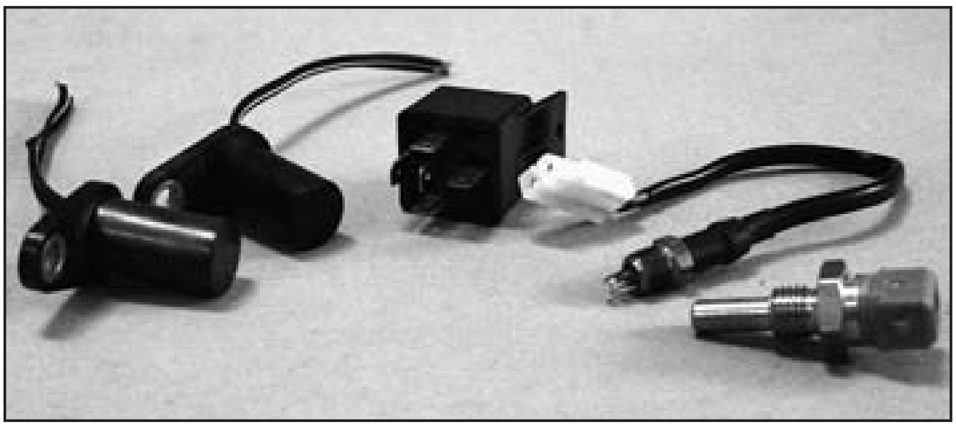
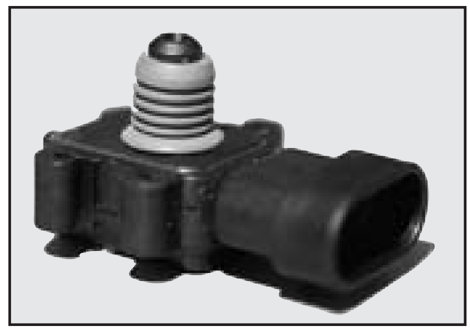
## Chapter 4

# ECU Inputs



***There are many different sensors and actuators that make up the components of a fuel-injection system. In this chapter we will take a look at some of the more common ones used in most aftermarket EFI systems.***



***The term MAP represents manifold absolute pressure — the amount of vacuum or boost inside the manifold at any given time. The MAP sensor uses absolute pressure because this type of reading will always be constant and will not be affected by changing atmospheric conditions like a normal pressure gauge would.***

In this chapter we will cover some of the basic working components of the EFI system and the theory behind how they work independently and as part of the entire system. We will begin with a look at the inputs the ECU uses to collect information, and then in the next chapter we will look at the outputs, which it uses to carry out its commands.

### MAP Sensor

The MAP (manifold absolute pressure) sensor is most commonly used as the primary input for determining the engine's load. The term load in this instance describes how hard the engine is working at any given engine speed. In other words, the amount of air that flows through the engine per cycle does not necessarily increase simply because of an increase in engine speed. The overall amount of air moving through the engine is greater for a given amount of time, but the amount per cycle doesn't vary greatly unless there is a change in engine load.

As an example, picture a car sitting at idle in neutral. In order to get the engine to climb up to say, 5,000 rpm, the operator need only push down very lightly on the accelerator pedal. Now picture the same car in overdrive going 20 miles per hour and going up a steep hill. In order to get the engine speed up to 5,000 rpm the accelerator pedal will need to be pushed to the floor and the engine will be working much harder because the load on the engine is greater for the same engine speed.

The MAP, manifold absolute pressure, is the amount of vacuum or boost inside the manifold at any given time. The sensor uses absolute pressure because this type of reading will always be constant and will not be affected by changing atmospheric conditions like normal gauge pressure would.

***The MAP sensor consists of a flexible diaphragm that conducts electricity. The resistance of the diaphragm changes when it flexes or bends. When pressure is applied to the MAP sensor, it causes the diaphragm to flex. The resistance acting on the electricity passing through the sensor changes in proportion to the actual pressure acting on it, and the computer is able to read the changes in the signal that returns to the ECU.***


***If we have a tire pressure gauge and we connect it to a tire that reads 32 psi, we can say that the tire filled to a gauge pressure of 32 psi. So by adding our gauge pressure to the known atmospheric pressure (14.7 psi), we have an absolute pressure of 32 psi + 14.7 psi = 46.7 psi absolute. A tire is like a manifold in that it can hold a certain amount of pressure — assuming there aren't too many leaks.***

Before we go any farther it will be useful to briefly touch on what absolute pressure is and what the units of measurements are that represent it. Normal atmospheric pressure is rated in units of pounds per square inch, or psi. The pressure at sea level is 14.7 psi. As the altitude changes, so does the density of the air. An increase in altitude produces a decrease in air density and a corresponding decrease in the measured pressure. It is also worth mentioning that as the altitude increases, the temperature of the air decreases in direct proportion. The air's altitude, pressure, density, and temperature are all related, and a change in any one of these factors affects all the others.

If we have a tire pressure gauge and we connect it to a tire that reads 32 psi, we can say that the tire is filled to a pressure of 32 psi. This number is referred to as the gauge pressure. The absolute pressure that actually exists inside the tire would be the atmospheric pressure plus the gauge pressure. So, if we measure the tire's absolute pressure at sea level the tire would have an absolute pressure of 14.7 + 32 = 46.7 psi absolute.

It is important that we only use absolute pressure when dealing with calibrating our ECU. That way, when the vehicle is operated in different geographic areas, at different altitudes and air densities, the calibration for any given manifold absolute pressure will remain the same.

Again, it is important to remember here that the density of any quantity of air is directly related to its absolute pressure. The higher the pressure, the denser the air will be for that given volume. This is easily recognizable in engines that are supercharged or turbocharged. The more boost you have to pressurize the engine with, the more total airflow it uses, and thus the more power it makes.

It will help here to also understand that nearly all automotive computers measure absolute pressure in metric units of bars, or kPa, meaning kilopascals. The reason for doing this is because when the absolute pressure inside the engine is less that 0 psi, it is operating in a vacuum. When discussing amounts of vacuum, we typically use terms like inches of mercury, or InHg, and when we talk about positive pressure or boost in an engine, we use pounds per square inch, or psi. It can be very tricky and time consuming to constantly convert these units to make them something easy to understand.

Instead, we use metric units of pascals. A pressure of 14.7 psi is considered to be one atmosphere, or 100 kPa. One kPa represents 1,000 pascals. Also a pressure of 14.5 psi is equal to one bar, so the two terms are very closely related in actual measurements, and are often used in place of each other. A bar of boost, which indicates a manifold pressure of roughly 14.5 psi gauge pressure or 25.2 psi absolute (at sea level). These measurements are also the same as having 200 kPa of manifold pressure.

When referring to automotive ECUs, we typically only use measurements of kPa. Thus, an engine operating in vacuum would have a manifold absolute pressure of something less than 100 kPa, and when the engine is at wide open throttle in a state where it has no vacuum or boost, it would have a MAP value of about 100 kPa. When the engine sees positive pressure, or boost, the MAP signal would be higher than 100 kPa. This means that a gauge pressure in the manifold of 14.5 psi of boost