Relays

OBJECTIVES

- Describe the anatomy of a relay
- Describe the components of a common automotive SPDT relay
- Discuss the use of a SPDT relay in an electrical circuit

INTRODUCTION

Relays are used for many installation applications. These applications range from protecting a turn-on signal from a head unit or adding aftermarket door locks, to interfacing a security system. A relay is a switch that can be turned on and off with an electrical signal instead of through the manual motion of a hand or other physical mechanism. In this lesson the basics of a relays construction and uses will be covered.

Relays

The relay is nothing more than a switch. In fact, the relay is technically known as an electromechanical switch. The basic use of a relay in automotive applications is for one or more of the following four things:

1) Turn something "ON".
2) Turn something "OFF".
3) Change the polarity of something.
4) Increase the current supply of something.

Relays involve the simple matter of switching. The difference between a switch that you might activate and deactivate with your finger (pushing a button or flipping a rocker or toggle switch) and a relay is the method of activation. Your finger might manually activate a switch "on" or "off", while a relay is activated electronically without human hands ever having to touch it. This is the basis of how a function can operate automatically or without someone turning a switch manually. Remote car starters, keyless entry systems and time delayed headlights are all controlled by relays.

Nearly every modern security system is designed to have great interfacing capabilities. To activate the features on many alarms, relays must be used to handle the large electrical loads of door locks, lights, horn etc. While there are also many applications for relays in audio systems, relays are used mostly in security and convenience systems.

Bosch 30 Amp SPDT relay

The Anatomy of a Relay

There are typically 3 integral parts to a standard automotive relay. They are known as the COIL, the CONTACTS and the SPRING.

The COIL

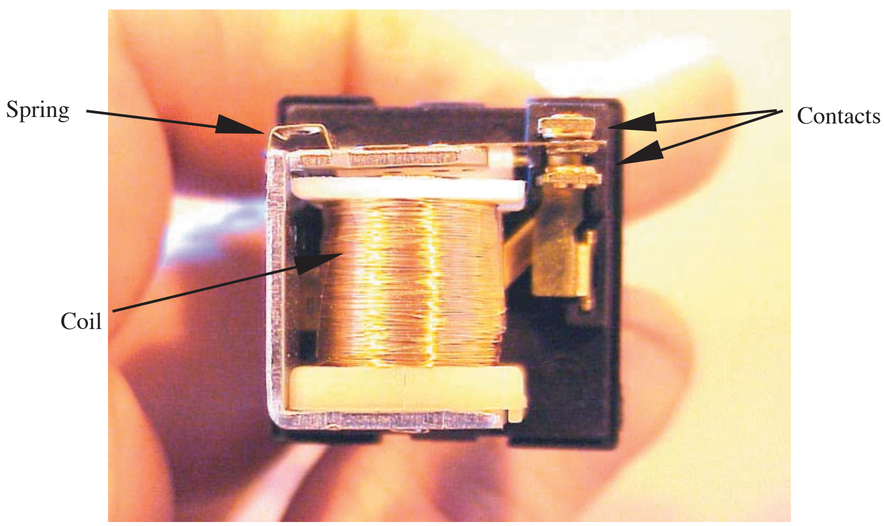
This is the "electromagnetic" part of the switch that allows the relay to be controlled electronically rather than by someone pressing a button or switch. The coil is made up of many turns of small gauge wire wrapped around an iron core. When this coil is energized it creates a magnetic field.

The CONTACTS

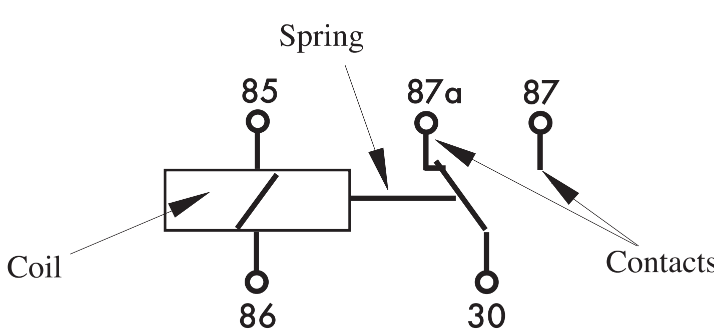
These are the terminals that connect into the vehicle electrical system. Functions include turning a vehicle circuit On/Off, changing polarity (from the control polarity) or increasing the current (from the control current). Think of the contacts as the place that wires get connected or disconnected depending on the state of the relay and how they're wired.

The SPRING

This is the part of the relay that keeps the common and normally closed contact connected while the coil is not energized (off position). The spring is actually made of spring steel, similar to the pocket clip on a ballpoint pen. Magnetic force created by the coil attracts the spring which is connected to the common terminal.



A look inside an automotive relay

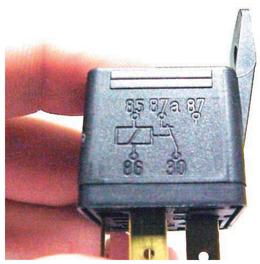


A look at the schematic of a Bosch SPDT relay as pictured above. This schematic is illustrated on the side of each Bosch relay

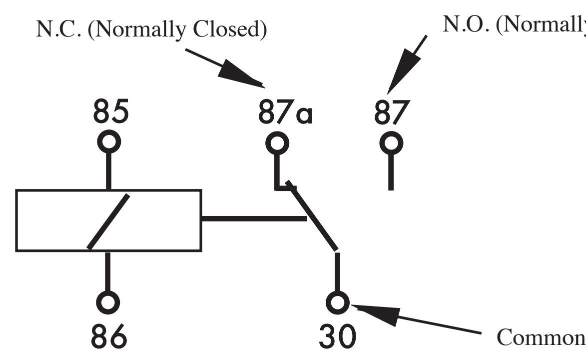
Contact Function

An SPDT relay has two contact states - NORMALLY OPEN and NORMALLY CLOSED. This is the most common type of relay found in the installation bay. SPDT stands for <u>S</u>ingle <u>P</u>ole, <u>D</u>ouble <u>T</u>hrow. This means there's a single COMMON pole (contact) that connects to two other contacts, the NORMALLY CLOSED and NORMALLY OPEN contacts.

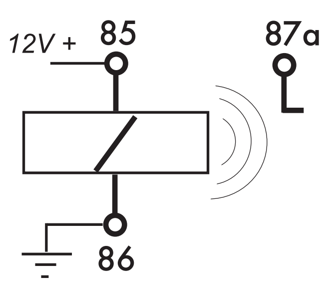
When the relay is not active the common terminal is connected to the normally closed terminal. When the relay is switched on, the common terminal becomes disconnected with the normally closed terminal and instead connects with the normally open terminal for the duration that relay stays activated.



The "schematic" for how the relay functions is located on the side or top of every relay. This Bosch relay shows terminals 30 and 87a connected while it's in the rest or off position. When the relay switches on, you can see that 30 and 87 become connected, while 87a becomes disconnected. 30 is connected to something all of the time.



SPDT Relay NOT ACTIVE (OFF)
Note that terminals 87a and 30 remain connected permanently when the relay is in this OFF state

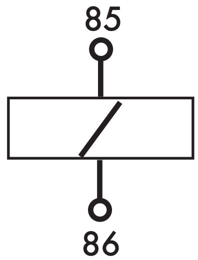


SPDT Relay ACTIVE (ON)
Note that terminals 87a and 30 have broken contact and that now terminals 30 and 87 are connected. Note also that terminal 85 has been connected to 12V + and that terminal 86 is grounded .

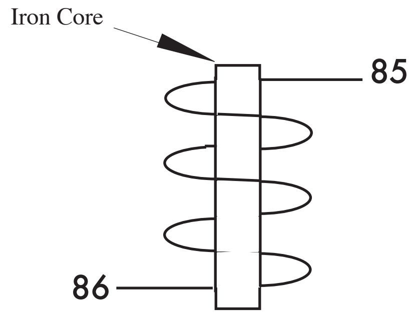
Identifying the Relay Terminals

The Coil (Pins 85 and 86)

The coil will energize the relay and magnetically pushes the switch to close a circuit when the coil receives voltage. The way it works is by creating magnetism that pushes the spring to another contact. Magnetism is created any time current flows through a conductor. A typical relay coil has about 85 ohms of resistance that will cause about 150mA of current to flow if positive and negative voltage are applied to opposing ends of the coil. The magnetic field that is generated is what causes the relay to switch states from normally closed to normally open.

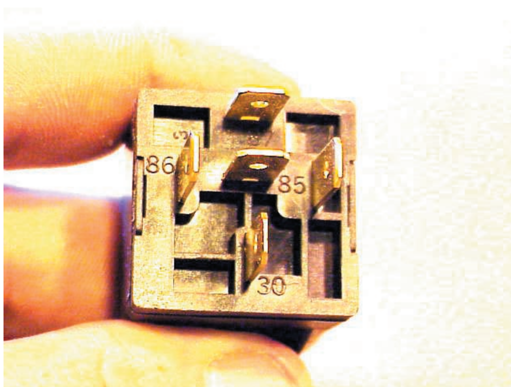


The coil side of a typical automotive SPDT relay as seen on the schematic located on side of the relay



A coil is a device that when connected to a power source and ground will produce a magnetic field.

Note that in the diagram above terminals 85 and 86 are simply the two ends of a long piece of conductor. When one end gets connected to power (12V +) and the other is connected to a ground source the current flow through the wire causes a reaction with the iron rod and creates a magnetic field. This concept is where many students of relay theory start to have difficulty in understanding. The simplicity of this device confuses many a student. The function of the coil is simply to create a magnetic field. This field in turn moves the arm connected to terminal 30 from its rest position at 87a to terminal 87.

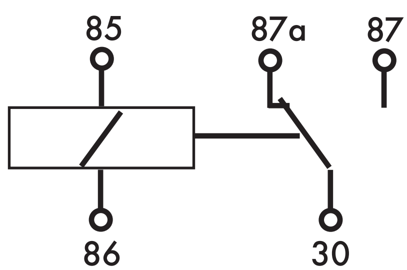


Activating the coil requires nothing more than a (+)12 volt connection on one terminal of the coil (85 or 86) and a (-) ground connection on the other remaining terminal. It doesn't matter which terminal is connected to which polarity, only that current flows in the coil to create a magnetic field. One side of the coil is typically controlled by an alarm output such as the door lock or flashing light output of a security system. The other side of the coil is connected to a "constant" source, whichever opposing polarity is required.

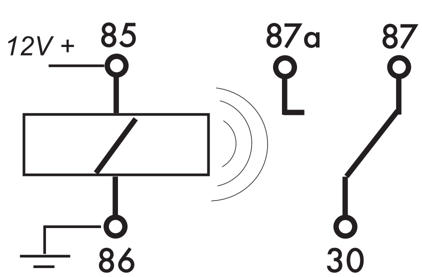
The Common Terminal (# 30)

Pin 30 - The Common Terminal takes anything connected to it and offers two choices much like a railroad switch. While the relay is off or "at rest", terminal 30 is connected to the normally closed terminal (87a). As soon as the coil is energized, terminal 30 connects with the normally open terminal (87).

Terminal 30 is called the common terminal because it's connected to something ALL OF THE TIME, whether the relay is on or off. That's important to remember as you start applying your relay knowledge into actual applications.



In this diagram terminal 30 is connected to terminal 87a, this is the normal or (off) state of the relay and will remain this way until the coil is energized.

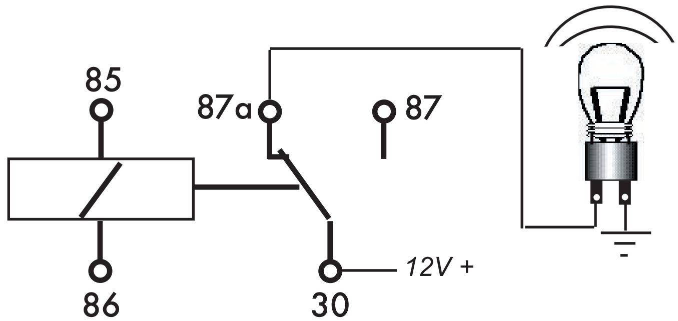


In this diagram the coil side of the relay has been energized. As a result, a magnetic field has effected the spring and caused the common terminal (30) to disconnect from terminal 87a and instead make contact with terminal 87.

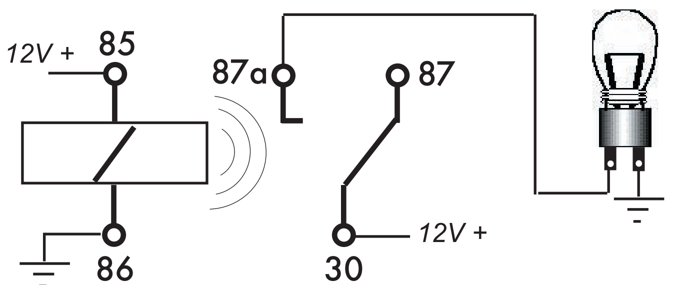
The Normally Closed Terminal (#87a)

Pin 87a - The N.C. (normally closed) terminal completes a circuit with the common terminal (30) only if there is no power to the coil. If the relay becomes energized, the connection between 87a and 30 become disconnected.

This "normally closed" state is useful for turning things "off" or interrupting a circuit such as a starter kill. The circuit must pass through the relay, in series, to be able to be "interrupted".



In this diagram the light bulb is lit and will remain lit until the coil side of the relay has been energized. This is a common turn off circuit. If controlled by the alarm system the bulb would shut off when activated by a signal from the alarm system.

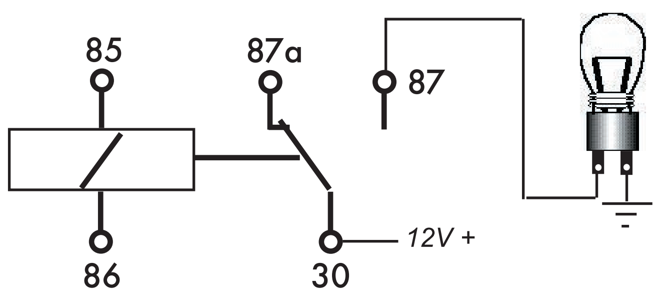


In this diagram the coil side of the relay has been energized. The magnetic force created has effected the spring and caused terminal 30 to break contact with terminal 87a and instead make contact with terminal 87. The effect of this action is that the light bulb has been shut off resulting from a break in its source for 12V +. The bulb will remain shut off the entire time that the coil remains energized. Note that terminal 87 is not connected to anything except terminal 30. This is very common, in most cases you are only making connections 4 of the 5 terminals on a relay.

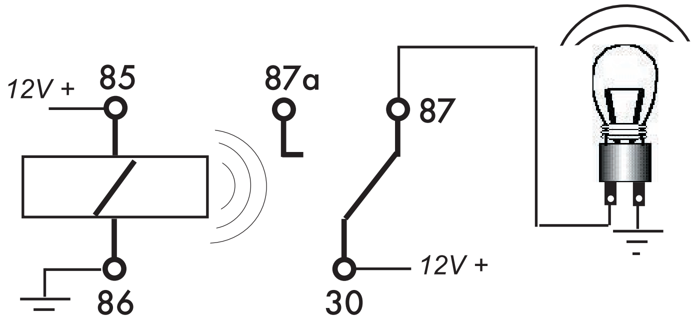
The Normally Open Terminal (#87)

Pin 87 - The N.O. (normally open) terminal completes a circuit with the common terminal (30) only when the relay coil has power and ground. This means that while the relay is activated, pins 30 and 87 are electrically connected. This connection is active for the duration of time the relay remains active, but becomes disconnected when the relay coil is de-energized.

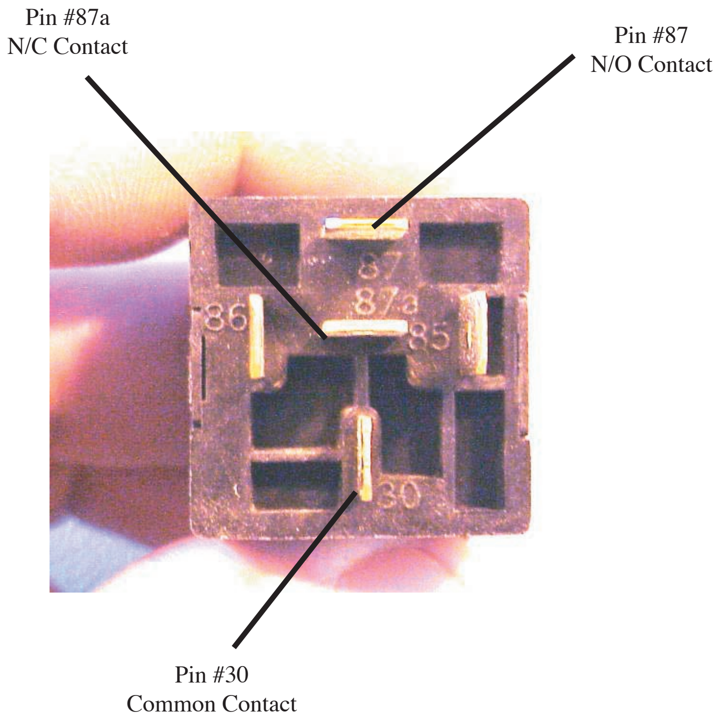
This "normally open" state is typically the configuration used to turn something "on", to invert a polarity, or to increase the supply of current. Typically with a turn on circuit, the relay provides a secondary, or parallel, supply path to the circuit in addition to the normal switch.



In this diagram the light bulb positive lead has been connected in series with terminals 30 and 87. In its current off state the relay does not allow the 12V+ signal to travel to the light bulb. The bulb will not light regardless of the fact that is connected permanently to ground.



In this diagram the coil of the relay has been energized and has caused contact between terminals 30 and 87. As a result the bulb lights up and will remain lit until the coil side of the relay is de-energized.



A look at the back of a Bosch relay and terminals 30, 87a, and 87. Actual connections are soldered onto these terminals or a custom wired harness is plugged into the back of the relay.

Relay Specifications

Coil Voltage
Coil Current
Contact Arrangement
Contact Current

Rating a Relay

Relays are rated according to 4 categories. These are the Coil Voltage and Current, Contact Arrangement and Contact Current capability.

Coil Voltage

The coil voltage is the voltage required to create the magnetic field we discussed earlier. There are many different types of relays with varied voltage requirements. Most automotive relays of the types we use in the mobile electronics industry have a coil rating of 12 Volts DC.

Coil Current

This is the amount of work or current required to affect the spring located in the relay. This is typically dependant on the weight of the spring. As the current capability of terminals 87a, 87, and 30 increases so does the current required to move the spring. For example a relay capable of handling 300 Amps of current would require a much heavier spring and contact points to that of a 30 Amp relay. For our purposes the 30 Amp relay we use in mobile electronics installations requires approximately 150mA (milliamperes) of current to move the spring.

Since a relay coil only requires about 150mA to activate (0.150A), a very small amount of current can control the turning on or off of a much larger amount, in this case up to 30 amps. That's roughly 200 times the control signal. This is why relays can increase (or amplify) current as one of their other functions.

Contact Arrangement

The relay of discussion in this module is the SPDT (single pole double throw) relay. There are many contact arrangement available to the electronics industry. Another common relay in our industry is the 4 Pole Double Throw. You will find these relays in car audio display boards. They are capable of switching four contact simultaneously and are ideal for switching the outputs of a head unit or amplifier.

Contact Current

The mobile electronics industry uses mainly a 30A (Amp) relay. This amount of current is ideal for the automotive industry as virtually all vehicle circuits are 30 Amps or lower in current draw. This allows us to switch almost anything in the car through our relay. These relays are typically rated at two current capabilities. A Bosch relay for example is rated 20/30. This specification indicates to the user that terminals 87a and 30 when in contact can pass 20 Amps of current indefinitely, while terminals 87 and 30 when connected can pass 30 Amps of current. It's very common to see such ratings since there are different requirements of current stability depending on the length of time the contacts are in use. Other brands such as Siemens, Rayex and Potter & Brumfield post a higher rating at 30/40 in many of their SPDT relays (Figures 2 and 3).

Figure 1

Figure 2

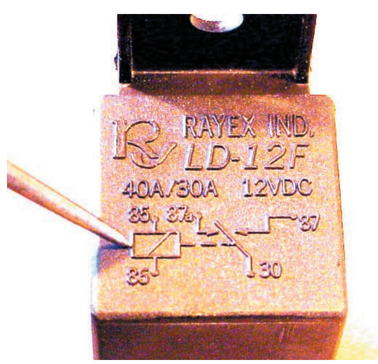


Figure 3

Don't get confused with the differences in the schematic drawings on figures 2 and 3. Notice the differences? Some manufacturers show the terminals 87 and 87a reversed. However, it makes no difference to you the installer. The relay still works the same way.