TomcoTechtips

TM

ISSUE 18

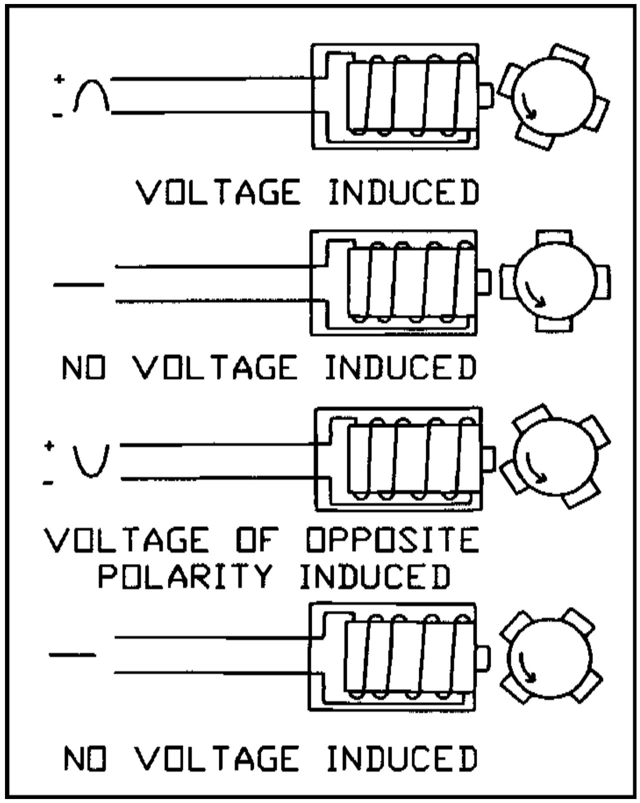
CAM AND CRANK POSITION SENSORS

In this issue we will talk about magnetic type position sensors. The magnetic position sensor consists of a permanent magnet with a coil of wire wrapped around it. The ends of the wire are attached to a control module or to the computer. In the case of a crankshaft position sensor, there is also a steel disc located on the crankshaft with protruding tabs on it.

This type of magnetic sensor is called a variable reluctance sensor. This means that the sensor has a magnetic field that can be varied. The magnetic field is varied by passing a ferromagnetic or steel material through the magnetic flux lines of the permanent magnet. When the steel tab is across from the magnet, the magnetic flux lines are increased. This in turn increases the strength of the magnetic field. It is important to remember that a voltage is only induced when there is a variance or change in the magnetic field.

As one of the tabs approaches the magnetic sensor, the strength of the magnetic field begins to increase. This change in magnetic field strength induces a voltage across the coil of wire. (Figure 1)

When one of the tabs is located directly across from the magnetic sensor, although the magnetic field is strongest at this point, there is no change in the magnetic field. Therefore no voltage is induced in the coil of wire.



Tab placement and corresponding wave form

Figure 1

As the tab begins to move away from the magnetic sensor, the magnetic field begins to decrease in strength. This change in the magnetic field results in a voltage of opposite polarity being induced in the coil of wire.

see "Cam & Crank", page 4

ELECTRONICS 101

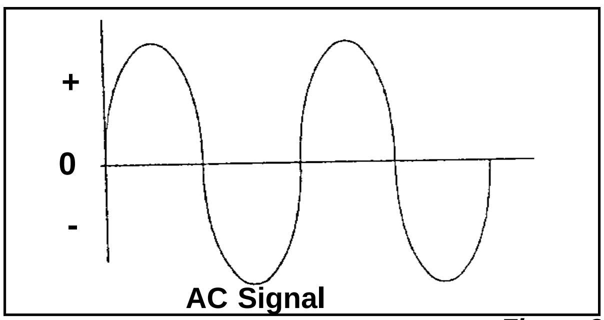
Diodes and their uses

Small signal diodes can be used to multiply voltage, perform logic, and absorb voltage spikes.

The most common use of small signal diodes is to convert alternating current (AC) into direct current (DC). This process is know as rectification.

Half-Wave Rectification

One type of rectification is called half-wave rectification. This type of rectification causes an AC signal to be converted to a single polarity DC signal. Lets follow through the steps to see how this works.

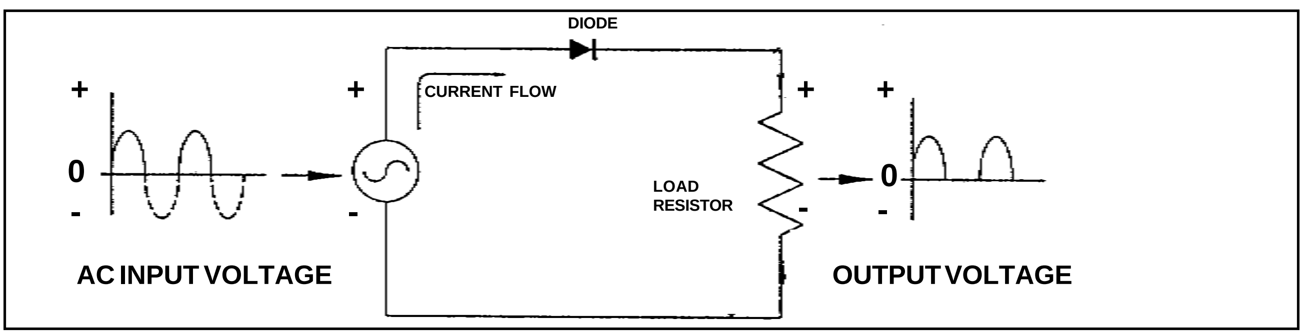


AC Signal **Figure 2**

An AC signal is an alternating current whose polarity is constantly changing from positive to negative. (Figure 2) When we apply this AC current to a circuit with a diode in it, the current flowing with the positive polarity (the upper portion of the wave), causes the diode to become forward biased. Current then flows in the circuit, allowing the positive voltage portion of the AC wave to flow through the circuit. (Figure 3)

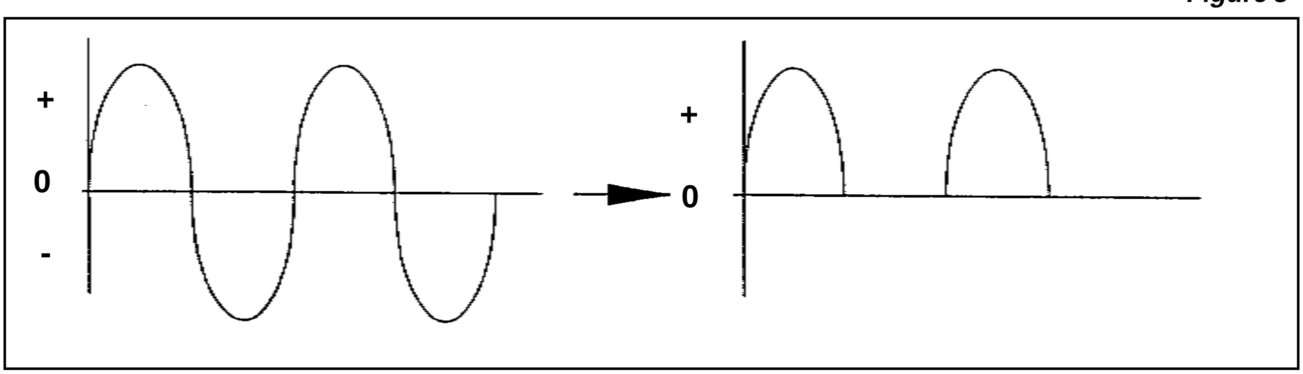
When the polarity of the AC current is negative (the lower portion of the wave) the diode becomes reversed biased. Therefore no current will flow.

The end result is that just the top halves, or positive portions, of the wave are allowed to come through the diode. (Figure 4)

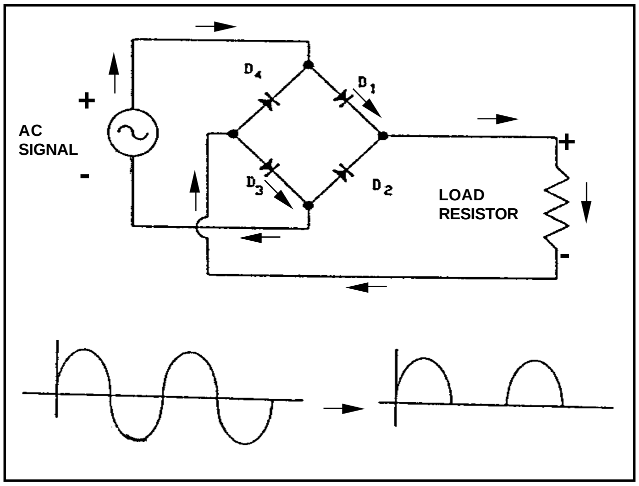


The positive polarity (upper portion of the AC wave) causes the diode to become forward bised, thus allowing current to flow.

Figure 3

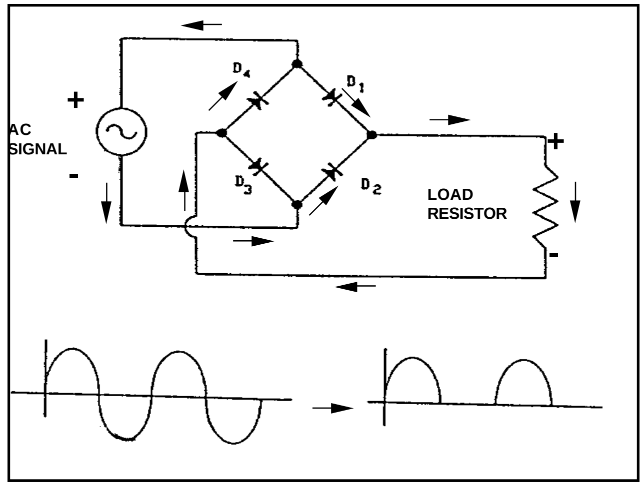


Only the upper portions of the AC wave are allowed to come through the diode. **Figure 4**



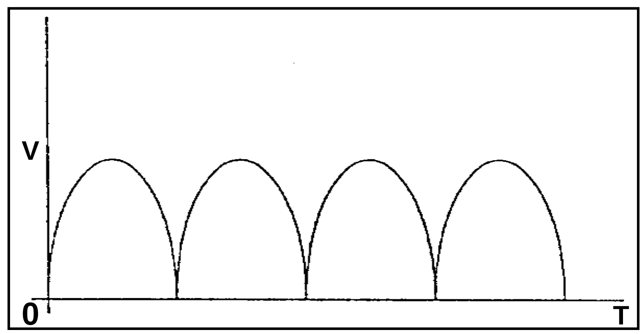
When the AC signal is positive, diodes D_1 and D_2 are forward biased and moving the positive half of the AC signal through

Figure 5



When the AC signal is negative, diodes D_2 and D_4 are forward biased. This inverts the negative half of the AC signal to make it positive.

Figure 6



This represents a full-wave rectified signal.

Figure 7

Full-Wave Rectification

Another type of rectification is called full-wave rectification. This type of rectification converts both the positive and negative halves of the AC signal into a DC signal. This is accomplished by using a series of diodes. Following along with the illustrations we can see how this happens.

When the AC signal is positive, diodes D1 and D3 are forward biased, and diodes D2 and D4 are reversed biased. This allows current to flow as shown in Figure 5. This represents the positive half of the AC signal.

When the AC signal is negative, diodes D2 and D4 are forward biased, and diodes D1 and D3 are reversed biased. This allows current to flow as shown in Figure 6. This represents the negative half of the AC signal.

As we follow the direction of the current flow in Figure 6, we see that as far as the load resistor is concerned, the current flow is the same as when the AC signal is positive. Therefore, the voltage across the load is positive. The net result is the circuit inverted the negative half of the AC input signal to make it positive.

Therefore, a full-wave rectifier output voltage will be a series of successive half cycles as shown in figure 7. The positive portion of the AC signal is reproduced exactly, while the negative portion of the AC signal is inverted and made positive.

This is the same process used in today's alternators. If you have ever scoped an alternator, the pattern in figure 7 will look familiar to you.

CAM & CRANK (continued from page 1)

When the gap between the tabs is across from the magnetic sensor, there is no change in the magnetic field, therefore there is no voltage induced in the coil of wire.

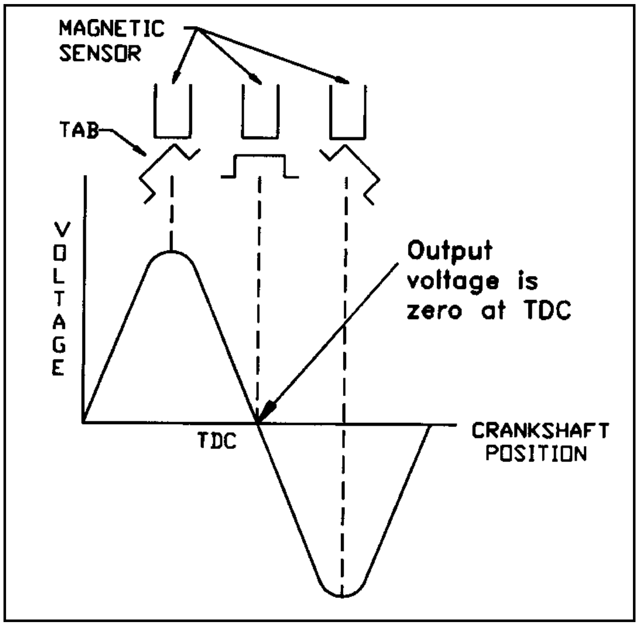


Figure 8

On a crankshaft position sensor each of these tabs correspond to the top dead center (TDC) position of a cylinder on its compression stroke. The computer uses these signals as a reference for crankshaft position and speed.

This type of magnetic position sensor produces a modified sine wave signal. This signal pattern can be seen on an oscilloscope. Figure 8 is a representation of what a normal signal should look like.

The oscilloscope pattern can be helpful in diagnosing position sensor problems. If there is increased resistance in the position sensor circuit, some of the voltage will be dropped across this resistance. This will

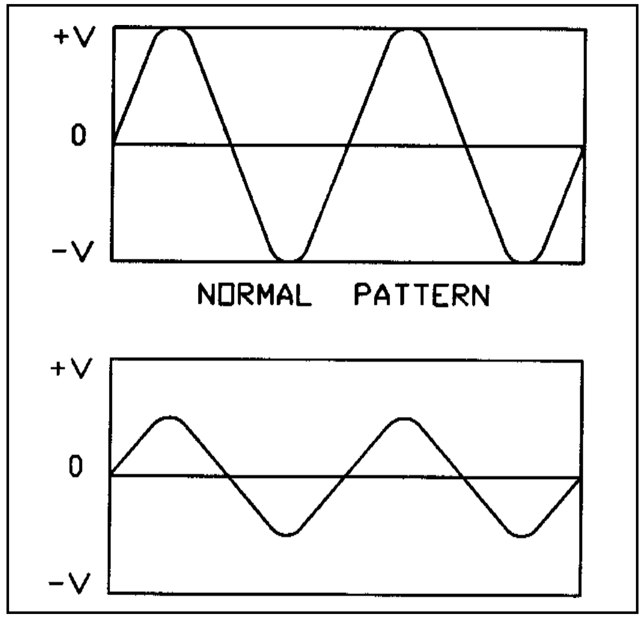


Figure 9

result in lower than normal voltage peaks in the sine wave pattern on the oscilloscope.

This same condition can occur if the sensor is misadjusted. If the sensor is located too far away from the steel tabs the magnetic field will not be as strong. Since the magnetic field is weaker there will also be a smaller change in the magnetic field. This will result in a smaller voltage being produced and hence a lower voltage sine wave pattern will be displayed on the oscilloscope. (Figure 9)