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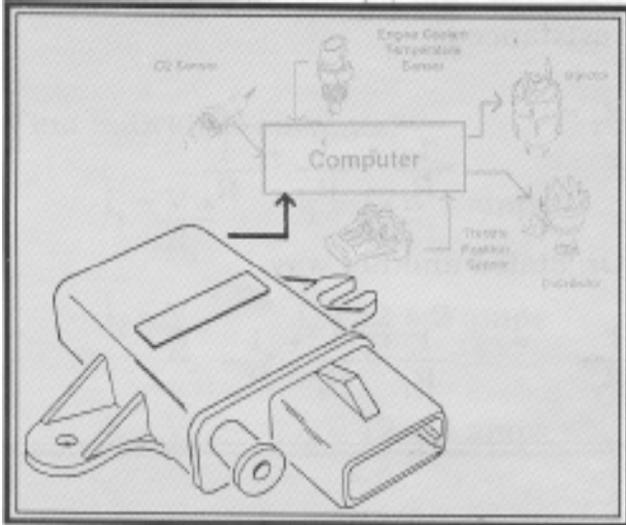
Engine Computer Controls

Ford MAP Sensor

In the last issue of Tech Tips, we looked at a type of MAP sensor that sent a varying *voltage* to the computer in response to pressure changes.

Ford's EEC IV systems use a different style MAP sensor called a frequency-generating pressure sensor. These sensors send a *frequency* signal to the computer in response to pressure changes.

The computer sends a reference voltage to the sensor. This reference voltage is converted to a frequency signal by a solid state switching device inside the sensor. The frequency signal changes in response to sensed pressure differences. This change in frequency is monitored by the computer. At low manifold pressure (high vacuum) the sensor produces a frequency of 92 cycles per second. At wide open throttle (low vacuum) the sensor produces a frequency of 162 cycles per

second. The computer uses this information to control air/fuel mixture, EGR flow and timing.

Mass Air Flow Sensors

In order to make a fuel injection system work most effectively we need to have the proper air to fuel ratio. The computer has to be able to calculate the mass of incoming air so it can inject the proper amount of fuel.

An efficient way of determining the mass of incoming air is a system that uses a mass air flow sensor (MAF). The
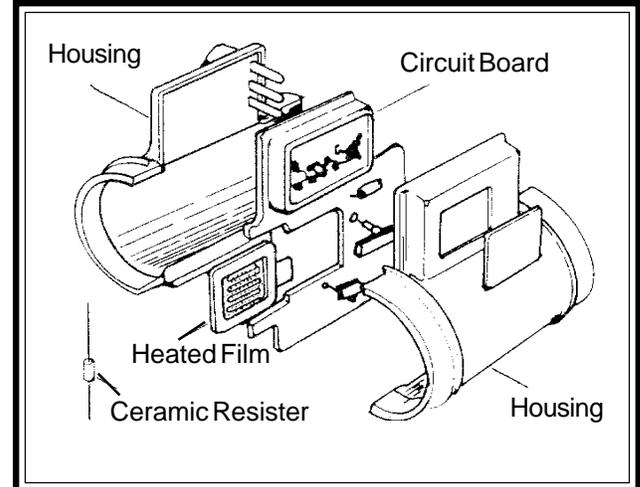
mass air flow sensor is located in the intake air duct between the air filter and the throttle body. It directly measures the mass of air flowing into the engine. The MAF sensor then sends a proportional signal to the computer.

There are different types of mass air flow sensors in use today. We will use the

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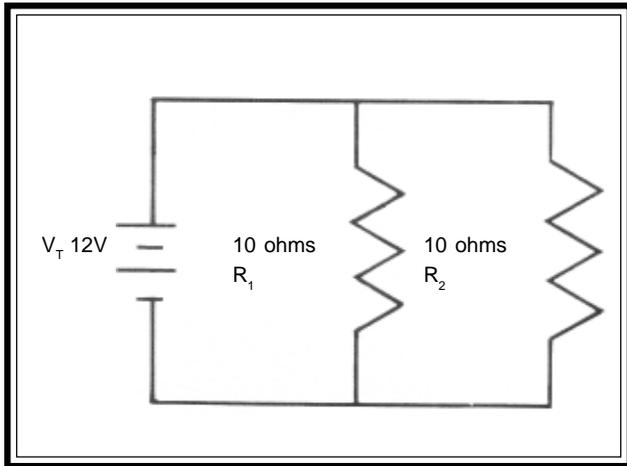
A parallel circuit is a circuit that has more than one path for current to flow on. The loads or electrical devices in this type circuit are placed side by side. In a parallel circuit if one electrical device fails, the other device(s) will continue to work. This is an advantage over the series circuit, in which if one device fails the other one would be inoperative.

There are some rules for parallel circuits that we need to take a look at:

1. The voltage drop across each load is the same.

2. The sum of the currents in the circuit is equal to the total circuit current.

3. Loads having different resistance values will have currents that are proportionally different.

4. The total resistance of the total circuit is less than the resistance value of the smallest path.

Lets look at some formulae to calculate resistance for parallel circuits. If we have two loads in a parallel circuit we can use the product over the sum method. This formula states that the total resistance is equal to the product of the two resistances divided by the sum of the resistances.

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2}$$
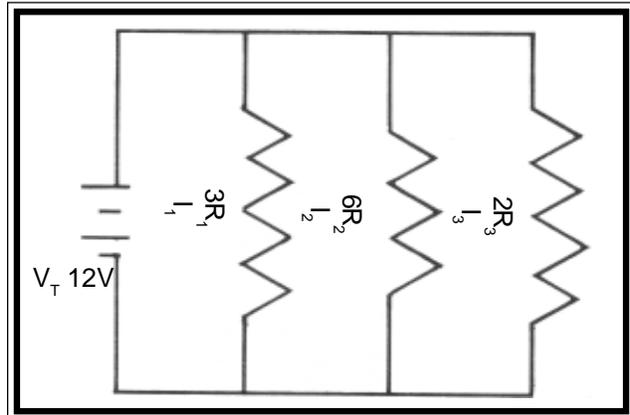
In Figure A this means

$$R_T = \frac{10 \times 10}{20} = \frac{100}{20} = 5 \text{ ohms}$$

If we have three or more loads there are two different formulae we can use. The first method of calculating resistance is:

$$R_T = \frac{1}{\dfrac{1}{R_1} + \dfrac{1}{R_2} + \dfrac{1}{R_3}}$$

Or, stated another way:

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

In figure B we can calculate the total resistance:

$$R_T = \frac{1}{\dfrac{1}{3} + \dfrac{1}{6} + \dfrac{1}{2}} = \frac{1}{\dfrac{4}{12} + \dfrac{2}{12} + \dfrac{6}{12}} = \frac{1}{\dfrac{12}{12}} = \frac{1}{1} = 1 \text{ ohm}$$

$$R_T = 1 \text{ ohm}$$

The second method of calculating resistance with three or more loads follows this procedure:

1. Find the individual currents in each of the circuits.
2. Add the currents to get the total current.
3. Divide the total source voltage by the total current to determine total resistance.

In Figure B, lets apply this procedure, using Ohms Law:

$$E = I \bullet R \ \text{ or } \ I = \frac{E}{R}$$

Find individual currents:

$$I_1 = \frac{V}{R_1} \qquad I_1 = \frac{12}{3} = 4 \text{ amps}$$

$$I_2 = \frac{V}{R_2} \qquad I_2 = \frac{12}{6} = 2 \text{ amps}$$

$$I_3 = \frac{V}{R_3} \qquad I_3 = \frac{12}{2} = 6 \text{ amps}$$

Add currents to get total current:

$$I_T = I_1 + I_2 + I_3$$
$$I_T = 4 + 2 + 6$$
$$I_T = 12 \text{ amps}$$

Using the formula for Ohms Law we can now determine the total resistance:

$$E_T \qquad \qquad = I_T \bullet R_T$$
$$12 \qquad \qquad = 12 \bullet R_T$$
$$1 \text{ ohm} = R_T$$

So the total resistance would be 1 ohm, the same answer we derived from our first formula. These examples also follow our parallel circuit rules: the voltage drop across each load is 12 volts, the sum of the currents is equal to the total current and the total resistance is less than the resistance of the smallest path.

If all resistances are equal there is an easier way to figure these values. All we need to do is take the resistance load of one part of the circuit and divide it by the total number of resistances.
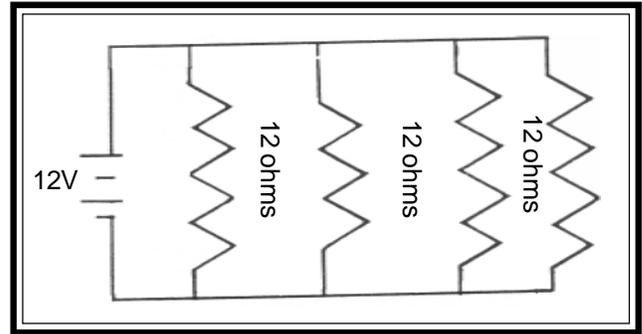

Figure C's resistance would be calculated as follows:

$$R_T = \frac{R \text{ (of one circuit path)}}{N \text{ (number of loads)}} = \frac{12}{4} = 3 \text{ ohms}$$

Mass Air Flow Sensors

GM AC type mass air flow sensor to continue our discussion.

The AC MAF sensor has a cylindrical housing through which intake air is passed. The air first passes over a ceramic resistor which measures the air's temperature. The incoming air is then directed over a heated film. This film is heated to and kept at a temperature of 75° C above the temperature of the incoming air as measured by the ceramic resistor. As air flow is increased or colder air is introduced into the sensor, more power will be required to keep the film heated to 75° C above the incoming air temperature.

The extra electrical power needed to keep the film heated is a measure of mass air flow.

This extra electrical power is changed to a digital signal which is sent to the computer as a frequency signal. The frequency of a MAF sensor will range from 30 cycles per second to 150 cycles per second.

Inside the computer there are lookup tables which have pre-programmed information. The computer compares the signal from the MAF sensor with these tables to find the air flow rate in grams per second. The computer uses this reading plus engine RPM and air temperature to correctly adjust the air/fuel ratio.

"Masked" Air Flow Sensor

Most GM vehicles from 1985 to 1989 with a 2.8 "W" engine use this AC type mass air flow sensor. This OEM sensor has a high failure rate and has become the source of many driveability problems, including stalling, idling problems and hard starting. This has led to many technical service bulletins (TSBs) from GM to try to correct this problem.

One such TSB which came out concerned the 1987-88 "W" engines. This bulletin consists of changing the MAF system back to a speed density system. In this repair the PROM or MEMCAL is updated with a new chip. This PROM change ignores the signals from the MAF sensor and uses signals from the MAP sensor to control fuel supply. MAP sensors are *usually* not used on MAF sensor systems. These particular vehicles (with 1987-88 "W" engines) *have* a MAP sensor to help control spark advance and aid the MAF sensor in fuel control.

This repair does not include the removal of the MAF sensor. On these vehicles the MAF sensor contains an air charge temperature sensor which must be used by the speed density system. So, by first glance it may still look like a mass air flow sensor system. The question is: how can we tell if we are dealing with a vehicle that has been converted from a mass air flow system to a speed density system?

When this bulletin is performed, the MAF power relay is supposed to be disconnected or removed. This relay is located under the hood by the left front strut tower. The problem is that this repair will still work even if the relay is not removed or disconnected.

The best way to tell if the speed density conversion has been performed is to check the system with a scan tool. The scan tool readings will be erratic if the system has been converted. Look at the coolant temperature sensor reading. If the system has been converted, the coolant temperature system reading will stay at -40° C. Next take a look at the elapsed time reading. If the elapsed time does not change or updates in four minute increments, the system has been changed to speed density.

Don't get fooled by the masked bandit.

Tomco has developed a MAF sensor with a superior design to the OEM sensor. We have redesigned the circuit board to solve the high OEM failure. Tomco's MAF sensor is a quick and lasting fix for the troublesome OEM sensor.