AMERICAN MOTORS COMPUTER CONTROLLED CATALYTIC CONVERTER

American Motors
2.5L (151") 4-Cyl.
Man. Trans. (Calif. Only)
Auto. Trans. (Nationwide)

NOTE – *Some of the above listed models may be equipped with the CEC System rather than the C-4 System. If equipped with CEC System, see appropriate article in this section.*

DESCRIPTION

The Computer Controlled Catalytic Converter (C-4) system is an electronically controlled system that closely controls air/fuel ratio to lower exhaust emissions while maintaining good fuel economy. The C-4 system is primarily an emission control system. Primary objective of C-4 system is to maintain an ideal air/fuel ratio of 14.7:1 under all operating conditions. When ideal ratio is maintained, catalytic converter can effectively control nitrogen oxides (NOx), hydrocarbons (HC) and carbon monoxide (CO).

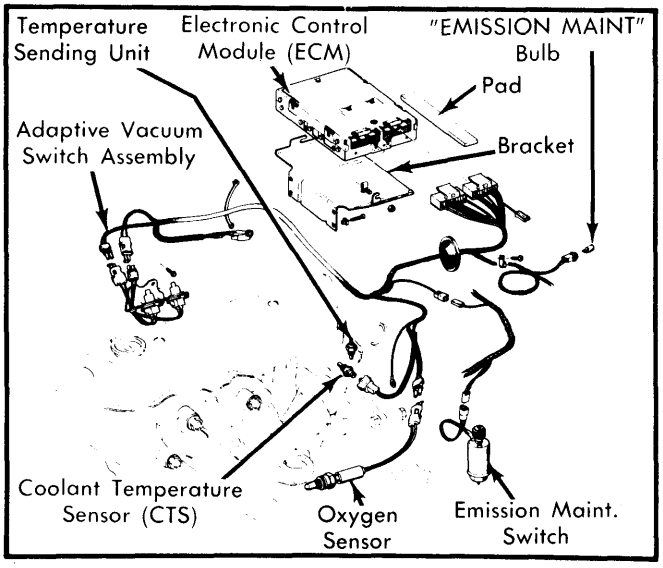


Fig. 1 American Motors C-4 System

OPERATION

The C-4 system consists of 5 sub-systems: Fuel control, data sensors, Electronic Control Module (ECM), catalytic converter and diagnostic system.

FUEL CONTROL

All models are equipped with feedback carburetors which contain an electronically operated Mixture Control (M/C) solenoid. The M/C solenoid operates a single metering rod in float bowl. Metering rod supplements fuel supplied to idle and main systems, varying air/fuel ratio within a pre-calibrated range. The M/C solenoid also controls air/fuel ratio through use of an idle air bleed circuit that operates in conjunction with metering rod.

The ECM, responding to inputs from data sensors, constantly adjusts air/fuel mixture to maintain engine performance. The ECM controls M/C solenoid by providing a ground for solenoid. When solenoid is energized, fuel flow through carburetor is reduced, providing a leaner mixture. When solenoid is de-energized, fuel flow through carburetor is increased, providing a richer mixture. The solenoid is cycled (turned on and off) at a rate of 10 times per second.

When ECM responds to signals received from oxygen sensor to adjust fuel mixture, the C-4 system is in closed loop operation. Under certain operating conditions, the ECM may ignore inputs from various sensors and use a pre-programmed calibration control to operate the engine under that particular condition. During cold engine starts (engine speed below 200 RPM), M/C solenoid is turned off by ECM to provide rich mixture. Operating conditions which cause ECM to ignore oxygen sensor signals, causes the C-4 system to operate in open loop mode.

DATA SENSORS

Each sensor furnishes electronic impulses to ECM. The ECM computes fuel mixture ratio necessary to maintain proper engine operation. The function of each sensor is closely related to each of the other sensors. Operation of each sensor is as follows:

Oxygen Sensor – This sensor is mounted in engine exhaust stream. It supplies a low voltage (under ½ volt) when fuel mixture is lean (too much oxygen) and a higher voltage (up to 1 volt) when fuel mixture is rich (not enough oxygen). Oxygen sensor must be hot (over 600°F) to function properly and to allow ECM to accept its electrical signals. The oxygen sensor measures quantity of oxygen only.

To ensure proper functioning of oxygen sensor, it must be replaced every 30,000 miles. An "EMISSION MAINTENANCE" lamp on the instrument panel will glow at the appropriate time.

NOTE – *No attempt should be made to measure oxygen sensor voltage output. Current drain of conventional voltmeter could permanently damage sensor, shift sensor calibration range and/or render sensor unusable. Do not connect jumper wire, test leads or other electrical connectors to sensor. Use these devices only on ECM side of harness after disconnecting from sensor.*

Coolant Temperature Sensor (CTS) – The CTS is located in engine coolant stream to supply coolant temperature information to ECM. It does not allow C-4 system operation (closed loop) while coolant temperature is below 150°F. Below this temperature, the ECM uses a pre-programmed ratio and maintains air/fuel ratio at a fixed ratio (open loop).

Adaptive Vacuum Switch (AVS) – The AVS is located inside engine compartment on right inside fender panel. This switch is closed during engine idle and partial throttle engine operation. During partial throttle operation (adaptive operation mode), the M/C solenoid is regulated to produce predetermined air/fuel mixture ratios. During acceleration from idle to partial throttle and deceleration from partial throttle to idle, oxygen sensor cannot react fast enough to changes in air/fuel mixture. As a consequence, high HC and CO exhaust gases would be emitted momentarily unless the system switched to pre-determined air/fuel mixture ratios.

Wide Open Throttle Switch (WOT) – This switch is used to detect full throttle condition by sensing manifold vacuum. When activated, a signal from WOT switch to ECM sets a temporary full rich mixture until throttle moves off wide open throttle position. Then the C-4 system returns to pre-WOT operating conditions. When wide open throttle condition occurs, decreased manifold vacuum (5 in. Hg) closes the WOT switch.

AMERICAN MOTORS COMPUTER CONTROLLED CATALYTIC CONVERTER (Cont.)

Distributor Reference – The distributor reference line provides ECM with engine RPM data. The M/C solenoid is de-energized until voltage is equal to 200 RPM. This results in a rich air/fuel mixture for engine starting.

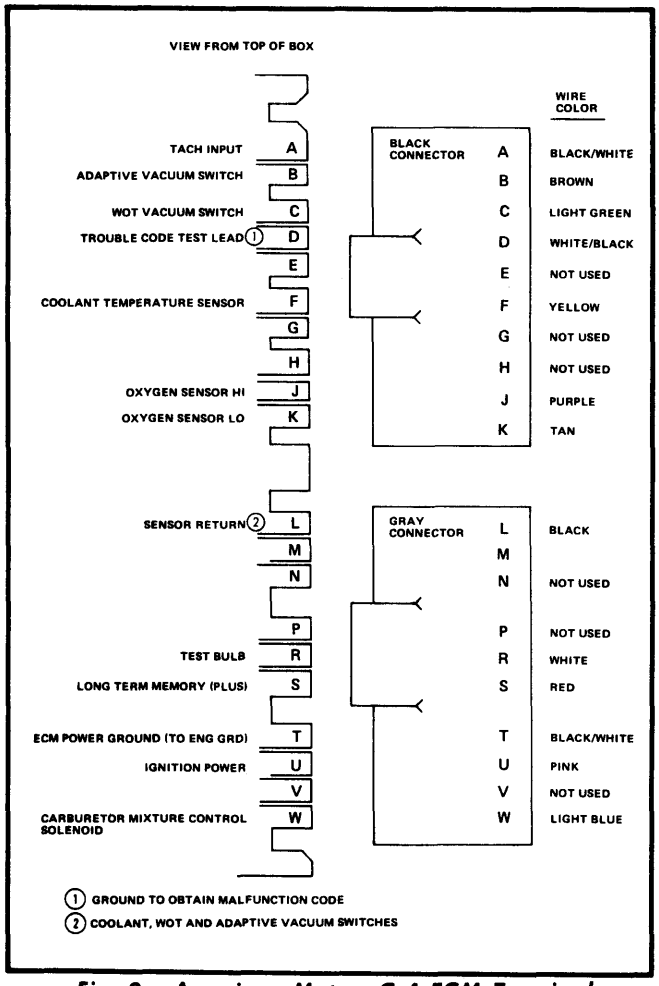


Fig. 2 American Motors C-4 ECM Terminal Identification

ELECTRONIC CONTROL MODULE (ECM)

The ECM is located in passenger compartment on the right-hand side, beneath heater assembly. The ECM consists of input/output devices, Central Processing Unit (CPU), power supply and memories. A brief description and operation of each component is as follows:

Input/Output Devices – These integral devices of ECM convert electrical signals received by data sensors and switches to digital signals for use by CPU.

Central Processing Unit (CPU) – Digital signals received by CPU are used to perform all mathematical computations and logic functions necessary to deliver proper air/fuel mixture.

Power Supply – Main source of power for the ECM is from the battery, through the ignition circuit.

Memories – The 3 types of memories in the ECM are: Read Only Memory (ROM), Random Access Memory (RAM) and Programmable Read Only Memory (PROM). Function of each memory is as follows:

- **Read Only Memory (ROM)** – The ROM is programmed information that can only be read by ECM. The ROM program cannot be changed. If battery voltage is removed, ROM information will be retained.

- **Random Access Memory (RAM)** – This memory is the scratch pad for the CPU. Information can be read into or out of RAM memory; similar to a calculator. Data sensor information, diagnostic codes and results of calculations are temporarily stored in RAM memory. If battery voltage is removed, all information stored in this memory is lost.

- **Programmable Read Only Memory (PROM)** – This memory is factory-programmed information containing engine calibration data for each engine, transmission, body and rear axle ratio application. If battery voltage is removed, PROM information will be retained.

CATALYTIC CONVERTER

Proper emission control is accomplished with the special catalytic converter system used with the C-4 system. All models are equipped with a 3-way, pellet type converter. 3-way means that it converts all 3 major pollutants (CO, HC and NOx). In order for these converters to be effective, precise control of oxygen content of gases entering the converter is necessary. This is why an oxygen sensor, ECM and feedback carburetor are needed.

DIAGNOSTIC SYSTEM

The ECM of the C-4 system is equipped with a self-diagnostic system which detects system failures or abnormalities. These failures will illuminate a test bulb (connected to ECM terminal "R"). Malfunctions are recorded as "hard failures" or "intermittent failures".

- "Hard failures" cause test bulb to glow and remain on until malfunction is repaired. If test lamp remains on during vehicle operation, cause of malfunction MUST be determined.

- "Intermittent failures" cause test bulb to flicker or go off when fault no longer exists, but a corresponding trouble code will be retained in ECM memory until battery voltage is removed.

As a routine system check, the test bulb will be illuminated when ignition switch is turned on without engine being cranked. When engine is started, the bulb will go out after a few seconds if no "hard failure" is detected.

NOTE – *Trouble codes will be recorded at various operating times. Some codes require operation of engine at partial throttle for 5-18 minutes, before being diagnosed and recorded in memory.*

DIAGNOSIS & TESTING

C-4 DIAGNOSIS

The ECM stores component failure information for C-4 system under a related trouble code which can be recalled for diagnosis and repair. When recalled, these codes will be dis-

AMERICAN MOTORS COMPUTER CONTROLLED CATALYTIC CONVERTER (Cont.)

played by flashes of test lamp connected to ECM wiring harness. Codes are displayed starting with lowest numbered code. Only codes in which a related malfunction has occurred will be displayed.

System Check – 1) As a routine check of diagnostic system, turn ignition switch on (engine stopped) and ground trouble code test lead located beneath dash (black/white wire attached to ECM terminal "D").

2) Insert test lamp into terminal "R" of ECM (white wire) with ignition on. If system is operating properly, test lamp will flash code "12", which indicates proper operation. Code"12" will be flashed as follows: "FLASH", short pause, "FLASH", "FLASH", followed by a longer pause. After the long pause, code "12" will repeat itself 2 more times. This will continue until engine is started, ignition turned off or test lead ungrounded.

CAUTION – *Do not ground test terminal before ignition is turned on or engine is started.*

Entering Diagnostic Mode – Turn ignition on (engine off). Insert test lamp into ECM terminal "R" and ground ECM terminal "D". Trouble code "12" should flash 3 times. If any trouble codes are stored in ECM memory, they will be displayed. Trouble codes will flash from lowest to highest (3 times) in same manner as code "12". Cycle will be repeated as long as test terminal of ECM is grounded.

NOTE – *Trouble codes will flash 3 times, then be followed by next trouble code, from lowest to highest numbered code. For example: A FLASH, pause, FLASH, FLASH, FLASH, FLASH followed by a longer pause indicates code "14". A FLASH, FLASH, FLASH, FLASH, pause, FLASH, FLASH, FLASH, FLASH, FLASH followed by a longer pause indicates code "45".*

Exiting Diagnostic Mode – To exit diagnostic mode, disconnect test lamp and remove ground from test lead. Turn ignition off.

ECM TROUBLE CODE IDENTIFICATION

Code	Circuit Affected
12	No RPM voltage to ECM.
13	Oxygen sensor circuit.
14	Shorted coolant temperature sensor circuit.
15	Open coolant temperature sensor circuit.
21 & 22	At same time, grounded WOT switch circuit.
22	Short in adaptive vacuum or WOT circuit to ground.
23	Open or grounded M/C solenoid circuit.
44	Lean oxygen sensor indication.
44 & 45	At same time, fautly oxygen sensor circuit.
45	Rich oxygen sensor indication.
51	Faulty PROM or improper PROM installation.
52 & 53	Test bulb off – intermittent ECM problem, test bulb on – faulty ECM.
54	Faulty M/C solenoid and/or ECM.
55	Faulty oxygen sensor circuit or ECM.

Clearing Trouble Codes – Trouble codes stored in ECM memory may be cleared by removing negative battery terminal for 10 seconds, AFTER exiting diagnostic mode.

NOTE – *The terms "enter diagnostics" and "exit diagnostics" will be used periodically throughout this section. Follow the procedure for entering diagnostic mode when instructed to "enter diagnostics". Follow the procedure for exiting diagnostic mode when instructed to "exit diagnostics".*

FAILURE CODE DETERMINATION

During any diagnostic procedure, "hard failure" codes MUST be distinguished from "intermittent failure" codes. Diagnostic charts CANNOT be used to analyze "intermittent failure" codes, except as noted under Diagnostic Procedure. To determine "hard failure" codes, proceed as follows:

1) Turn ignition on. Enter diagnostics. Read and record all stored trouble codes. Exit diagnostics and clear memory. Reconnect negative battery cable.

2) Apply parking brake and place transmission in neutral (manual) or park (automatic). Block drive wheels. Start engine. Enter diagnostic mode. Operate engine below 800 RPM for 5 minutes.

3) If test lamp flashes trouble codes (except "13", "44" and "45"), note and record trouble codes. This will reveal "hard failures". Codes "13", "44" and "45" require engine operation at partial throttle with an engine load (road test) for an extended period of time before fault is detected.

NOTE – *Trouble code "15" fault will only display after 5 minutes of engine operation. Trouble code "12" will display only during time of no reference pulses received by ECM; it will never be stored as a malfunction.*

4) If test lamp does not flash trouble codes (except "13", "44" and "45"), all trouble codes stored in memory were "intermittent failures", except as noted under Diagnostic Procedure.

NOTE – *Grounding test terminal with engine running will force engine to operate in closed loop mode if engine is warm and oxygen sensor is hot. If test lamp does not glow while in closed loop, C-4 system is operating properly.*

DIAGNOSTIC PROCEDURE

NOTE – *If vehicle exhibits performance problems and no codes are flashed, refer to System Performance Chart. Components recorded by trouble codes generally do not cause performance problems when no codes are stored in ECM memory.*

The C-4 system should be considered as a possible source of trouble on engine performance, fuel economy and exhaust emission complaints ONLY after normal checks, which apply to a vehicle without C-4, have been performed. Diagnosis of C-4 system consists of 3 check sheets: Diagnostic Circuit Check, Driver Complaint Sheet and System Performance Check. Any of these check sheets may lead to a chart for locating source of problem or indicate no problem on that sheet and refer to another sheet. If there is no trouble in C-4 system, all 3 check sheets will result in that conclusion. The check sheets and their procedure are as follows:

Diagnostic Circuit Check – 1) If complaint is test lamp related, this check will lead to probable problem area, if malfunction exists. Enter diagnostics and record stored trouble codes. Begin diagnosis with lowest numbered code which is displayed and refer to appropriate trouble code chart.

AMERICAN MOTORS COMPUTER CONTROLLED CATALYTIC CONVERTER (Cont.)

2) If code "52" or "53" is displayed, check PROM installation before replacing ECM.

3) If codes "54" or "55" are displayed with another code, always refer to diagnostic chart for code "54" or "55" first, then proceed to lowest numbered code.

NOTE – *Any time codes "51", "52", "53", "54" or "55" are displayed with another code, start with "50-series" code first, then proceed to lowest numbered code.*

4) If codes "44" and "55" are both displayed, replace oxygen sensor and perform System Operational Test.

5) If "intermittent failure" codes "13", "15", "44" or "45" are displayed, use diagnostic chart for corresponding "hard failure" code.

Driver Complaint Sheet – 1) If complaint is not test lamp related, this check sheet will lead to probable problem area, if malfunction exists. Make checks that would normally be made for the complaint on a vehicle without C-4 system.

2) Follow diagnostic chart and repair malfunction. After repair, perform System Performance Check.

System Performance Check – 1) This check verifies that C-4 system is functioning properly. This check should always be made after any repair to C-4 system.

2) The oxygen sensor will cool off after only a short period of time while engine is idling. This will cause engine to go into open loop. To restore closed loop mode, run engine at part throttle several minutes and accelerate from idle to part throttle several times.

NOTE – *Although there are many charts connected with C-4 diagnosis, only 2 charts are needed to prove the system is operating properly. Normally only 3 charts are necessary to find a problem, if one exists.*

Diagnostic Tools – 1) The C-4 system does not require specially produced tools for diagnosis. A dwell meter, tachometer, test light, ohmmeter, digital voltmeter with 10 megohms impedance (minimum), vacuum pump, vacuum gauge and 6 jumper wires 6" long (1 wire with female connectors at both ends; 1 wire with male connectors at both ends; 4 wires with male and female connectors at opposite ends) are only tools necessary for diagnosis.

2) A test light, rather than a voltmeter, must be used when indicated by diagnostic chart.

NOTE – *If dwell meter causes a change in engine operation when connected to M/C solenoid "DWELL" lead (green connector near carburetor), it CANNOT be used. The following tach/dwell models should not be used: G, GA, TDT 1, 2 or 5, 216 and 216/1.*

Connecting Dwell Meter – 1) Dwell meter set on "6-cylinder" scale is used to measure ECM output and M/C dwell (duty cycle). A green connector located in wiring harness near carburetor is dwell meter connection point.

2) When dwell meter is connected, do not allow terminal to touch any ground source, including hoses. This could damage ECM. On a normal operating engine, dwell at both idle and part throttle should read between 10-50° and will be varying. "Varying" means needle will continually move up and down the scale. The amount of variation does not matter, only fact that it does move.

3) This variation of needle indicates system is in closed loop and ECM is responding to signals from oxygen sensor. At wide open throttle or cold engine operation, dwell will be fixed (needle steady). This indicates open loop and ECM is ignoring oxygen sensor signal.

4) If there is doubt whether engine is in closed loop or open loop, richen or lean mixture (choke carburetor or cause air leak). This action will cause dwell to change if engine is in closed loop.

DRIVER COMPLAINT SHEET

Engine performance problem (odor, surge, fuel economy ...)

Emission Problem

If the test bulb is not on, normal checks that would be performed on cars without C-4 should be done first. If generator or coolant light is on with test bulb, diagnose those first.

Inspect for poor connections at coolant sensor, M/C solenoid, etc., and poor or loose vacuum hoses and connections. Repair as necessary.

- Intermittent test bulb light but no trouble code stored:

  1) Check for poor connection in circuit from:

     - Distributor tach terminal to ECM terminal A.
     - Ignition terminal 1 to ECM terminal U.
     - ECM terminal T to ground.

  2) Tach filter resistance should be 14,000-18,000 ohms between distributor and ECM terminals (with 1 end disconnected) and open circuit to ground.

  3) Battery voltage below 9 volts.

  4) Loss of long term memory. Momentarily grounding M/C solenoid dwell wire connector with engine idling should cause trouble code "23", which should be retained after engine is stopped and restarted. If voltage is present at long term memory terminal (S) but code was not flashed. ECM is defective.

- Acceleration Stumble.

  See Chart No. 5 (Adaptive Vacuum Switch Circuit Test).

- All Other Complaints.

  Perform System Performance Check on warm engine (upper radiator hose HOT).

NOTE: Any time engine is first started, even if warm, it must be operated at partial throttle for 3 minutes or until dwell starts to vary before proceeding with any test. Also, install test bulb before performing tests.

AMERICAN MOTORS COMPUTER CONTROLLED CATALYTIC CONVERTER (Cont.)

DIAGNOSTIC CIRCUIT CHECK

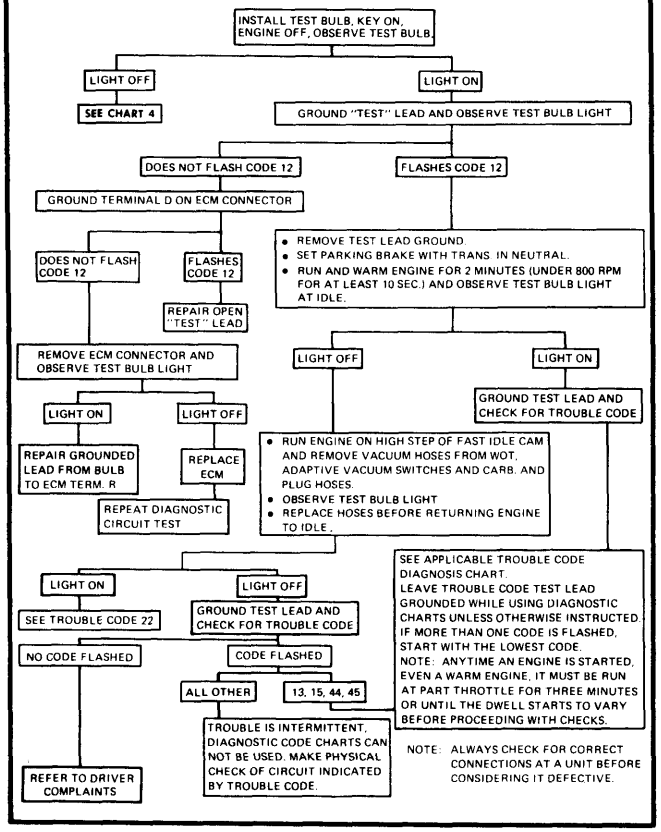
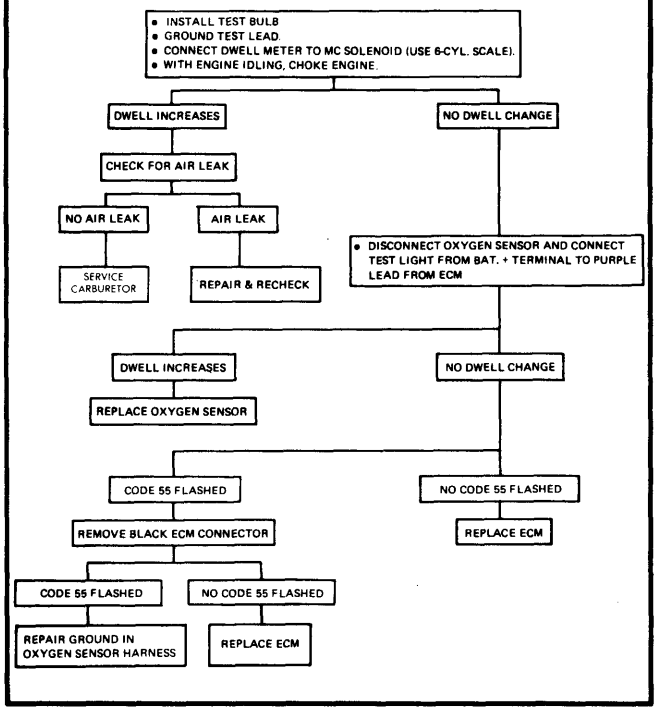
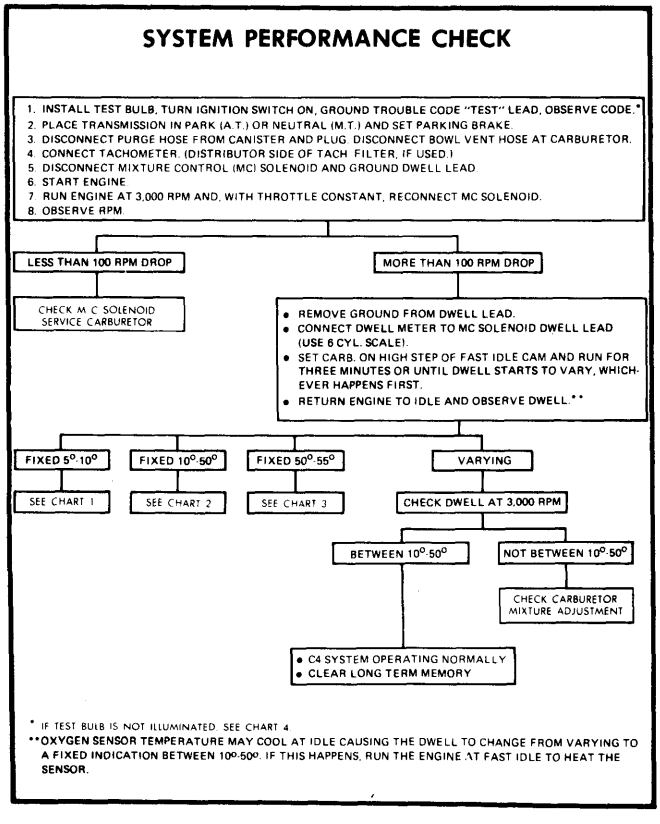


CHART NO. 1
DWELL FIXED – 5-10°



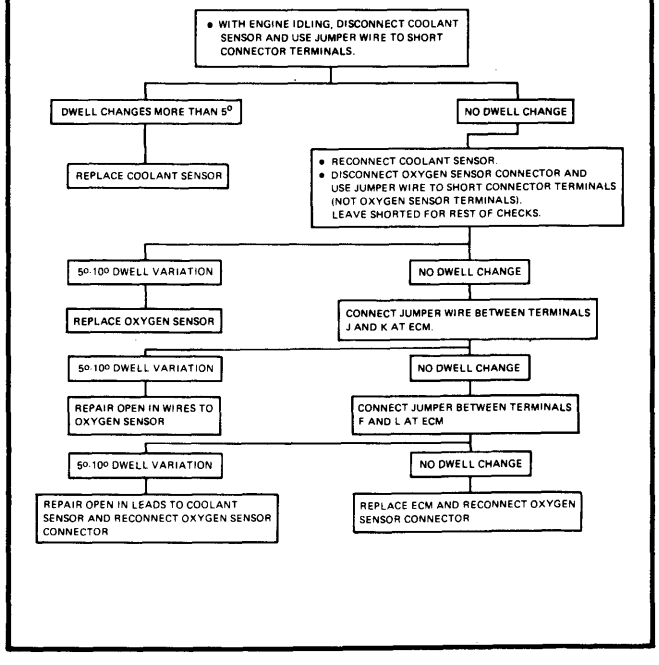
SYSTEM PERFORMANCE CHECK



* IF TEST BULB IS NOT ILLUMINATED, SEE CHART 4.

**OXYGEN SENSOR TEMPERATURE MAY COOL AT IDLE CAUSING THE DWELL TO CHANGE FROM VARYING TO A FIXED INDICATION BETWEEN 10°-50°. IF THIS HAPPENS, RUN THE ENGINE AT FAST IDLE TO HEAT THE SENSOR.

CHART NO. 2
DWELL FIXED – 10-50°



AMERICAN MOTORS COMPUTER CONTROLLED CATALYTIC CONVERTER (Cont.)

CHART NO. 3
DWELL FIXED – 50-55°

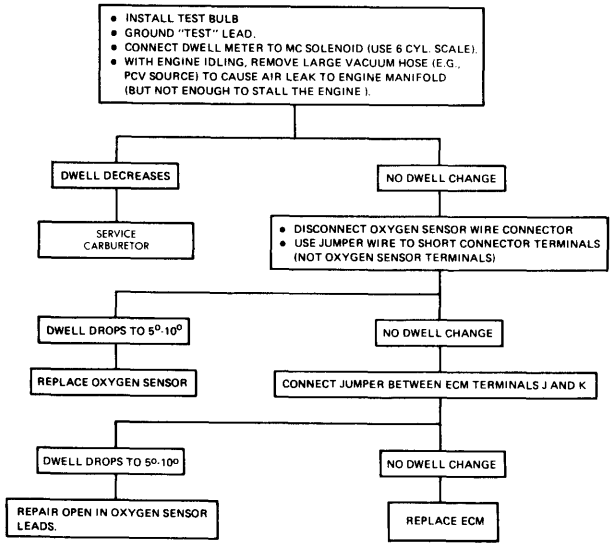
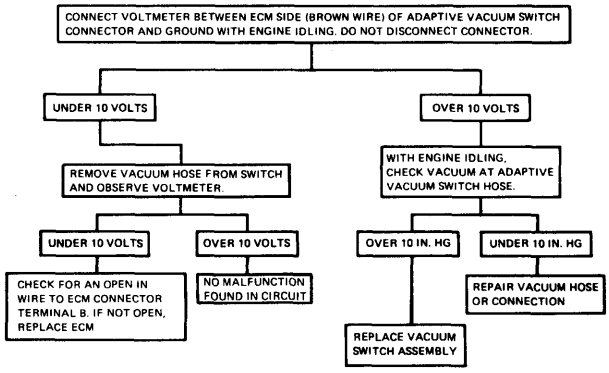


CHART NO. 5
ADAPTIVE VACUUM SWITCH CIRCUIT TEST



TROUBLE CODE 12

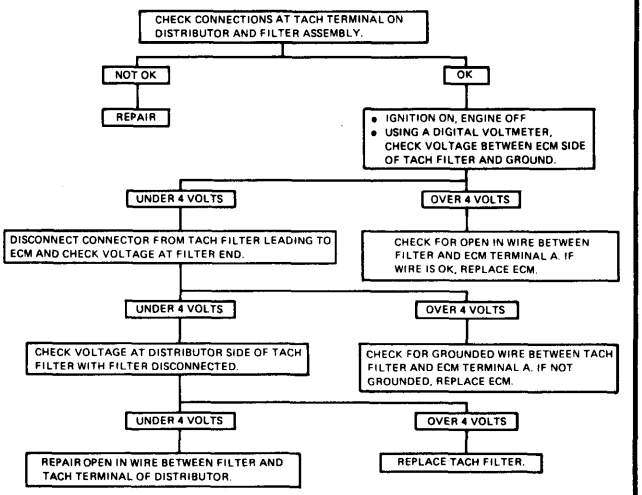
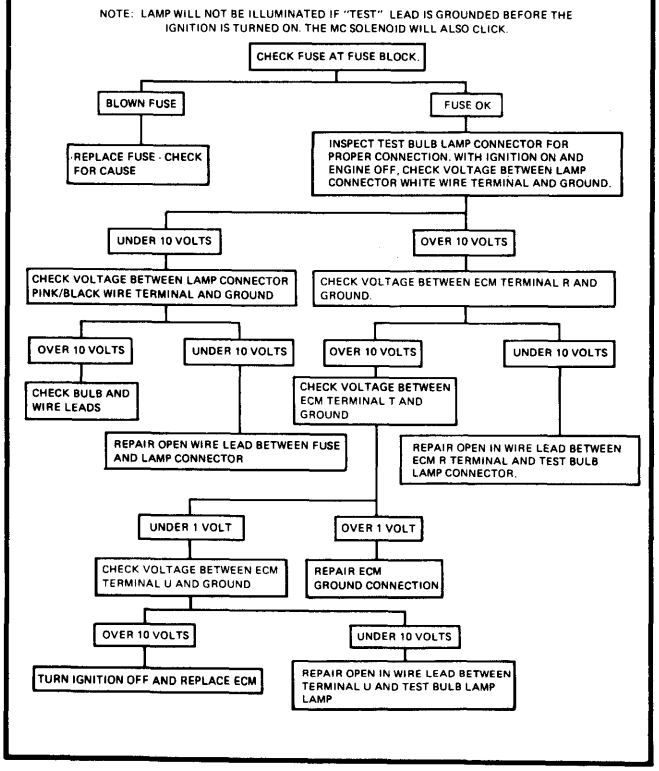
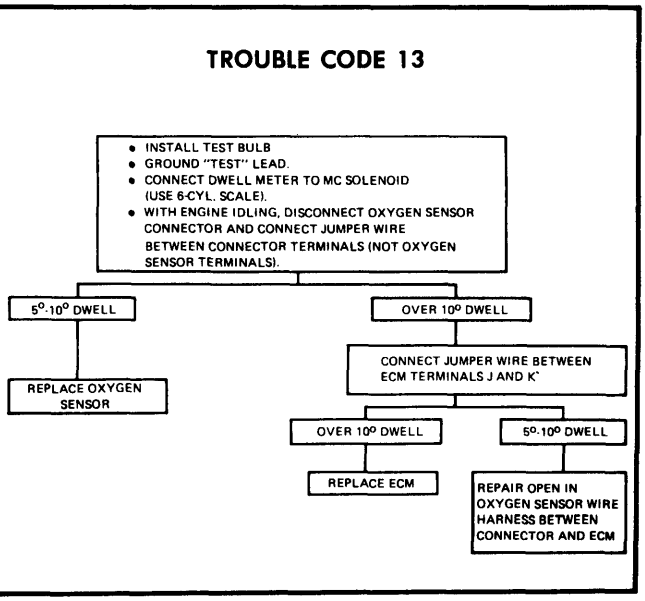


CHART NO. 4
TEST BULB CIRCUIT INOPERATIVE



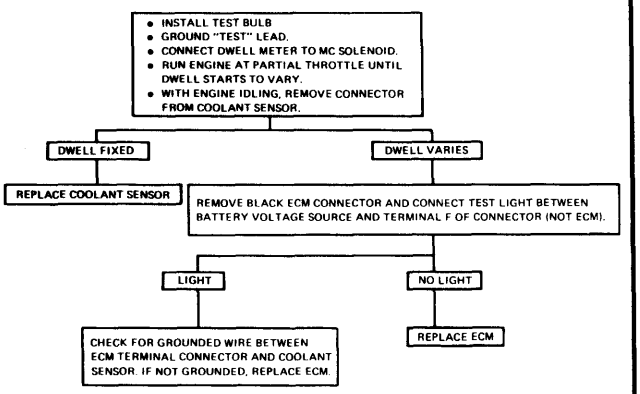
TROUBLE CODE 13



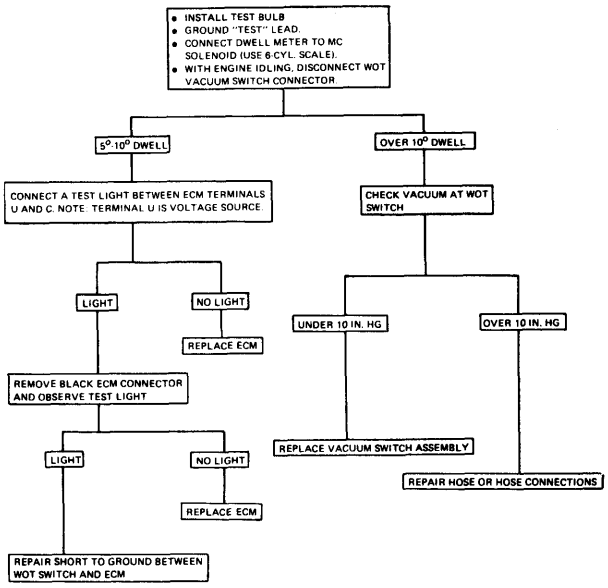
AMERICAN MOTORS COMPUTER CONTROLLED CATALYTIC CONVERTER (Cont.)

TROUBLE CODE 14

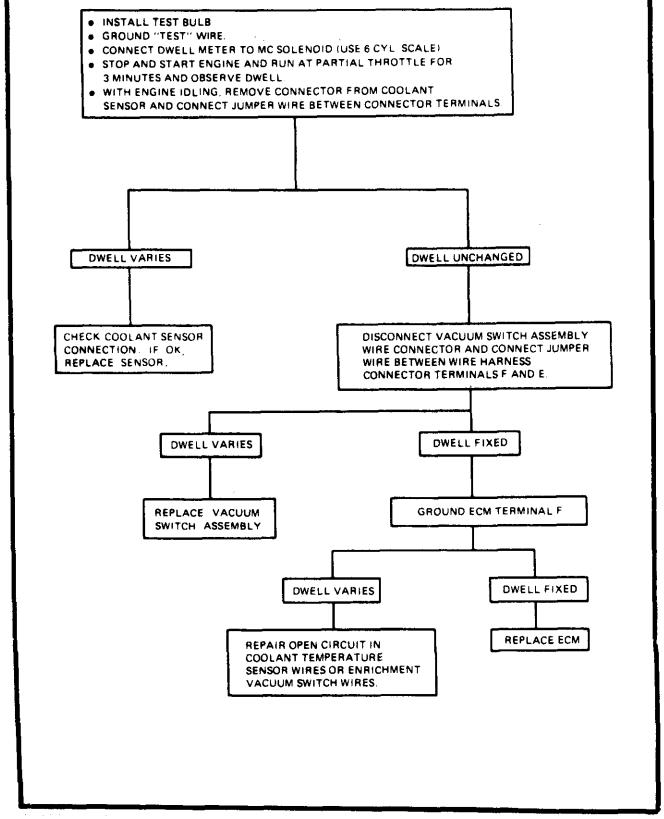
NOTE: IF THE ENGINE COOLANT IS EXCESSIVELY HOT, CHECK FOR CAUSE OF OVERHEATING CONDITION BEFORE PERFORMING THE FOLLOWING TEST.



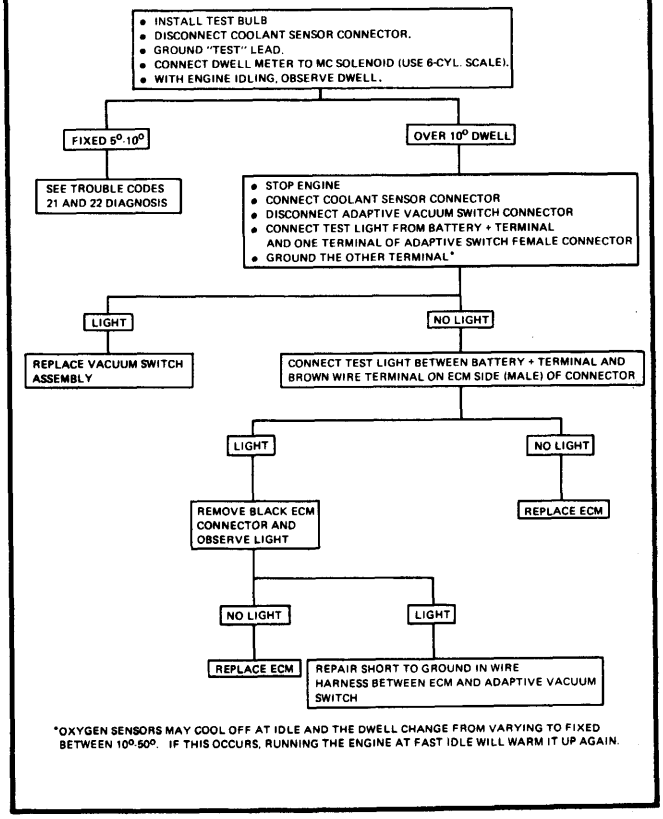
TROUBLE CODES 21 & 22 TOGETHER



TROUBLE CODE 15



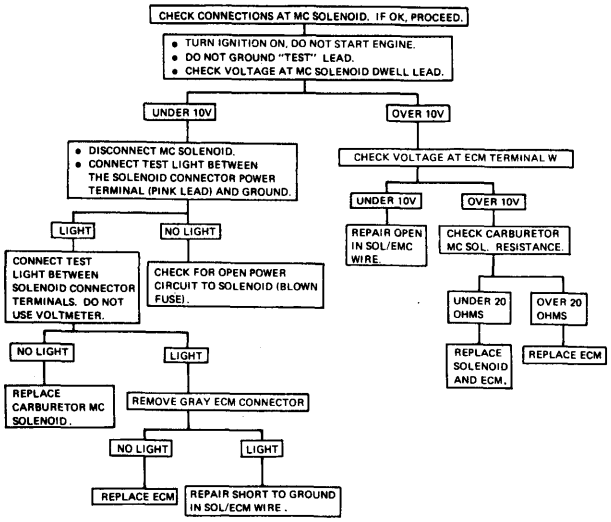
TROUBLE CODE 22



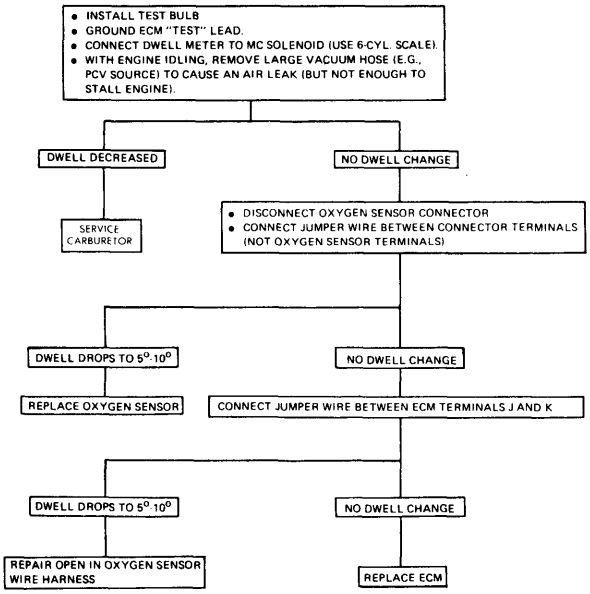
*OXYGEN SENSORS MAY COOL OFF AT IDLE AND THE DWELL CHANGE FROM VARYING TO FIXED BETWEEN 10°-50°. IF THIS OCCURS, RUNNING THE ENGINE AT FAST IDLE WILL WARM IT UP AGAIN.

AMERICAN MOTORS COMPUTER CONTROLLED CATALYTIC CONVERTER (Cont.)

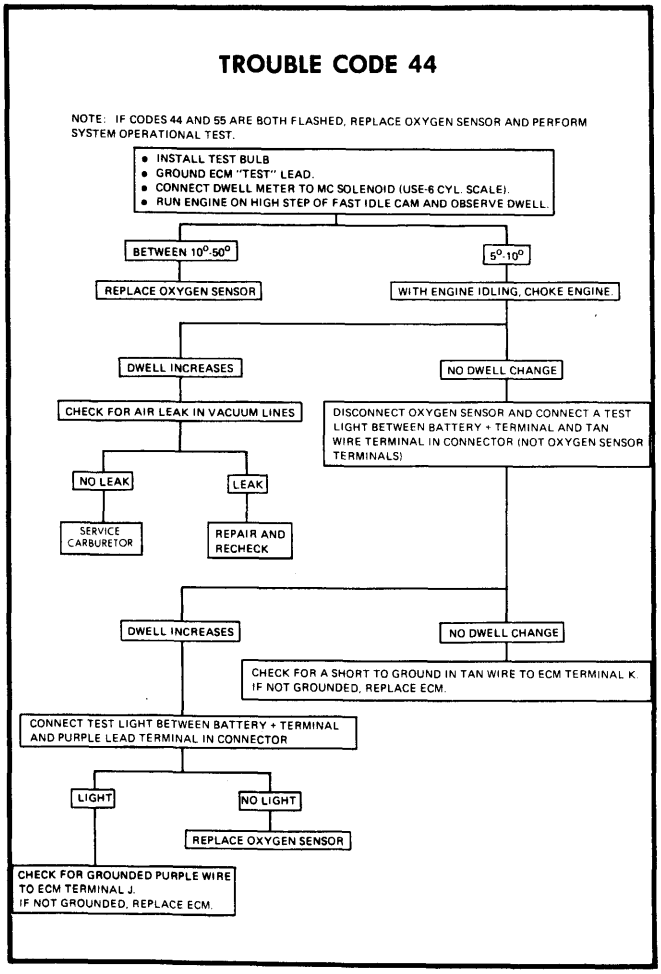
TROUBLE CODE 23



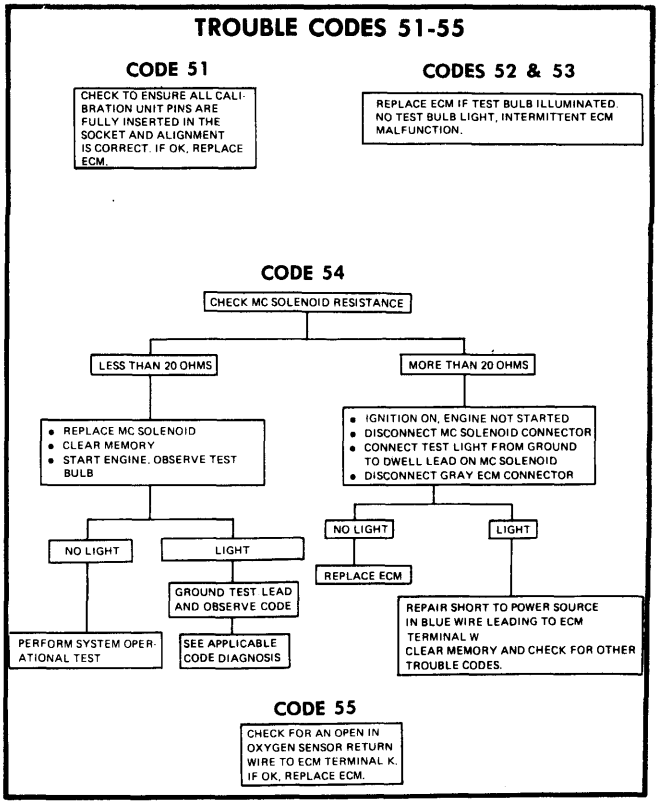
TROUBLE CODE 45



TROUBLE CODE 44



TROUBLE CODES 51-55



AMERICAN MOTORS COMPUTER CONTROLLED CATALYTIC CONVERTER (Cont.)

MAINTENANCE

OXYGEN SENSOR REPLACEMENT

Every 30,000 miles, an "EMISSION MAINT" lamp will glow on instrument panel, indicating need for oxygen sensor replacement.

"EMISSION MAINT" LAMP RESET

The emission maintenance lamp is located between upper and lower speedometer cables under the hood of left side of dash panel. To reset, turn spring-loaded reset screw on switch body 1/4 turn counterclockwise to reset detent position.

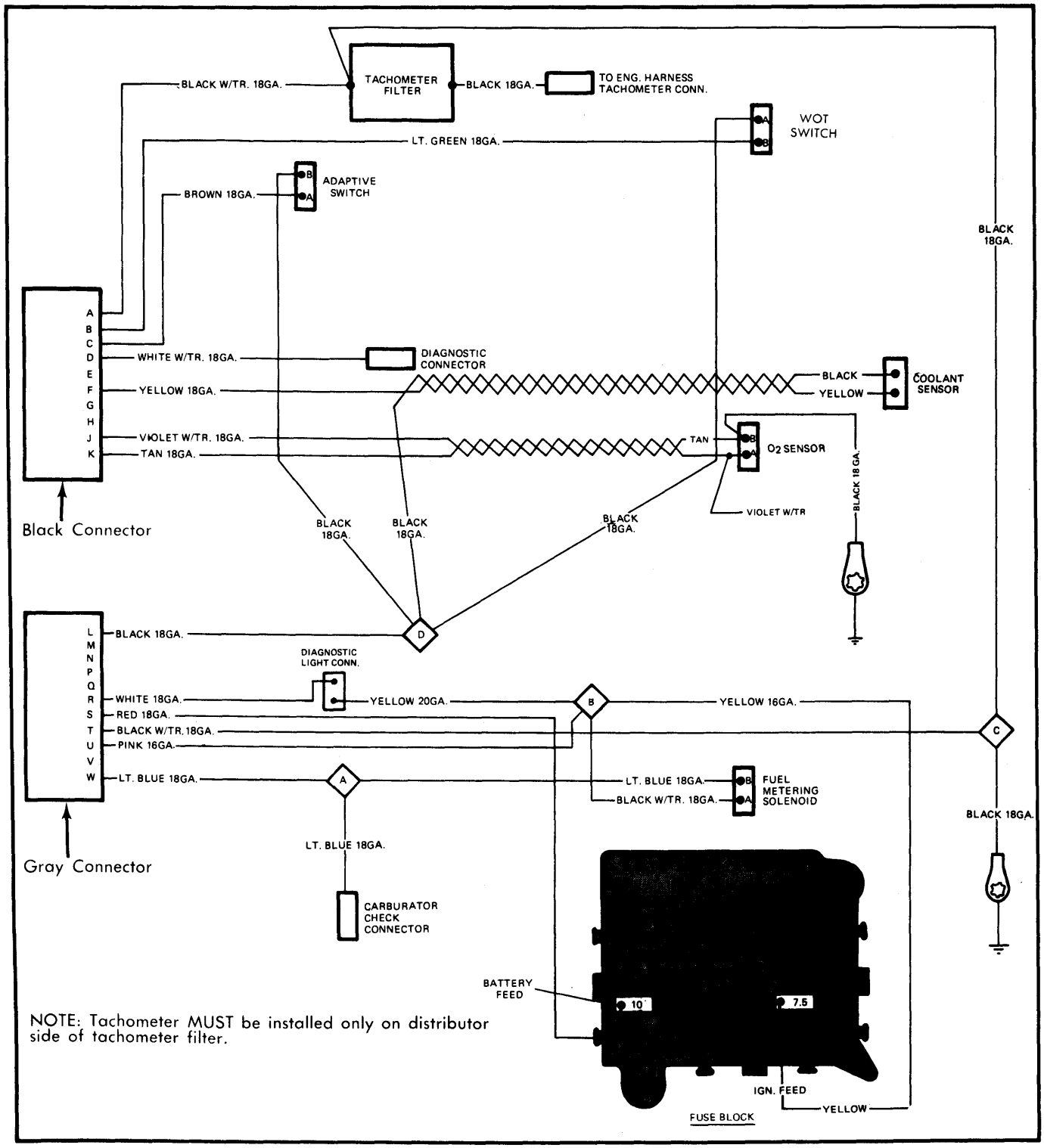


Fig. 3 American Motors C-4 Wiring Diagram

AMERICAN MOTORS COMPUTER CONTROLLED CATALYTIC CONVERTER (Cont.)

REMOVAL & INSTALLATION

ELECTRONIC CONTROL MODULE (ECM)

Removal & Installation – Disconnect electrical connector and remove sensor. Install replacement sensor and tighten to 72 INCH lbs. (8.1 N·m). Reconnect electrical lead.

COOLANT TEMPERATURE SENSOR

Removal & Installation – Disconnect electrical connector and remove sensor. Install replacement sensor and tighten to 72 INCH Lbs. Reconnect electrical lead.

ADAPTIVE VACUUM SWITCHES

Removal & Installation – Note positions of vacuum hoses and disconnect from switches. Disconnect electrical leads. Remove vacuum switches and bracket assembly. To install, reverse removal procedure.

NOTE – *Vacuum switches are not serviced individually. Replace as component set.*

OXYGEN SENSOR

Removal & Installation – Disconnect sensor electrical lead. Using remover (J-29533), carefully remove oxygen sensor. Clean threads of manifold. To install, coat threads of new oxygen sensor with anti-seize compound and carefully install sensor. Tighten sensor to 20-25 ft. lbs. (27-34 N·m) and reconnect electrical lead. Reset "EMISSION MAINT" lamp.