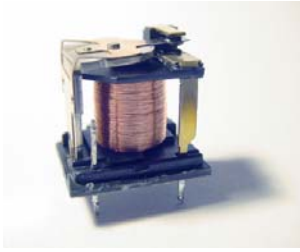
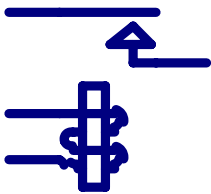


Relay Basics:



A relay is an electrical switch that uses an electromagnet to move the switch from the off to on position instead of a person moving the switch. It takes a relatively small amount of power to turn on a relay but the relay can control something that draws much more power. Ex: A relay is used to control the air conditioner in your home. The AC unit probably runs off of 220VAC at around 30A. That's 6600 Watts! The coil that controls the relay may only need a few watts to pull the contacts together.



This is the schematic representation of a relay. The contacts at the top are normally open (i.e. not connected). When current is passed through the coil it creates a magnetic field that pulls the switch closed (i.e. connects the top contacts). Usually a spring will pull the switch open again once the power is removed from the coil. A good diagram (without the return spring) is at: <http://www.railway-technical.com/relay.gif>

Relay Selection:

Relays (and switches) come in different configurations. The most common are shown to the right. Single Pole Single Throw (SPST) is the simplest with only two contacts.

Single Pole Double Throw (SPDT) has three contacts. The contacts are usually labeled Common (COM), Normally

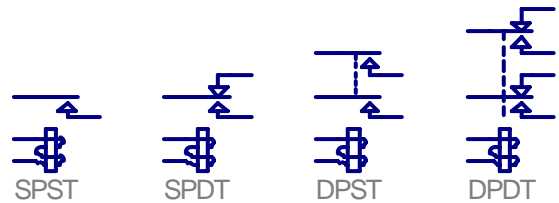
Open (NO), and Normally Closed (NC). The Normally Closed contact will be connected to the Common

contact when no power is applied to the coil. The Normally Open contact will be

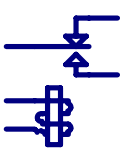
open (i.e. not connected) when no power is applied to the coil. When the coil is energized the Common is connected to the Normally Open contact and the

Normally Closed contact is left floating. The Double Pole versions are the same

as the Single Pole version except there are two switches that open and close together.



COM



NC.

NO.

Select a relay with contacts that can handle the voltage and current requirements of the load. Keep in mind that some loads (such as motors) draw much more current when first turned on than they do at steady state.

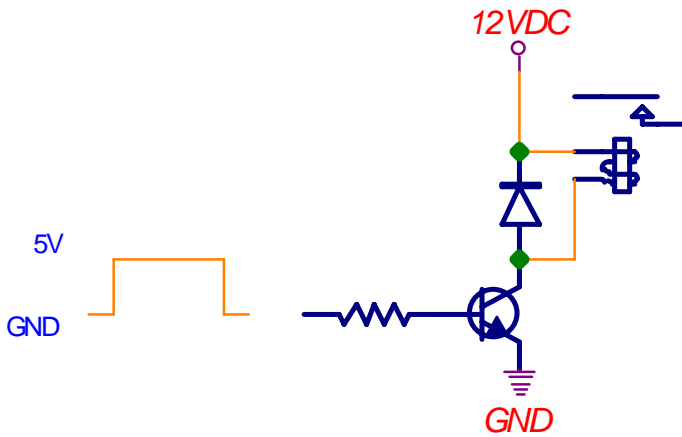
Select a relay with a coil voltage and current that you can control easily. Ex: If you want to turn on the AC unit with a 12VDC power supply get a 12VDC coil. Note: Coils will be rated for either AC or DC operation.

Practical Considerations:

Check the relay datasheet for the expected lifetime (i.e. # of times it can open and close before failure). If the relay won't be used much (say to control the headlights on a car) a 20,000 cycle lifetime would last about 18 years if used three times a day. If the same relay was used to control a home AC unit which switches on and off much more often it would wear out in a few years. Some relays have lifetimes of over a million cycles.

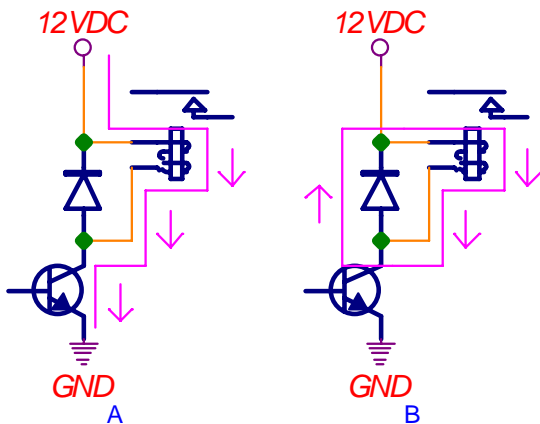
Flyback Diode:

A relay coil is not only an electromagnet but it's also an inductor. When power is applied to the coil the current in the coil builds up and levels off at its rated current (depends on the DC resistance of the coil, $I = V/R$). Some energy is now stored in the coil's magnetic field ($E = 0.5LI^2$). When the current in the coil is turned off this stored energy has to go somewhere. The voltage across the coil quickly increase trying to keep the current in the coil flowing in the same direction ($V = Ldi/dt$). This voltage spike can reach hundreds or thousands of volts and can damage electronic parts.



By adding a flyback diode the current has a path to continue flowing through coil until the stored energy is used up. The diode also clamps the voltage across the coil to about 0.7V protecting the electronics. The stored energy dissipates quickly in the diode ($E = V \cdot I \cdot t$). The current stops flowing and the relay turns off. The diode should be able to handle the coil current for a short time and switch relatively fast. Note: A resistor or zener diode can be placed in series with the diode to use up the stored energy quicker. This increases the amplitude of the voltage spike

above 0.7V but the energy is used up quicker (i.e. the voltage spike won't last as long). Usually it doesn't matter if the relay takes 1ms or 100ms to turn off.



The schematic on the left illustrates how current flows in a relay. Fig A shows the current flow when the transistor is on. Fig B shows the current flow when the transistor is off. Notice how the diode completes the current loop.

Note: An automotive ignition coil uses the stored energy in an inductor combined with a step up transformer to power the spark plugs in your car. By quickly collapsing the magnetic field over 20,000V can be generated.

Note: If the load is DC and inductive add a flyback diode across the relay contacts (as shown to the right). The **inductive kickback** from the load will shorten the lifetime of the relay contacts if the diode isn't present.

