1975-79 COMPUTERIZED ENGINE CONTROLS
Computer Controlled Catalytic Converter

1979 3.8L & 1979 1/2-1980 2.5L & 2.8L General Motors Engines

NOTE: This article contains information which is applicable to 1979 models and to 1980 Buick Skylark, Chevrolet Citation, Oldsmobile Omega and Pontiac Phoenix.

DESCRIPTION

The Computer Controlled Catalytic Converter (C-4) system closely controls air/fuel ratio through a feedback system from an oxygen sensor in the exhaust system. The major components of this system include an exhaust gas oxygen sensor, an Electronic Control Module (ECM), an electronically controlled carburetor, and a 3-way catalytic converter. *See Fig. 1.*

This system is used on some 1979 models with 231" (3.8L - VIN 2) V6 engines for sale in California, and also on 1980 Buick Skylark, Chevrolet Citation, Oldsmobile Omega and Pontiac Phoenix models equipped with 151" (2.5L) 4-cylinder engine or 171" (2.8L) V6 engine. All models are so equipped if sold in California.

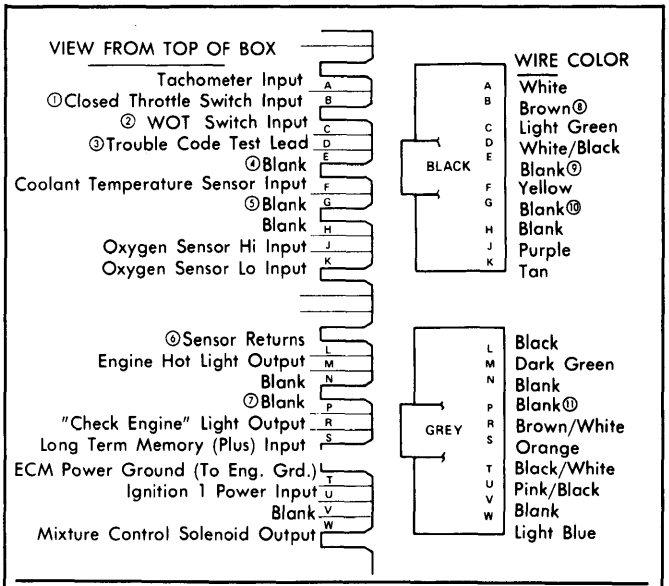
NOTE: A similar system is also used in 1979, except it is vacuum controlled. See GENERAL MOTORS ELECTRONIC FUEL CONTROL SYSTEM in this section. This system is applicable to Chevrolet Monza, Oldsmobile Starfire and Pontiac Phoenix and Sunbird. These models are equipped for California only.

OPERATION

ELECTRONIC CONTROL MODULE (ECM)

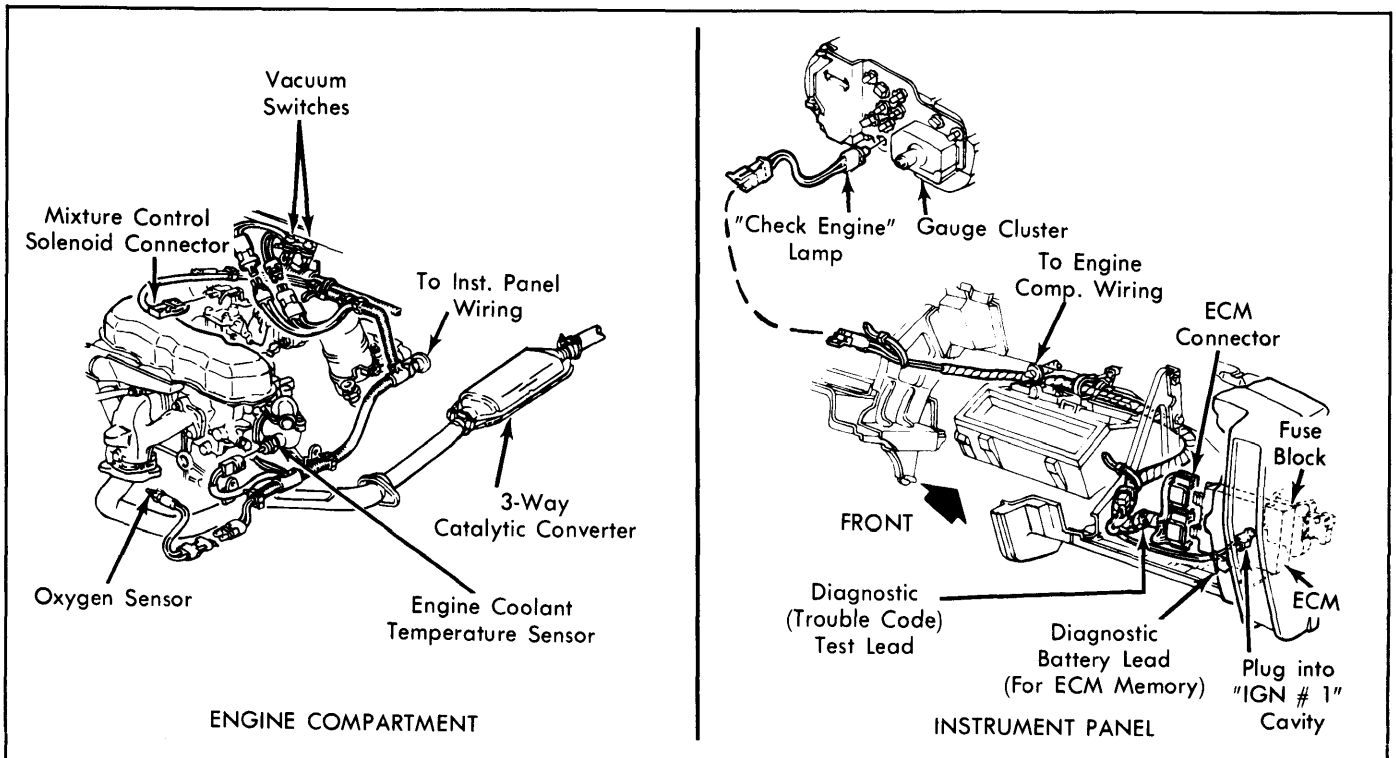
The Electronic Control Module (ECM) reads the voltage signal from the oxygen sensor. *See Fig. 2.* In response, it sends a proportionate signal to the carburetor mixture control solenoid, which creates either a lean or rich mixture, as required. A high voltage signal from the oxygen sensor causes the ECM to send a similar signal to the carburetor solenoid to energize it. A leaner mixture results. The signal which is sent from the ECM to the carburetor solenoid is also modified by inputs from other engine sensors, which include vacuum switches, an engine coolant sensor and a throttle position sensor (1980 2.8L V6 engine only).

The ECM also contains a "memory" system which stores an average set of operating conditions with the ideal air/fuel ratio for those



① – Blank on 1980 V6.
② – Lean Authority Limiter on 1980 V6.
③ – Ground to Get Malfunction Code.
④ – Throttle Position Sensor Reference on 1980 V6.
⑤ – Throttle Position Sensor on 1980 V6.
⑥ – Connects to Lo Side of Throttle Position Sensor Coolant Sensor and Shield Connections.
⑦ – Pulse Air Solenoid on 1980 V6.
⑧ – Brown on 1980 V6.
⑨ – Grey on 1980 V6.
⑩ – Dark Blue on 1980 V6.
⑪ – Black/Pink on 1980 V6.

Fig. 2: Electronic Control Module Pin Identification



Courtesy of General Motors Corp.

Fig. 1: Layout of Typical C-4 System Showing Engine & Instrument Panel Component Locations

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Computer Controlled Catalytic Converter (Cont.)

conditions. If any settings change from these stored conditions (as determined by engine sensors), the ECM will make necessary adjustments to bring engine back to the "ideal" set of conditions.

Before the ECM can begin governing the air/fuel ratio, it is important to note that a minimum of 10 seconds must have elapsed after start-up before any C-4 operation begins, engine coolant temperature must be above 90°F, and the oxygen sensor must be sufficiently warm and putting out sufficient voltage before the ECM can react. During cold engine startup, the ECM is off-line and a fixed carburetor condition is maintained until proper warm-up occurs.

DIAGNOSTIC MEMORY

The C-4 system is designed with a short-term memory. It will store a trouble code as long as the ignition switch is on. When it is turned off, the memory will be erased. To remember intermittent problems, and because some trouble codes do not register for 5-18 minutes after engine warmup, a long-term memory is sometimes needed. To create a long-term memory, connect the "S" terminal lead of the ECM to a battery positive source (such as fuse block cavity marked "GAUGES").

A long term memory is not factory connected because it will create a small drain on the battery during ignition off and could cause a discharged condition. When repairs are completed, disconnect this wire.

TROUBLE CODES

The C-4 diagnostic system is programmed to flash a series of codes through the "CHECK ENGINE" light. After light becomes activated by the system, it is necessary to ground trouble code test lead, with engine running, so system can flash proper trouble code.

When "CHECK ENGINE" light comes on, a trouble in C-4 system is indicated. A series of codes are programmed to assist in diagnosis and correction of the problem. See TROUBLE CODE IDENTIFICATION table for explanation of codes.

Codes are flashed by "CHECK ENGINE" light after the trouble code test lead is grounded. See *Fig. 3*.

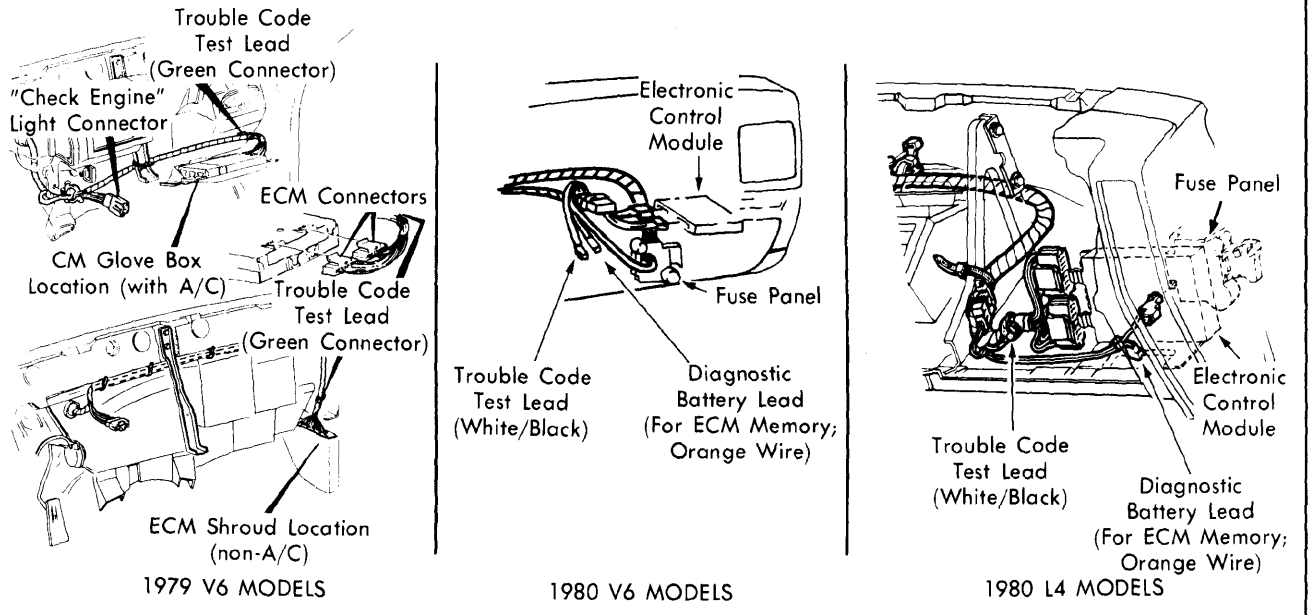
Codes will be flashed as follows: Light will flash 1, 2, 4 or 5 times to indicate first number of code; then after a short pause, it will flash 1, 2, 3, 4 or 5 more times to indicate second number of code.

For example, if problem is a shorted coolant sensor circuit, light will flash one time, pause, then flash 4 times (Code 14). After a long pause, signal will repeat itself 2 more times. If more than one trouble spot is detected, one code series will flash, then the other code series will flash.

TROUBLE CODE IDENTIFICATION

Code	Problem
12	No Signal To ECM
13 [1]	Oxygen Sensor Circuit
14	Shorted Coolant Sensor
15	Open Coolant Sensor Circuit
21 [2]	Throttle Position Sensor Circuit
22 [3]	Grounded Closed Throttle or WOT Switch Circuit
23	Open or Grounded Carburetor Mixture Control Solenoid Circuit
43	Throttle Position Sensor Adjustment
44 [4]	Lean Oxygen Sensor Signal
45	Rich Oxygen Sensor Signal
51 [5]	Faulty PROM
52	Faulty ECM
53	Faulty ECM
54	Faulty Mixture Control Solenoid or ECM
55	Faulty TPS (If Used) or ECM

[1] - If Codes 13 and 41 appear at the same time, see Code 43.
[2] - On 1979 3.8L and 1980 2.5L engine, problem is a grounded WOT switch circuit and an open throttle switch circuit at the same time. On 1979 3.8L and 2.5L engine, codes 21 and 22 will appear at the same time.
[3] - 1979 3.8L V6 and 1980 2.5L 4-cylinder engines only.
[4] - If Codes 44 and 55 appear at the same time, and "CHECK ENGINE" light is off, check for a faulty oxygen sensor.
[5] - Check PROM for faulty installation.



Courtesy of General Motors Corp.

Fig. 3: Trouble Code Test Leads Locations

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CARBURETORS

Two feedback carburetors are used with the C-4 system, depending an application. The 1979 models use a Rochester Dualjet E2ME. All 1980 models use a Rochester Dualjet E2SE. These carburetors are designed with an electrically operated mixture control solenoid in the fuel bowl. This solenoid controls a metering rod which responds to impulses (dwell) from the ECM to make the carburetor mixture leaner or richer, as determined by oxygen sensor.

Closed Loop - On a normally operating engine, dwell at both idle and part throttle will fluctuate between 10-50 degrees (closed loop mode). The dwell (air/fuel mixture) is varying due to the interaction between the oxygen sensor and the ECM.

Open Loop - At wide open throttle or cold engine, dwell will be fixed (needle steady). This is the open loop mode, since oxygen sensor has no effect on the dwell (air/fuel mixture).

NOTE: For additional carburetor information, including adjustments and specifications, see appropriate carburetor article in FUEL SYSTEMS section of this manual.

ENGINE SENSORS & SWITCHES

Engine Coolant Sensor - This switch determines engine coolant temperature and sends a proportionate signal to the ECM. It does not allow C-4 system operation while engine coolant is below 90°F.

Wide Open Throttle (WOT) Switch (1979 3.8L Engine) - This switch is mounted on carburetor to detect full throttle. When activated, a signal from this switch to the ECM sets a temporarily rich mixture (5-10 degrees dwell) in carburetor until throttle moves off full-open position.

Closed Throttle Switch Assembly (1979 3.8L Engine) - Made up of a Ported Vacuum Switch (PVS) and a Manifold Vacuum Switch (MVS) electrically connected in series, this assembly informs the ECM about carburetor operating conditions to determine best overall performance and emissions settings. PVS is normally closed until 5 in. Hg vacuum or more is present above throttle valve. MVS is normally open until 13 in. Hg vacuum or more occurs at intake manifold.

Thermal Vacuum Switch (1979 3.8L Engine) - The Thermal Vacuum Switch (TVS) is located in air cleaner housing and controls secondary choke vacuum break. *See Fig. 4.* Below 62°F ambient temperature, switch prevents vacuum break from operating (for better cold driveability). Above 62°F, normal operation occurs.

Distributor Advance/Retard System (1979 3.8L Engine) - This system assists C-4 warmup, but is not controlled by ECM. It consists of electrical relay, coolant temperature switch, 2 solenoids, and a dual diaphragm vacuum advance unit. When engine is cold, system is designed to create spark retard during light throttle to improve converter and engine warmup. During cold acceleration, spark advance occurs for improved driveability.

Vacuum Control Switches (1980 2.5L Engine) - These switches monitor vacuum signal, telling ECM when closed throttle or open throttle operation occurs.

Vacuum Control Switch (1980 2.8L Engine) - This switch (lean authority limiter) monitors incoming carburetor air temperature through the air cleaner TVS and prevents excessively lean carburetor operations during cold engine conditions.

Throttle Position Sensor (1980 2.8L Engine) - The Throttle Position Sensor (TPS) provides throttle position information to the ECM. The ECM then stores this information in memory and creates an average set of operating conditions with an ideal air/fuel ratio for those conditions. When throttle change is detected, ECM shifts to last stored set of operating conditions to create the best air/fuel ratio.

Oxygen Sensor - The oxygen sensor generates a voltage signal which varies with oxygen content in exhaust gases. If the oxygen content of the exhaust gas is high (lean mixture), the voltage signal created by the sensor is low. If the oxygen content is low (rich mixture), the voltage signal to the ECM is high.

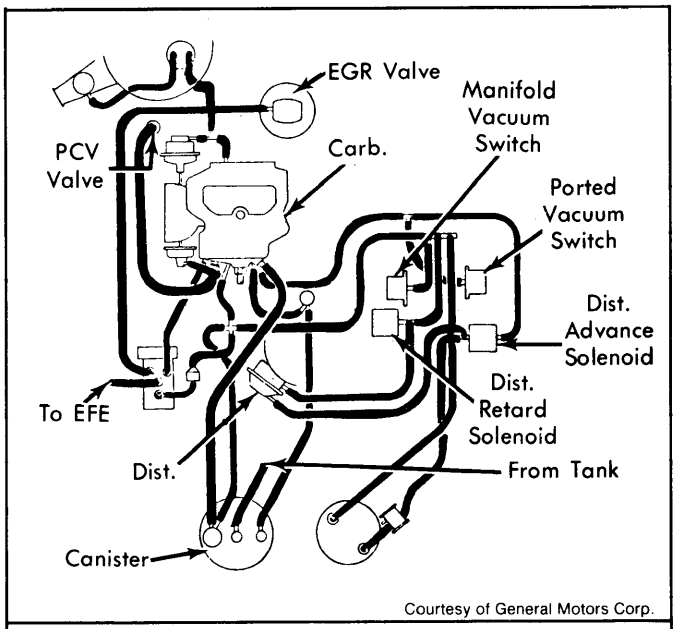

Fig. 4: 1979 3.8L Engine C-4 System Vacuum Hose Schematic

CATALYTIC CONVERTER

Proper emission control is accomplished with a 3-way catalytic converter that converts all 3 major pollutants (HC, CO and NOx) into carbon dioxide and water. In order for this catalytic converter to be effective, precise control of the oxygen content of gases entering the converter is necessary, thus the need for the oxygen sensor, the ECM and the feedback carburetor.

MAINTENANCE

OXYGEN SENSOR REPLACEMENT

To ensure proper operation of the oxygen sensor, it must be replaced at 15,000 miles (1979 models) or 30,000 miles (1980 models), a maintenance reminder flag appears in the speedometer, indicating the need for oxygen sensor replacement. Replace sensor as follows:

Removal - 1) On all 1979 models and 1980 models with 4-cylinder engine, remove air cleaner and hot air pipe from exhaust shroud. On 1980 models with V6 engine, raise vehicle on hoist.

2) Disconnect electrical lead from sensor and spray sensor threads with heat valve lubriocant. Allow to soak a few minutes, then carefully back out oxygen sensor (care is required to avoid damaging threads in exhaust pipe).

Installation - Coat threads of new oxygen sensor with anti-seize compound and carefully install. Tighten sensor to 30 ft. lbs. Reconnect electrical lead. Reset flag.

MAINTENANCE REMINDER FLAG RESET

Remove instrument panel trim plate. Remove instrument cluster lens. Using an awl, apply light downward pressure on notches of flag until it is reset. An alignment mark will appear in left center of odometer window when flag is reset. *See Fig. 5.*

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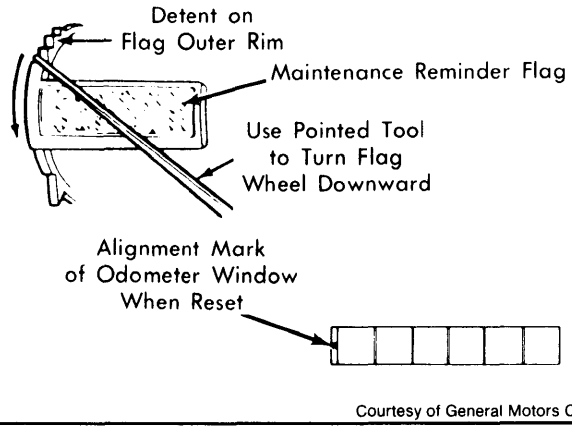

Courtesy of General Motors Corp.

Fig. 5: Maintenance Reminder Flag Reset

TESTING & DIAGNOSIS

TEST EQUIPMENT

A dwell meter, digital volt/ohmmeter, test light, tachometer, hand-held vacuum pump, and jumper wires are needed to test and diagnose the C-4 system.

Connecting Dwell Meter - Set dwell meter to 6-cylinder scale and connect meter to mixture control solenoid lead. On normally operating engine, dwell at both idle and part throttle will fluctuate between 10-50 degrees (closed loop).

NOTE: Do not allow dwell meter lead to touch ground. This includes hoses, since they are conductive.

DISTRIBUTOR ADVANCE/RETARD SYSTEM TESTS (1979 3.8L ENGINE)

Functional Test - **1)** To check proper operation, connect timing light and check timing at normal operating temperature. Adjust if necessary. See appropriate article in TUNE-UP PROCEDURES section.

2) Detach connector from temperature switch at water outlet housing. Engine timing should remain at specification.

3) Ground temperature switch connector. Timing should decrease by about 6 degrees. If not, check hoses and wiring for proper condition and connections. If hoses and wiring are okay, test solenoids, relay and distributor dual diaphragm vacuum advance unit.

Advance/Retard Solenoids (Hot Test) - With vacuum gauge connected to outlet port of solenoid and engine idling at normal operating temperature, no vacuum signal should be read on gauge.

Advance/Retard Solenoids (Cold Test) - With vacuum gauge connected to outlet port of solenoid and 12 volts applied to solenoid connector, 12 in. Hg vacuum or more should be read on gauge.

Spark Control Relay - With ignition key in "ON" position and coolant below 120°F, a reading of 12 volts should be obtained at solenoid connector.

Distributor Dual Diaphragm Vacuum Advance Unit - Using a hand-held vacuum pump, attach pump to either side of unit. Create at least 12 in. Hg vacuum with pump. Vacuum unit linkage should move. Vacuum reading on pump should remain constant. If linkage does not move or if vacuum drops, unit is defective. Repeat test procedure on other side of unit.

C-4 SYSTEM DIAGNOSIS

A built-in diagnostic system is likely to activate if a problem occurs in the system, therefore, begin vehicle diagnosis with the DIAGNOSTIC CIRCUIT CHECK chart. If the C-4 system contains a problem, the "CHECK ENGINE" light will come on. The following items should be checked for proper operation prior to C-4 system diagnosis:

- Intake Manifold & Carburetor Vacuum Leaks
- Vacuum Hoses
- Engine Compression
- Ignition System
- Air Intake System
- Early Fuel Evaporation System
- Positive Crankcase Ventilation (PCV) System
- Exhaust Gas Recirculation (EGR) System

NOTE: See appropriate fuel evaporation, PCV, and EGR system articles in EXHAUST EMISSION SYSTEMS section.

"CHECK ENGINE" LIGHT TEST

1) Ensure the C-4 diagnostic system is operating properly, turn off ignition switch, leave engine stopped, and ground the trouble code (White/Black) test lead.

2) If system is operating properly, the "CHECK ENGINE" light will flash Code 12, which indicates proper operation. See DIAGNOSTIC CIRCUIT CHECK chart.

NOTE: If fault is intermittent, "CHECK ENGINE" light may come on and then go out; however, fault problem will be stored in ECM memory so diagnosis can be performed.

SYSTEM PERFORMANCE CHECK

Since it is not possible to store a code for every possible problem, one may develop in which the "CHECK ENGINE" light does NOT come on. If C-4 system is suspected, perform system performance check. See SYSTEM PERFORMANCE CHECK chart in this article.

C-4 SYSTEM DIAGNOSTIC CHARTS

Follow testing sequence given in diagnostic charts. Also see wiring diagrams and other illustrations to assist in diagnosis.

WIRING DIAGRAMS

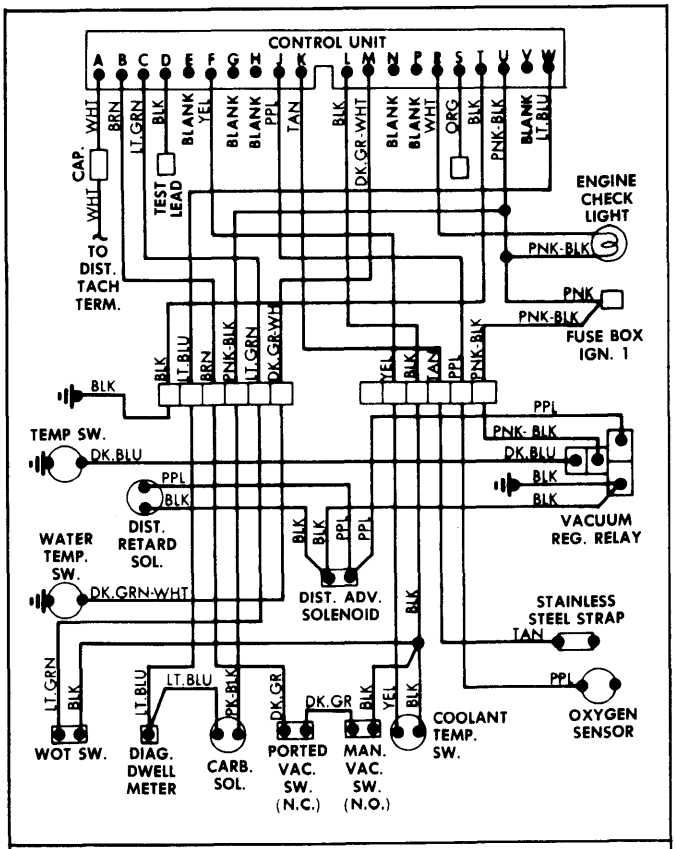

Fig. 6: 1979 V6 Engine C-4 System Wiring Diagram

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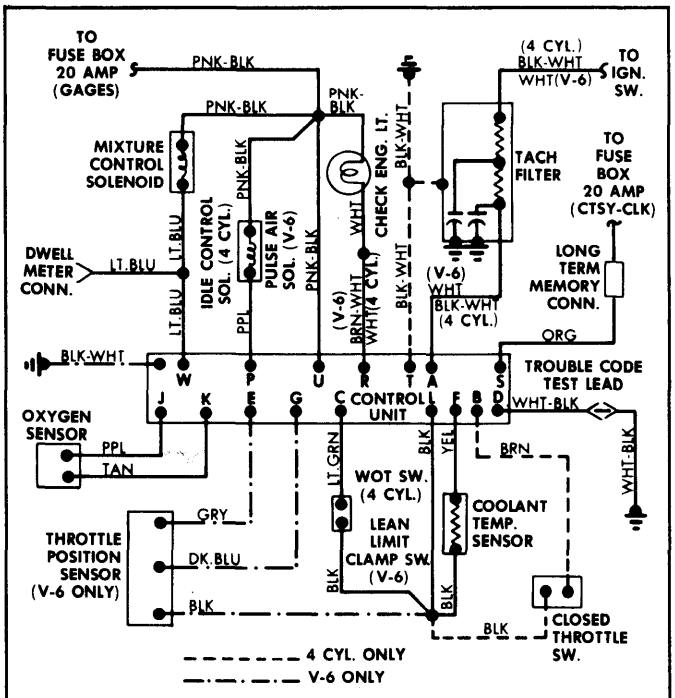

Fig. 7: 1980 4-Cylinder & V6 Engine C-4 System Wiring Diagram

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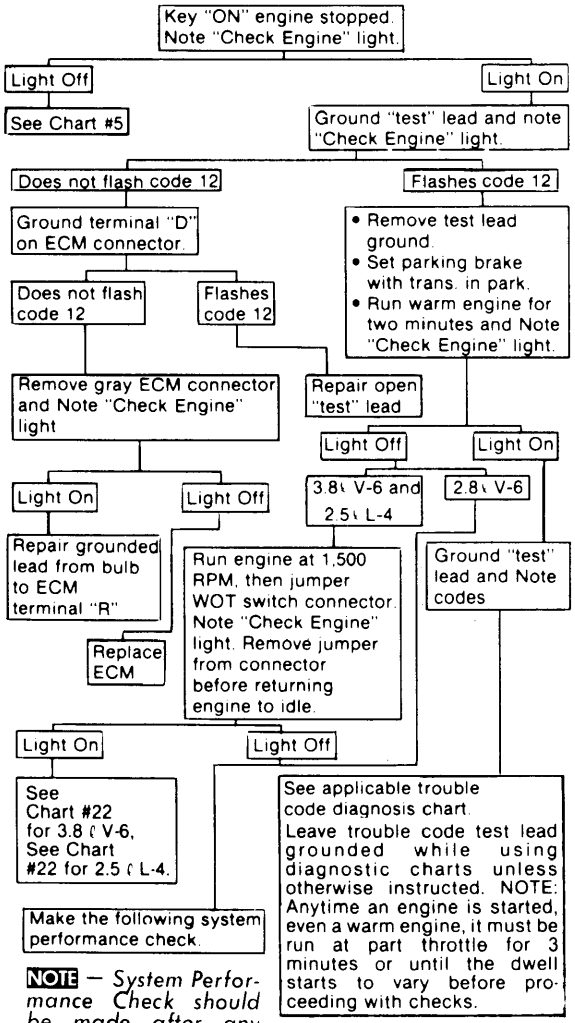
Computer Controlled Catalytic Converter (Cont.)

DIAGNOSTIC CIRCUIT CHECK

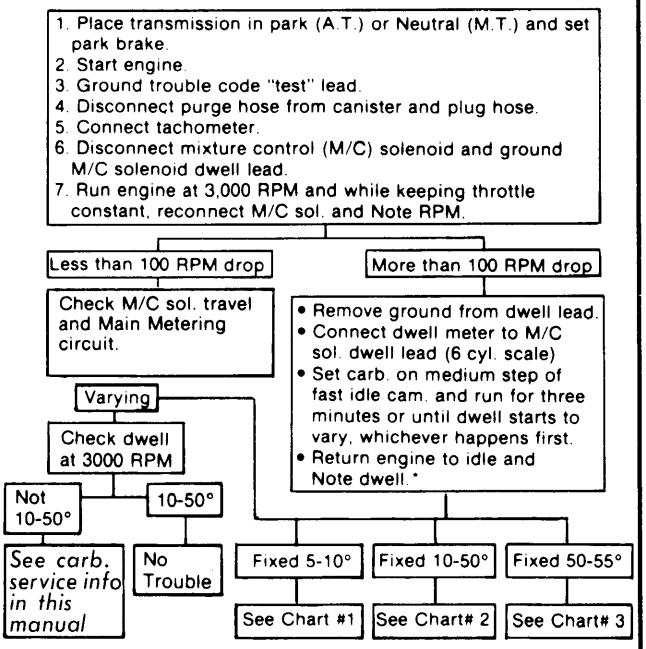
NOTE – *Procedure applies to all engines unless otherwise specified.*



NOTE – *System Performance Check should be made after any repairs have been completed.*

SYSTEM PERFORMANCE CHECK ENGINE PERFORMANCE PROBLEM (ODOR, SURGE, FUEL ECONOMY)

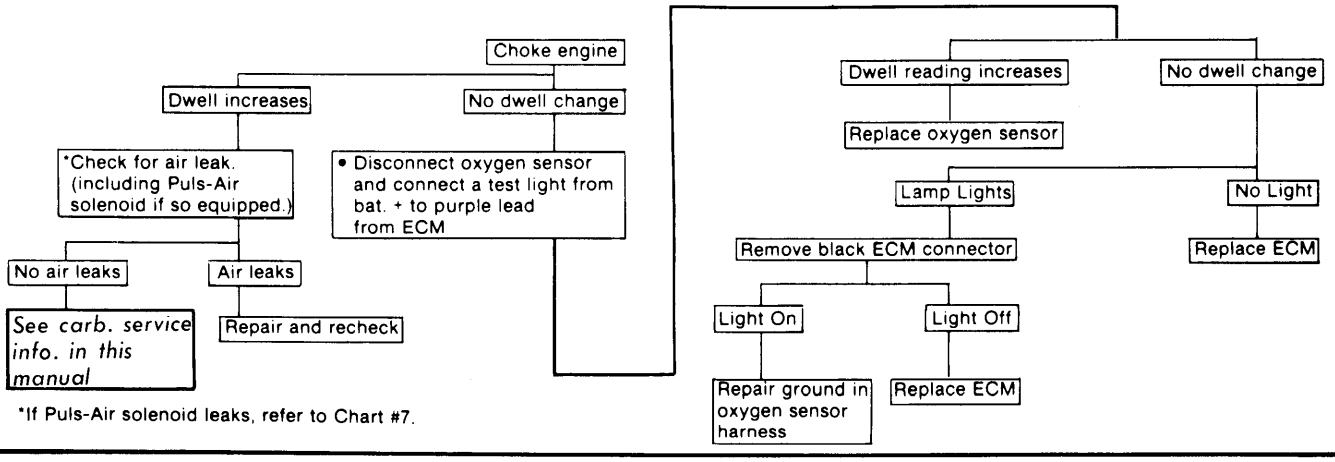
- Cold operation complaint.
  2.8ℓ V-6 See Chart #6 - lean limit switch check.
- Full throttle performance complaint
  3.8ℓ V-6 See Chart #4 for 3.8ℓ V-6
  2.5ℓ L-4 See Chart #4 for 2.5ℓ L-4 (Cold performance complaint only).
  2.8ℓ V-6 See chart #4 for 2.8ℓ V-6
- All other complaints - follow Chart below on warm engine (upper radiator hose hot).



*Oxygen sensors may cool off at idle and the dwell change from varying to fixed between 10-50°. If this happens running the engine at fast idle will warm it up again.

NOTE – *System Performance Check should be made after any repairs have been completed.*

CHART 1
DWELL FIXED AT 5-10 DEGREES



*If Puls-Air solenoid leaks, refer to Chart #7.

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CHART 2
DWELL FIXED BETWEEN 10-50 DEGREES

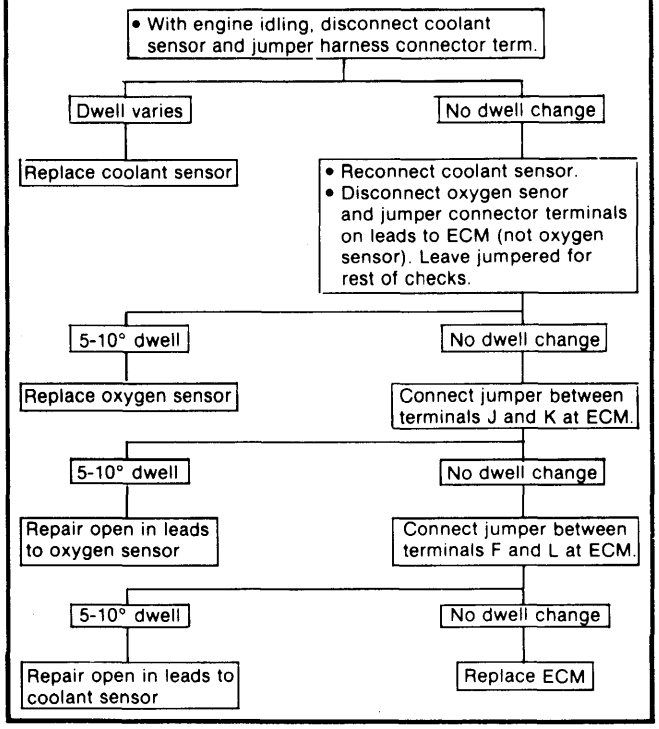


CHART 3
DWELL FIXED BETWEEN 50-55 DEGREES

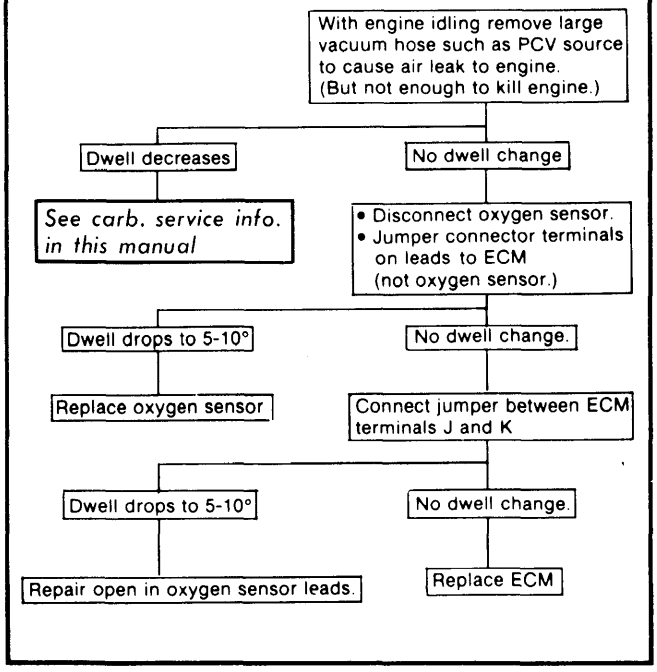


CHART 4
1979 3.8L
WOT SWITCH CIRCUIT CHECK

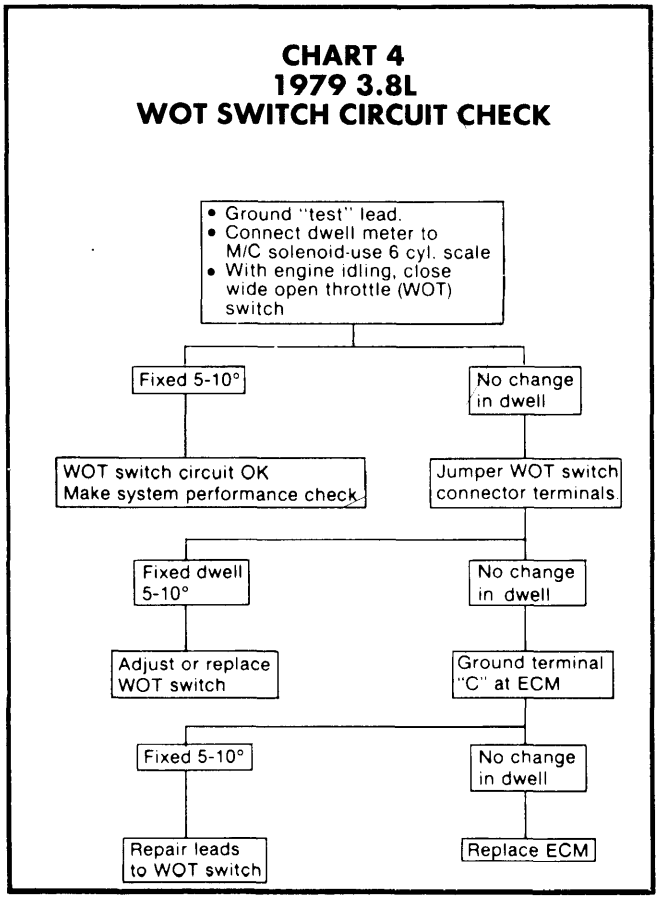
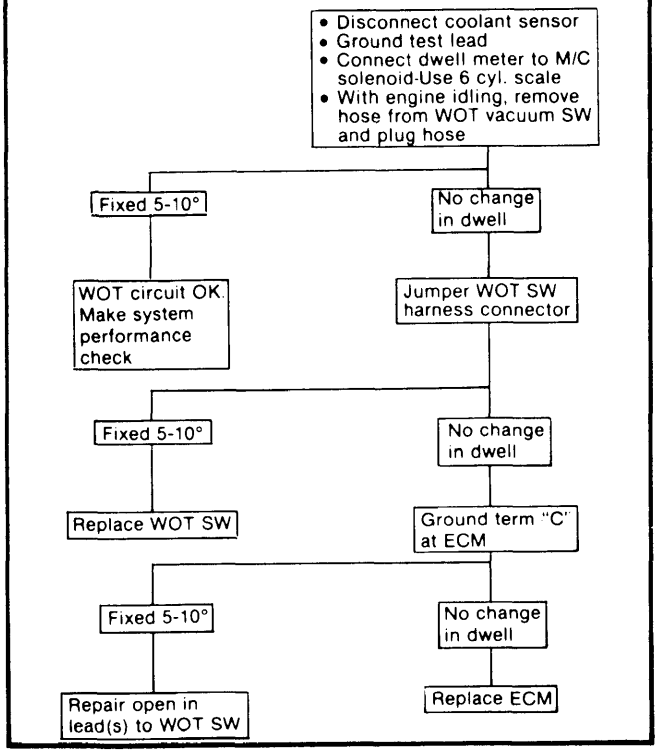


CHART 4
1979 1/2-1980 2.5L
WOT ENRICHMENT CIRCUIT CHECK



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Computer Controlled Catalytic Converter (Cont.)

CHART 4
1980 2.8L
TPS ENRICHMENT CIRCUIT CHECK

- Ground "test" lead with ignition on, engine stopped
- Connect dwell meter set on 6 cyl. scale to M/C sol.
- Move throttle to wide open and note dwell

- 5-10° → Enrichment Circuit OK. Make system performance check
- No dwell change →
  - Disconnect TPS Harness Connector from sensor.
  - Check Voltage from harness connector terminal "B" to "C" with digital voltmeter.
    - Under 2 volts → Check for ground in wire to ECM term G. If OK, replace ECM.
    - Over 2 volts → Adjust TPS

CHART 5
"CHECK ENGINE" LIGHT INOPERATIVE

NOTE: Light will not come on if "test" lead is grounded and then the ignition is turned on; the solenoid will also click.

- Check gauge fuse
  - Blown fuse → Replace fuse - check for cause
  - OK → Check "Check Engine" light connector for proper connection. With ign. "on", engine stopped, check voltage from same connector white wire term. to ground
    - Under 10 volts → Check voltage from same connector pink/black. wire term. to ground.
      - Over 10 volts → Check bulb and leads to it
      - Under 10 volts → Repair open in lead from fuse to connector
    - Over 10 volts → Check voltage from ECM term. "R" to ground.
      - Over 10 volts → Check voltage from ECM term. "T" to ground
        - Under 1 volt → Check voltage from ECM term. "U" to ground
          - Over 10 volts → Turn ign. off and replace ECM
          - Under 10 volts → Repair open in lead from ECM TERM. "U" to "Check Engine" light connector
        - Over 1 volt → Repair ECM ground
      - Under 10 volts → Repair open in lead to ECM "R" term. from "Check Engine" light connector

CHART 6
LEAN LIMIT SWITCH CIRCUIT CHECK

- Check for proper connections at switch connector
  - Not OK → Repair
  - OK →
    - Turn ignition "on" engine stopped.
    - Disconnect lean limit switch and connect voltmeter between connector terminals on harness to ECM
      - Over 10 volts → Connect test light from Bat.+ to one terminal on lean limit switch and ground the other term.
        - NO LIGHT → Replace switch
        - LIGHT → Start engine
          - Light → Disconnect vacuum hose from switch and check vacuum at the hose
            - Under 10" → Check vacuum hose and connections. If OK, replace temp. sensor in air cleaner.
            - Over 10" → Replace limit switch
          - No Light → Circuit OK. Make system performance check
      - Under 10 volts → Connect voltmeter between terminals "C" and "L" at ECM
        - Over 10 volts → Repair open in wire to term. "C"
        - Under 10 volts → Disconnect black ECM connector and check voltage between term. "C" and "L"
          - Over 10 volts → Repair ground in wire to ECM term. "C"
          - Under 10 volts → Replace ECM

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CHART 7
1980 2.8L
PULSE-AIR SOLENOID CHECK

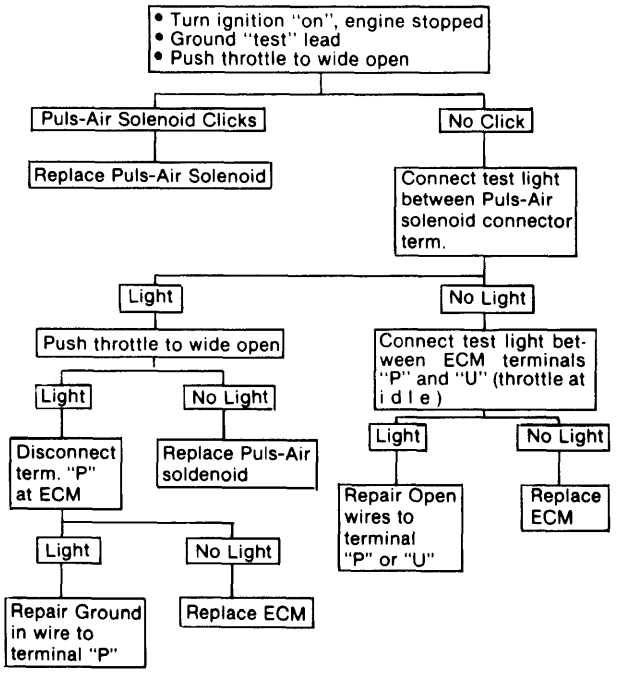

CHART 12
TROUBLE CODE

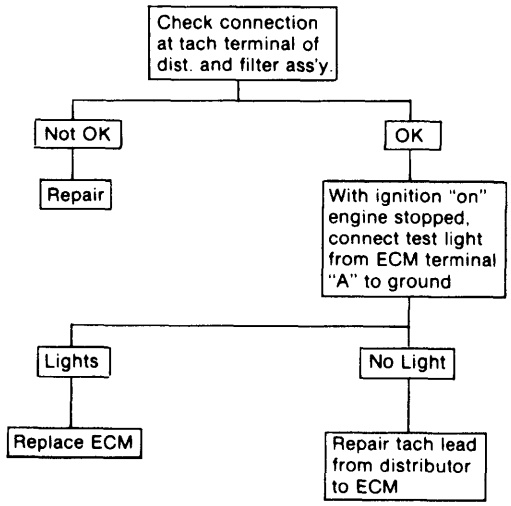

CHART 13
TROUBLE CODE 13

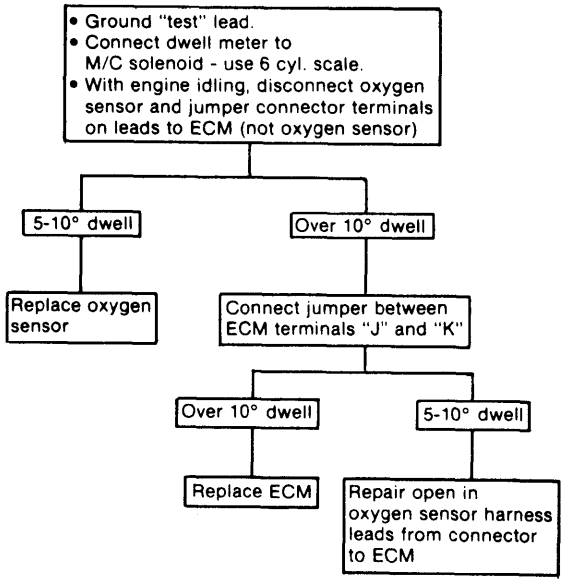

CHART 14
TROUBLE CODE 14

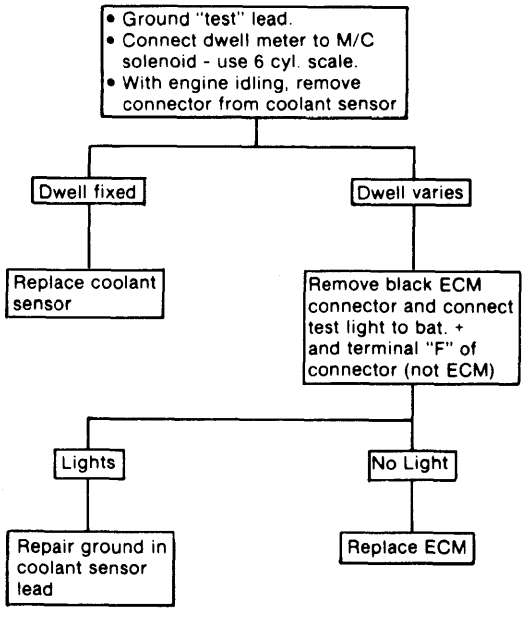

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CHART 15
TROUBLE CODE 15

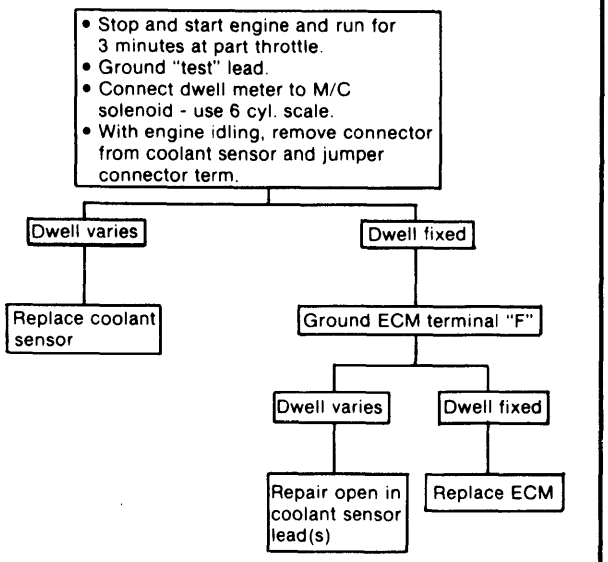


CHART 21
1979 3.8L
TROUBLE CODE 21 & 22
APPEAR AT THE SAME TIME

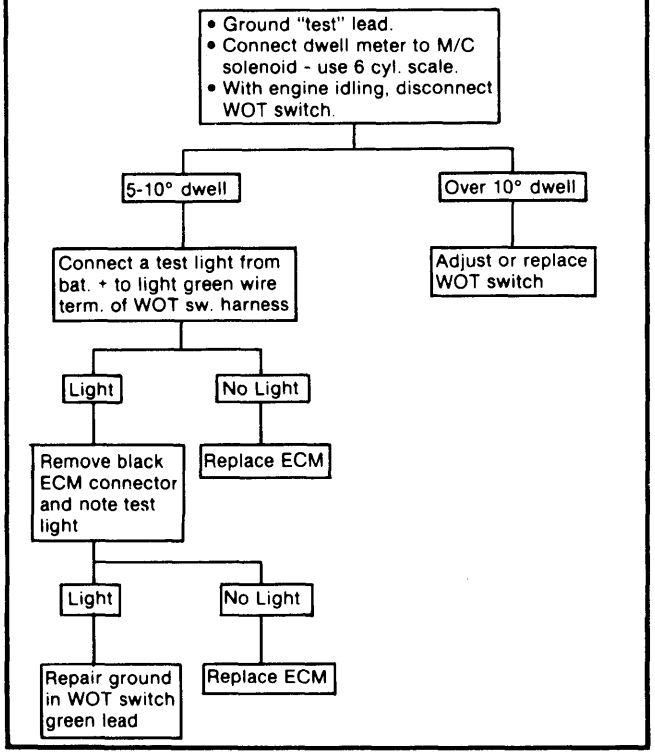
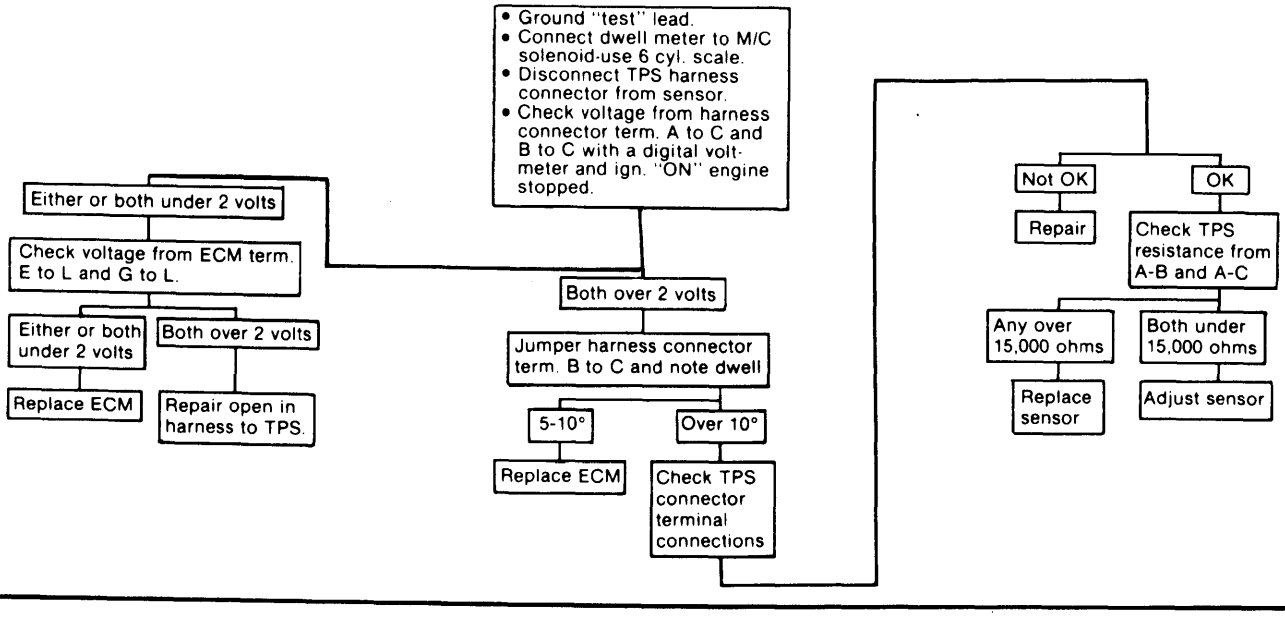


CHART 21
1980 2.8L
TROUBLE CODE 21



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Computer Controlled Catalytic Converter (Cont.)

CHART 21
1979 1/2-1980 2.5L
TROUBLE CODE 21

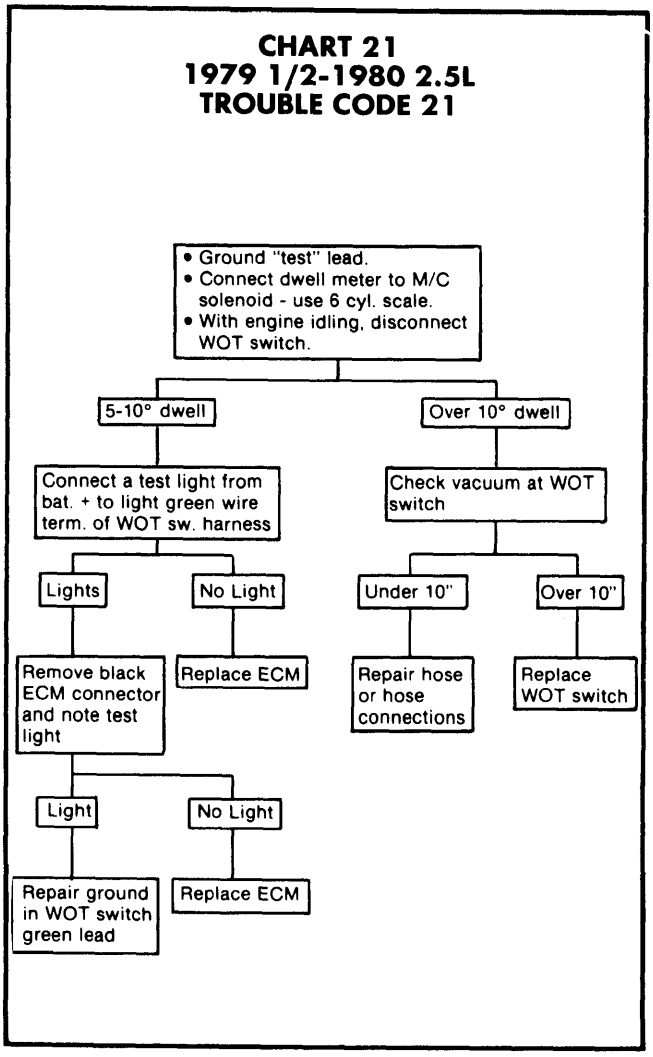


CHART 22
1979 3.8L
TROUBLE CODE 22

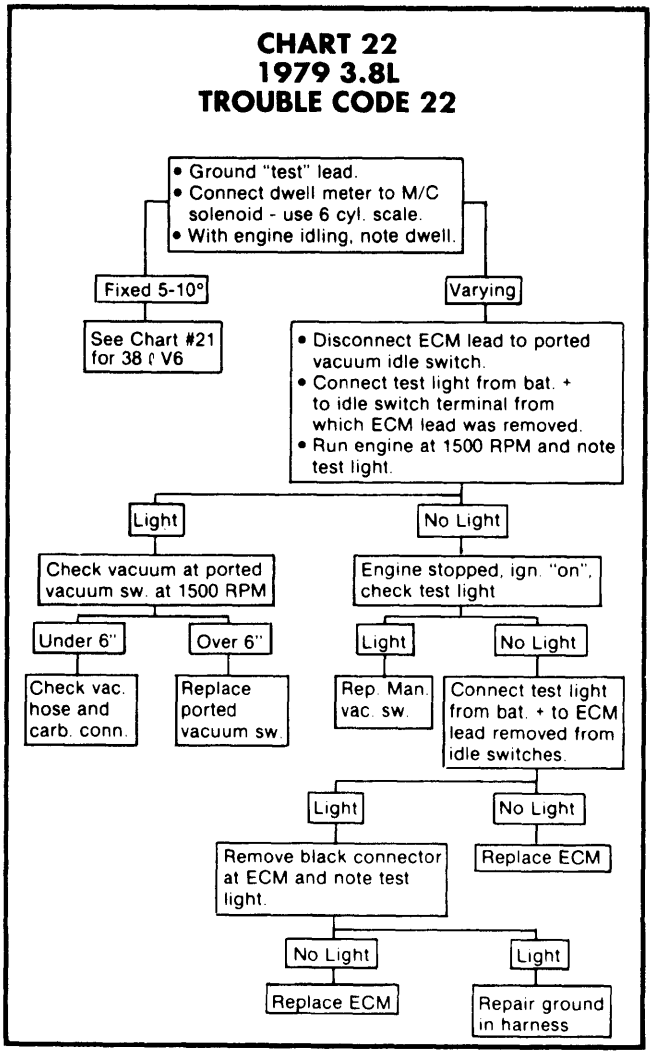
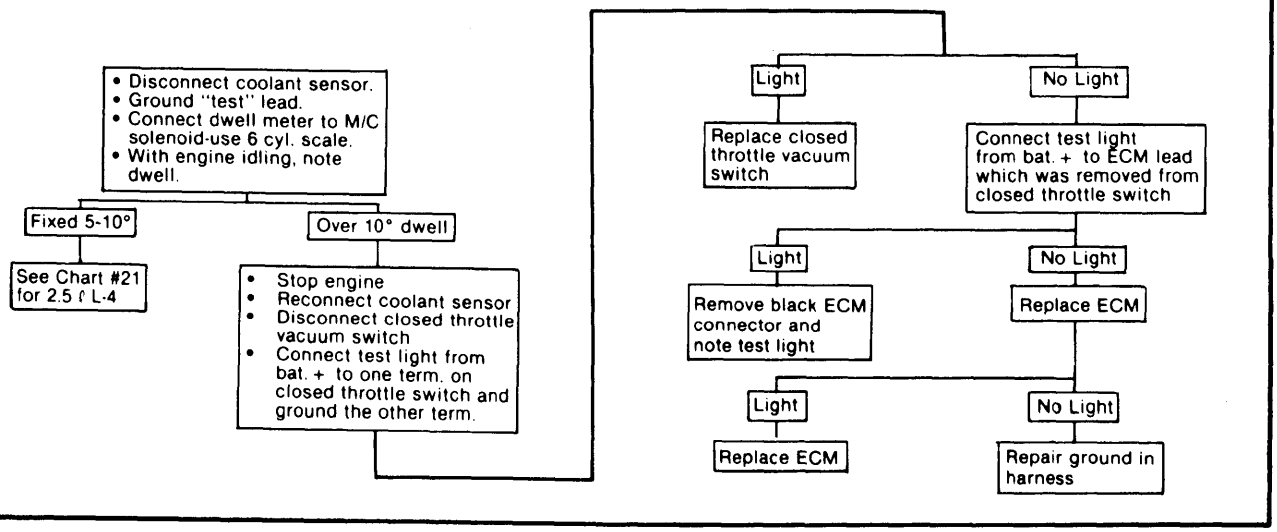
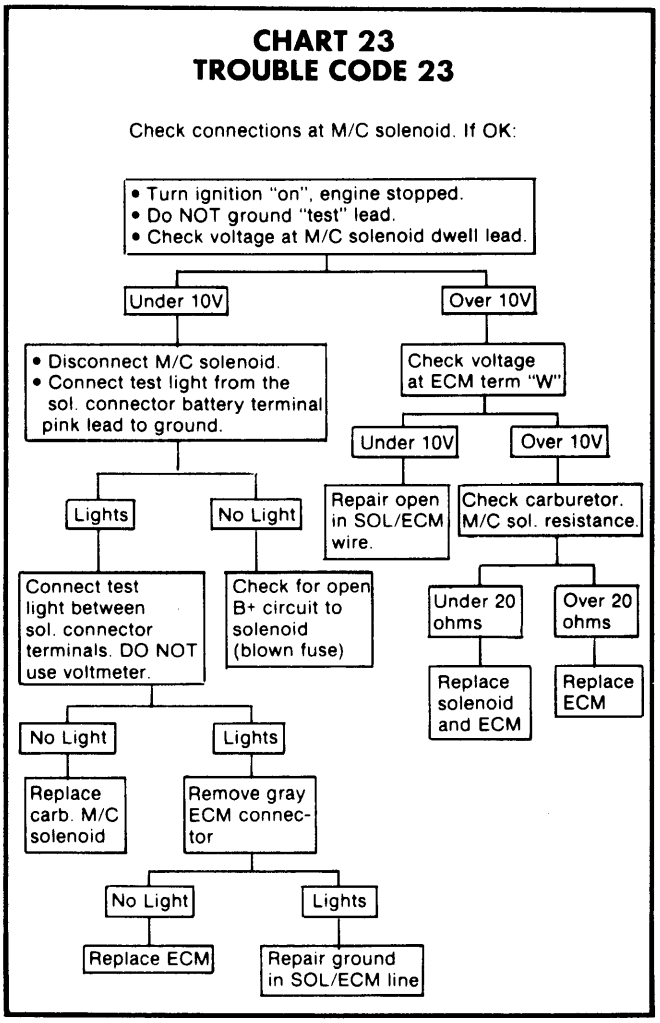


CHART 22
1979 1/2-1980 2.5L
TROUBLE CODE 22



1975-79 COMPUTERIZED ENGINE CONTROLS
Computer Controlled Catalytic Converter (Cont.)

CHART 23
TROUBLE CODE 23



CHARTS 51 THROUGH 54
TROUBLE CODES 51 THROUGH 54

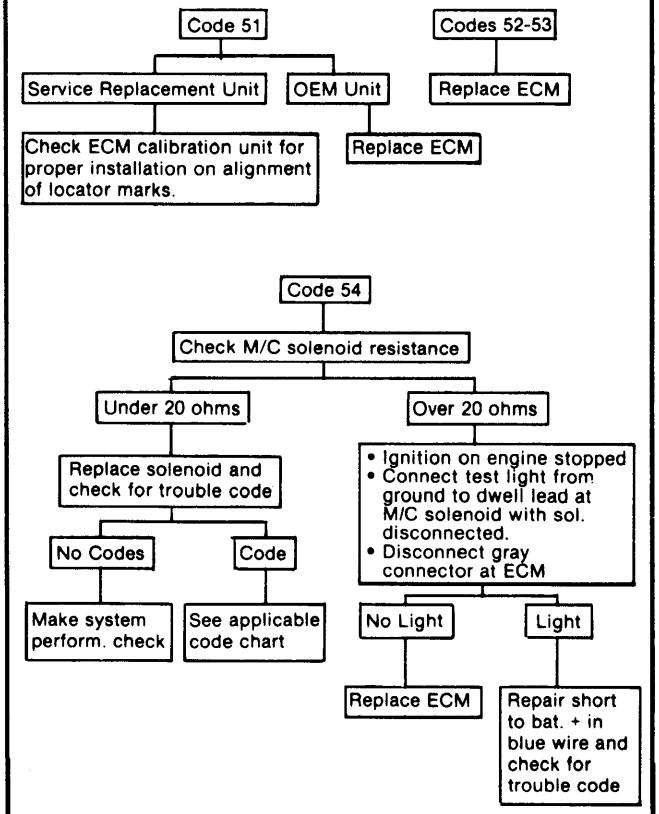


CHART 55
TROUBLE CODE 55