Figure 57-1  Engine coolant temperature is too high.

Figure 57-2  Engine oil pressure too low.
Figure 57-3 Water detected in fuel. Notice to drain the water from the fuel filter assembly on a vehicle equipped with a diesel engine.

Figure 57-4 Maintenance required. This usually means that the engine oil is scheduled to be changed or other routine service items replaced or checked.

Figure 57-5 Malfunction indicator lamp (MIL), also called a check engine light. The light means the engine control computer has detected a fault.
Figure 57-6 Charging system fault detected.

Figure 57-7 Fasten safety belt warning light.

Figure 57-8 Fault detected in the supplemental restraint (airbag) system.
Figure 57-9  Fault detected in base brake system.

Figure 57-10  Brake light bulb failure detected.

Figure 57-11  Exterior light bulb failure detected.
Figure 57-12 Worn brake pads or linings detected.

Figure 57-13 Fault detected in antilock brake system.

Figure 57-14 Low tire pressure detected.
Figure 57-15  Door open or ajar.

Figure 57-16  Windshield washer fluid low.

TECH TIP: Check the Spare
Some vehicles that are equipped with a full-size spare tire also have a sensor in the spare. If the warning lamp is on and all four tires are properly inflated, check the spare.
Figure 57-17  Low fuel level.

Figure 57-18  Headlights on.

Figure 57-19  Low traction detected. Traction control system is functioning to restore traction (usually flashes when actively working to restore traction).
Figure 57-20  Vehicle stability control system either off or working if flashing.

Figure 57-21  Traction control system has been turned off.

Figure 57-22  Indicates that the cruise control is on and able to maintain vehicle speed if set. Some vehicles use a symbol that looks like a small speedometer to indicate that the cruise control is on.
A typical oil pressure sending unit provides a varying amount of resistance as engine oil pressure changes. The output from the sensor is a variable voltage.

Figure 57-23

Figure 57-24

REAL WORLD FIX: The Low Oil Pressure Story

After replacing valve cover gaskets on a Chevrolet V-8, the technician discovered that the oil pressure warning lamp was on. After checking the oil level and finding everything else okay, the technician discovered a wire pinched under the valve cover. The wire went to the oil pressure sending unit. The edge of the valve cover had cut through the insulation and caused the current from the oil lamp to go to ground through the engine. Normally the oil lamp comes on when the sending unit grounds the wire from the lamp.

The technician freed the pinched wire and covered the cut with silicone sealant to prevent corrosion damage.
Figure 57-25  Typical brake warning light switch located on or near the master brake cylinder.

Figure 57-26  The red brake warning lamp can be turned on if the brake fluid level is low.

Figure 57-27  ELECTROMAGNETIC FUEL GAUGE WIRING. If the sensor wire is unplugged and grounded, the needle should point to "E" (empty). If the sensor wire is unplugged and held away from ground, the needle should point to "F" (full).
Figure 57-28 A typical instrument display uses data from the sensors over serial data lines to the
individual gauges.

Figure 57-29 Most stepper motors use four wires which are pulsed by the computer to rotate
the armature in steps.

Figure 57-30 The ground for the check oil indicator lamp is controlled by the electronic low-oil
buffer. Even though this buffer is connected to an oil level sensor, the buffer also takes into
consideration the amount of time the engine has been stopped and the temperature of the engine.
The only way to properly diagnose a problem with this circuit is to use the procedures specified by
the vehicle manufacturer. Besides, only the engineer who designed the circuit knows for sure how it
is supposed to work.
Figure 57-31 A typical head-up display showing zero miles per hour, which is actually projected on the windshield from the head-up display in the dash. 

Figure 57-32 The dash-mounted control for the head-up display on this Cadillac allows the driver to move the image up and down on the windshield for best viewing. 

Figure 57-33 A typical head-up display (HUD) unit.
Figure 57-34  A night vision camera behind the grille of a Cadillac.

Figure 57-35  (a) Symbol and line drawing of a typical light-emitting diode (LED). (b) Grouped in seven segments, the array is a common-anode seven-segment LED display with a common-anode (positive connection). The dash computer toggles the cathode (negative) side of each individual segment to display numbers and letters. (c) When all segments are turned on, the number 8 is displayed.

Figure 57-36  A typical navigation system. This Honda/Acura system uses some of the climate control functions as well as the trip information on the display. This particular unit uses a DVD unit in the trunk along with a global positioning satellite (GPS) to display a real and more exact location for the entire country.
View of the vehicle dash with the instrument cluster removed. Sometimes the dash instruments can be serviced by removing the padded dash cover (crash pad) to gain access to the rear of the dash.

Front view of the electronic analog dash display.

Rear view of the dash display showing that there are a few bulbs that can be serviced, but otherwise the unit is serviced as an assembly.
TECH TIP: The Bulb Test

Many ignition switches have six positions. Notice the bulb test position (between "on" and "start"). When the ignition is turned to "on" (run), some dash warning lamps are illuminated. When the bulb test position is reached, additional dash warning lamps often are ligthed.

Technicians use this ignition switch position to check the operation of fuses that protect various circuits. Dash warning lamps are not all powered by the same fuses. If an electrical component or circuit does not work, the power side (fuse) can be quickly checked by observing the operation of the dash lamps that have a common fuse with the problem circuit. Consult a wiring diagram for fuse information on the exact circuit being tested. See Figures 57–38 and 57–39.

Figure 57–38 Typical ignition switch positions. Notice the bulb check position between "on" (run) and "start." These inputs are often just voltage signal to the body control module and can be checked using a scan tool.

Figure 57–39 Many newer vehicles place the ignition switch on the dash and incorporate antitheft features. Note the location of the accessory position.
REAL WORLD FIX: The Speedometer Works as If It Is a Tachometer

The owner of a Lincoln Town Car complained that all of a sudden the speedometer needle went up and down with engine speed rather than vehicle speed. In fact, the speedometer needle went up and down with engine speed even though the gear selector was in "park" and the vehicle was not moving. After hours of troubleshooting, the service technician went back and started checking the basics and discovered that the alternator had a bad diode. The technician measured over 1 volt AC and over 10 amperes AC ripple current using a clamp-on AC/DC ammeter. Replacing the alternator restored the proper operation of the speedometer.

TECH TIP: The Soldering Gun Trick

Diagnosing problems with digital or electronic dash instruments can be difficult. Replacement parts generally are expensive and usually not returnable if installed in the vehicle. A popular trick that helps isolate the problem is to use a soldering gun near the PM generator.

A PM generator contains a coil of wire. As the magnet inside revolves, a voltage is produced. The frequency of this voltage is what the dash (or engine) computer uses to calculate vehicle speed. A soldering gun plugged into 110 volts AC will provide a strong varying magnetic field around the soldering gun. This magnetic field induces a voltage in the windings of the PM generator. This induced voltage at 60 hertz (Hz) is converted by the computer circuits to a miles per hour (mph) reading on the dash.

To test the electronic speedometer, turn the ignition to on (engine off) and hold a soldering gun near the PM generator.
TECH TIP: The Soldering Gun Trick (cont.)

CAUTION: The soldering gun tip can get hot, so hold it away from wiring or other components that may be damaged by the hot tip.

If the PM generator, wiring, computer, and dash are okay, the speedometer should register a speed, usually 54 mph (87 km/h). If the speedometer does not work when the vehicle is driven, the problem is in the PM generator drive.

If the speedometer does not register a speed when the soldering gun is used, the problem could be caused by the following:

1. Defective PM generator (check the windings with an ohmmeter)
2. Defective open or shorted wiring from the PM generator to the computer
3. Defective computer or dash circuit

REAL WORLD FIX: The Toyota Truck Story

The owner of a Toyota truck complained that several electrical problems plagued the truck, including the following:

1. The cruise (speed) control would kick out intermittently.
2. The red brake warning lamp would come on, especially during cold weather.

The owner had replaced the parking brake switch, thinking that was the cause of the red brake warning lamp coming on.

An experienced technician checked the wiring diagram in service information, checking the warning lamp circuit, the technician noticed that the same wire went to the brake fluid level sensor. The brake fluid was at the minimum level. Filling the master cylinder to the maximum level with clean brake fluid solved both problems. The electronics of the cruise control stopped operation when the red brake warning lamp was on as a safety measure.

REAL WORLD FIX: Look for Previous Repairs

A technician was asked to fix the speedometer on a Pontiac Grand Am that showed approximately double the actual speed. Previous repair had included a new vehicle speed (VS) sensor and computer. Nothing made any difference. Further investigation revealed that the automatic transaxle had been repaired, so it was replaced. After hours of troubleshooting, the technician just happened to mention that the automatic transaxle had been replaced shortly before the speedometer problem. The root cause of the problem was discovered when the technician learned that a reluctor assembly, from a 4T60-E transaxle had been installed in the 3T-40 transaxle. The 4T60-E final drive assembly has 13 reluctor teeth whereas the 3T-40 has 7 teeth. The difference in the number of teeth caused the speedometer to read almost double the actual vehicle speed. After the correct part was installed, the speedometer registered correctly. The technician now always asks if there has been any recent work performed to the vehicle prior to any diagnosis.
Some odometers are mechanical and are operated by a stepper motor.

Many vehicles are equipped with an electronic odometer.

**REAL WORLD FIX:**

**Electronic Devices Cannot Swim**

The owner of a Dodge minivan complained that after the vehicle was cleaned inside and outside, the temperature gauge, fuel gauge, and speedometer stopped working. The vehicle speed sensor was checked and found to be supplying a square wave signal that changed with vehicle speed. A scan tool indicated a speed, yet the speedometer displayed zero all the time. Finally, the service technician checked the body computer to the right of the accelerator pedal and noticed that it had been wet, from the interior cleaning. Drying the computer did not fix the problem, but a replacement body computer fixed all the problems. The owner discovered that electronic devices do not like water and that computers cannot swim.
Figure 57-42 A fuel tank module assembly that contains the fuel pump and fuel level sensor in one assembly.

Figure 57-43 Global positioning systems use 24 satellites in high earth orbit whose signals are picked up by navigation systems. The navigation system computer then calculates the location based on the position of the satellite overhead.

Figure 57-44 A typical GPS display screen showing the location of the vehicle.
FREQUENTLY ASKED QUESTION

Does the Government Know Where I Am?
No. The navigation system uses signals from the satellites and uses the signals from these or more to determine position. If the vehicle is equipped with OnStar, then the vehicle position can be monitored by the use of the cellular telephones link to OnStar call centers. Unless the vehicle has a cellular phone connection to the outside world, the only people who will know the location of the vehicle are the persons inside the vehicle viewing the navigation screen.

Figure 57-45 A typical navigation display showing various options. Some systems do not allow access to these functions if the vehicle is in gear and moving.

TECH TIP

Window Tinting Can Hurt GPS Reception
Most factory-installed navigation systems use a GPS antenna inside the rear back glass or under the rear package shelf. If a metalized window tint is applied to the rear glass, the signal strength from the GPS satellites can be reduced. If the customer concern includes inaccurate or nonfunctioning navigation, check for window tint.
Tech Tip

Most vehicle navigation systems use a touch screen for use by the driver (or passenger) to input information or other on-screen prompts. Most touch screens use infrared beams projected from the top and bottom plus across the screen to form a grid. The system detects where on the screen a finger is located by the location of the beams that are cut. Do not push harder on the display if the unit does not respond, or damage to the display unit may occur. If no response is detected when lightly depressing the screen, rotate the finger to cause the infrared beams to be cut.

Figure 57-46
A screen display of a navigation system that is unable to acquire usable signals from GPS satellites.

Figure 57-47
The three-button OnStar control is located on the inside rearview mirror. The left button is pushed if a hands-free cellular call is to be made. The center button is depressed to contact an OnStar advisor and the right emergency button is used to request that help be sent to the vehicle’s location.
FREQUENTLY ASKED QUESTION: What Is Navigation Enhanced Climate Control?

Some vehicles, such as the Acura RL, use data from the navigation system to help control the automatic climate control system. Data about the location of the vehicle includes:

- Time and date. This information allows the automatic climate control system to determine where the sun is located.
- Direction of travel. The navigation system can also help the climate control system determine the direction of travel.
- Acceleration data. This data can help the climate control system determine if the vehicle is accelerating.

As a result of the input from the navigation system, the automatic climate control system can control the cabin temperature in various ways. Sensing the temperature outside the vehicle, for example, if the vehicle was traveling south in the late afternoon in July, the climate control system would ensure that the passenger cooler side of the vehicle would be shaded more by the sun than the driver's side and could increase the airflow to the passenger side to help cool passengers for the additional solar heating.
**TECH TIP: Check for Repainted Bumper**

The ultrasonic sensors embedded in the bumper are sensitive to paint thickness because the paint covers the sensors. If the system does not seem to be responding to objects, and if the bumper has been repainted, measure the paint thickness using a nonferrous paint thickness gauge. The maximum allowable paint thickness is 6 mils (0.006 inch or 0.15 mm).

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**Figure 57-50**  A typical backup sensor display located above the rear window inside the vehicle. The warning lights are visible in the inside rearview mirror.

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**Figure 57-51**  The small round buttons in the rear bumper are ultrasonic sensors used to sense distance to an object.
Figure 57-52. A lane departure warning system often uses cameras to sense the road lines and warns the driver if the vehicle is not staying within the lane, unless the turn signal is on.

TECH TIP: Keep Stock Overall Tire Diameter

Whenever larger or smaller wheels or tires are installed, the speedometer and odometer calibration are also affected. This is because the overall tire diameter changes. The following guidelines should be followed:

- Larger diameter tires. The speed showing on the speedometer is slower than the actual speed. The odometer reading will show fewer miles than actual.
- Smaller diameter tires. The speed showing on the speedometer is faster than the actual speed. The odometer reading will show more miles than actual.

General Motors trucks can be recalibrated with a recalibration kit (1988–1991) or with a replacement controller assembly called a digital ratio adapter controller (DRAC) located under the dash. It may be possible to recalibrate the speedometer and odometer on earlier models, before 1988, or vehicles that use speedometer cables by replacing the drive gear in the transmission. Check service information for the procedure on the vehicle being serviced.

FUEL GAUGE DIAGNOSES 1. Observe the fuel gauge. This General Motors vehicle shows an indicated reading of slightly above one-half tank.
FUEL GAUGE DIAGNOSIS 2
Consult the factory service manual for the specifications, wire color, and recommended test procedure.

FUEL GAUGE DIAGNOSIS 3
From the service manual, the connector for the fuel gauge-sending unit was located under the vehicle near the rear. A visual inspection indicated that the electrical wiring and connector were not damaged or corroded.

FUEL GAUGE DIAGNOSIS 4
To test resistance of the sending unit (tank unit) use a digital multimeter and select ohms (Ω).
FUEL GAUGE DIAGNOSIS 5  Following the schematic in the service manual, the sending unit resistance can be measured between the pink and the black wires in the connector.

FUEL GAUGE DIAGNOSIS 6  The meter displays 50 ohms or slightly above the middle of the normal resistance value for the vehicle of 0 Ω (empty) to 90 Ω (full).

FUEL GAUGE DIAGNOSIS 7  To check if the dash unit can move, the connector is unplugged with the ignition key on (engine off).
As the connector is disconnected, the needle of the dash unit moves toward F. After a couple of seconds, the needle disappears above the full reading. The open connector represented infinity, since and normal maximum reading occurs when the tank unit reads 90 ohms. If the technician does not realize that the needle could disappear, an incorrect diagnosis could be made.

To check if the dash unit is capable of reading empty, a fuse jumper wire is connected between the signal wire at the dash end of the connector and a good chassis ground.
A check of a dash unit indicated that the needle does accurately read empty.

After testing, reconnect the electrical connectors and verify for proper operation of the fuel level gauge.