National Plastic Heater
Call Toll Free 1.877.674.9744

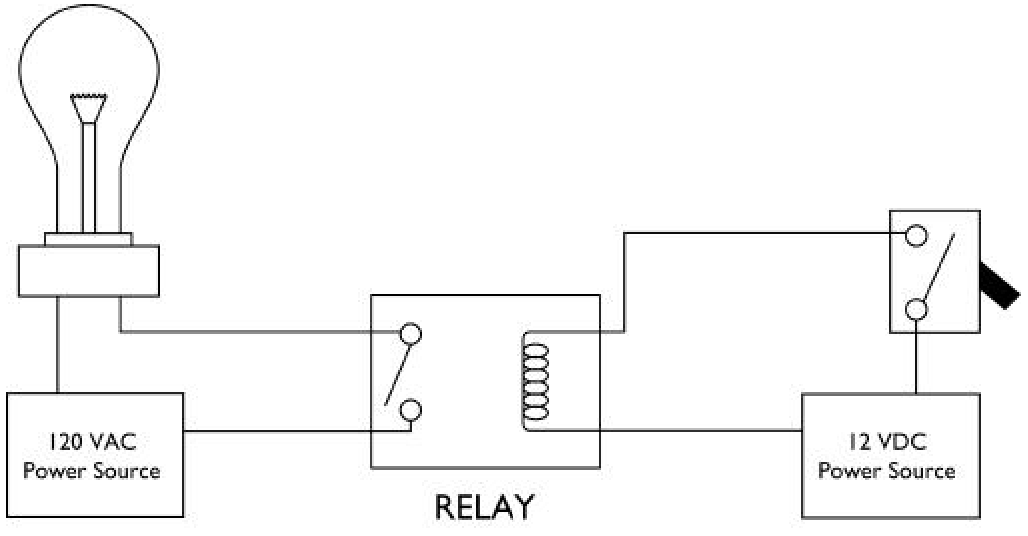
Relays

What is a relay?

A relay is usually an electromechanical device that is actuated by an electrical current. The current flowing in one circuit causes the opening or closing of another circuit. Relays are like remote-control switches and are used in many applications because of their relative simplicity, long life, and proven high reliability. Relays are used in a wide variety of applications throughout industry, such as in telephone exchanges, digital computers and automation systems. Highly sophisticated relays are utilized to protect electric power systems against trouble and power blackouts as well as to regulate and control the generation and distribution of power. In the home, relays are used in refrigerators, washing machines and dishwashers, and heating and air-conditioning controls. Although relays are generally associated with electrical circuitry, there are many other types, such as pneumatic and hydraulic. Input may be electrical and output directly mechanical, or vice versa.

How do relays work?

All relays contain a sensing unit, the electric coil, which is powered by AC or DC current. When the applied current or voltage exceeds a threshold value, the coil activates the armature, which operates either to close the open contacts or to open the closed contacts. When a power is supplied to the coil, it generates a magnetic force that actuates the switch mechanism. The magnetic force is, in effect, relaying the action from one circuit to another. The first circuit is called the control circuit; the second is called the load circuit.



There are three basic functions of a relay: On/Off Control, Limit Control and Logic Operation.

On/Off Control: Example: Air conditioning control, used to limit and control a "high power" load, such as a compressor

Limit Control: Example: Motor Speed Control, used to disconnect a motor if it runs slower or faster than the desired speed

Logic Operation: Example: Test Equipment, used to connect the instrument to a number of testing points on the device under test

Types of Relays

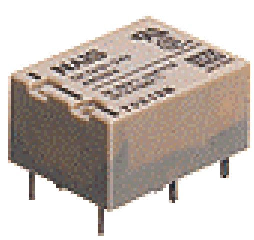
There are two basic classifications of relays: Electromechanical and Solid State. Electromechanical relays have moving parts, whereas solid state relays have no moving parts. **Advantages of Electro-mechanical relays include lower cost, no heat sink is required, multiple poles are available, and they can switch AC or DC with equal ease.**

A.) Electromechanical Relays

General Purpose Relay: The general-purpose relay is rated by the amount of current its switch contacts can handle. Most versions of the general-purpose relay have one to eight poles and can be single or double throw. These are found in computers, copy machines, and other consumer electronic equipment and appliances.

General Purpose Relay

Power Relay: The power relay is capable of handling larger power loads – 10-50 amperes or more. They are usually single-pole or double-pole units.



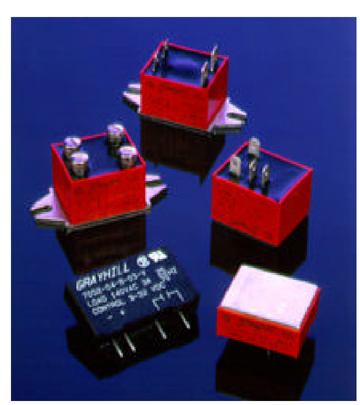
Hi Power Relay

Contactor: A special type of high power relay, it's used mainly to control high voltages and currents in industrial electrical applications. Because of these high power requirements, contactors always have double-make contacts.

Time-Delay Relay: The contacts might not open or close until some time interval after the coil has been energized. This is called delay-on-operate. Delay-on-release means that the contacts will remain in their actuated position until some interval after the power has been removed from the coil. A third delay is called interval timing. Contacts revert to their alternate position at a specific interval of time after the coil has been energized. The timing of these actions may be a fixed parameter of the relay, or adjusted by a knob on the relay itself, or remotely adjusted through an external circuit.

B.) Solid State Relays

These active semiconductor devices use light instead of magnetism to actuate a switch. The light comes from an LED, or light emitting diode. When control power is applied to the device's output, the light



Solid State Relays

is turned on and shines across an open space. On the load side of this space, a part of the device senses the presence of the light, and triggers a solid state switch that either opens or closes the circuit under control. Often, solid state relays are used where the circuit under control must be protected from the introduction of electrical noises. **Advantages of Solid State Relays include low EMI/ RFI, long life, no moving parts, no contact bounce, and fast response. The drawback to using a solid state relay is that it can only accomplish single pole switching.**

Contact Information

The contacts are the most important constituent of a relay. Their characteristics are significantly affected by factors such as the material of the contacts, voltage and current values applied to them (especially, the voltage and current waveforms when energizing and de-energizing the contacts), the type of load, operating frequency, and bounce. If any of these factors fail to satisfy a predetermined value, problems such as metal degradation between contacts, contact welding, wear, or a rapid increase in the contact resistance may occur.

The quantity of electrical current that flows through the contacts directly influences the contacts' characteristics. For example, when the relay is used to control an inductive load, such as a motor of a lamp. The contacts will wear faster and metal decomposition between the mating contacts will occur more often as the inrush current to the contacts increases.

To prolong the life expectancy of a relay, a contact protection circuit is recommended. This protection will suppress noise and prevent the generation of carbon at the contact surface when the relay is opened. Examples of these synergistic components that provide contact circuit protection include resistor capacitors, diodes, Zener diodes and varsitors.

Contact Arrangement/Poles

The arrangement of contacts on a relay includes a form factor and a number of poles. Each form factor is explained below.

> Form A is a contact that is Normally Open (NO), or "make" contact. It is open when the coil is de-energized and closes when the coil is energized. Form A contacts are useful in applications that must switch a single power source of high current from a remote location. An example of this is a car horn, which cannot have a high current applied directly to the steering wheel. A Form A relay can be used to switch the high current to the horn.
>
> Form B is a contact that is Normally Closed (NC), or "break" contact. It is closed in the de-energized position and opens when the coil is energized. Form B contacts are useful in applications that require the circuit to remain closed, and when the relay is activated, the circuit is shut off. An example of this is a machine's motor that needs to run at all times, but when the motor must be stopped, the operator can do so by activating a Form B relay and breaking the circuit.
>
> Form C is a combination of Form A and B arrangement, sharing the same movable contact in the switching circuit. Form C contact are useful in applications that require one circuit to remain open; when the relay is activated, the first circuit is shut off, and another circuit is turned on. An example of this is on a piece of equipment that runs continually: when the

relay is activated, it stops that piece of equipment and opens a second circuit to another piece of equipment.

Make-before-break Contact: a contact arrangement in which part of the switching section is shared between both a Form A and a Form B contact. When the relay operates or releases, the contact that closes the circuit operates before the contact that opens the circuit releases. Thus both contact are closed momentarily at the same time. The inverse of a Make-before-break contact is a Break-before-make contact.

Poles are the number of separate switching circuits within the relay. The most common versions are Single Pole, Double Pole and Four Pole.

Load Types

Load parameters include the maximum permissible voltage and the maximum permissible amperage the relay can handle, both volts and amps. Both the size of the load and its type are important. There are four types of loads: 1.) Resistive, 2.) Inductive, 3.) AC or DC, and 4.) High or Low Inrush.

1.) Resistive Load is one that primarily offers resistance to the flow of current. Examples of resistive loads include electric heaters, ranges and ovens, toasters and irons.

2.) Inductive Loads include power drills, electric mixers, fans, sewing machines and vacuum cleaners. Relays that are going to be subjected to high-inrush inductive loads, such as an AC motor, will often be rated in horsepower, rather than in volts and amps. This rating reflects the amount of power the relay contacts can handle at the moment the device is turned on (or switched).

3.) AC or DC – This affects the contacts circuit of the relay (due to EMF) and the timing sequencing and may result in performance issues in the switching capacity of the relay for different load types (i.e. resistive, inductive, etc.).

4.) High or Low Inrush - Some load types draw significantly higher amounts of current (amperage) when first turned then they do when the circuit later stabilizes (loads may also pulsate as the circuit continues operating, thus increasing and decreasing the current). An example of a high inrush load is a light bulb, which may draw 10 or more times its normal operating current when first turned on (some manufacturers refer to this as lamp load).

In addition to the above load parameters, you now have to determine what parameters are involved with the control circuit, or coil circuit as it is sometimes called. These may include:

Sensitivity: Coils that actuate the relay when supplied with very low voltage or low current are called sensitive. Sensitivity is a relative term that differentiates low-power coils from high-power coils.

Polarized: Coils of some relays that required DC voltage are polarized. That means there are specific terminals for positive and negative voltage to power the coil.

Coil Information

Characteristics of coils should be understood as a part of the relay chosen. Some important specifications include:

Coil Resistance: (applicable to DC-switching relays only) the resistance to the flow of electrical current. This resistance is measured at a temperature, depending on the manufacturer. The coil resistance of an AC-switching relay may be given for reference when the coil inductance is specified.

Maximum voltage: the maximum value of permissible over voltage in the operating power supply to the relay coil.

Rated coil voltage: a reference voltage applied to the coil when the relay is used under normal operating conditions.

Power consumption: the power consumed by the coil when the rated voltage is applied to it.

Single Side Stable: The switch contacts in the relay remain in a normal or stable position as long as no power is applied to the coil. When power is applied to the coil, the contacts move to a new position, but stay in that position as long as power is applied to the coil.

Single-winding, latching type: This type has one coil that serves as both the set and reset coil, depending on the direction of current flow. When current flows through the coil in a forward direction, it serves as a set coil; when the current flows in the reverse direction, it functions as a reset coil.

Dual-winding, latching type: This latching relay has two coils: set and reset. It can retain the ON or OFF states even when a pulsating voltage is supplied or when the voltage is removed.

- ♦ Latching relays often have one set of terminals designated for the positive voltage and another for the negative voltage used to power the coil. Such a polarized coil allows one action to take place when the coil voltage is positive, and an opposite action when the coil voltage is reversed. The difference between a single side stable relay and a latching relay is like the difference between a momentary action switch and a maintained action switch.

- ♦ Impulse Relay: A special version of the latching relay. A pulse of current to the coil results in the contact changing position. The contact remains in that position until the coil receives another pulse of current that moves the contacts back to their original position. Polarity is not important to the impulse relay; therefore, it can be actuated by AC or DC.

Stepping Relay: Each time the relay coil is energized, the switch is actuated to a new set of contacts. This is similar to a rotary switch.

Internal Operation of Mechanical Relays

- Standard: Single Side Stable with any of the following three different methods for closing contacts:

    1. Flexure Type: The armature actuates the contact spring directly, and the contact is driven into a stationary contact, closing the circuit
    2. Lift-off Type: The moveable piece is energized by the armature, and the contact closes
    3. Plunger Type: The lever action caused by the energization of the armature produces a long stroke action
- Reed: A Single Side Stable Contact that involves low contact pressure and a simple contact point
- Polarized: Can be either a single side stable or dual-winding. A permanent magnet is used to either attract or repel the armature that controls the contact. A definite polarity (+ or -) is required by the relay coil. The latching option makes a polarized relay dual-winding, meaning it remains in the current state after the coil is de-energized.

Relay Packages

Plastic Housing: Most relays are enclosed in a plastic housing. It's not a sealed housing, and only keeps stray fingers and wires from interfering with the relay mechanism.

Semi-sealed: Special design construction prevents flux from penetrating into the relay base housing. This type of relay cannot be immersion-cleaned.

Light Duty Seal: Also made of plastic, this seal is used for relays that will be mounted to printed circuit boards. The light-duty seal allows immersion cleaning of the printed circuit board. This type of seal should not be considered a permanent seal, not a protection against all contaminants. Very small molecules can pass through the plastic housing after a period of time.

Hermetically Sealed: This type of seal protects against nearly all kinds of contaminants. It is always a metal encased relay. It's used where high reliability is demanded in harsh environments and is more expensive than other packages.

Unsealed: Relays of this type are intended for manual soldering. No measures are taken against penetration of flux and cleaning solvent into the relay. This type of relay cannot be immersion-cleaned.

Relay Mounting

There are several typical ways for relays to be mounted and terminated.

- Socket – The spade lugs of the relay can be inserted into a mating tab or into a mating socket. The relay lugs carry one side of the termination. The mating side may be connected to a mating tab or mount into the connector designed for that relay package.
- PCB Mounting – Wavesolderable pins are provided that protrude from the inside of the relay to the outside and spaced (distance and height) according to the manufacturers determined design. The pins of the relay are inserted through holes in the Printed Circuit Board (PBC) designed to match the pinout of the relay and wavesoldered to affix the relay to the PCB.
- Chassis Mounting – Mounting ears, tabs or holes are designed as part of the relays mechanical package. Those locations typically accept nuts, bolts or screws to secure the relay to some sort of chassis. This chassis may function as a mounting location only or can also be used to provide thermal management (in higher power applications). The relay may also be secured to a PCB for the purpose of stability.

How to Specify a Relay

1. What are the switching requirements: What voltage? How much current is being switched?

2. Coil voltage: is the power source AC or DC? What voltage is available to power the coil?

3. What is the contact arrangement:
   - Form A contacts
   - Form B contacts
   - Form C contacts

4. How many poles are required? (number of circuits being switched)

5. What is the mounting type:
   - Surface Mount
   - PC Board
   - Plug-in socket
   - Plug-in terminal socket
   - Top mount
   - Top mount - PC board

Applications

General Purpose Relays:
HVAC, Appliances, Security, Pool & Spa, Industrial Controls, Office Equipment

Low Signal Relays:
Telecommunications, Datacom, CP/OA, Security

Power Relays:
Office Automation, Process Control, Automotive, Energy Management Systems, HVAC, Motor Drives/Controls, Appliance Controls

Solid State Relays:
Industrial Control, Motors, Timers

Signal Relays:
Telecommunications, Instrumentation, Test Equipment

Glossary of Relay Terminology

Dielectric Strength: The critical value, which a dielectric can withstand without rupturing when a high-tension voltage is applied for 1 minute between the following points:
Between coil and contact
Between contacts of different poles
Between contacts of same poles
Between set coil and reset coil
Between current-carrying metal parts and ground terminal

Dropout Time: The time that elapses between the moment a relay coil is de-energized until the contacts have closed.

Electrical Service Life: The life of a relay when it is switched at the rated operating frequency with the rated load applied to its contacts.

Insulation Resistance: The resistance between an electric circuit such as the contacts and coil, and grounded, non-conductive metal parts.

Maximum Operating Frequency: The frequency or intervals at which the relay continuously picks up and drops out.

Mechanical Service Life: The life of a relay when it is switched at the rated operating frequency without the rated load.

Operate Bounce Time: The bounce time of the normally open contact of a relay when the rated coil voltage is applied to the relay coil at a specified temperature.

Release Bounce Time: The bounce time of the normally closed contact of a relay when the coil is de-energized at a specified temperature.

Reset Pickup Time: (applicable to latching relays only) The time that elapses from the moment a relay coil is de-energized until the contacts have closed.

Set Pickup Time: The time that elapses after power is applied to a relay coil until the contacts have closed.

Shock: The shock resistance of a relay is divided into two categories: 1.) Mechanical durability, which quantifies the characteristic change of, or damage to, the relay due to considerably large shocks which may develop during the transportation or mounting of the relay, and 2.) Malfunction durability, which quantifies the malfunction of the relay while it is in operation.

Vibration: The vibration resistance of a relay is divided into two categories: 1.) Mechanical durability, which quantifies the characteristic change of, or damage to, the relay due to considerably large vibrations which may develop during the transportation or mounting of the relay, and 2.) Malfunction durability, which quantifies the malfunction of the relay due to vibrations while it is in operation.

NPH
National Plastic Heater Sensor & Control Co.
phone: 416.491.8436 toll free: 1.877.674.9744 fax: 416.491.2433
Toronto, Ontario Canada e-mail: sales@nphheaters.com website www.nphheaters.com