": APPROX. 1.4V	0V
LI59-17	INPUT	OXYGEN SENSOR	0 – 1V SWING	ENGINE OFF: 0V
LI59-18	INPUT	OXYGEN SENSOR GROUND	GROUND	GROUND
LI59-19	OUTPUT	SERIAL COMMUNICATIONS DATA LINK CONNECTOR	GROUND	GROUND
LI59-20	INPUT	AIR TEMPERATURE SENSOR	SENSED VOLTAGE: 2.3V @ 24°C	0V
LI59-21	INPUT	A/C COMPRESSOR (IDLE STEP)	12V	0V
LI59-22	OUTPUT	THROTTLE POSITION SENSOR POWER	5V	0V
LI59-23	NOT USED			
LI59-24	OUTPUT	CRANKSHAFT SENSOR GROUND	GROUND	GROUND
LI59-25	NOT USED			



BATTERY POWER SUPPLY IGNITION SWITCHED POWER SUPPLY CONSULT APPROPRIATE ELECTRICAL GUIDE



BATTERY POWER SUPPLY IGNITION SWITCHED POWER SUPPLY CONSULT APPROPRIATE ELECTRICAL GUIDE

CONNECTORS

CODE	DESCRIPTION	LOCATION / INTERFACE
FE1	WHITE EYELET	RF INNER FENDER AT IGNITION COIL / COIL POSITIVE
FE2	WHITE EYELET	RF INNER FENDER AT IGNITION COIL / COIL NEGATIVE
FE3	WHITE EYELET	RF INNER FENDER, FRONT OF IGNITION AMPLIFIER / AMPLIFIER GROUND
FE4	7-WAY LUCAR (BLACK)	RF INNER FENDER AT IGNITION AMPLIFIER / AMPLIFIER
FE5	WHITE EYELET	RF INNER FENDER AT IGNITION COIL STRAP / COIL GROUND
FE9	PM 5 (BLACK)	ABOVE TOP RADIATOR HOSE / CRANKSHAFT SENSOR
FE12	2-WAY LUCAR (BROWN)	MOUNTED ON THERMOSTAT HOUSING NEAR TOP HOSE / COOLANT THERMISTOR
FE14	2-WAY NIPPON DENSO (BLUE)	ABOVE AIR INJECTION PUMP / AIR INJECTION SOLENOID VALVE
FE15	PM 5 (BLACK)	ABOVE AIR INJECTION PUMP / AIR INJECTION PUMP
FE17	2-WAY ECONOSEAL III LC (BLACK)	BELOW AIR INTAKE / EGR TEMPERATURE SENSOR
FE18	2-WAY LUCAR (BLACK)	ON AIR INTAKE, BEHIND MASS AIR FLOW METER / AIR TEMPERATURE SENSOR
FE19	6-WAY SUMITOMO ATTACH. (BLACK)	BELOW CRUISE CONTROL BELLOWS / THROTTLE POSITION SENSOR
FE20	6-WAY LUCAR (BLACK)	ON MASS AIR FLOW METER (MAF) / MAF
FE21	2-WAY LUCAR (SLATE)	ABOVE INLET PORT #1 / INJECTOR #1
FE22	2-WAY LUCAR (SLATE)	ABOVE INLET PORT #2 / INJECTOR #2
FE23	2-WAY LUCAR (SLATE)	ABOVE INLET PORT #3 / INJECTOR #3
FE24	4-WAY PACKARD (BLACK)	BETWEEN CYLINDERS 2 AND 3 / IDLE SPEED ACTUATOR
FE25	2-WAY LUCAR (SLATE)	ABOVE INLET PORT #4 / INJECTOR #4
FE26	2-WAY LUCAR (BLACK)	BELOW HEATED BREATHER / INTAKE HEATED BREATHER
FE27	2-WAY LUCAR (SLATE)	ABOVE INLET PORT #5 / INJECTOR #5
FE30	2-WAY NIPPON DENSO (BLUE)	REAR OF #6 INLET PORT, BELOW WIPER MOTOR / EGR SOLENOID
FE31	2-WAY LUCAR (BLACK)	ADJACENT TO DIPSTICK / OXYGEN SENSOR
FE32	.250 BLADE (WHITE)	ADJACENT TO DIPSTICK / OXYGEN SENSOR
FE34	RELAY BASE (RED)	RIGHT BULKHEAD RELAY PANEL / AIR INJECTION RELAY
FE38	RELAY BASE (BLACK)	RIGHT BULKHEAD RELAY PANEL / EMS MAIN RELAY
FE40	25-WAY ECM (BLUE)	RIGHT DASH UNDER PANEL / ECM HIGH POWER BOARD
FE41	25-WAY ECM (YELLOW)	RIGHT DASH UNDER PANEL / ECM LOW POWER BOARD
FE44	RELAY BASE (YELLOW)	RIGHT BULKHEAD RELAY PANEL / OXYGEN SENSOR HEATER RELAY
FE46	2-WAY LUCAR (BLACK)	LF INNER FENDER NEAR WHEEL ARCH / PURGE CONTROL VALVE
FP1	2-WAY ECONOSEAL III HC (BLACK)	RFI MODULE, TOP OF FUEL TANK / FUEL PUMP HARNESS
LB11	20-WAY MULTILOCK 40 (BLUE)	REAR FACE OF LEFT BLOWER, UNDER FASCIA / BULKHEAD TO LF HARNESS
LB65	2-WAY MULTILOCK 40 (BLACK)	BEHIND INSPECTION PANEL IN GLOVE BOX / BULKHEAD HARNESS
LB66	20-WAY AMP PCB POWER (BLACK)	MOUNTING BRACKET UNDER GLOVE BOX / BULKHEAD HARNESS
LB85	20-WAY MULTILOCK 70 (WHITE)	RIGHT DASH UNDER PANEL BY 'A' POST / BULKHEAD HARNESS
LB86	4-WAY ECONOSEAL III HC (BLACK)	RIGHT DASH UNDER PANEL / BULKHEAD HARNESS
LB88	20-WAY MULTILOCK 40 (BLACK)	REAR FACE OF RIGHT BLOWER, UNDER FASCIA / BULKHEAD TO RF HARNESS
LS6	13-WAY ECONOSEAL III LC (BLACK)	RIGHT BULKHEAD ADJACENT TO ABS PUMP / RIGHT SIDE HARNESS
RS15	2-WAY ECONOSEAL III HC (BLACK)	RIGHT OF FUEL TANK, ABOVE BATTERY / FUEL PUMP RFI MODULE
RS18	RELAY BASE (BLACK)	ABOVE RR BULB FAIL MODULE / FUEL PUMP RELAY

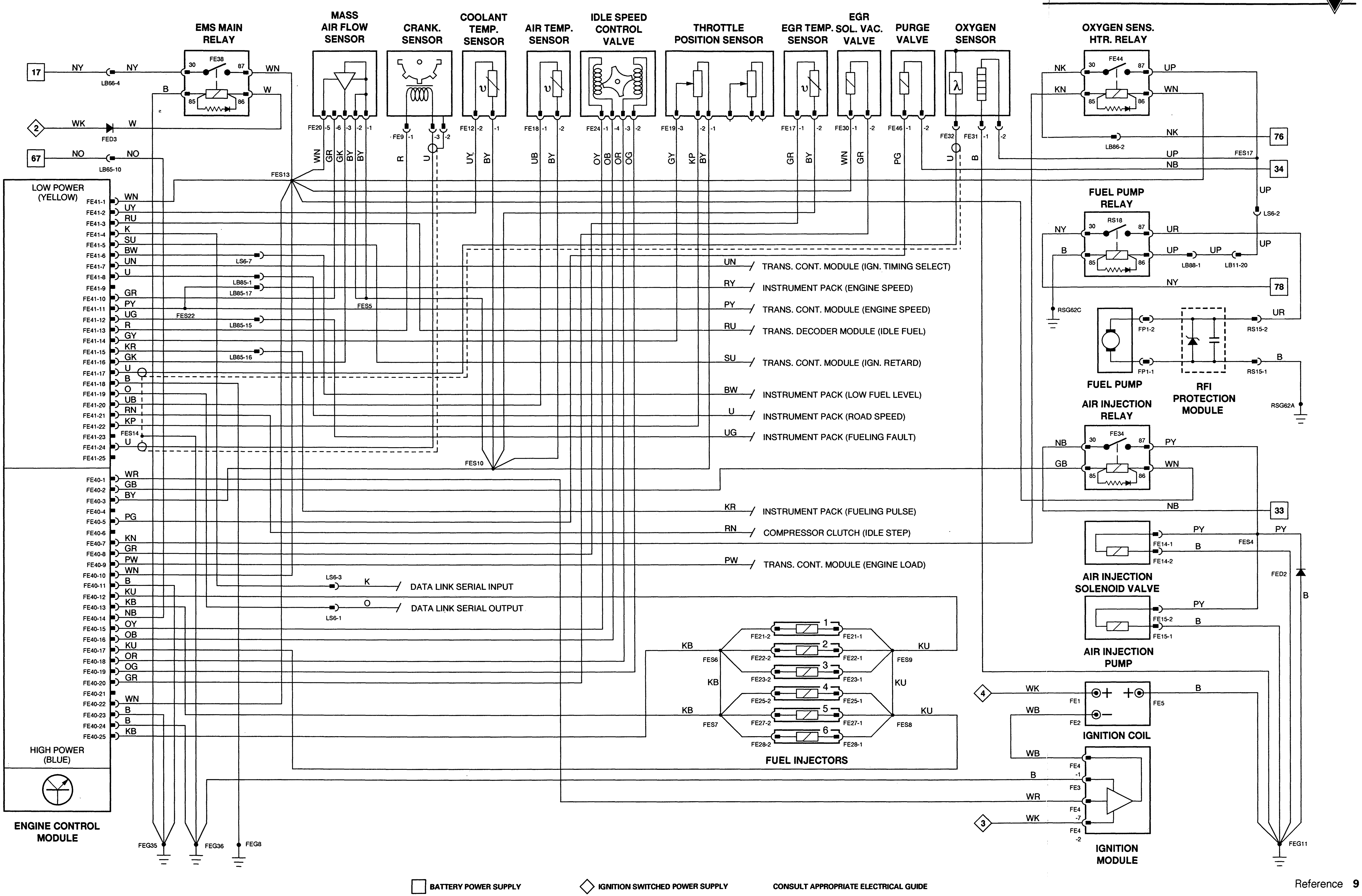
GROUNDS

CODE	DESCRIPTION	LOCATION / INTERFACE
FEG8	WHITE EYELET	ENGINE COMPARTMENT AT #3 INTAKE RUNNER / GROUND
FEG11	WHITE EYELET	ENGINE COMPARTMENT AT #1 INTAKE RUNNER / GROUND
FEG35	WHITE EYELET	ENGINE COMPARTMENT BULKHEAD BEHIND CYLINDER HEAD / GROUND
FEG36	WHITE EYELET	ENGINE COMPARTMENT BULKHEAD BEHIND CYLINDER HEAD / GROUND
RSG62A	WHITE EYELET	TRUNK, RIGHT, BELOW BULB FAIL MODULE / GROUND

INPUTS / OUTPUTS

ENGINE CONTROL MODULE

CODE	IN / OUT	CIRCUIT	ACTIVE	INACTIVE
FE40-1	OUTPUT	IGNITION AMPLIFIER DRIVE (SPEED SIGNAL)	PULSED DRIVE: 0.5V CRANKING; APPROX 0.6V AT 800 RPM; 1.3V AT 2000 RPM	
FE40-2	OUTPUT	AIR INJECTION PUMP RELAY	GROUND	12V
FE40-3	OUTPUT	AIR MASS METER / SENSOR GROUNDS	GROUND	GROUND
FE40-4	NOT USED			
FE40-5	OUTPUT	PURGE VALVE CONTROL — CHARCOAL CANISTER	GROUND	12V
FE40-6	NOT USED			
FE40-7	OUTPUT	OXYGEN SENSOR HEATER RELAY	GROUND	12V
FE40-8	INPUT	EGR TEMPERATURE SENSOR	2000 RPM, EGR VALVE CLOSED: 4.9V	2000 RPM, VALVE OPEN: VOLTAGE DROPS
FE40-9	OUTPUT	ENGINE LOAD PULSE TO TRANSMISSION CONTROL MODULE	PULSED SIGNAL	0V
FE40-10	INPUT	IGNITION / EMS MAIN RELAY	KEY ON: 12V	KEY OFF: OPEN CIRCUIT
FE40-11	INPUT	POWER GROUND	GROUND	GROUND
FE40-12	OUTPUT	INJECTOR SUPPLY	BATTERY VOLTAGE	KEY OFF: OPEN CIRCUIT
FE40-13	OUTPUT	INJECTOR DRIVE	PULSED SIGNAL (2.6 MS IDLE)	KEY OFF: OPEN CIRCUIT
FE40-14	INPUT	BATTERY POWER	12V	12V
FE40-15	OUTPUT	IDLE SPEED ACTUATOR	STEPPER MOVING: 12V	NOT MOVING: GROUND
FE40-16	OUTPUT	IDLE SPEED ACTUATOR	STEPPER MOVING: 12V	NOT MOVING: GROUND
FE40-17	OUTPUT	INJECTOR SUPPLY	BATTERY VOLTAGE	KEY OFF: OPEN CIRCUIT
FE40-18	OUTPUT	IDLE SPEED ACTUATOR	STEPPER MOVING: 12V	NOT MOVING: GROUND
FE40-19	OUTPUT	IDLE SPEED ACTUATOR	STEPPER MOVING: 12V	NOT MOVING: GROUND
FE40-20	OUTPUT	EGR SOLENOID VACUUM VALVE	GROUND	12V
FE40-21	NOT USED			
FE40-22	INPUT	IGNITION / EMS MAIN RELAY	KEY ON: 12V	KEY OFF: OPEN CIRCUIT
FE40-23	INPUT	POWER GROUND	GROUND	GROUND
FE40-24	INPUT	POWER GROUND	GROUND	GROUND
FE40-25	OUTPUT	INJECTOR DRIVE	PULSED SIGNAL (2.6 MS IDLE)	KEY OFF: OPEN CIRCUIT
FE41-1	INPUT	IGNITION SWITCHED POWER	KEY ON: 12V	KEY OFF: OPEN CIRCUIT
FE41-2	INPUT	COOLANT TEMPERATURE SENSOR	APPROX 2.1V AT 89°F (30°C)	APPROX 0.5V AT 200°F (95°C)
FE41-3	INPUT	TRANSMISSION DECODER MODULE GEAR INPUT	P, N: GROUND; R, D, 3, 2: 5V	
FE41-4	INPUT	SERIAL COMMUNICATIONS DATA LINK	JDS	—
FE41-5	INPUT	TRANSMISSION CONTROL (IGNITION RETARD)	PULSED SIGNAL	0V
FE41-6	INPUT	INSTRUMENT PACK (LOW FUEL LEVEL)	LOW FUEL: 12V	GROUND
FE41-7	INPUT	TRANSMISSION SELECT SWITCH (IGNITION SELECT)	PULSED SIGNAL	0V
FE41-8	INPUT	INSTRUMENT PACK — ROAD SPEED	PULSED SIGNAL	0V
FE41-9	NOT USED			
FE41-10	INPUT	MASS AIR FLOW METER	KEY ON: 5V	KEY OFF: OPEN CIRCUIT
FE41-11	OUTPUT	ENGINE SPEED SIGNAL	PULSED SIGNAL: 0.63V DC AT 800 RPM; 0.57V DC AT 2000 RPM	
FE41-12	OUTPUT	INSTRUMENT PACK FUELING FAULT	FAULT: GROUND	NO FAULT: 12V
FE41-13	INPUT	CRANKSHAFT SENSOR	PULSED SIGNAL: 1.3V AC CRANKING; 5.5V AC AT 1000 RPM; 13.6V AC AT 2000 RPM	
FE41-14	INPUT	THROTTLE POSITION SENSOR WIPER	MINIMUM: 0.58 – 0.62V IDLE	MAXIMUM: 4.9V W.O.T.
FE41-15	OUTPUT	INSTRUMENT PACK — TRIP COMPUTER FUEL PULSE	PULSED SIGNAL	OPEN CIRCUIT
FE41-16	INPUT	MASS AIR FLOW METER LOAD	IDLE IN 'N': APPROX 1.4V	0V
FE41-17	INPUT	OXYGEN SENSOR	0.0 – 1.0V SWING: CLOSED LOOP	GROUND
FE41-18	INPUT	POWER GROUND	GROUND	GROUND
FE41-19	OUTPUT	SERIAL COMMUNICATIONS DATA LINK	JDS	—
FE41-20	INPUT	AIR TEMPERATURE SENSOR	SENSED VOLTAGE: 2.3V AT 75°F (24°C)	0V
FE41-21	INPUT	COMPRESSOR CLUTCH LOAD	12V	OPEN CIRCUIT
FE41-22	OUTPUT	THROTTLE POSITION SENSOR REFERENCE VOLTAGE	5V	OPEN CIRCUIT
FE41-23	OUTPUT	SHIELD — CRANKSHAFT / OXYGEN SENSOR	GROUND	GROUND
FE41-24	INPUT	CRANKSHAFT SENSOR GROUND	GROUND	GROUND
FE41-25	NOT USED			


EMS MAIN RELAY
MASS AIR FLOW SENSOR
CRANK. SENSOR
COOLANT TEMP. SENSOR
AIR TEMP. SENSOR
IDLE SPEED CONTROL VALVE
THROTTLE POSITION SENSOR
EGR TEMP. SENSOR
EGR SOL. VAC. VALVE
PURGE VALVE
OXYGEN SENSOR
OXYGEN SENS. HTR. RELAY
FUEL PUMP RELAY
FUEL PUMP
RFI PROTECTION MODULE
AIR INJECTION RELAY
AIR INJECTION SOLENOID VALVE
AIR INJECTION PUMP
IGNITION COIL
IGNITION MODULE
FUEL INJECTORS
ENGINE CONTROL MODULE
LOW POWER (YELLOW)
HIGH POWER (BLUE)
TRANS. CONT. MODULE (IGN. TIMING SELECT)
INSTRUMENT PACK (ENGINE SPEED)
TRANS. CONT. MODULE (ENGINE SPEED)
TRANS. DECODER MODULE (IDLE FUEL)
TRANS. CONT. MODULE (IGN. RETARD)
INSTRUMENT PACK (LOW FUEL LEVEL)
INSTRUMENT PACK (ROAD SPEED)
INSTRUMENT PACK (FUELING FAULT)
INSTRUMENT PACK (FUELING PULSE)
COMPRESSOR CLUTCH (IDLE STEP)
TRANS. CONT. MODULE (ENGINE LOAD)
DATA LINK SERIAL INPUT
DATA LINK SERIAL OUTPUT
BATTERY POWER SUPPLY
IGNITION SWITCHED POWER SUPPLY
CONSULT APPROPRIATE ELECTRICAL GUIDE

CONNECTORS

CODE	DESCRIPTION	LOCATION / INTERFACE
FP1	2-WAY ECONOSEAL III HC (BLACK)	ABOVE FUEL TANK / FUEL PUMP
LI82	2-WAY NIPPON DENSO (BLUE)	BETWEEN INJECTOR #5 & 6 / EGR SOLENOID VACUUM VALVE
LI84	2-WAY ECONOSEAL III LC (BLACK)	ABOVE ENGINE OIL FILTER / EGR TEMPERATURE SENSOR
LI92	25-WAY ECM CONNECTOR (BLUE)	PASSENGER'S FOOTWELL TRIM / ENGINE CONTROL MODULE, LOW POWER
LI93	25-WAY ECM CONNECTOR (YELLOW)	PASSENGER'S FOOTWELL TRIM / ENGINE CONTROL MODULE, HIGH POWER
LI95	RELAY BASE (RED)	RIGHT 'A' POST TRIM / ECM MAIN RELAY
LI98	2-WAY LUCAR (BROWN)	AIR INTAKE ELBOW / ENGINE BREATHER HEATER
LI100	4-WAY PACKARD (BLACK)	BETWEEN INJECTOR #2 & 3 / IDLE SPEED ACTUATOR
LI101	2-WAY LUCAR (BROWN)	ON THERMOSTAT HOUSING / COOLANT TEMPERATURE SENSOR
LI102	3-WAY PM 5 (BLACK)	ABOVE AIR PUMP / AIR INJECTION PUMP
LI103	6-WAY SUMITOMO SEALED (BLACK)	ADJACENT TO THROTTLE BODY / THROTTLE POSITION SENSOR
LI104	6-WAY LUCAR (BLACK)	ADJACENT TO MASS AIR FLOW METER / MASS AIR FLOW METER
LI106	2-WAY LUCAR (BLUE)	ABOVE AIR INJECTION PUMP / AIR INJECTION SOLENOID VACUUM VALVE
LI109	3-WAY PM 5 (BLACK)	FRONT OF ENGINE / CRANKSHAFT SENSOR
LI110	EYELET (WHITE)	BEHIND RIGHT HEADLIGHT ON INNER FENDER / IGNITION COIL "+"
LI111	EYELET (WHITE)	BEHIND RIGHT HEADLIGHT ON INNER FENDER / IGNITION COIL "–"
LI112	EYELET (WHITE)	BEHIND RIGHT HEADLIGHT ON INNER FENDER / IGNITION AMPLIFIER GROUND
LI113	7-WAY LUCAR (BLACK)	BEHIND RIGHT HEADLIGHT ON INNER FENDER / IGNITION AMPLIFIER
LI116	2-WAY LUCAR (SLATE)	INTAKE MANIFOLD / INJECTOR #1
LI117	2-WAY LUCAR (SLATE)	INTAKE MANIFOLD / INJECTOR #2
LI118	2-WAY LUCAR (SLATE)	INTAKE MANIFOLD / INJECTOR #3
LI119	2-WAY LUCAR (SLATE)	INTAKE MANIFOLD / INJECTOR #4
LI120	2-WAY LUCAR (SLATE)	INTAKE MANIFOLD / INJECTOR #5
LI121	2-WAY LUCAR (SLATE)	INTAKE MANIFOLD / INJECTOR #6
LI122	2-WAY LUCAR (BLACK)	RIGHT PLENUM DRAIN PIPE / OXYGEN SENSOR HEATER
LI123	.250 BLADE (WHITE)	RIGHT PLENUM DRAIN PIPE / OXYGEN SENSOR FEEDBACK
LI130	RELAY BASE (GREEN)	LEFT FRONT COMPONENT PANEL / AIR INJECTION RELAY
LI131	RELAY BASE (BLACK)	LEFT FRONT COMPONENT PANEL / BREATHER HEATER RELAY
LI132	6-WAY PM 4 (BROWN)	BELOW RIGHT A/C OUTLET / DIAGNOSTIC DATA LINK CONNECTOR (JDS)
LI133	IN-LINE FUSE CONNECTOR (BLACK)	BELOW RIGHT A/C OUTLET / DIAGNOSTIC DATA FUSE (JDS)
LI134	20-WAY MULTILOCK 70 (WHITE)	RIGHT DASH UNDER PANEL / FUEL INJECTION HARNESS
LI135	4-WAY ECONOSEAL III LC (BLACK)	RIGHT DASH UNDER PANEL / FUEL INJECTION HARNESS
LI142	2-WAY LUCAR (BLACK)	ADJACENT TO AIR INJ. PUMP / CHARCOAL CANISTER PURGE VALVE
RH104	2-WAY ECONOSEAL III HC (BLACK)	ABOVE FUEL TANK, RIGHT / FUEL PUMP HARNESS
RH160	14-WAY SUMITOMO BLOCK (WHITE)	BY LEFT LOWER A/C OUTLET / RIGHT SIDE INJECTION HARNESS
RH173	RELAY BASE (YELLOW)	ABOVE RIGHT REAR WHEEL ARCH / FUEL PUMP RELAY

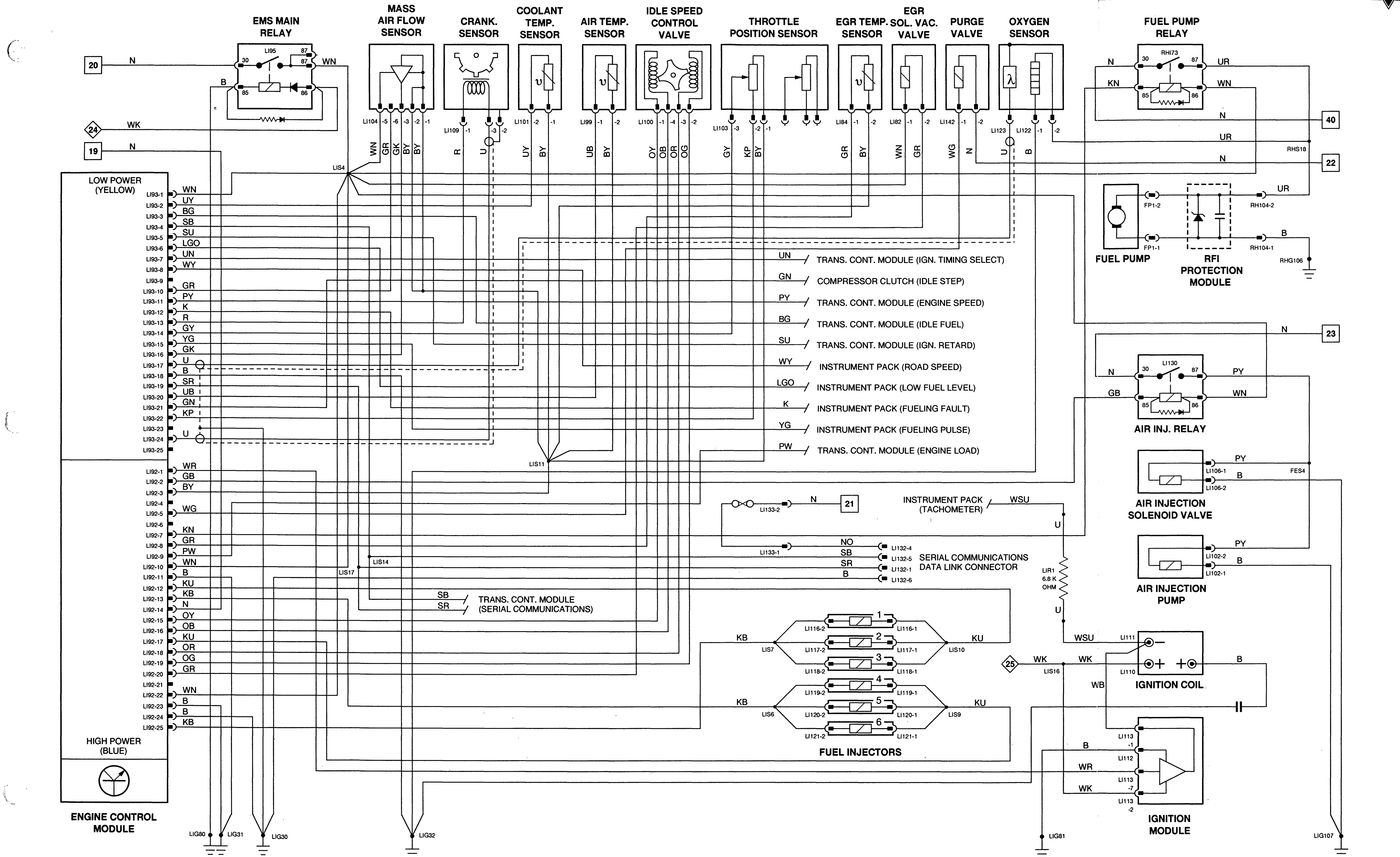
GROUNDS

CODE	DESCRIPTION	LOCATION / INTERFACE
LIG30	EYELET	ENGINE COMPARTMENT, BEHIND ABS PUMP ON BULKHEAD / POWER GROUND
LIG31	EYELET	ENGINE COMPARTMENT, BEHIND ABS PUMP ON BULKHEAD / POWER GROUND
LIG32	EYELET	ENGINE COMPARTMENT, BEHIND ABS PUMP ON BULKHEAD / POWER GROUND
LIG80	EYELET	ENGINE COMPARTMENT, BEHIND ABS PUMP ON BULKHEAD / POWER GROUND
LIG81	EYELET	ENGINE COMPARTMENT, BEHIND ABS PUMP ON BULKHEAD / POWER GROUND
LIG107	EYELET	ABOVE #1 INTAKE RUNNER ON ENGINE / POWER GROUND
RHG106	EYELET	RIGHT OF BATTERY AT WHEEL ARCH / BATTERY NEGATIVE CABLE

INPUTS / OUTPUTS

ENGINE CONTROL MODULE

CODE	IN / OUT	CIRCUIT	ACTIVE	INACTIVE
LI92-1	OUTPUT	IGNITION AMPLIFIER DRIVE	PULSED DRIVE: 0.5V CRANKING; APPROX. 0.6V @1000 RPM; 1.5V @2000 RPM	
LI92-2	OUTPUT	AIR INJECTION PUMP RELAY	GROUND	12V
LI92-3	OUTPUT	AIR MASS AND SENSOR GROUNDS	GROUND	GROUND
LI92-4	NOT USED			
LI92-5	OUTPUT	CANISTER PURGE	GROUND	12V
LI92-6	NOT USED			
LI92-7	OUTPUT	FUEL PUMP RELAY	GROUND	12V
LI92-8	INPUT	EGR TEMPERATURE SENSOR	2000 RPM, EGR VALVE CLOSED: 4.9V	2000 RPM, VALVE OPEN: VOLTAGE DROPS
LI92-9	OUTPUT	ENGINE LOAD TO TRANSMISSION CONTROL MODULE	PULSED SIGNAL: 13V AT IDLE, DECREASES WITH ENGINE LOAD	
LI92-10	INPUT	IGNITION SWITCHED POWER	KEY ON: 12V	KEY OFF: OPEN CIRCUIT
LI92-11	INPUT	POWER GROUND	GROUND	GROUND
LI92-12	OUTPUT	INJECTOR SUPPLY	ENGINE RUNNING: 12V	KEY OFF: OPEN CIRCUIT
LI92-13	OUTPUT	INJECTOR DRIVE	PULSED SIGNAL: 2.6 MS @ IDLE	KEY OFF: OPEN CIRCUIT
LI92-14	INPUT	BATTERY POWER	12V	12V
LI92-15	OUTPUT	IDLE SPEED ACTUATOR	STEPPER MOVING: 12V – 0.8V	NOT MOVING: OPEN CIRCUIT
LI92-16	OUTPUT	IDLE SPEED ACTUATOR	STEPPER MOVING: 12V – 0.8V	NOT MOVING: OPEN CIRCUIT
LI92 -17	OUTPUT	INJECTOR SUPPLY	ENGINE RUNNING: 12V	KEY OFF: OPEN CIRCUIT
LI92-18	OUTPUT	IDLE SPEED ACTUATOR	STEPPER MOVING: 12V – 0.8V	NOT MOVING: OPEN CIRCUIT
LI92-19	OUTPUT	IDLE SPEED ACTUATOR	STEPPER MOVING: 12V – 0.8V	NOT MOVING: OPEN CIRCUIT
LI92-20	OUTPUT	EGR SOLENOID VACUUM VALVE	GROUND	12V
LI92-21	NOT USED			
LI92-22	INPUT	ECM MAIN RELAY	KEY ON: 12V	KEY OFF: OPEN CIRCUIT
LI92-23	INPUT	POWER GROUND	GROUND	GROUND
LI92-24	INPUT	POWER GROUND	GROUND	GROUND
LI92-25	OUTPUT	INJECTOR DRIVE	2.6 MS @ IDLE	KEY OFF: OPEN CIRCUIT
LI93-1	INPUT	ECM MAIN RELAY	KEY ON: 12V	KEY OFF: OPEN CIRCUIT
LI93-2	INPUT	COOLANT TEMPERATURE SENSOR	APPROX. 2.2V AT 70°F (21.1°C)	APPROX. 0.5V AT 200°F (94°C)
LI93-3	INPUT	IDLE FUEL DEMAND	"P", "N": GROUND; "R", "D", "3", "2": 5V	
LI93-4	INPUT	SERIAL COMMUNICATIONS DATA LINK	JDS	—
LI93-5	INPUT	TRANSMISSION CONTROL (IGNITION RETARD)	PULSED SIGNAL	0V
LI93-6	INPUT	INSTRUMENT PACK — LOW FUEL LEVEL	LOW FUEL: 12V	GROUND
LI93-7	INPUT	IGNITION TIMING SELECT	PULSED SIGNAL	GROUND
LI93-8	INPUT	INSTRUMENT PACK — ROAD SPEED	PULSED SIGNAL	GROUND
LI93-9	NOT USED			
LI93-10	INPUT	MASS AIR FLOW METER	KEY ON: 5V	KEY OFF: OPEN CIRCUIT AFTER 15 SEC.
LI93-11	OUTPUT	ENGINE SPEED SIGNAL	PULSED SIGNAL: 0.67V DC @800 RPM; 0.59V DC @2000 RPM	DECREASES WITH RPM
LI93-12	OUTPUT	INSTRUMENT PACK — FUELING FAULT	FAULT: GROUND	NO FAULT: 12V
LI93-13	INPUT	CRANKSHAFT SENSOR	PULSED SIGNAL: 1.0V AC CRANKING; 2.7V AC @1000 RPM; 5.3V AC @2000 RPM	
LI93-14	INPUT	THROTTLE POSITION SENSOR WIPER	MIN: 0.58V – 0.62V IDLE POS.	MAX: 4.9V WOT
LI93-15	OUTPUT	TRIP COMPUTER FUEL PULSES	PULSED SIGNAL	OPEN CIRCUIT
LI93-16	INPUT	MASS AIR FLOW METER LOAD	IDLE IN 'N': APPROX. 1.4V	0V
LI93-17	INPUT	CRANKSHAFT SENSOR	SENSOR GROUND	GROUND
LI93-18	INPUT	POWER GROUND	GROUND	GROUND
LI93-19	OUTPUT	SERIAL COMMUNICATIONS DATA LINK	JDS	—
LI93-20	INPUT	AIR TEMPERATURE SENSOR	SENSED VOLTAGE: 2.0V @ 70°F (21°C)	0V
LI93-21	INPUT	A/C COMPRESSOR CLUTCH LOAD	CLUTCH ON: 12V	CLUTCH OFF: OPEN CIRCUIT
LI93-22	OUTPUT	THROTTLE POSITION SENSOR REFERENCE VOLTAGE	KEY ON: 5.0V	KEY OFF: OPEN CIRCUIT
LI93-23	NOT USED			
LI93-24	INPUT	CRANKSHAFT SENSOR SHIELD	GROUND	GROUND
LI93-25	NOT USED			



BATTERY POWER SUPPLY　IGNITION SWITCHED POWER SUPPLY　CONSULT APPROPRIATE ELECTRICAL GUIDE

CONNECTORS

CODE	DESCRIPTION	LOCATION / INTERFACE
BF3	10-WAY MULTILOCK 70 (WHITE)	ADJACENT TO RIGHT TAIL LIGHT CLUSTER / RIGHT REAR HARNESS
FP1	4-WAY SUMITOMO 'DL090' (WHITE)	ABOVE FUEL TANK / FUEL PUMP
LI82	2-WAY NIPPON DENSO (BLUE)	BETWEEN INJECTOR #5 & 6 / EGR SOLENOID VACUUM VALVE
LI84	2-WAY ECONOSEAL III LC (BLACK)	ABOVE ENGINE OIL FILTER / EGR TEMPERATURE SENSOR
LI92	25-WAY ECM CONNECTOR (BLUE)	PASSENGER'S FOOTWELL TRIM / ENGINE CONTROL MODULE, HIGH POWER
LI93	25-WAY ECM CONNECTOR (YELLOW)	PASSENGER'S FOOTWELL TRIM / ENGINE CONTROL MODULE, LOW POWER
LI95	RELAY BASE (RED)	RIGHT 'A' POST TRIM / EMS MAIN RELAY
LI99	2-WAY LUCAR (BROWN)	ON AIR INTAKE ELBOW / AIR TEMPERATURE SENSOR
LI100	4-WAY PACKARD (BLACK)	BETWEEN INJECTOR #2 & 3 / IDLE SPEED ACTUATOR
LI101	2-WAY LUCAR (BROWN)	ON THERMOSTAT HOUSING / COOLANT TEMPERATURE SENSOR
LI102	3-WAY PM 5 (BLACK)	ABOVE AIR PUMP / AIR INJECTION PUMP
LI103	6-WAY SUMITOMO SEALED (BLACK)	ADJACENT TO THROTTLE BODY / THROTTLE POSITION SENSOR
LI104	6-WAY LUCAR (BLACK)	ADJACENT TO MASS AIR FLOW METER / MASS AIR FLOW METER
LI106	2-WAY LUCAR (BLUE)	ABOVE AIR INJECTION PUMP / AIR INJECTION SOLENOID VALVE
LI109	3-WAY PM 5 (BLACK)	FRONT OF ENGINE / CRANKSHAFT SENSOR
LI110	EYELET (WHITE)	BEHIND RIGHT HEADLIGHT ON INNER FENDER / IGNITION COIL "+"
LI111	EYELET (WHITE)	BEHIND RIGHT HEADLIGHT ON INNER FENDER / IGNITION COIL "–"
LI112	EYELET (WHITE)	BEHIND RIGHT HEADLIGHT ON INNER FENDER / IGNITION AMPLIFIER GROUND
LI113	7-WAY LUCAR (BLACK)	BEHIND RIGHT HEADLIGHT ON INNER FENDER / IGNITION AMPLIFIER
LI114	EYELET (WHITE)	RIGHT FRONT INNER FENDER / IGNITION COIL CONDENSER GROUND
LI116	2-WAY LUCAR (SLATE)	INTAKE MANIFOLD / INJECTOR #1
LI117	2-WAY LUCAR (SLATE)	INTAKE MANIFOLD / INJECTOR #2
LI118	2-WAY LUCAR (SLATE)	INTAKE MANIFOLD / INJECTOR #3
LI119	2-WAY LUCAR (SLATE)	INTAKE MANIFOLD / INJECTOR #4
LI120	2-WAY LUCAR (SLATE)	INTAKE MANIFOLD / INJECTOR #5
LI121	2-WAY LUCAR (SLATE)	INTAKE MANIFOLD / INJECTOR #6
LI122	2-WAY LUCAR (BLACK)	RIGHT REAR OF ENGINE / OXYGEN SENSOR HEATER
LI123	.250 BLADE (WHITE)	RIGHT REAR OF ENGINE / OXYGEN SENSOR FEEDBACK
LI130	RELAY BASE (GREEN)	LEFT FRONT COMPONENT PANEL / AIR INJECTION RELAY
LI134	20-WAY MULTILOCK 70 (WHITE)	LOWER RIGHT 'A' POST / ENGINE MANAGEMENT HARNESS
LI135	4-WAY ECONOSEAL III HC (BLACK)	LOWER RIGHT 'A' POST / BULKHEAD TO ENGINE HARNESS
LI142	2-WAY LUCAR (BLACK)	ADJACENT TO AIR INJ. PUMP / CHARCOAL CANISTER PURGE VALVE
RH104	2-WAY ECONOSEAL III HC (BLACK)	ABOVE FUEL TANK, RIGHT / FUEL PUMP HARNESS
RH160	24-WAY SUMITOMO BLOCK (WHITE)	BELOW LOWER LEFT A/C OUTLET / REARWARD HARNESS
RH173	RELAY BASE (YELLOW)	ABOVE RIGHT REAR WHEEL ARCH / FUEL PUMP RELAY

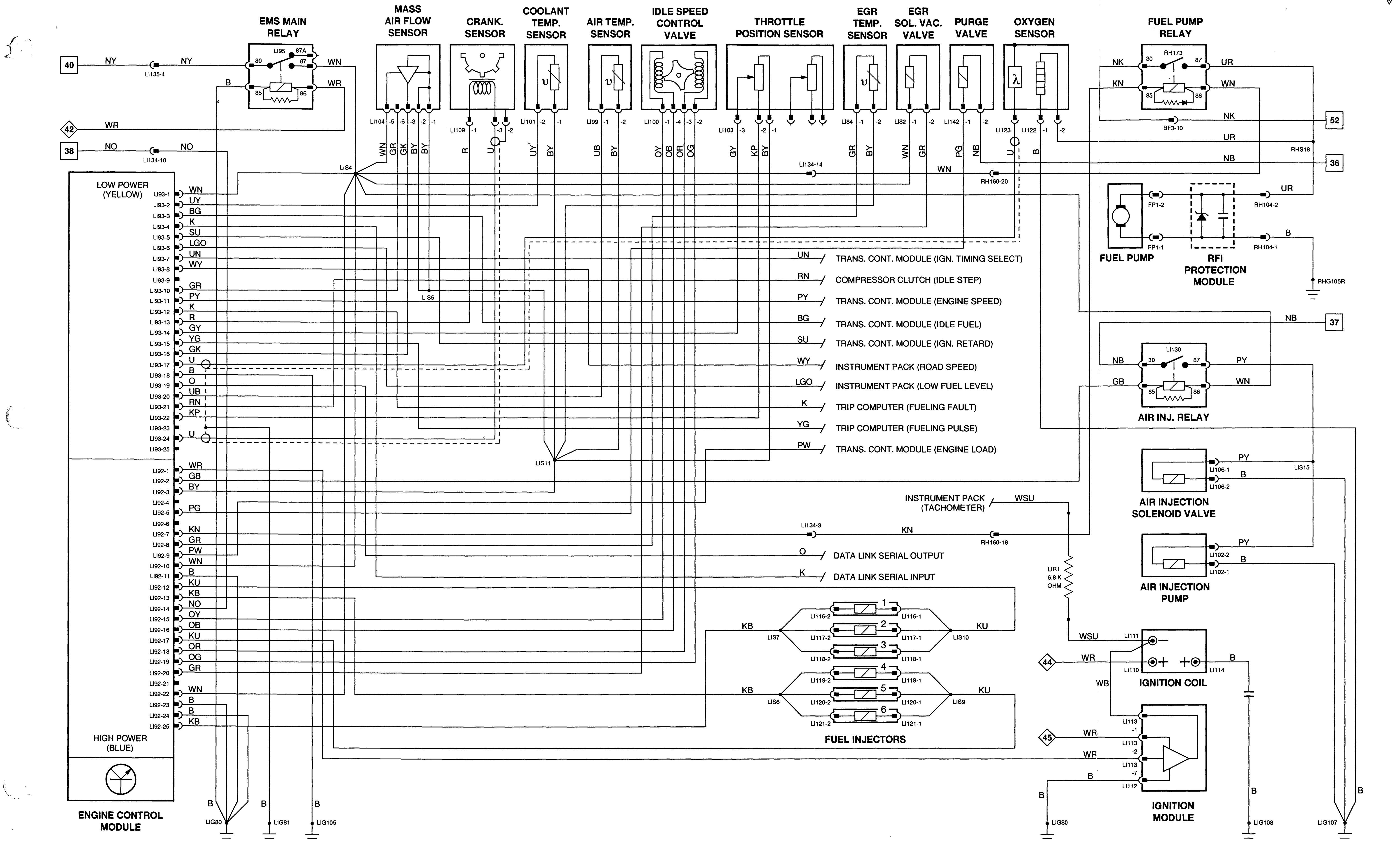
GROUNDS

CODE	DESCRIPTION	LOCATION / INTERFACE
LIG80	EYELET	ENGINE COMPARTMENT, BEHIND ABS PUMP ON BULKHEAD / POWER GROUND
LIG81	EYELET	ENGINE COMPARTMENT, BEHIND ABS PUMP ON BULKHEAD / POWER GROUND
LIG105	EYELET	ENGINE COMPARTMENT, BEHIND ABS PUMP ON BULKHEAD / POWER GROUND
LIG107	EYELET	ABOVE #1 INTAKE RUNNER ON ENGINE / POWER GROUND
LIG108	EYELET	RIGHT INNER FENDER ON COIL MOUNT / POWER GROUND
RHG105R	EYELET	RIGHT FRONT BULKHEAD IN ENGINE COMPARTMENT / POWER GROUND

INPUTS / OUTPUTS

ENGINE CONTROL MODULE

CODE	IN / OUT	CIRCUIT	ACTIVE	INACTIVE
LI92-1	OUTPUT	IGNITION AMPLIFIER DRIVE	PULSED DRIVE: 0.5V CRANKING; APPROX. 0.6V @1000 RPM; 1.5V @2000 RPM	
LI92-2	OUTPUT	AIR INJECTION PUMP RELAY	GROUND	12V
LI92-3	OUTPUT	AIR MASS AND SENSOR GROUNDS	GROUND	GROUND
LI92-4	NOT USED			
LI92-5	OUTPUT	CANISTER PURGE	GROUND	12V
LI92-6	NOT USED			
LI92-7	OUTPUT	FUEL PUMP RELAY	GROUND	12V
LI92-8	INPUT	EGR TEMPERATURE SENSOR	2000 RPM, EGR VALVE CLOSED: 4.9V	2000 RPM, VALVE OPEN: VOLTAGE DROPS
LI92-9	OUTPUT	ENGINE LOAD TO TRANSMISSION CONTROL MODULE	PULSED SIGNAL: 13V AT IDLE, DECREASES WITH ENGINE LOAD	
LI92-10	INPUT	IGNITION SWITCHED POWER	KEY ON: 12V	KEY OFF: OPEN CIRCUIT
LI92-11	INPUT	POWER GROUND	GROUND	GROUND
LI92-12	OUTPUT	INJECTOR SUPPLY	ENGINE RUNNING: 12V	KEY OFF: OPEN CIRCUIT
LI92-13	OUTPUT	INJECTOR DRIVE	PULSED SIGNAL: 2.6 MS @ IDLE	KEY OFF: OPEN CIRCUIT
LI92-14	INPUT	BATTERY POWER	12V	12V
LI92-15	OUTPUT	IDLE SPEED ACTUATOR	STEPPER MOVING: 12V – 0.8V	NOT MOVING: OPEN CIRCUIT
LI92-16	OUTPUT	IDLE SPEED ACTUATOR	STEPPER MOVING: 12V – 0.8V	NOT MOVING: OPEN CIRCUIT
LI92-17	OUTPUT	INJECTOR SUPPLY	ENGINE RUNNING: 12V	KEY OFF: OPEN CIRCUIT
LI92-18	OUTPUT	IDLE SPEED ACTUATOR	STEPPER MOVING: 12V – 0.8V	NOT MOVING: OPEN CIRCUIT
LI92-19	OUTPUT	IDLE SPEED ACTUATOR	STEPPER MOVING: 12V – 0.8V	NOT MOVING: OPEN CIRCUIT
LI92-20	OUTPUT	EGR SOLENOID VACUUM VALVE	GROUND	12V
LI92-21	NOT USED			
LI92-22	INPUT	ECM MAIN RELAY	KEY ON: 12V	KEY OFF: OPEN CIRCUIT
LI92-23	INPUT	POWER GROUND	GROUND	GROUND
LI92-24	INPUT	POWER GROUND	GROUND	GROUND
LI92-25	OUTPUT	INJECTOR DRIVE	2.6 MS @ IDLE	KEY OFF: OPEN CIRCUIT
LI93-1	INPUT	ECM MAIN RELAY	KEY ON: 12V	KEY OFF: OPEN CIRCUIT
LI93-2	INPUT	COOLANT TEMPERATURE SENSOR	APPROX. 2.2V AT 70°F (21.1°C)	APPROX. 0.5V AT 200°F (94°C)
LI93-3	INPUT	IDLE FUEL DEMAND	"P", "N": GROUND; "R", "D", "3", "2": 5V	
LI93-4	INPUT	SERIAL COMMUNICATIONS DATA LINK	JDS	—
LI93-5	INPUT	TRANSMISSION CONTROL (IGNITION RETARD)	PULSED SIGNAL	0V
LI93-6	INPUT	INSTRUMENT PACK — LOW FUEL LEVEL	LOW FUEL: 12V	GROUND
LI93-7	INPUT	IGNITION TIMING SELECT	PULSED SIGNAL	GROUND
LI93-8	INPUT	INSTRUMENT PACK — ROAD SPEED	PULSED SIGNAL	GROUND
LI93-9	NOT USED			
LI93-10	INPUT	MASS AIR FLOW METER	KEY ON: 5V	KEY OFF: OPEN CIRCUIT AFTER 15 SEC.
LI93-11	OUTPUT	ENGINE SPEED SIGNAL	PULSED SIGNAL: 0.67V DC @800 RPM; 0.59V DC @2000 RPM	DECREASES WITH RPM
LI93-12	OUTPUT	TRIP COMPUTER — FUELING FAULT	FAULT: GROUND	NO FAULT: 12V
LI93-13	INPUT	CRANKSHAFT SENSOR	PULSED SIGNAL: 1.0V AC CRANKING; 2.7V AC @1000 RPM; 5.3V AC @2000 RPM	
LI93-14	INPUT	THROTTLE POSITION SENSOR WIPER	MIN: 0.58V – 0.62V IDLE POS.	MAX: 4.9V WOT
LI93-15	OUTPUT	TRIP COMPUTER FUEL PULSES	PULSED SIGNAL	OPEN CIRCUIT
LI93-16	INPUT	MASS AIR FLOW METER LOAD	IDLE IN 'N': APPROX. 1.4V	0V
LI93-17	INPUT	CRANKSHAFT SENSOR	SENSOR GROUND	GROUND
LI93-18	INPUT	POWER GROUND	GROUND	GROUND
LI93-19	OUTPUT	SERIAL COMMUNICATIONS DATA LINK	JDS	—
LI93-20	INPUT	AIR TEMPERATURE SENSOR	SENSED VOLTAGE: 2.0V @ 70°F (21°C)	0V
LI93-21	INPUT	A/C COMPRESSOR CLUTCH LOAD	CLUTCH ON: 12V	CLUTCH OFF: OPEN CIRCUIT
LI93-22	OUTPUT	THROTTLE POSITION SENSOR REFERENCE VOLTAGE	KEY ON: 5.0V	KEY OFF: OPEN CIRCUIT
LI93-23	NOT USED			
LI93-24	INPUT	CRANKSHAFT SENSOR SHIELD	GROUND	GROUND
LI93-25	NOT USED			



BATTERY POWER SUPPLY IGNITION SWITCHED POWER SUPPLY CONSULT APPROPRIATE ELECTRICAL GUIDE