

# On-Board Diagnostics and Scan Tools



- On-board diagnostic systems
- Scanning computer problems
- Erasing trouble codes

# On-Board Diagnostic Systems

- Modern automotive computer systems are designed to detect problems and indicate where they might be located
- This has greatly simplified the troubleshooting of complex automotive systems

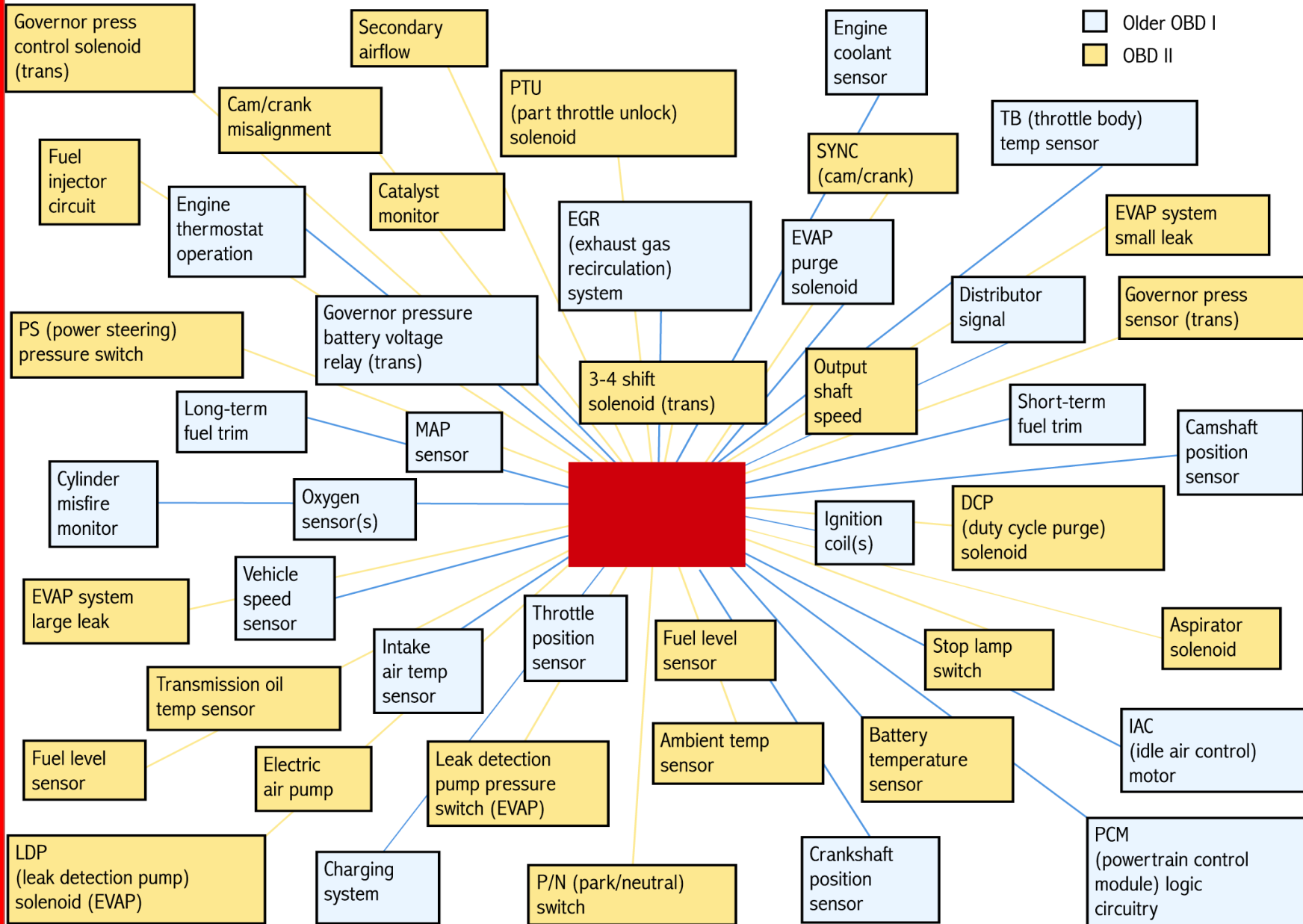
# OBD I Systems

- Most early on-board diagnostic systems can only check a limited number of items
  - able to detect a problem in a circuit, but unable to determine the type of problem (faulty wiring, defective component, etc.)
- There was little standardization
  - each manufacturer used different connectors, terminology, and trouble codes

# OBD II Systems

- Designed to more efficiently monitor the condition of hardware and software that affect emissions
- Diagnostics can detect part deterioration, not just complete failure
- OBD II standardized data link connectors, trouble codes, terminology, and scan tool capabilities

# SYSTEMS MONITORED BY ON-BOARD DIAGNOSTICS



# Malfunction Indicator Lamp (MIL)

- If an unusual condition or electrical value occurs, the computer will illuminate the warning light on the instrument panel
- This will notify the driver that the vehicle needs service
- The technician can then use a scan tool to retrieve information

# Malfunction Indicator Lamp (MIL)

- Continuous illumination means the trouble should be repaired at the owner's convenience
- A flashing MIL means the trouble could damage the catalytic converter and should be fixed immediately
- An intermittent MIL means the problem is intermittent



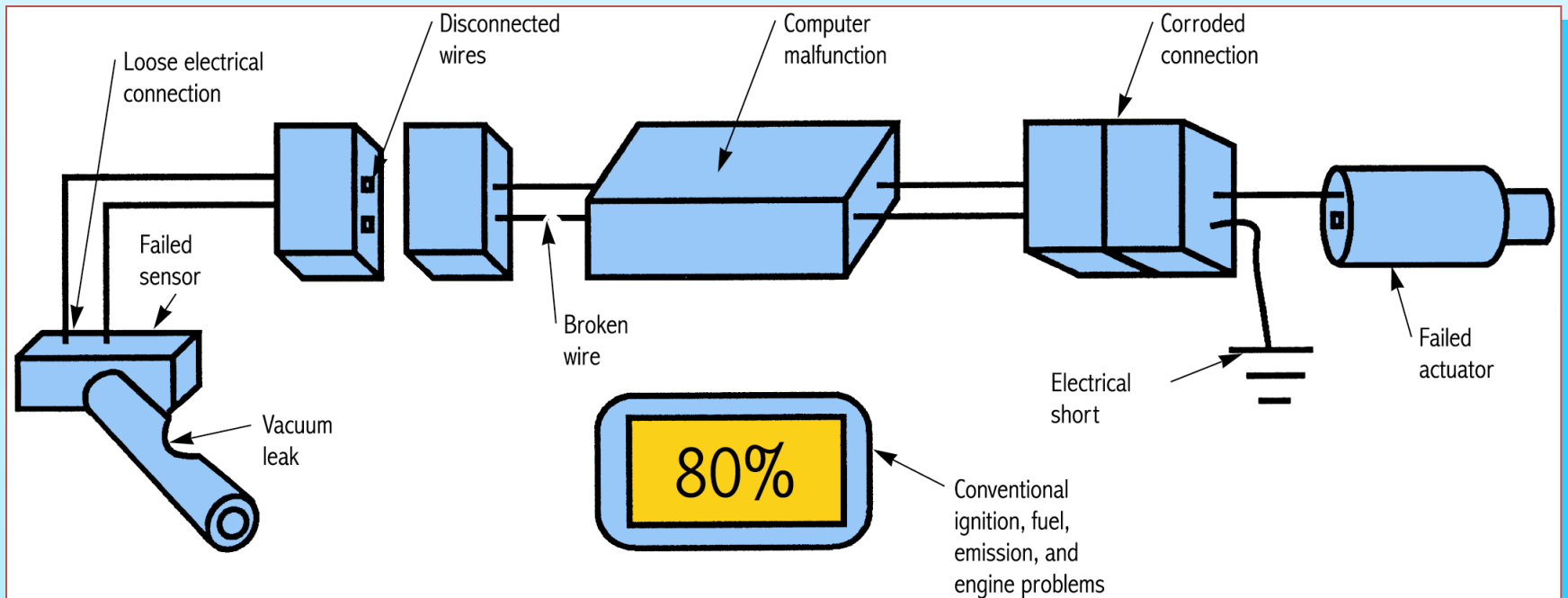
# Trouble Code Chart

- Provided in the service manual
- States what each number code represents
- Most scan tools have the capability to perform trouble code conversion
  - scan tool automatically converts the number code into abbreviated words that explain the code

# Diagnostic Trouble Codes

- Digital signals produced and stored by the computer when an operating parameter is exceeded
- Parameters include sensor voltage or resistance range, actuator current flow, and actuator movement

# Computer System Problems



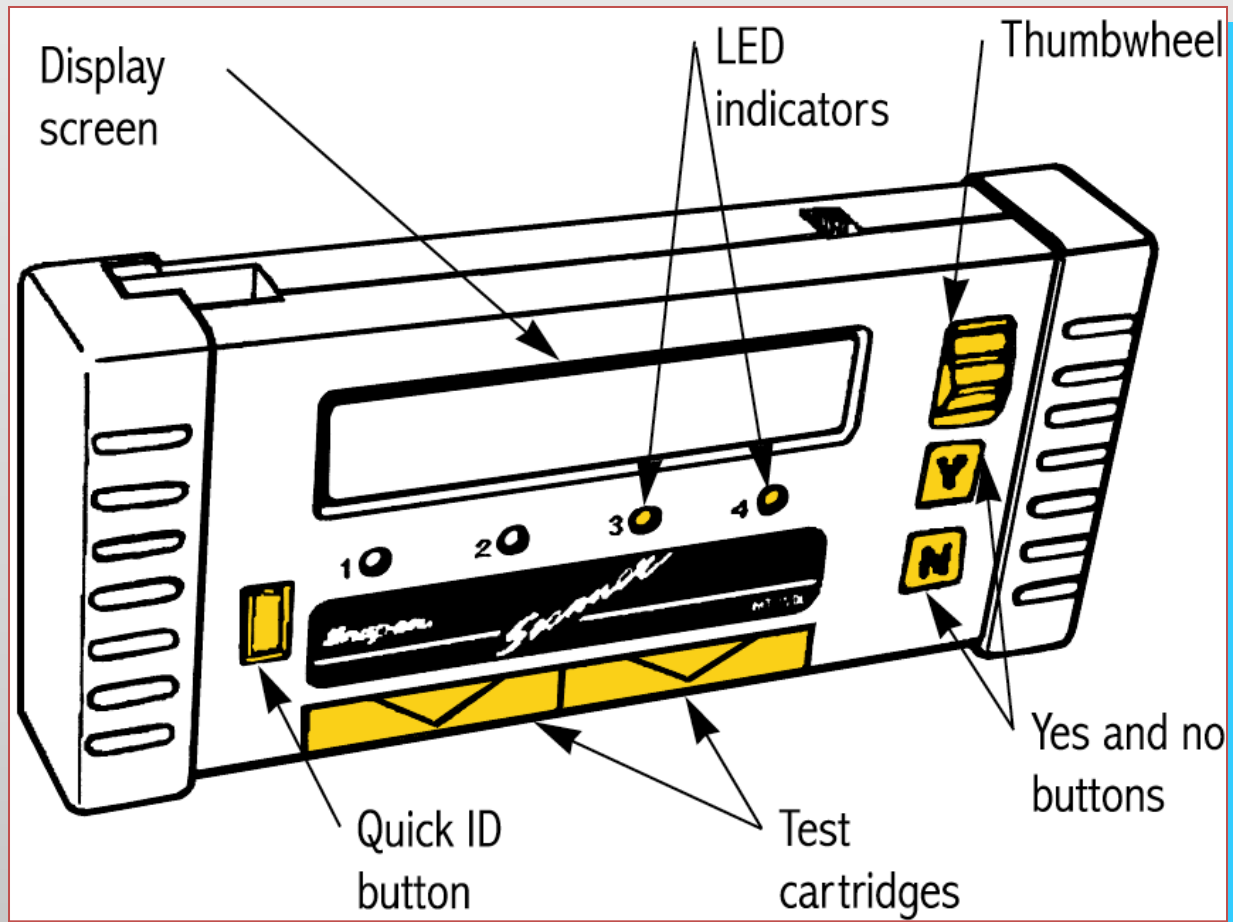
Most performance problems are not caused by the computer, its sensors, or its actuators

# Scanning Computer Problems

A scan tool is an electronic test instrument used to retrieve trouble codes from the computer's memory and display the codes as numbers and words

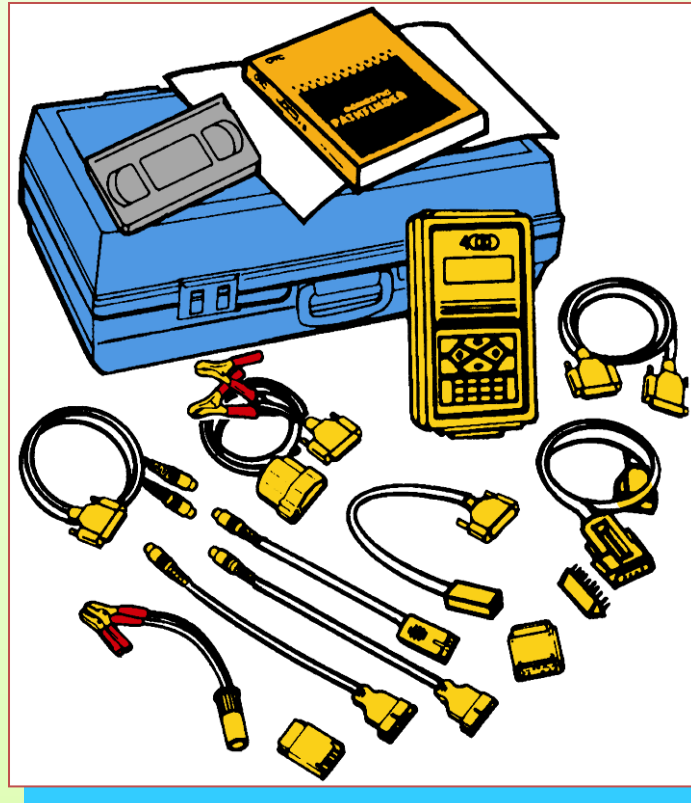
Many scan tools can also display input and output circuit operating values

# Scan Tool



On many vehicles, the scan tool is the only way to access on-board diagnostics

# Scan Tool Kit



Read the tool's operating instructions. Operating procedures vary.

# Scan Tool Program Cartridges

- Contain specific information about the vehicle to be scanned
- Available for systems such as engines, anti-lock brakes, or automatic transmissions
- Some cartridges are now updated by downloading current specifications from a computer

# Scan Tool Program Cartridges





# Installing Cartridges



Do not touch the cartridge terminals; static electricity could damage the electronics

# Troubleshooting Cartridge

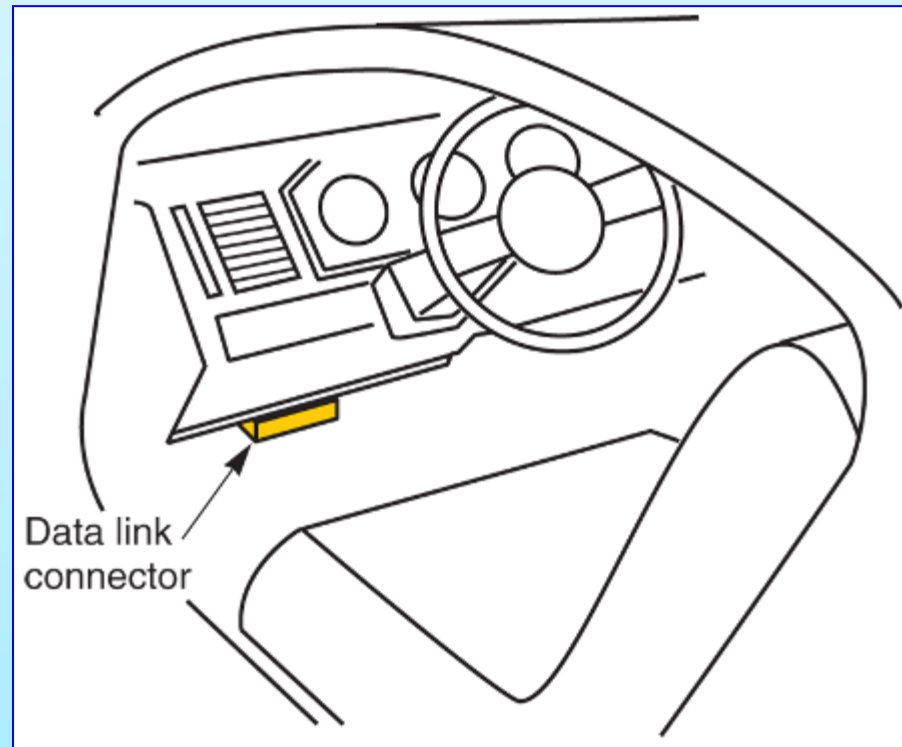


Provides additional information about how to verify the source of various trouble codes

# Data Link Connector

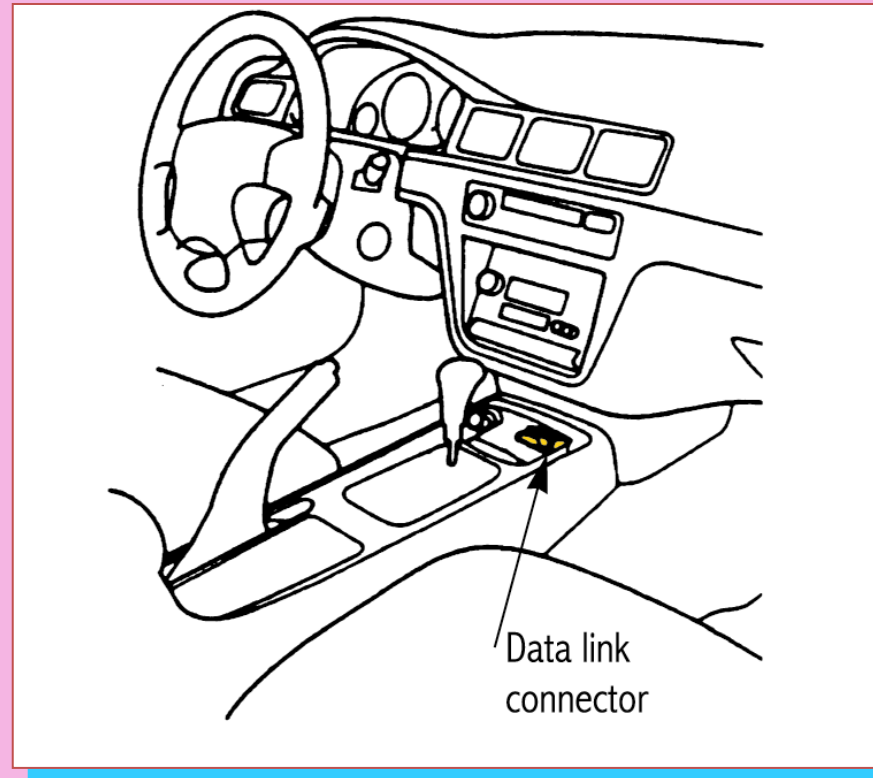
- Multipin terminal used to link the scan tool to the computer
- OBD I connectors came in various shapes, sizes, and locations
- OBD II connectors are standardized 16-pin connectors located under the dash

# Diagnostic Connector Location



This OBD II connector is located below the dash

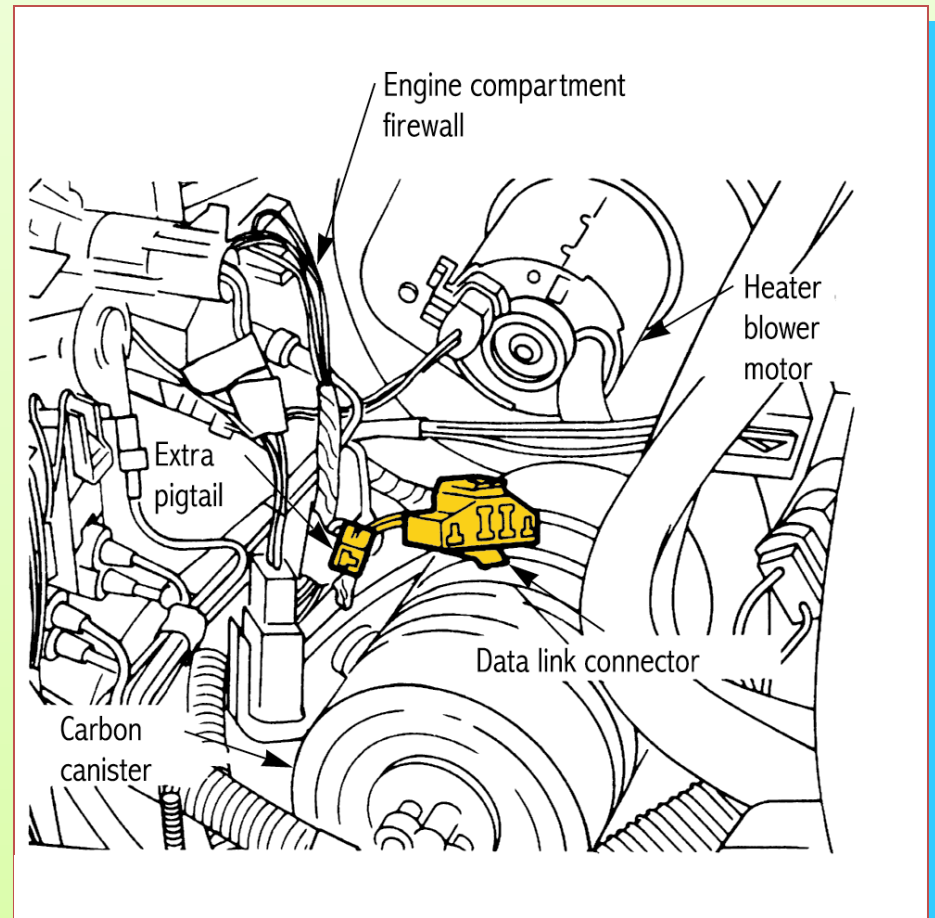
# Diagnostic Connector Location



This OBD II connector is located in the center console

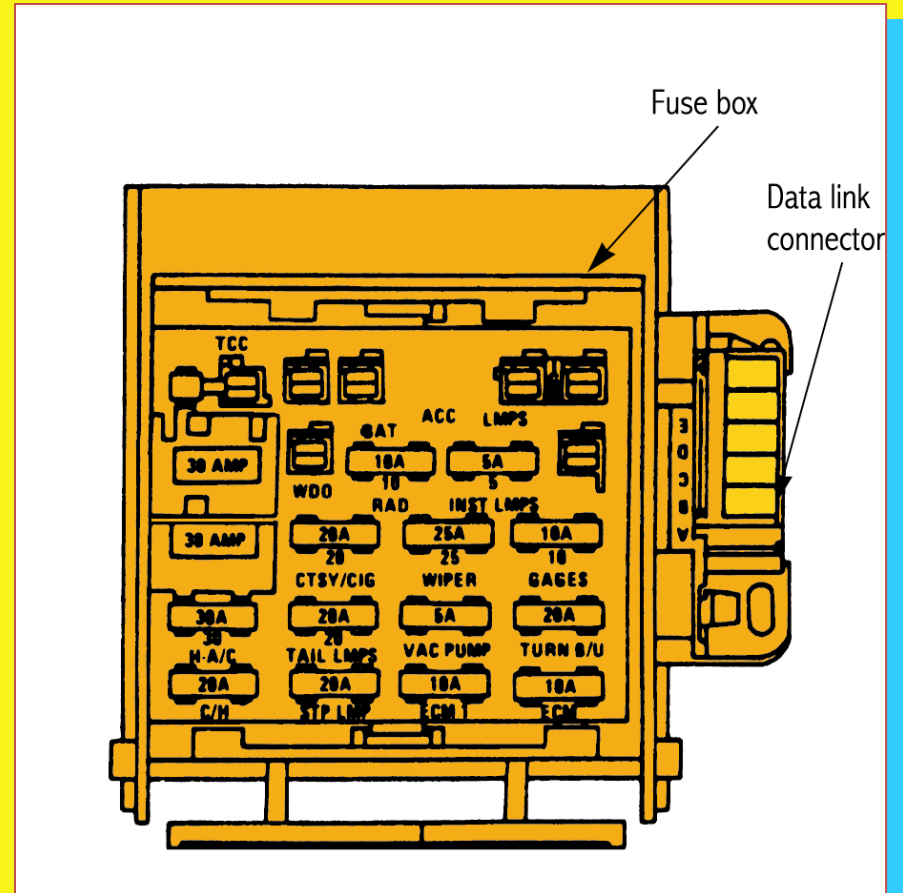
# Diagnostic Connector Location

Early Ford  
diagnostic connector  
located by the engine

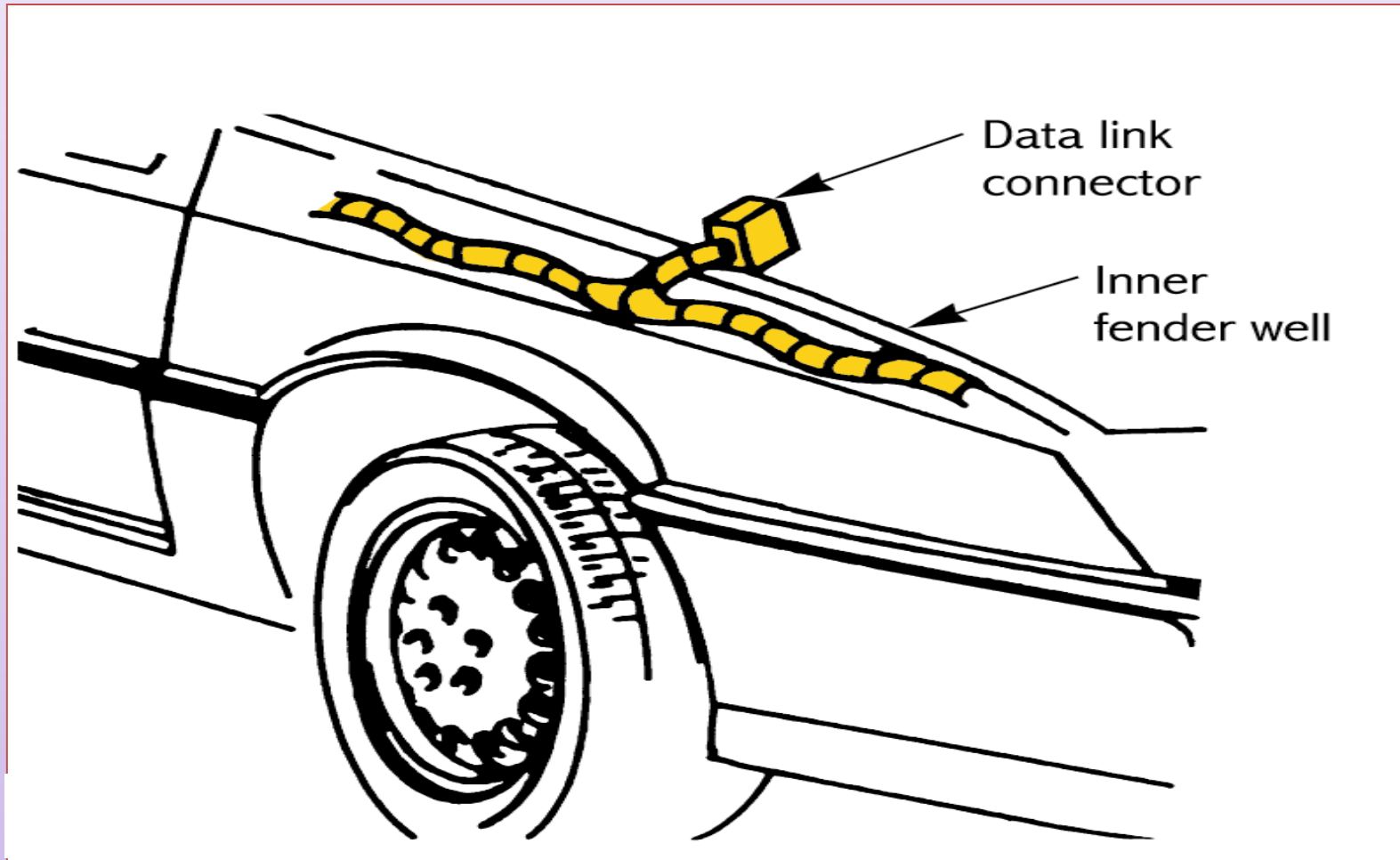


# Diagnostic Connector Location

Early General Motors diagnostic connector located next to the fuse box



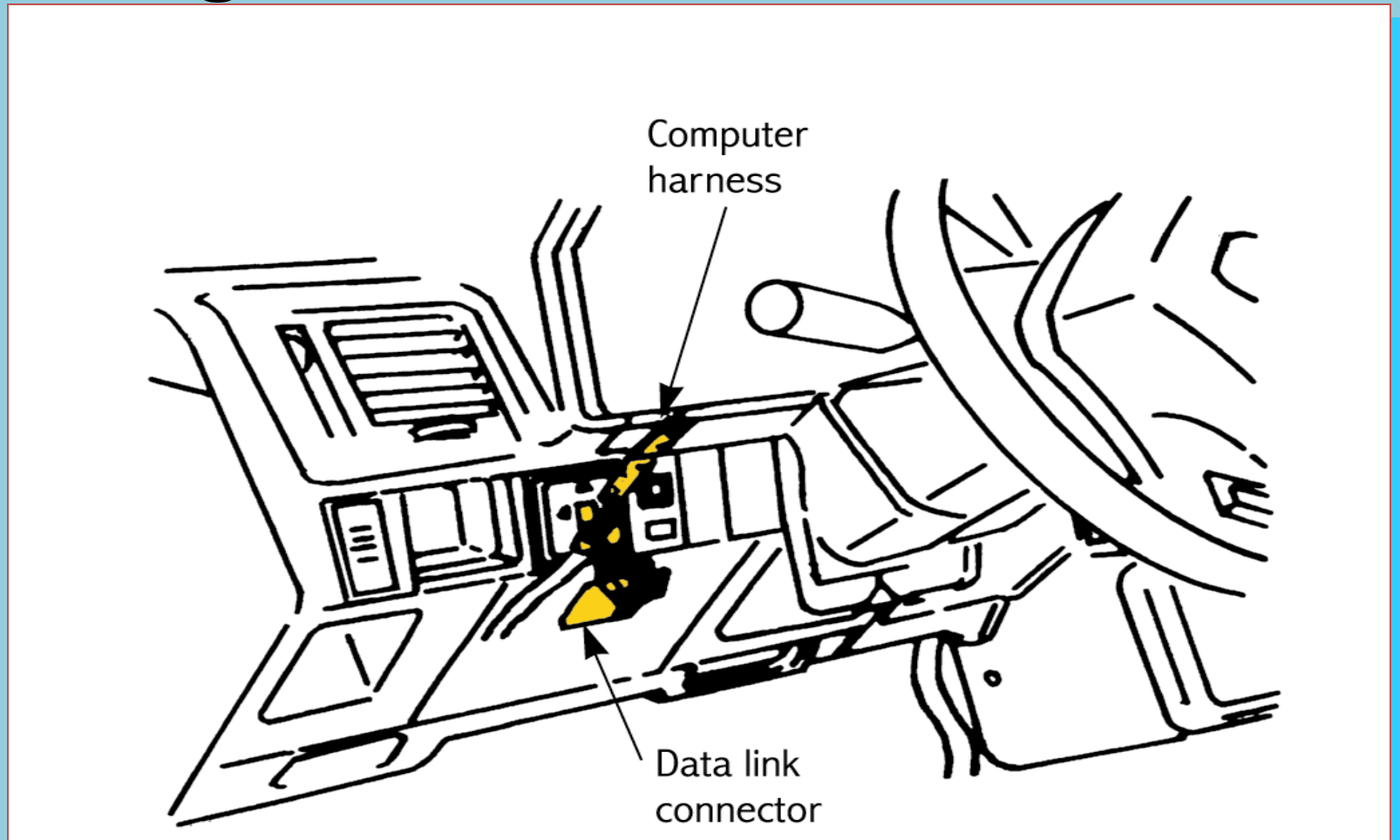
# Diagnostic Connector Location



Early Chrysler connector located in the engine compartment



# Diagnostic Connector Location



This connector is located behind the dash

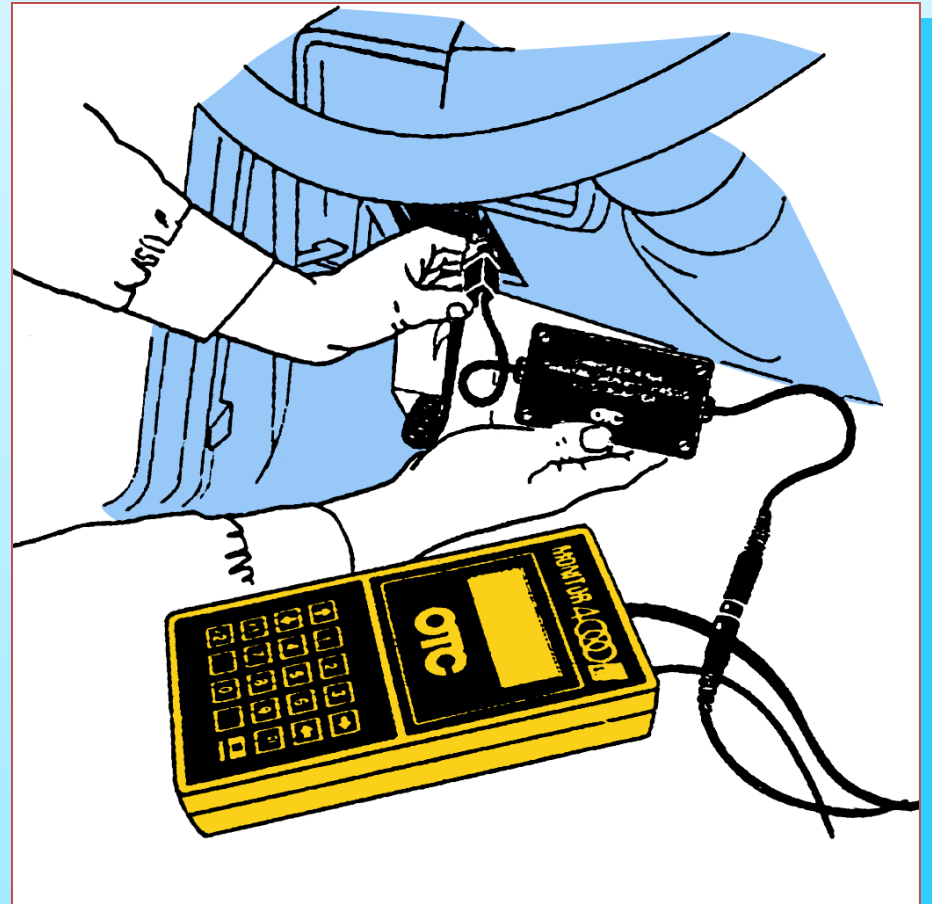
# Connecting the Scan Tool



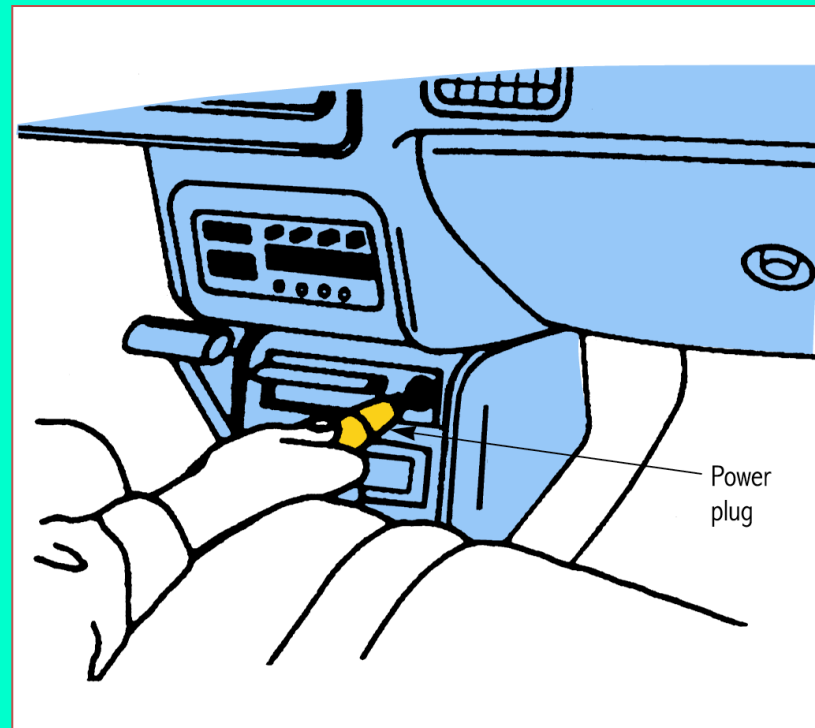
Adapters are sometimes needed between the scan tool connector and the data link connector on OBD I systems

# Connecting the Scan Tool

Connect the scan tool cable to the vehicle's data link connector

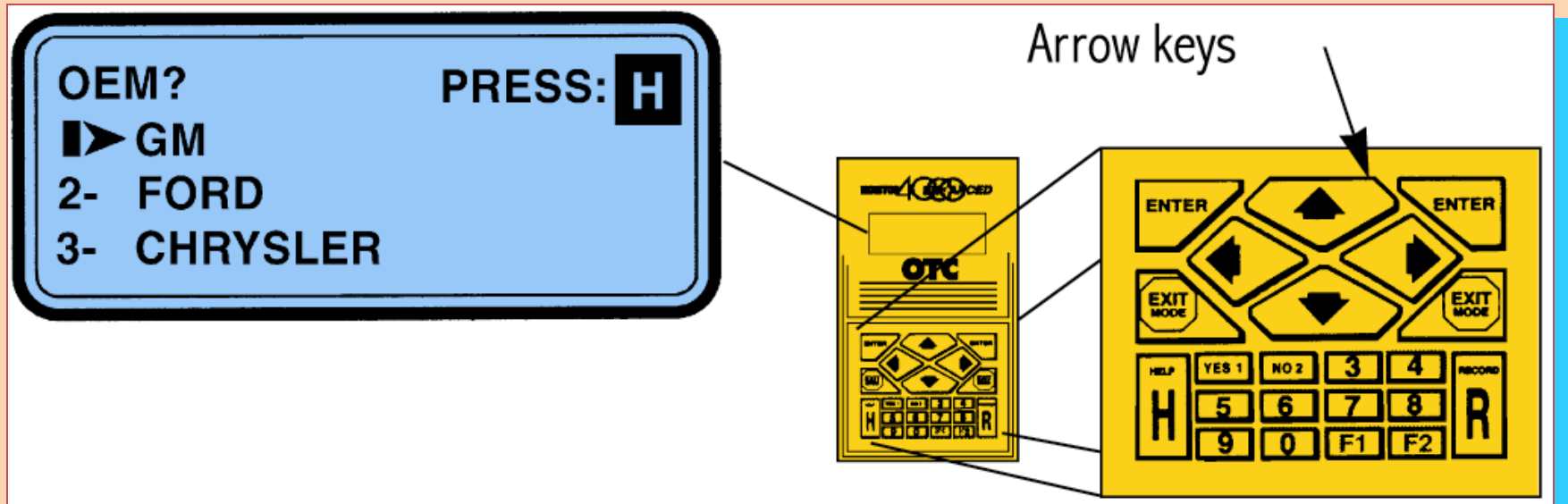


# Connecting the Scan Tool



OBD I systems may require a separate power cord connection to the battery or cigarette lighter

# Using Scan Tools



Most scan tools will give prompts in their display windows

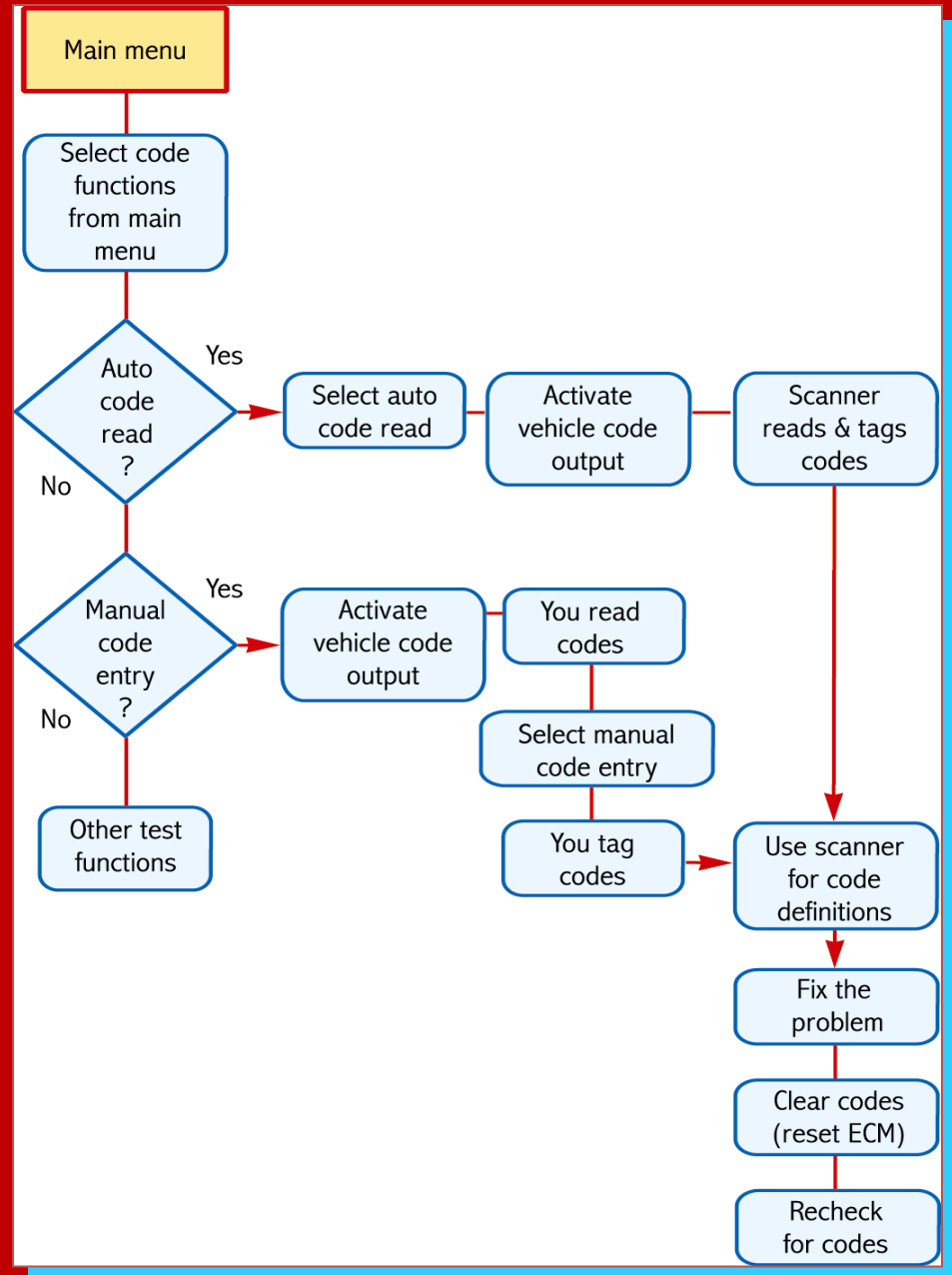
Answer the questions or select the choices as they appear

# Using Scan Tools

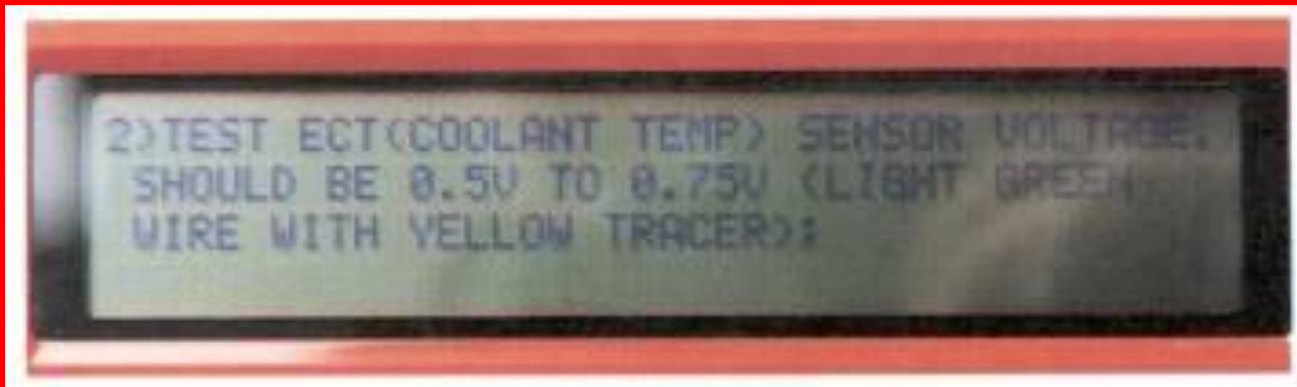


VIN data lets the scan tool know which engine, transmission, and options are installed on the vehicle

# Scan Tool Steps



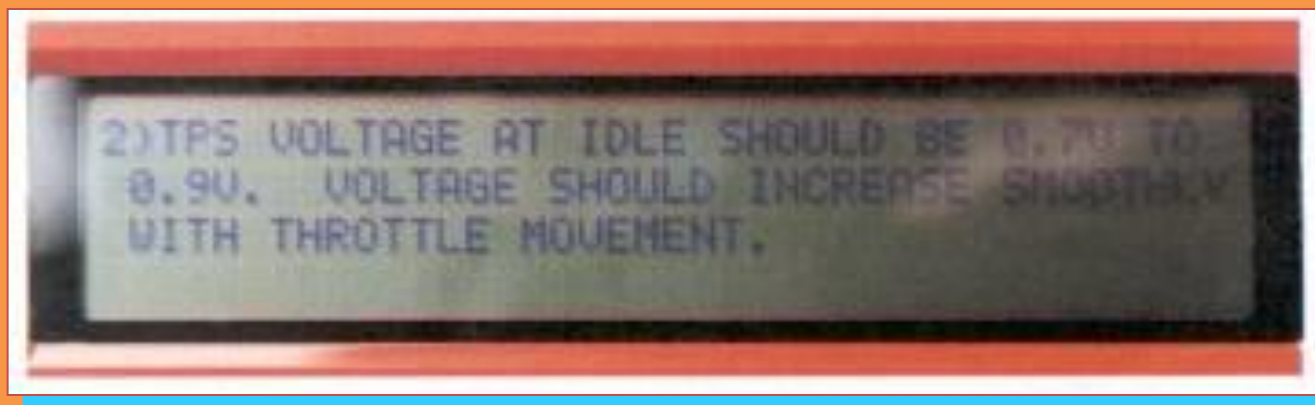
# Troubleshooting Tips



This scan tool is showing normal voltage range and which wire to probe for voltage

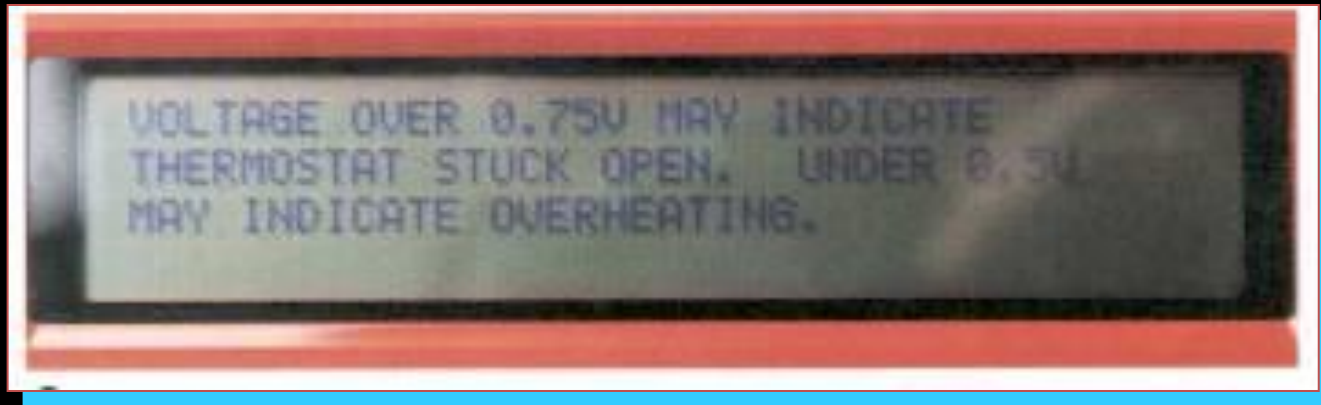


# Troubleshooting Tips



This scan tool is giving information for testing the throttle position sensor

# Troubleshooting Tips



This scan tool explains how engine operating temperature can fool the computer into signaling a problem with the engine coolant temperature sensor

# Repairing the Problem

- Always correct the cause of the lowest number diagnostic trouble code first and then recheck for codes
  - fixing the cause of the lowest code may clear other codes
- Trouble codes do not always mean that a certain component is bad, only that the circuit parameters have been exceeded

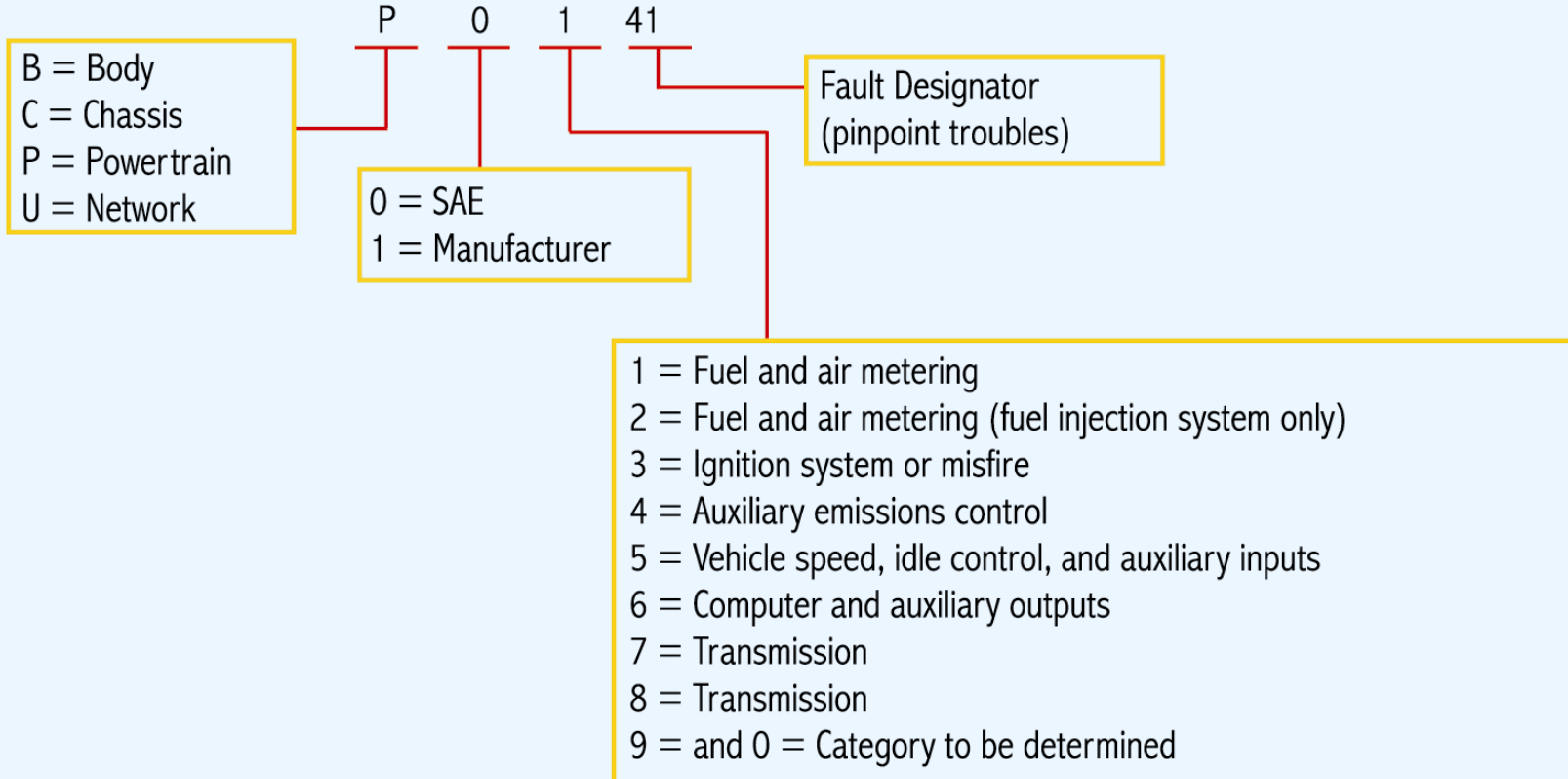
# DTC Identification

- OBD I and earlier codes were different for each manufacturer
- To simplify troubleshooting, OBD II requires all manufacturers to use a set of standardized alpha-numeric codes
- Each generic trouble code identifies the same problem in all vehicles

# OBD II Diagnostic Code

Example: P0141 O<sub>2</sub>

sensor heater circuit malfunction (Bank 1, Sensor 2)



# Failure types, Codes, Clearing codes

# Failure Types

- Computer system failures can be grouped into two general types:
- Hard failure
  - problem that is always present
- Soft failure
  - problem only occurs when certain conditions are present (intermittent)
  - soft failure codes will be stored in memory for 30–50 ignition or warm-up cycles

# Failure Types

- Failure types can be further broken down into four categories:
- General circuit failure
  - circuit or component has a fixed value, no output, or an output that is out of specifications
- Low-input failure
  - voltage, current, or frequency is below normal operating parameters



# Failure Types

- High-input failure
  - signal has more voltage, more current, or a higher frequency than normal
- Improper range/performance failure
  - sensor or actuator is producing values slightly lower or higher than normal
  - device is still functioning, but not as well as it should
  - OBD II systems have this capability

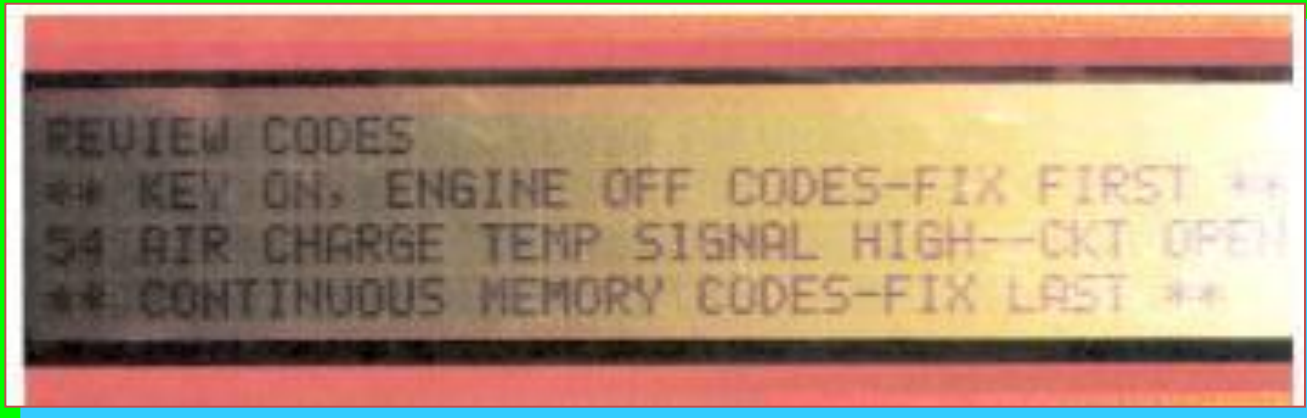
# Datastream Values

- Produced by the vehicle's computer
- Provide electrical operating values of sensors, actuators, and circuits
- Values can be read on the scan tool's digital display and compared to known values in the service manual

# Key-On/Engine-Off Diagnostics

- On most vehicles, diagnostic trouble codes, datastream values, and some functional tests are available with the key on and the engine off
- Key-on/engine-off diagnostics are usually performed before any key-on/engine-on diagnostics

# Key-On/Engine-Off Diagnostics



This scan tool shows a problem with the intake air temperature sensor circuit

# Key-On/Engine-Off Diagnostics



Checking the sensor connector after the trouble code review

# Wiggle Test

- A wiggle test can be used to pinpoint intermittent failures caused by loose, dirty, or corroded connections
- To perform a wiggle test:
  - connect a scan tool
  - set the scan tool to the appropriate test mode
  - place the vehicle in the key-on/engine-off mode
  - flex suspected harness connectors while watching the scan tool readout

# Wiggle Test



If wiggling a wire trips a code or changes datastream values, you found the location of the problem

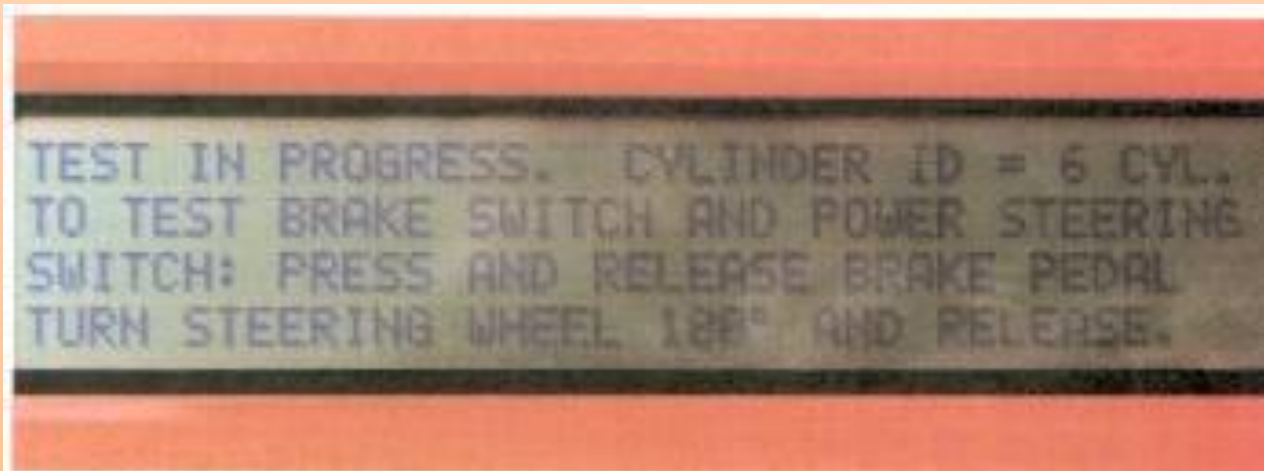
# Key-On/Engine-On Diagnostics

- This test is performed with the engine running at full operating temperature
- Checks the condition of the sensors, actuators, computer, and wiring while they are operating under normal conditions



# Switch Diagnostic Test

- Some vehicles support switch tests that verify switch input functions
- You may be prompted to close different switches to verify their operation



# Actuator Diagnostic Test

- Uses the scan tool to order the vehicle's computer to energize specific output devices
- Allows you to verify actuator operation
- Some of the actuator tests available:
  - firing or preventing the firing of the coil
  - opening and closing fuel injectors
  - cycling the idle speed motor or solenoid

# Scanning during a Test Drive

- You can scan the vehicle datastream while driving to simulate the conditions present when the problem occurs
- Some scan tools allow you to take a “snapshot” or “freeze frame” when the problem occurs

# Scanning during a Test Drive

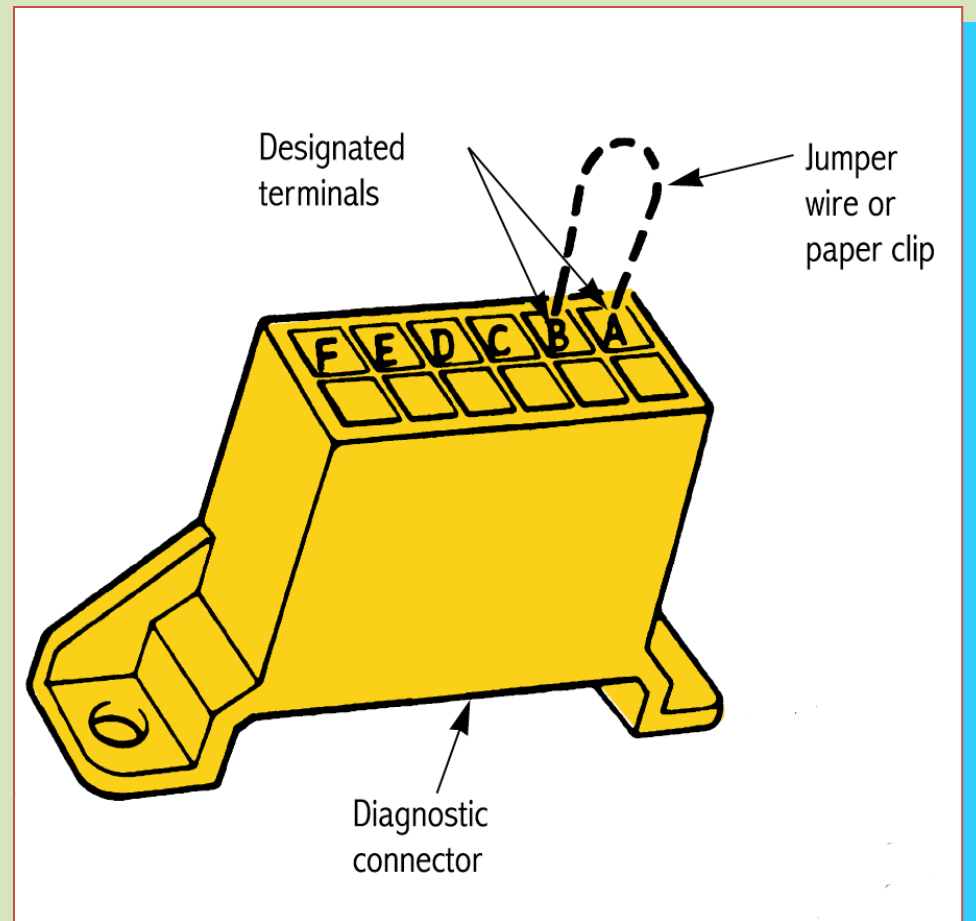


# Energizing OBD I Systems without a Scan Tool

- On OBD I systems, there are several ways to activate the computer's on-board diagnostics and to retrieve trouble codes
- Always refer to the service manual for detailed instructions

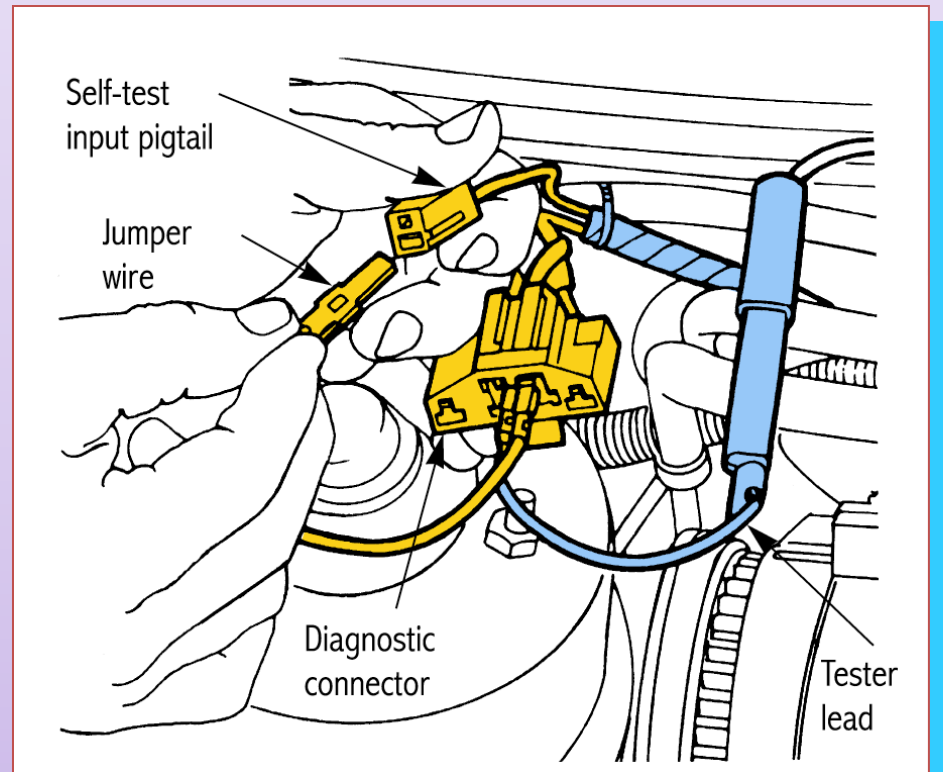
# Activating Diagnostics

Jump designated terminals on most GM connectors



# Activating Diagnostics

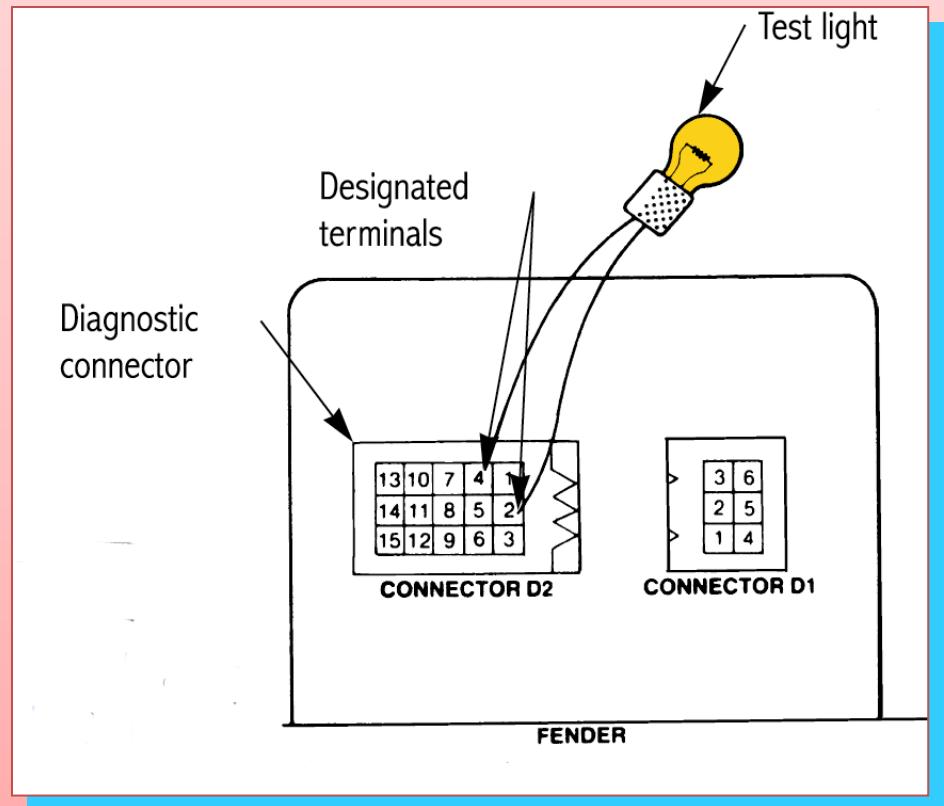
On Ford connectors, jump the extra pigtail to a specified terminal



# Activating Diagnostics

Connect a test light across specified terminals in this connector.

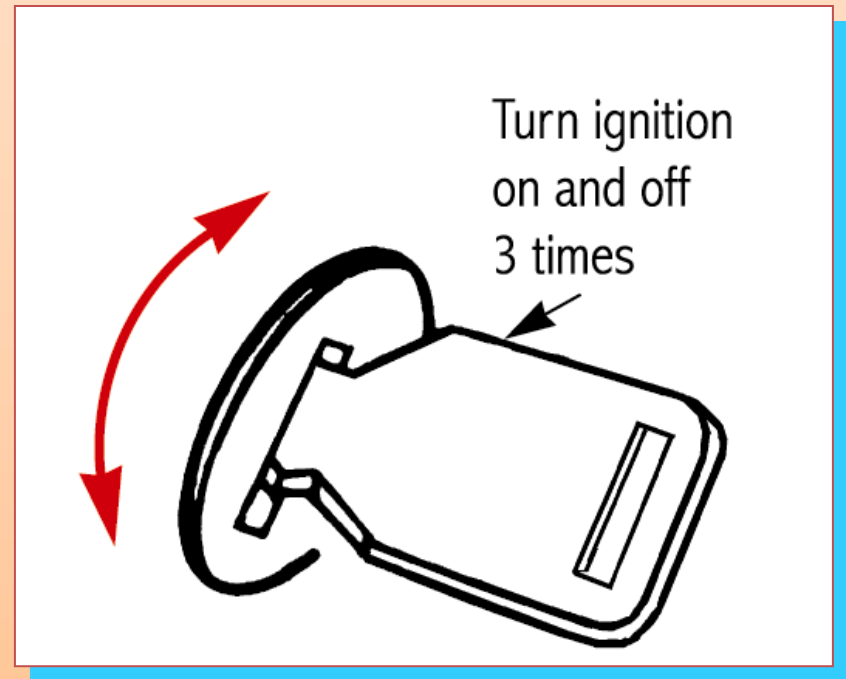
Watch the flashes for the trouble codes.



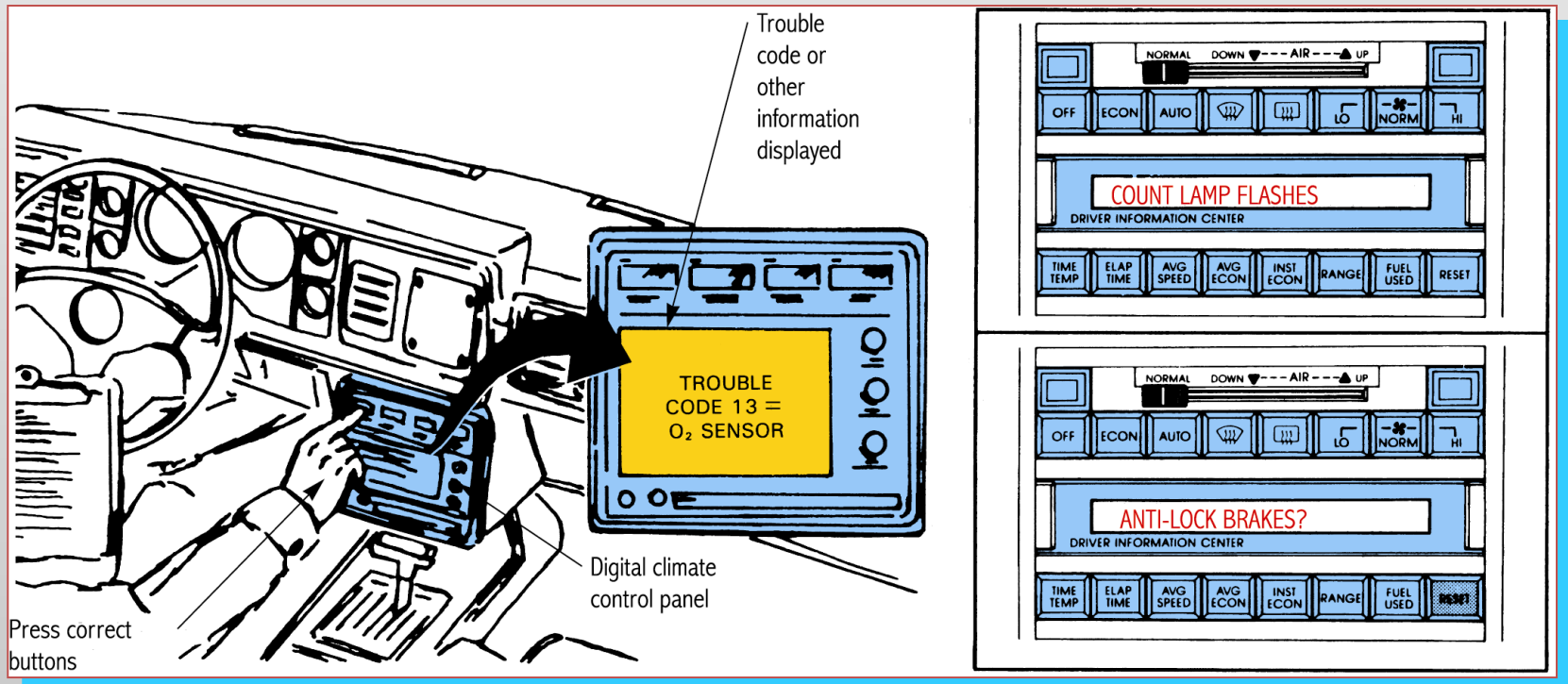


# Activating Diagnostics

Turning the ignition on, off, on, off, and then on within 5 seconds will activate diagnostics on most older Chrysler cars



# Activating Diagnostics

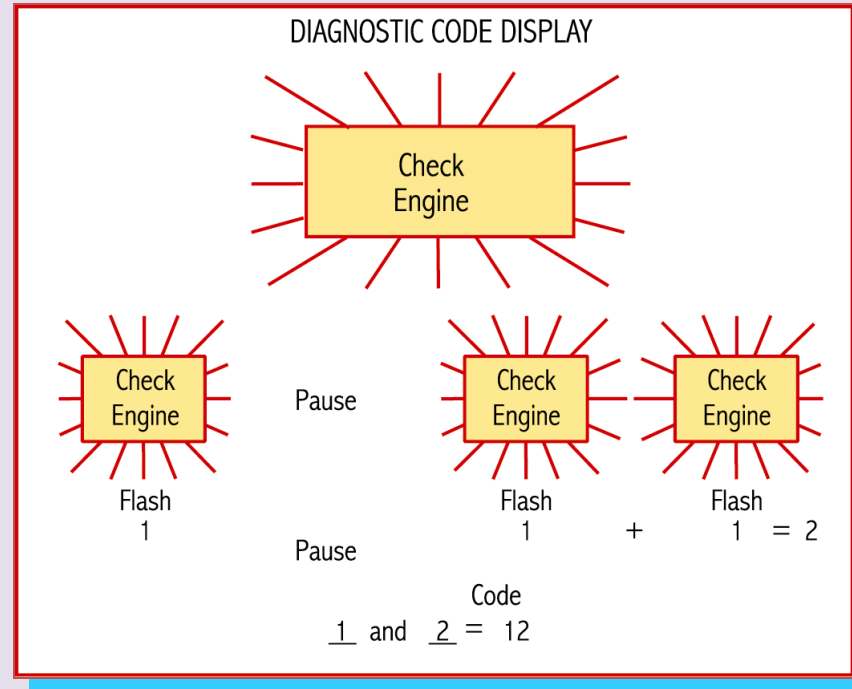


By pressing two buttons at the same time, the readout will display stored trouble codes

# Reading Trouble Codes (without a Scan Tool)

- After activating diagnostics, codes may be read using various methods:
  - observing check engine light flashes
  - noting an analog voltmeter's needle movements
  - observing a test light connected to the diagnostic connector
  - reading the climate control display
  - observing flashing LED's on the computer

# Check Engine Light

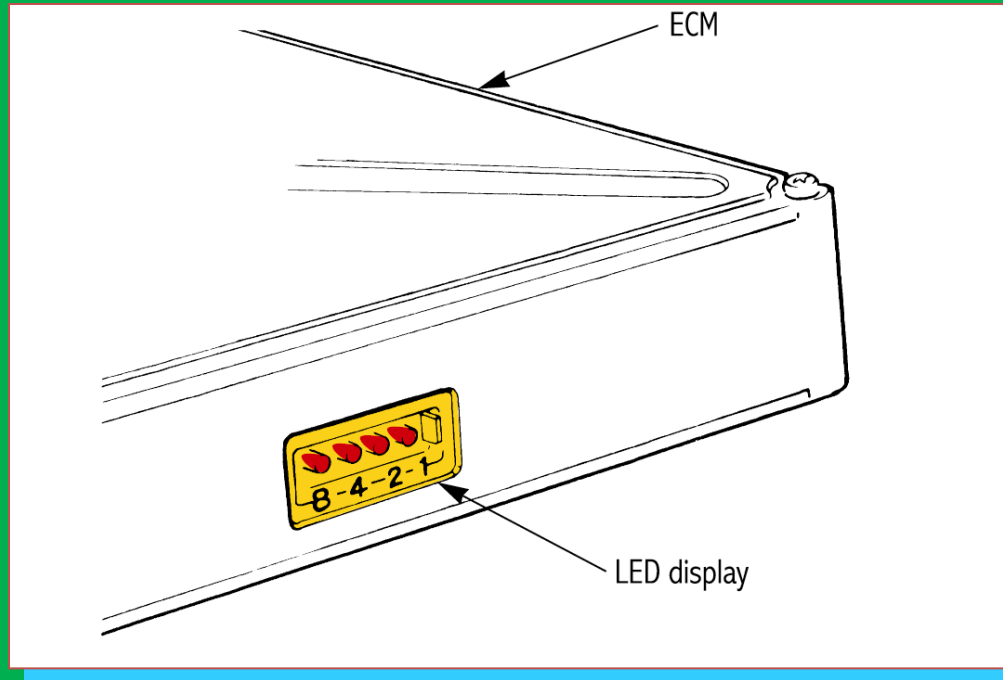


During diagnostics, the check engine light may flash to indicate DTCs

# Analog Voltmeter

- A meter is connected between specific terminals on the diagnostic connector
- During diagnostics, the computer produces voltage pulses at the terminals, causing the meter to sweep
- Meter sweeps can be read as a trouble code

# LED Displays



This computer has light emitting diodes on the side of its casing.

During diagnostics, the diodes can be read to obtain trouble codes.

# Trouble Code Chart

DTC. No.	DTC detecting condition	Trouble area
P0171	When the air-fuel ratio feedback is stable after engine warming up, the fuel trim is considerably in error on the RICH side.	<ul style="list-style-type: none"><li>• Air intake (hose loose)</li><li>• Fuel line pressure</li><li>• Injector blockage</li><li>• Heated oxygen sensor malfunction</li><li>• Mass airflow meter</li><li>• Engine coolant temperature sensor</li></ul>
P0171	When the air-fuel ratio feedback is stable after engine warming up, the fuel trim is considerably in error on the LEAN side.	<ul style="list-style-type: none"><li>• Fuel line pressure</li><li>• Injector leak, blockage</li><li>• Heated oxygen sensor malfunction</li><li>• Mass airflow meter</li><li>• Engine coolant temperature sensor</li></ul>

Service manual chart that shows different trouble code numbers and possible problems and causes

# Erasing Trouble Codes

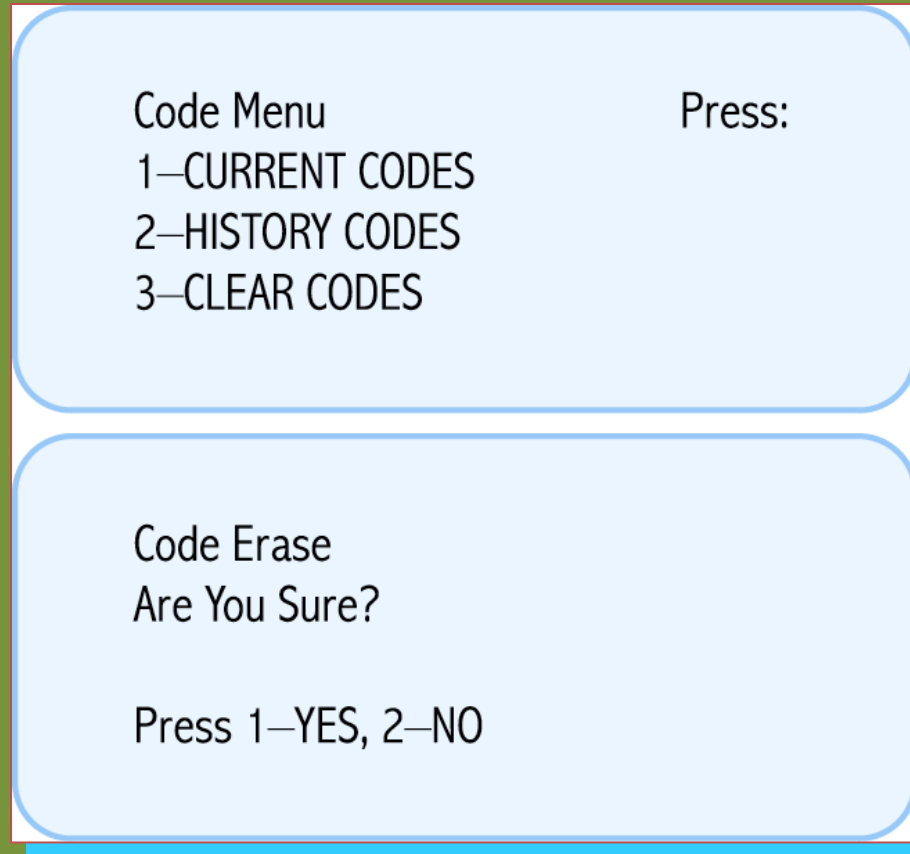
- Removes the stored codes from computer memory after system repairs have been made
- Codes should be erased after service to prevent misdiagnosis in the future
  - on OBD II vehicles, codes may need to be cleared to extinguish the MIL lamp



# Erasing Trouble Codes

- There are various ways to erase trouble codes from the computer:
- Use a scan tool
  - this is the best way
- Disconnect the battery ground cable or unplug the fuse to the ECM
  - will erase radio, seat, clock, and ECM adaptive strategy memories

# Erasing Trouble Codes



With most scan tools, simply choose the menu selection to clear codes and then press YES

# Erasing Trouble Codes

- After clearing codes, re-energize on-board diagnostics to verify that no codes are present
- This will help to verify your repair

THANK YOU