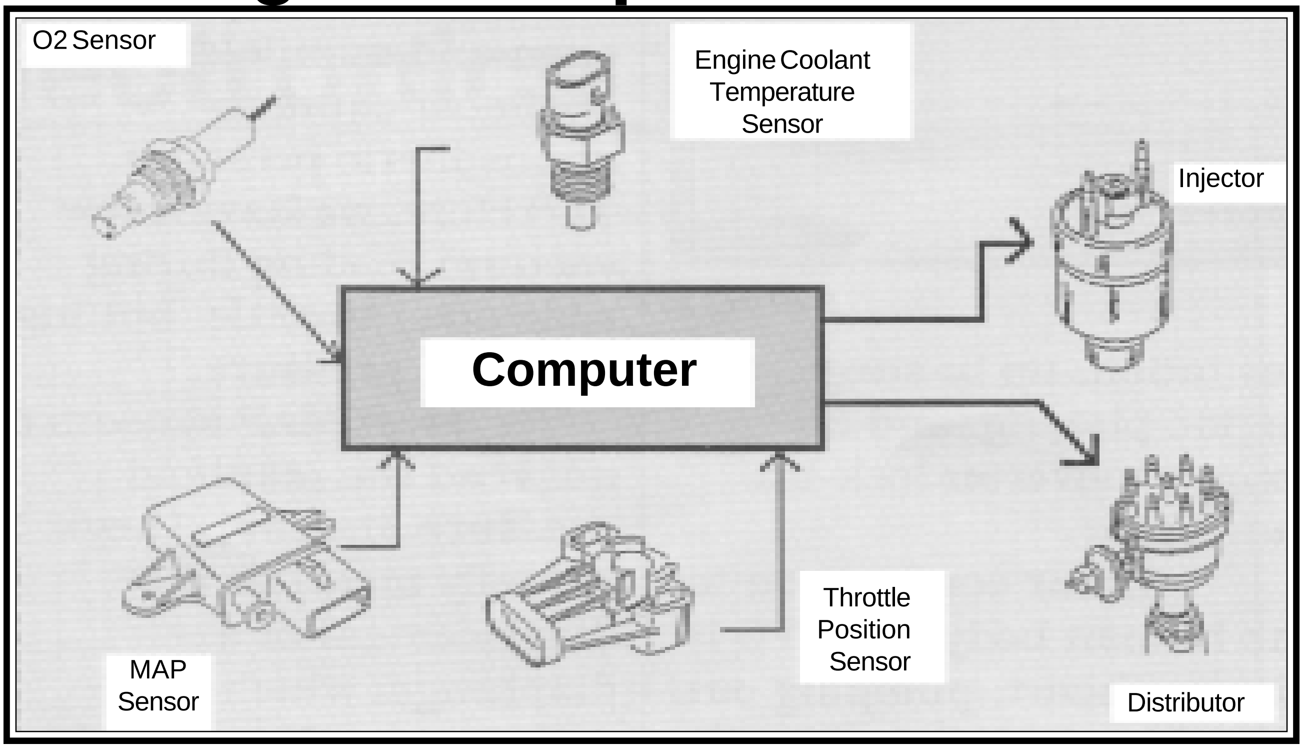
TomcoTechtips

TM

Engine Computer Controls

ISSUE 13



The computer is information-hungry. It gets input from the various sensors to control fuel supply and ignition timing.

The prospect of repairing a driveability problem on a computer-controlled car can cause a repairman to panic. Horror stories from mechanics about days spent on vehicles that they were never able to fix flood their minds.

All too often we lose sight of, or don't have a good enough understanding of, the basics. In this issue we are going to take a look at engine computer controls and their functions. Gaining a working knowledge of these controls will help in making a proper diagnosis and repair.

Our human brain is like a computer. It is capable of receiving, processing and making a decision based on the information it receives. It also coordinates and regulates all other functions of the body. We use our senses to gain input from the world around us. When we see or hear something, our brain processes that information and decides a course of action.

Car computers act in much the same way. Contained in the computer is a central processing unit (CPU). It mathematically makes decisions based on data it receives from sensors and from preprogrammed information that is stored in its memory.

The computer has a memory capacity just as we do. This memory is broken down into three basic parts called *Read Only Memory* (ROM), *Random Access Memory* (RAM), and *Programmable Read Only Memory* (PROM).

ROM is that part of the memory that has been preprogrammed. The CPU can read this memory but cannot alter it at all. The program the ROM contains leads the CPU to perform certain functions in accordance with the information it receives. ROM is like

Tomco, Inc. 1992

the basic program we are born with that allows us to survive and perform certain necessary tasks such as breathing.

RAM is a memory that can be read, but also has the ability to be written on. It is that part of the computer that stores, and continuously updates information from the sensors. It is here that we will find trouble codes or fault codes, should there be a malfunction in the system. This is like our human memory, receiving and storing knowledge for future use.

PROM is like the ROM in that it can be read only. It contains specific information on the size, weight, engine, transmission, and final drive ratio of the vehicle. This makes the computer suitable for the individual needs of each vehicle. This is similar to that part of us that makes us who we are: male or female, tall or short.

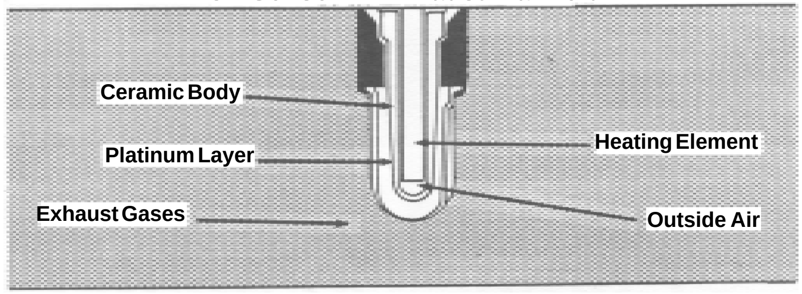
We now have a CPU ready to process information and a host of sensors ready to input information, but we have one problem. They don't speak the same language. The CPU speaks in a digital or numeric language, and the sensors speak in electrical signals. So we have an interpreter in our computer called an ARITHMETIC LOGIC UNIT (ALU). This changes electrical signals into digital signals that the CPU can understand. It also interprets the CPU's answers into electrical signals that can be used to control engine functions.

Computer Failure

Many times the computer is blamed for performance problems. The computer is replaced and the problem still exists. It has been reported that over 50% of the computers replaced have nothing wrong with them. The computer is a pretty reliable piece of equipment, so don't be too quick to condemn it.

The computer does have some enemies: vibration, thermal stress, and voltage overload. Remember to turn the key off before disconnecting any sensors, or you could create a voltage spike that may damage the computer. The computer *can* fail, but you need to perform a thorough diagnosis on all other system components before replacing it.

O2 Sensor in Exhaust Manifold



The O2 sensor contains a ceramic body coated with a platinum layer.
High exhaust O2 content = low voltage output.
Low exhaust O2 content = high voltage output.

O2 Sensors

The O2 sensor is one of the most critical sensors on the vehicle. It resembles a spark plug and is located in the exhaust manifold before the catalytic converter. It measures the amount of unburned oxygen in the exhaust stream. The O2 sensor contains a ceramic body with a platinum layer which is protected by a spinel coating. *(see above figure)*

The outside of this coated ceramic is exposed to the oxygen remaining after combustion. The inner part is vented to the oxygen contained in the atmosphere. The difference between these oxygen contents causes the O2 sensor to generate a voltage. This voltage ranges from 0.2 volts to 1.0 volts. A high oxygen content means a lean mixture and a lower voltage signal to the computer. A low oxygen content means a rich mixture and a higher voltage output signal to the computer. The computer uses this information to regulate the air/fuel mixture.

Engineers have found that an air/fuel mixture of 14.7:1 produces the best fuel economy and performance, and at the same time produces emissions that can be easily handled. The computer constantly adjusts the mixture from rich to lean to attain an average close to the 14.7:1 ratio.

Some conditions must be met for the O2 Sensor to send its signal to the computer. The sensor must reach a temperature of 600°F before it will begin to operate. While the O2 sensor is coming up to its operating temperature, the computer is in what we call an open loop. In open loop, the computer relies on a set of predetermined valves to control the air/fuel mixture. This keeps the mixture in a slightly rich state as needed for a cold running engine.

Once the O2 Sensor is warm enough and the computer starts reading its signal, we have a closed loop system. This means the computer is using the sensors to make changes in the fuel mixture and in timing.

For the sake of emissions, the quicker we enter closed loop and get out of cold running, the better. The heat from the exhaust will heat the O2 sensor, but it may take as long as a few minutes for this to happen. The result is higher emissions levels.

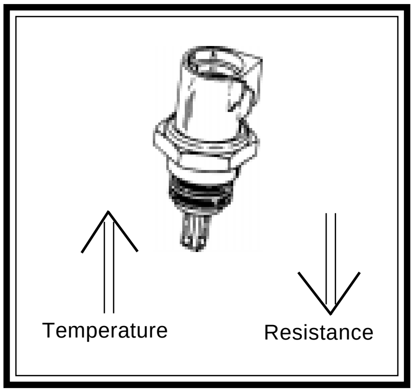
Today we find many O2 sensors have heaters in them to speed up the heating process. These sensors have three or four wires (as opposed to the one- or two-wire sensors). On sensors with one wire, the wire carries the generated signal to the computer. On two-wire sensors, one wire carries the signal and the other wire is a ground. On three-wire sensors, one wire is the signal wire and the other two wires are for the heater. Four-wire sensors are the same as three-wire sensors, but the extra wire is to carry off the residual signal caused by the heater. This is similar to television coaxial cable, where the outer wire serves to take away interference. This gives the computer a purer signal.

The O2 sensor is very sensitive. Leaded fuel, anti-freeze, oil and silicon contamination can cause it to fail. When an O2 sensor fails or becomes slow to react, poor performance, low gas mileage, high emissions and converter damage may occur.

In our analogy, the O2 sensor would correspond to two of our sense organs: the nose and the eyes. It is where oxygen is taken in (the nose). It is also the source of most critical input (the eyes).

As the coolant temperature increases, resistance decreases

ECT Sensors



The next sensor we'll take a look at is the Engine Coolant Temperature (ECT) Sensor. It is located in the vehicle cooling system in the thermostat housing, cylinder head, or engine block.

This sensor is called a thermistor. A thermistor is a device that changes resistance in relation to temperature.

An ECT in a cold engine will have a high resistance. This high resistance will cause the computer to read a high voltage signal which the computer interprets as a cold engine. As the coolant temperature rises, the resistance decreases, resulting in a lower voltage signal to the computer. On early model vehicles the computer would stay in open loop until it sensed a voltage that corresponds to a temperature of 150°F, thus allowing it to go into closed loop.

The engine coolant plays a big part in the functioning of the ECT. Coolant, particularly old coolant, may form deposits on the sensor causing it to malfunction. An improper coolant level may cause the ECT to read incorrectly. Installation of a higher or lower degree thermostat than recommended by factory may also result in problems.

One more thing to check before you fault the ECT is the connections. They can sometimes become loose or corroded.

If an ECT fails, hard starting, poor cold idle, or poor performance and economy may result.

The ECT sensor is like our sense of touch. If we put one hand on a hot stove, our brain will sense the heat and react (quickly, we hope) to tell us to remove our hand from the hot stove.

Sensor coverage will continue in the next issue of *Tomco Tech Tips* with Manifold Air Pressure Sensors (MAP) and Throttle Position Sensors (TPS).

Tomco Tech Tip #13

Electronics 101

In order to understand today's computer-controlled cars, we need a good understanding of electronics. Lets go back to some electrical basics. This may be new for some, but it will also be a good review for others.

The flow of electricity can be compared to the flow of water through a hose. This comparison will make it easier for us to understand electronics. Our first step is to define some terms that we will be using.

A **volt** is a measurement of electrical pressure. In order for current to flow through a circuit, we need the electrical pressure of voltage. This pressure can be compared to the pounds per square inch in a water hose. The symbol for volts or electromotive force is **E**.

An **ohm** is the electrical resistance that is in opposition to the current flow. This resistance can vary between different materials and with different temperatures. Resistance is like an obstruction in the water hose, or like putting your thumb over the end of the hose. The symbol for ohms or resistance is **R**.

An **ampere** is the measurement of flow or quantity of electrical current. This would compare to how many gallons of water are coming out of the hose. The symbol for amps or intensity of current flow is **I**.

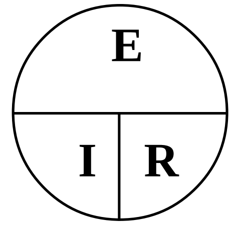
A **circuit** is the path through which current flows. A circuit must form a complete path to be a true circuit, so the current must be able to return to its source.

Lets take a look at an important law of electronics call "Ohms Law". Ohms law says that one volt of pressure (**E**) is required to push one ampere of current (**I**) through one ohm of resistance (**R**). This can be stated in equation form:

$$E = I \cdot R \text{ or}$$
$$I = E/R \text{ or}$$
$$R = E/I$$

Ohm's Law can help us in diagnosing electrical system troubles.

In the next issue of *Tomco Tech Tips*, we'll talk about some different types of electrical circuits.



An easy way to remember Ohm's Law's equations is by this diagram. If you put your finger over volts (E), you'll see that
E = I • R. Put your finger over amps (I), you see that
I = E/R. Put your finger over resistance (R) and you see that
R = E/I.

SUPER TIP

Ever have trouble getting a choke thermostat off of a Holley 5220 or 6520? Some of these come with a combination of pop rivets and tamper resistant screws. The pop rivets are easy enough to remove, but what about the tamper resistant screws?

If you drill out the two pop rivets, then pry up gently on the retaining ring, you can slip the choke thermostat out. Then you will be able to twist the retaining ring and, with the pressure off the screw, it will come out easily.

If they are all tamper resistant screws, cut a slotted groove with a hacksaw in the sheared-off part and use a flat head screwdriver to remove them.

Lunzer Evans
St. Louis, MO

TOMCO TI INC.

TTT13
Printed in U.S.A. • 3.00