**ELECTRICAL RELAYS AND THEIR APPLICATIONS**

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A relay are switches that can be operated both electrically and mechanically. Generally relays use an electromagnet (solenoid). Magnetic latching relays require pulses of coil power to send contacts in required directions. Magnetic latching relays are useful in applications where interrupted power should not be able to transition the contacts. Magnetic latching relays can have either single or dual coils. On a single coil device, the relay will operate in one direction when power is applied with one polarity, and will reset when the polarity is reversed. On a dual coil device, when polarized voltage is applied to the reset coil the contacts will transition. AC controlled magnetic latch relays have single coils that employ steering diodes to differentiate between operate and reset commands.

There are also other operating principles for its working. But they differ according to their applications. Most of the devices have the application of relays.

**DESIGN:**

There are only four main parts in a relay. They are

* Electromagnet
* Movable Armature
* Switch point contacts
* Spring

It is an electro-magnetic relay with a wire coil, surrounded by an iron core. A path of very low reluctance for the magnetic flux is provided for the movable armature and also the switch point contacts.  The movable armature is connected to the yoke which is mechanically connected to the switch point contacts. These parts are safely held with the help of a spring. The spring is used so as to produce an air gap in the circuit when the relay becomes de-energized.

### How relay works?

An iron core is surrounded by a control coil. As shown, the power source is given to the electromagnet through a control switch and through contacts to the load. When current starts flowing through the control coil, the electromagnet starts energizing and thus intensifies the magnetic field. Thus the upper contact arm starts to be attracted to the lower fixed arm and thus closes the contacts causing a short circuit for the power to the load. On the other hand, if the relay was already de-energized when the contacts were closed, then the contact move oppositely and make an open circuit.

As soon as the coil current is off, the movable armature will be returned by a force back to its initial position. This force will be almost equal to half the strength of the magnetic force. This force is mainly provided by two factors. They are the spring and also gravity.

Relays are mainly made for two basic operations. One is low voltage application and the other is high voltage. For low voltage applications, more preference will be given to reduce the noise of the whole circuit. For high voltage applications, they are mainly designed to reduce a phenomenon called arcing.

* **Energized Relay (ON)**
* **De – Energized Relay (OFF)**

### Pole and Throw

Relays have the exact working of a switch. So, the same concept is also applied. A relay is said to switch one or more poles. Each pole has contacts that can be thrown in mainly three ways. They are

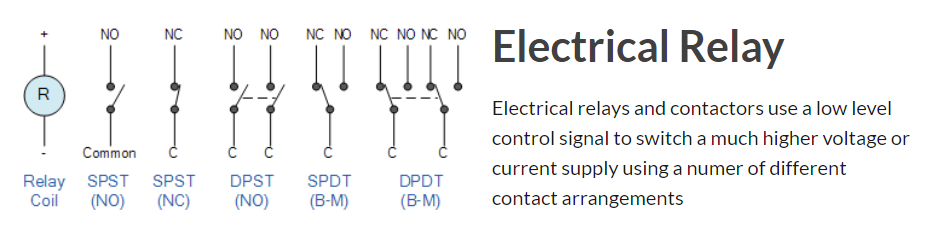
* **Normally Open Contact (NO)** – NO contact is also called a make contact. It closes the circuit when the relay is activated. It disconnects the circuit when the relay is inactive.
* **Normally Closed Contact (NC)** – NC contact is also known as break contact. This is opposite to the NO contact. When the relay is activated, the circuit disconnects. When the relay is deactivated, the circuit connects.
* **Change-over (CO) / Double-throw (DT) Contacts** – This type of contacts are used to control two types of circuits. They are used to control a NO contact and also a NC contact with a common terminal. According to their type they are called by the names **break before make** and **make before break** contacts.

Relays are also named with designations like

* **Single Pole Single Throw (SPST)** – This type of relay has a total of four terminals. Out of these two terminals can be connected or disconnected. The other two terminals are needed for the coil.
* **Single Pole Double Throw (SPDT)**– This type of a relay has a total of five terminals. Out f these two are the coil terminals. A common terminal is also included which connects to either of two others.
* **Double Pole Single Throw (DPST)** – This relay has a total of six terminals. These terminals are further divided into two pairs. Thus they can act as two SPST’s which are actuated by a single coil. Out of the six terminals two of them are coil terminals.
* **Double Pole Double Throw (DPDT)** – This is the biggest of all. It has mainly eight relay terminals. Out of these two rows are designed to be change over terminals. They are designed to act as two SPDT relays which are actuated by a single coil.

### Relay Applications

* Relays are used to realize logic functions. They play a very important role in providing safety critical logic.
* Relays are used to provide time delay functions. They are used to time the delay open and delay close of contacts.
* Relays are used to control high voltage circuits with the help of low voltage signals. Similarly they are used to control high current circuits with the help of low current signals.
* They are also used as protective relays. By this function all the faults during transmission and reception can be detected and isolated.



**TYPES OF RELAYS:**

**Voltage Suppression Relays**

As relays are used in industrial purposes very often, they are mostly controlled with the help of computers. But when relays are controlled with such devices, there will surely be the presence of semi-conductors like transistors. This will in turn cause the presence of voltage spikes. As a result, it is really necessary to introduce voltage suppression devices, otherwise they will clearly destroy the transistors.

**De-spiking Diode Relays**

A diode in the reverse-biased position is connected in parallel with the relay coil. As there is no flow of current due to such a connection, an open circuit of the relay will cause the current to stop flowing through the coil. This will have effect on the magnetic field. The magnetic field will be decreased instantly. This will cause the rise of an opposite voltage with very high reverse polarity to be induced. This is mainly caused because of the magnetic lines of force that cut the armature coil due to the open circuit. Thus the opposite voltage rises until the diode reaches 0.7 volts. As soon as this cut-off voltage is achieved, the diode becomes forward-biased. This causes a closed circuit in the relay, causing the entire voltage to pass through the load. The current thus produced will be flowing through the circuit for a very long time. As soon as the voltage is completely drained, this current flow will also stop. Take a look at the figure given below.

**De-spiking Resistor Relays**

A resistor is almost efficient as that of a diode. It can not only suppress the voltage spikes efficiently, but also allows the entire current to flow through it when the relay is in the on position. Thus the current flow through it will also be very high. To reduce this, the value of the resistance should be as high as 1 Kilo Ohm. But, as the value of the resistors increases the voltage spiking capability of the relay decreases.  Take a look at the circuit diagram below to understand more.

**Types Of Relays:**

Here is a detailed list of the different types of relays.

**Latching Relay**

Latching relays are also called impulse relays. They work in the bistable mode, and thus have two relaxing states. They are also called keep relays or stay relays because as soon as the current towards this relay is switched off, the relay continues the process that it was doing in the last state. This can be achieved only with a solenoid which is operating in a ratchet and cam mechanism.  It can also be done by an over-centre spring mechanism or a permanent magnet mechanism in which, when the coil is kept in the relaxed point, the over-centre spring holds the armature and the contacts in the right spot. This can also be done with the help of a remanent core.

In the ratchet and cam method, power consumption occurs only for a particular time. Hence it is more advantageous than the others.

**2. Reed Relay**

These types of relays have been given more importance in the contacts. In order to protect them from atmospheric protection they are safely kept inside a vacuum or inert gas.  Though these types of relays have a very low switching current and voltage ratings, they are famous for their switching speeds.

**3. Polarized Relay**

This type of relay has been given more importance on its sensitivity. These relays have been used since the invention of telephones. They played very important roles in early telephone exchanges and also in detecting telegraphic distortion. The sensitivity of these relays are very easy to adjust as the armature of the relay is placed between the poles of a permanent magnet.

**4. Buchholz Relay**

This relay is actually used as a safety device. They are used for knowing the amount of gas present in large oil-filled transformers. They are designed in such a way that they produce a warning if it senses either the slow production of gas or fast production of gas in the transformer oil.

**5. Overload protection Relay**

As the name implies, these relays are used to prevent the electric motors from damage by over current and short circuits. For this the heating element is kept in series with the motor. Thus when over heat occurs the bi-metallic strip connected to the motor heats up and in turn releases a spring to operate the contacts of the relay.

**6. Mercury Wetted Relay**

This relay is almost similar to the reed relay explained earlier. The only difference is that instead of inert gases, the contacts are wetted with mercury. This makes them more position sensitive and also expensive. They have to be vertically mounted for any operation. They have very low contact resistance and so can be used for timing applications. Due to these factors, this relay is not used frequently.

**7. Machine Tool Relay**

This is one of the most famous industrial relay. They are mainly used for the controlling of all kinds of machines. They have a number of contacts with easily replaceable coils. This enabkes them to be easily converted from NO contact to NC contact. Many types of these relays can easily be setup in a control panel. Though they are very useful in industrial applications, the invention of PLC has made them farther away from industries.

**8. Contractor Relay**

This is one of the most heavy load relay ever used. They are mainly used in switching electric motors. They have a wide range of current ratings from a few amps to hundreds. The contacts of these relays are usually made with alloys containing a small percentage of silver. This is done so as to avoid the hazardous effects of arcing. These type of relays are mainly categorized in the rough use areas. So, they produce loud noises while operated and hence cannot be used in places where noise is a problem.

**9. Solid State relay**

SSR relays, as its name implies are designed with the help of solid state components. As they do not have any moving objects in their design they are known for their high reliability.

**10. Solid State Contactor Relay**

These relays combine both the features of solid state relays and contactor relays. As a result they have a number of advantages. They have a very good heat sink and can be designed for the correct on-off cycles. They are mainly controlled with the help of PLC, micro-processors or microcontrollers.