RELAY BASICS

Relays are electro magnetically operated switches. An actuating current on a coil operates one or more galvanically separated contacts or load circuits.

The electro mechanical relay is a remote controlled switch capable of switching multiple circuits, either individually, simultaneously, or in sequence.

The primary functions of a relay are:

The galvanic separation of the primary or actuating circuit and the load circuits

Single input/multiple output capability

Separation of different load circuits for multi-pole relays

Separation of AC and DC circuits

Interface between electronic and power circuits

Multiple switching functions, e.g. delay, signal conditioning

Amplifier

Applications of a Relay

Typical applications for relays include laboratory instruments, telecommunication systems, computer interfaces, domestic appliances, air conditioning and heating, automotive electrics, traffic control, lighting control, building control, electric power control, business machines, control of motors and solenoids, tooling machines, production and test equipment.

Electromechanical Relays

Electromechanical relays are those where the switching element is a mechanical contact, actuated by an electromagnet. This is the most widely used type of relay design. The principal internal functions of an electromechanical relay are:

1. Conversion of electrical current (input, coil current) to a magnetic field
2. Conversion of the magnetic field into a mechanical force
3. This force operates the contacts (secondary side)
4. Contacts switch and conduct electrical current (output, load current)

Electromechanical Relay Design

The most important components are:

Magnetic system (or primary section)

Coil (to generate the necessary magnetic field to actuate the armature and the contacts)

Core (highly magnetic permeable - concentrates the magnetic field)

Yoke (to establish the magnetic circuit)

Armature (the moving part of the magnetic system which closes and opens the magnetic circuit and acts via an actuator or the moving relay contacts)

Return spring (For quick return of the moving contact to normal condition on removal of the coil power)

Contact system (or secondary section)

Fixed contacts

Moving contacts (contacts being moved by the magnetic system to switch the load circuit)

Contact springs (holding the contacts but sufficiently flexible to allow the contacts to move)

Mechanical components

Case & Base (to protect the relay against external influences and for protection against electric shock)

Insulation within the relay to separate the primary circuit from the secondary side and to provide the required Actuator (used in some relay designs to translate the motion of the magnetic system to the contact system)

Moving contacts must have insulation properties to isolate the primary circuit (coil, magnetic circuit) from the secondary side (contact system)

Pins or terminals to connect between the contact system and the load

Mounting devices such as sockets, solder hooks, PCB pins, brackets, captive screws

Basic Relay Terminologies

AC Coil: Relays for direct energization with AC supply. Unless otherwise specified, AC coils may be used with 50Hz supply.

Ambient Temperature: Temperature measured directly near the relay. The maximum allowed value may not be exceeded; otherwise there is a chance for relay failure. (e.g. Coil overheating)

Bounce Time: Time interval between the first and final closing (or opening) of a contact, caused by a mechanical shock process in contact movement. These shock processes are called contact bounce.

Break Contact: A contact that is closed in the rest state of the relay and open in the operating state.

Bridging Contact: A special contact assembly consisting of two stationary contacts that are connected by a movable bridge. When in *open contact* the bridge is separated on both sides from the stationary contacts. Due to this double interruption a bigger contact gap can be achieved. This is of advantage especially at very high contact loads or when there are safety requirements.

Change Over Contact: Compound contact consisting of a make contact and a break contact with a common contact spring. When one contact circuit is open the other one is closed.

Coil Current: The current (by design) drawn by the coil to generate the magnetic pull force. The moment the coil is switched to *On*, the current is higher than in continuous use.

Coil Resistance: Electrical resistance of the relay coil at reference temperature. The coil resistance varies with temperature.

Contact Forms: This denotes the contact mechanism and the number of contacts in the circuit. Form A contacts are also called NO (Normally Open) contacts or make contacts. Form B contacts are also called NC (Normally Closed) contacts or break contacts. Form C contacts are also called Changeover contacts.

Contact Gap: Distance between the contacts in the open contact circuit.

Contact Rating: The current a relay can switch *On* and *Off* within specified conditions.

Contact Resistance: The electrical resistance of a closed contact circuit, measured at the terminals of the relay within specified parameters.

Creepage Distance: Closest distance between two conductive parts, measured along the surface of insulated parts.

Dielectric Strength: The voltage the insulation can withstand between relay elements that are insulated from one another.

Driver Protection circuit: When the coil energization is switched off, a very high negative peak voltage is produced by the coil that may reach more than 10-20 times the nominal coil voltage. This can damage the coil. A solution is provided by a driver protection circuit that is a damping component, which is connected in parallel to the coil. This protects the driver but slows the release time of the relay. Also known as the *coil snubber circuit* or *suppressed coil.*

Dropout Voltage: The Voltage at or below which all the contacts of an operated relay must revert to unoperated position. Also known as release voltage.

Dust Proof Relays / Solder Proof Relay: Relay with a case for protection against dust and touch. If specified solder conditions are kept, no harmful amounts of flux or solder vapor can penetrate inside the relay.

Electrical Endurance (*Electrical Life*): Number of operations until switching failure of a relay under defined conditions of load and of ambient. The specified reference values for the life of the relay apply, within a resistive load window. At lower contact loads a substantially longer electrical life is achieved. At higher loads the electrical life is reduced substantially.

Hermetically Sealed Relays: Relay that is has a metal case, its connecting pins are sealed with glass it then fulfils highest requirements regarding sealing.

Inrush Current: This value specifies the instantaneous current that may flow under defined conditions.

Insulation Resistance: Electrical resistance, measured between insulated relay parts at a specified test voltage.

Make Contact: A contact that is open in the rest state and closed in the operating state.

Material Transfer: During the switching procedure the arc heats up the two contacts differently, depending on the load and polarity. This will result in material transfer from the hotter electrode to the cooler electrode. With higher DC loads on the contact a 'pip' is built up, the other contact loses material and it creates a crater.

Maximum Carrying Current: The maximum current the contacts can safely pass without being subject to temperature rise in excess of their design limit.

Maximum Continuous Voltage: The maximum voltage that can be applied to the relay coil uninterruptedly without causing damage.

Maximum Switching Current: The maximum current that can safely be switched by the contacts.

Maximum Switching frequency: The maximum switching frequency which satisfies the mechanical or electrical life under repeated operations by applying a pulse train at the rated voltage to the operating coil

Maximum Switching Power: The maximum value that can be switched by the contacts without causing damage.

Maximum Switching Voltage: The maximum open circuit voltage that can be safely switched by the contacts.

Mechanical Endurance (*Mechanical Life*): Number of switching operations, without contact load, the relay can operate whilst remaining within the specified characteristics.

Mechanical Flag Indication: Mechanical indicator in relays (mostly industrial relays) which is linked to the contacts and shows their position.

Nominal Coil Power: Power consumption of the coil at nominal voltage and nominal coil resistance. Also known as *Rated Power*.

Nominal Coil Voltage: The voltage designed to operate the relay coil. Also known as *Rated Voltage*.

Open Relay: Relay without case or cover.

Operating Power: Rated power at which the relay operates

Operate time: The time from the initial application of power to the coil until the closure of the normally open contacts. Excluding bounce time.

PCB Relays: Relays designed for soldering directly into printed circuit boards.

Pick-up Voltage: The value of the voltage that should be applied to an un-operated relay coil at or above which all the contacts of the relay should operate. Also known as *Pull-in voltage* / *Must operate voltage*.

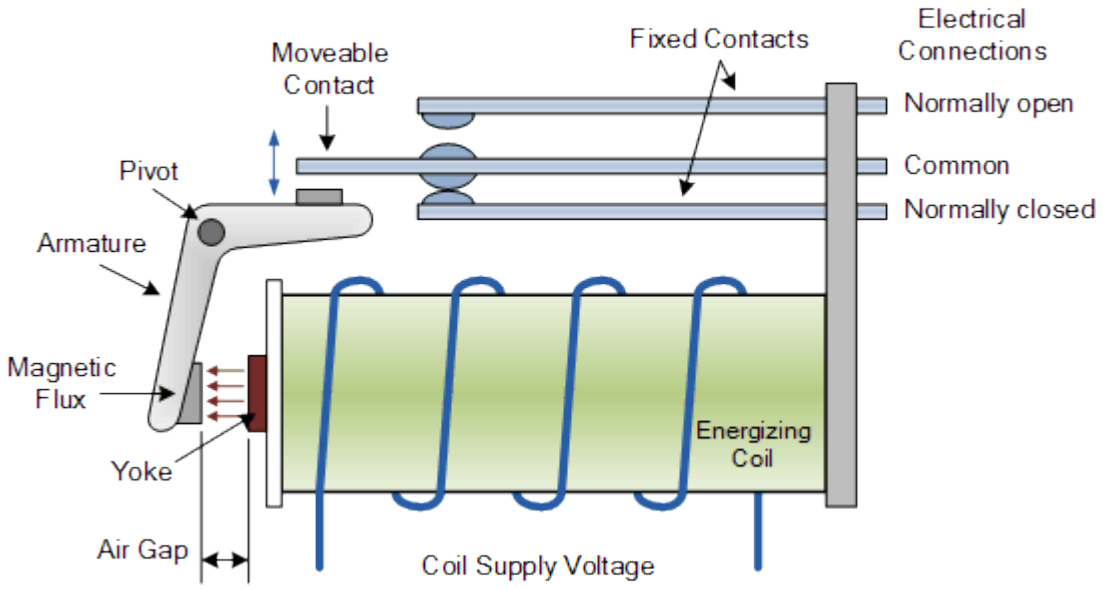
Plug-in Relay: Relays with socket pins.

Release Time: The time from the disconnection of the coil until the re-closure of the normally closed contacts. Excludes bounce time.

Shock Resistance: It specifies the mechanical shock the closed contact can resist or no damage occurs. (multiple of gravitational acceleration in measured in g's within a set duration in ms)

Test Button: button (usually in industrial relays), which is accessible from the outside. Typically it manually switches the contact circuit of a de-energized relay from Off to On condition.

Vibration Resistance: specifies the amplitude or the acceleration up to a defined frequency range for which the contacts are rated to operate without failure.



Contact Forms

Design	Sequence	Symbol	Form
SPST-NO	Make (1)		**A**
SPST-NC	Break (1)		**B**
SPDT	Break(1) - Make (2)		**C**
SPDT	Make (1) before Break (2)		**D**
SPDT (B-M-B)	Break (1) - Make (2) before Break (3)		**E**

Design	Sequence	Symbol	Form
SPDT-NO	Center OFF		**K**
SPST-NO (DM)	Double Make (1)		**X**
SPST (DB)	Double Break (1)		**Y**
SPDT-NC-NO (DB-DM)	Double Break (1) Double Make (2)		**Z**
SPST-NO (DM)	Double Make		**U**

SP—Single Pole **3P—Three Pole** **SB—Single Break** **ST—Single Throw** **DM—Double Make** **NC—Normally Closed**
DP—Double Pole **4P—Four Pole** **DB—Double Break** **DT—Double Throw** **NO—Normally Open**

CO stands for changeover, a term sometimes used for a double throw configuration.

Common Contact Material Abbreviations

Ag is silver.
AgCdO is silver-cadmium oxide.
AgNi 0.15 is fine grain silver.
AgNi or AgNi 20 is silver-nickel alloy.
AgPd is silver-palladium alloy.
AgSn is silver-tin alloy.
AgSnO is silver-tin oxide.
Au is gold.
AuAgNi is gold-silver-nickel alloy.
AuPtAg is gold-platinum-silver alloy.
AuRh is gold-rhodium alloy.
Hg is mercury.
PdCu is palladium-copper alloy.
PdNi is palladium-nickel alloy.
Rh is rhodium.
Ru is ruthenium.
W is tungsten.

NOTES

This document is not intended as a comprehensive guide and the information provided should generally be treated as illustrative. Any changes or proposed alterations are welcome.