Modern automotive computer systems use dedicated sensor ground circuits (sometimes called signal return). These sensor grounds return to the computer itself, rather than to the engine block or the vehicle’s body or chassis. For analog sensor inputs, such as temperature sensors, this provides better signal accuracy than you could get with an external ground. Digital sensors, such as Ford MAP sensors and most GM Mass Airflow sensors, generally don’t require much ground circuit precision. But these, too, share ground circuits that return to the computer.

The computer measures the incoming sensor signal against the internal ground level. Since it’s comparing the signal to its own zero level, the computer can be sure that its signal measurement is accurate. In addition, the sensor reference voltage circuit inside the computer grounds and references to the sensor ground. This allows the sensor inputs to remain accurate, even if the computer itself has faulty power grounds.

For instance, suppose the computer’s power ground circuit had an excess voltage drop of, say, 0.60 volts (0.10 volts is generally the limit). Since both sensor ground and reference voltage circuits reference to the sensor ground, the sensor signals remain accurate as compared to the computer’s internal circuits. This remains true, even though the sensor circuit voltages are 0.50 volts higher when compared to the engine ground. Despite this difference, the computer is still able to read the sensor output accurately, so a scan tool reading indicates correct values. Which means automotive computers can continue to take accurate sensor readings, even if the computer isn’t grounded correctly.

Figure 1 shows a typical computer sensor input circuit layout. Each of these circuits grounds through the sensor ground buss:

- Sensor reference voltage circuit
- Analog-to-digital (A/D) converter (measures the signal)
- Ground for the sensor itself

The large sensor ground buss is grounded through a lighter conductor to the power ground buss. So there will always be some voltage drop between the two buss circuits. Which means there will always be a voltage drop between the sensor ground circuit and engine ground.

Of course, there’s a limit to the
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computer’s ability to read sensor values accurately with faulty power grounds. That’s because the reference voltage regulator requires enough of a difference between its power input and ground level (the sensor ground buss) to generate a regulated voltage; usually about two volts more than the regulated value. So a 5.0 volt regulator requires about a 7.0-volt difference between its input voltage and ground.

In addition, DC voltmeters average the measurement on the display. Which means the peak value of the voltage drop will be higher than the measured reading. But the system can have a substantial voltage drop in the power ground before it affects sensor readings.

Why is this level of accuracy important? Analog sensors develop signals based on measured values, such as engine or transmission temperature, by producing a voltage signal that varies with measured changes.

Consider an Engine Coolant Temperature (ECT) sensor on a Ford EEC-IV system. At 194º F, it creates a 0.60-volt signal. That’s not much voltage; it wouldn’t take much inaccuracy in the ground level to cause a huge measurement error. If there were a voltage drop in the power ground circuit of 0.60 volts, comparing the sensor signal to the engine ground instead of the signal ground would put the sensor signal out of range. The computer would light the MIL and set a diagnostic trouble code, indicating an ECT sensor problem. But with the sensor signal compared to the sensor ground, the computer can read the signal accurately, despite the excess voltage drop on the power ground circuit.

The voltage drop between sensor systems connect the oxygen sensor ground directly to the engine block. In that case, measuring the power ground voltage against the oxygen sensor ground wouldn’t actually measure the voltage drop through the computer’s sensor grounds; it would be like measuring the voltage drop between the engine block and somewhere else on the engine block.

What’s more, the added circuit could easily cause the printed circuit inside the computer, which attaches the two ground buss circuits, to burn away. This printed circuit is only designed to carry the low current flow of the sensor circuits, not the greater current for the power outputs. This could occur if a power ground circuit developed higher-than-normal resistance, causing the power output circuits to seek an alternate ground path.

It’s also important to make sure the computer pins, and the connections are clean. Otherwise, any excess voltage between the terminals and pins would add to the voltage drop measurement.

Avoid using the oxygen sensor grounds when checking the ground circuit voltage drop. This is because some ground, current from the computer’s power circuits would seek ground through the new wiring. This would cause a voltage drop in the light gauge sensor ground between the computer and the sensor, again causing an error in the sensor readings.

Because signal return circuits carry only small amounts of current, they’re far less likely to develop excess voltage drop than the power ground circuits. The voltage drop between sensor ground circuits and engine ground should always be a few millivolts more than the drop between the sensor grounds and power grounds. So it’s important to verify the system’s power grounds and the contact between the computer’s connector pins and terminals before considering sensor ground circuit voltages to be out of range.

Voltage may be voltage, but a ground is not just a ground. Your success or failure in testing these is knowing the difference.
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