Diodes

OBJECTIVES

- Define the parts of a Diode
- Describe the two biasing conditions of a Diode
- Discuss the possible applications of a Diode

INTRODUCTION

Diodes can be thought of as one-way current valves. They let current flow one direction but not the opposite direction. This is extremely useful for isolating different functions in an electrical circuit. There are many different types of diodes, each have different uses, some of the diode types include "Light Emitting Diodes" (LED), Junction Diodes, and Zener Diodes. In this lesson the common Junction Diode will be focuses on.

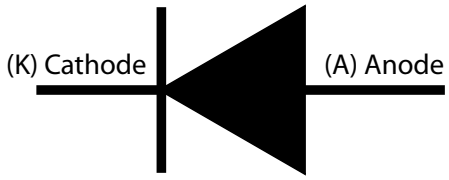
Rectifiers (Diodes)

Another name for a diode is rectifier, a diode is a device designed to allow electrons to flow in one direction only. The diode is used by mobile electronics installers primarily to isolate circuits.

How Do They Work?

The diode has two highly polarized terminals called the Anode (symbolized as "A") and Cathode (symbolized as "K"). Negative charges flow through the cathode and out the anode but won't flow in the other direction. In other words, negative (-) current (Electron Flow) will flow in only one direction through the diode. If you were to reverse the diode it would actually block current or create an "Open" circuit.

Conversely, the diode allows positive current (Hole Flow) to flow through the Anode and out the Cathode. Positive (+) current will not flow in the other direction. By rotating the diode within the electrical circuit current can be controlled or even directed. This ability is useful in many automotive electrical circuits.



Electical Symbol for a Junction Diode

This concept is easier to understand as an illustration. The following diagrams and descriptions illustrate current passing or being blocked by a diode.

Diodes and DC

In Figure 1, the circuit consists of a diode, light bulb, and battery. The diode is situated so that the positive (+) terminal of the battery is connected to the Anode (A) side of the diode. This type of connection allows the current of the battery to flow through the diode. This connection is called Forward Biased. A diode that is connected in a Forward Biased way allows current to flow. Note also that

the Cathode (K) is connected to the light bulb which in turn is connected to the battery's negative (-) terminal. This connection completes the circuit and allows current to flow though the diode, to the light bulb and then back to the negative terminal of the battery. This complete circuit causes the light bulb to illuminate.

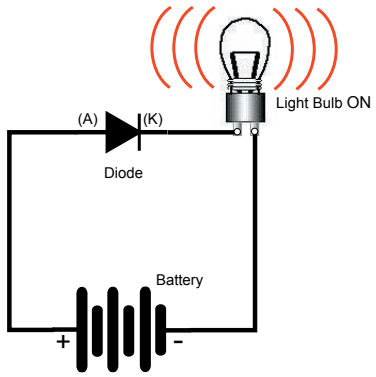


Figure 1

In Figure 2 note that the diode has been reversed. The battery's positive terminal is now connected to the Cathode (K) side of the diode. This type of connection is called Reverse Biased, and will cause current to be blocked. This prevents the circuit from being complete and causes an Open Circuit. This connection will prevent the light bulb from illuminating.

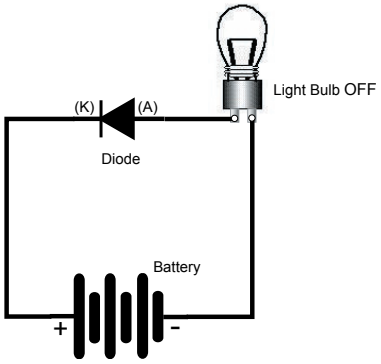
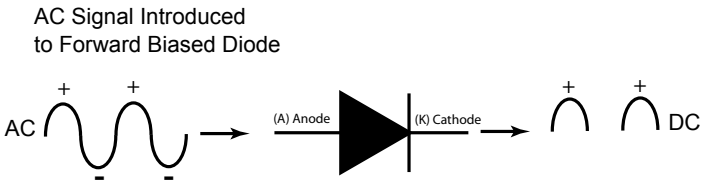


Figure 2

Diodes and AC

Another form of isolation circuit deals with AC signals. This application is part of the vehicle's charging system. An alternator generates AC energy which is converted to DC by using a process called Rectification.

As discussed earlier, the diode only allows positive current flow through the Anode (A) and out the Cathode (K). If an AC signal is introduced to the Anode, only the positive cycle of the AC waveform can pass through and out the Cathode. This effect only works if the diode is connected in Forward Bias. In Reverse Bias only the negative part of the AC waveform will pass.



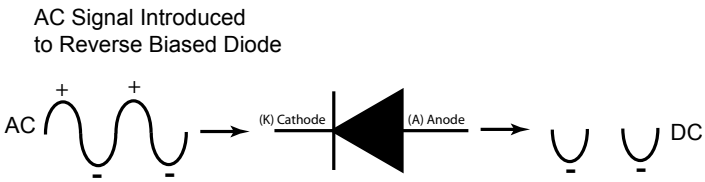


Figure 3

Note in Figure 3 how the AC signal reacts to both forward and reverse biased diodes. In the forward biased example, only the positive part of the AC signal can pass. In the reverse biased example, only the negative part of the AC signal can pass.

Cathode and Anode Identification

While there are several types of diodes, the most common, "Medium Power Junction Diodes", are identified by their white or silver band at the Cathode end of the diode.

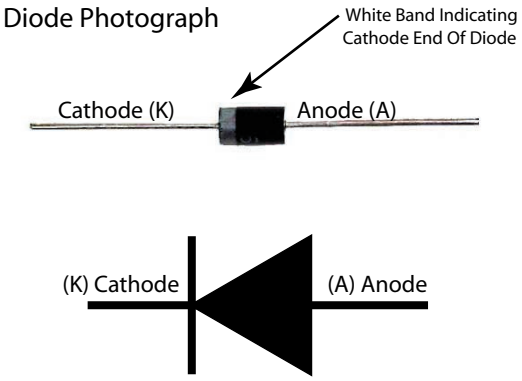


Figure 4

Electical Symbol for a Junction Diode

Note in Figure 4 the comparison between the electrical symbol and photograph of a diode. The band around the diode at one end in the photograph indicates to the user which end is the Cathode.

Voltage Loss

In order to understand the natural voltage loss of a diode we must first understand what the term "Semiconductor" means. Semiconductor is a type of material used to manufacture electronic components which have a certain amount of resistance between the conductor and insulator. In other words, a semiconductor is a material that has resistance. It will however, pass current when enough voltage is supplied by the source. The natural resistance of the material itself converts electrical energy into heat energy as it conducts electricity. The diodes we typically use for installation purposes are made of silicon. Silicon is a semiconductor that when used to make a diode has a voltage loss of around .7 Volts. In other words, when a diode is used in series with a 12.6 Volt circuit it will drop .7 V leaving 11.9 V for the rest of the circuit. This isn't a big deal when using diodes for security system isolation circuits, but can be of concern when using diodes to isolate batteries from the alternator.

Unit of Measure

There are only two considerations when determining the correct diode for your application, the amount of current and voltage that the diode will tolerate. Most diodes used by installers are not labeled directly on the diode for their value. The diode packaging typically has markings indicating voltage and current capability. Diodes come in many shapes and sizes, however, the most typical for isolation circuits is a 1 Amp, 50 Volt version that is both versatile and inexpensive. This diode is also know as a "1N4001" diode.

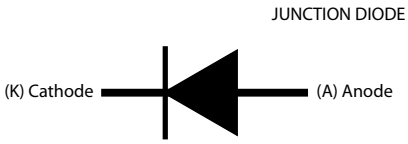
When choosing a diode always pick one that can handle more current and voltage than the application calls for. This will protect your circuit from damage. For example the "1N4001" is a 50 Volt, 1 Amp diode. As most automotive circuits are only 12.6 Volts we know the 50 Volt rating will be sufficient. The 1 Amp maximum current capability is also acceptable for most mobile security applications

where it is being used for trigger circuits. The minimum amperage rating would become considerably higher if the diode was being used to isolate two (2) automotive batteries. For this application you would be using a high power diode with a rating of over 100 Amps.

Diode Types

The most common diode to installers is the medium power junction diode. However, there are several categories and types to discuss in order to gain an overall view of the varied functions of each diode.

Junction Diodes



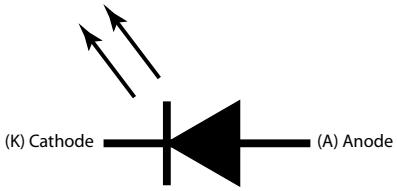
These diodes are used primarily for circuit isolation or rectification. They come in several shapes and sizes depending on the application.

i) Low Power - used primarily on circuit boards with low power and amperage needs. This type of diode is not typically used by installers.

ii) Medium Power - used by installers to isolate circuits.

iii) High Power - Typically used in the construction of battery isolators.

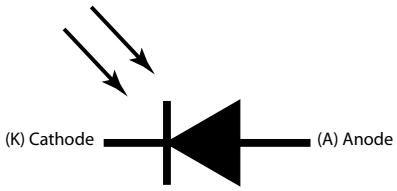
Light Emitting Diodes



Light Emitting Diodes or LED's have many uses. Virtually all electronics equipment incorporates some LED's. Typically, they are used to provide the user with some form of information regarding the operation of the equipment.

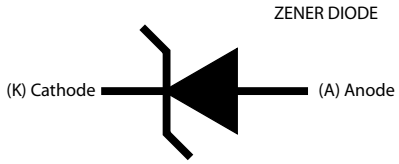
These diodes work the same as a junction diode with one exception–LED's convert some of the electrical energy moving through the diode into light energy. This energy is usually passed through by some form of colored lens. Also the Voltage Drop across an LED is usually between 2 to 3 Volts, unlike the .7 Volts across a typical silicon diode.

Photo Diodes



Although not used by installers, photo diodes are part of the diode family and should be briefly discussed. These types of diodes conduct current when energized by light energy. Think of the light as an on/off switch for the diode. Typically used to turn on a night light at night.

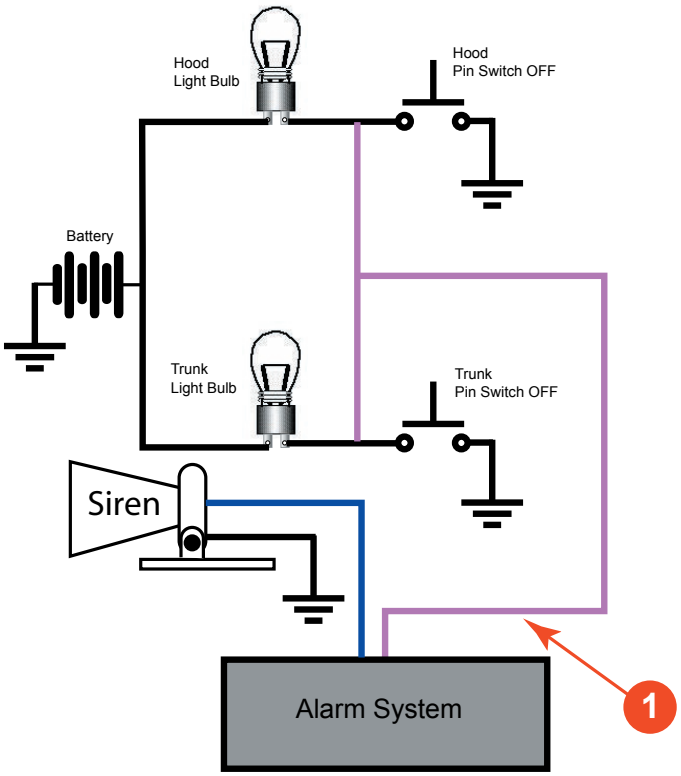
Zener Diodes



Also not typically used by installers, Zener diodes are used primarily in electronic circuits as a voltage regulation device. These devices, when wired in forward bias act as a regular junction diode. However, when wired in reverse bias, unlike the junction diode, current will pass through the diode once a certain amount of voltage is achieved. In other words, these diodes act as a voltage sensitive on/off switch.

Junction Diode Application

The following illustrations take you through a typical mobile security connection to a hood and trunk pin switch. This type of connection is necessary when a basic alarm is connected to monitor both the hood and trunk areas. The alarm system has only one (1) wire that can monitor the hood/trunk. This requires both of the sensor wires (hood & trunk) to be connected together at the alarm system. If either the hood or trunk pin switch is actuated by the intruder the alarm is designed to trip. It does this by sensing the ground signal sent by either the hood or trunk pin switches. Figure 5 shows this connection. Note that a wire has been connected to both pin switches which runs to the alarm system.



Negative Trigger Alarm Sensor Wire

1 This wire looks for a ground source, when a ground is introduced to this wire the alarm system will sound. In this case this wire is connected to both the hood and trunk pin switches. If either the hood, or the trunk are forced open, the alarm will sound.

Figure 5

Figure 6 shows what happens if the hood is opened. Notice that both the hood and trunk light bulbs turn on when just one pin switch is activated. This happens because of the connection made to the alarm. Both light bulbs actually find ground through the hood pin switch.

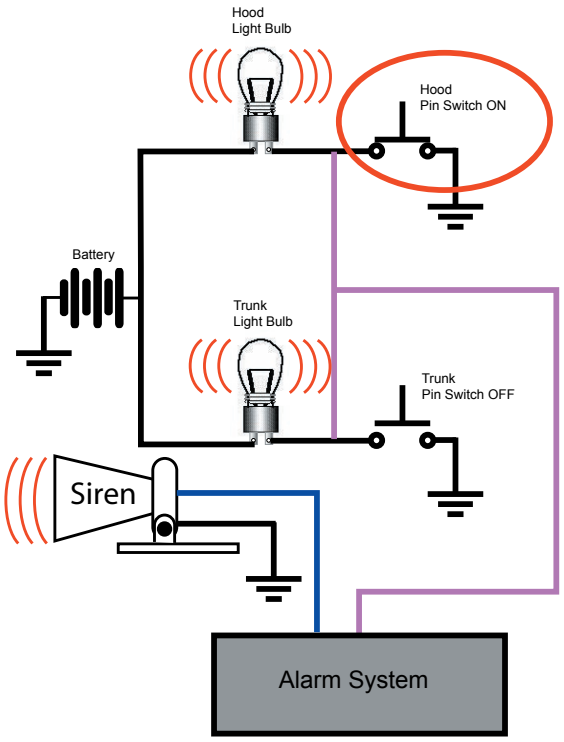


Figure 6

In order to prevent this from happening two (2) diodes are introduced to the circuit (Figure 6). This allows the ground signal from each pin switch to travel to the alarm sensor wire but prevents the light bulbs from sharing a ground at either pin switch. Remember, a ground signal will only flow through a diode in one direction (cathode to anode). The ground signal can only travel to its own light bulb or to the alarm, it can not travel to the other light bulb that is not part of its circuit. Figure 7 shows the hood switch as being activated, however, only the hood light bulb comes on. Note that the trunk light remains off while the hood is open.

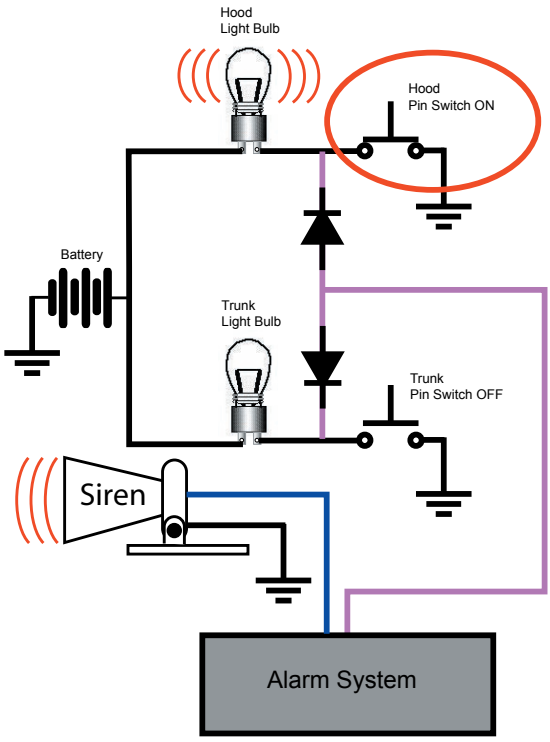


Figure 7

Figure 8 shows what happens when the trunk is opened. Note that with the diodes in place only the trunk light bulb activates. The hood light remains off.

This type of circuit is a good example of the use of a diode as an isolation circuit.

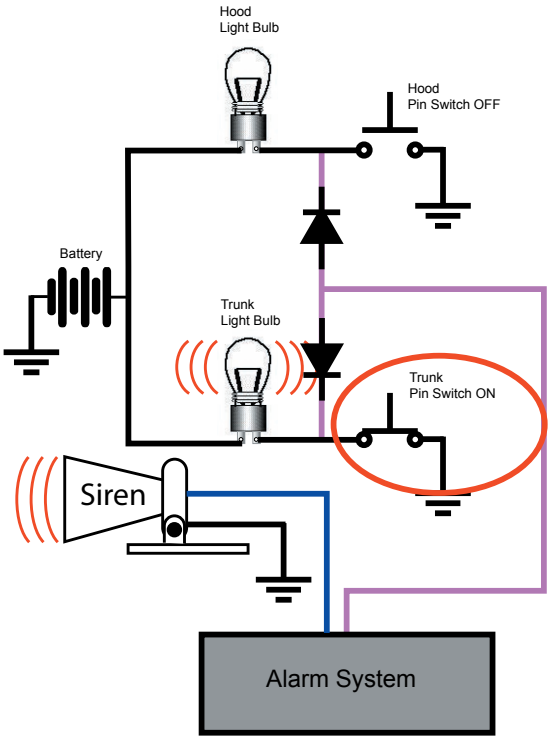


Figure 8