Introduction to Electro–Mechanical Relays

General Information

NTE Relays are electro–mechanical devices, which function by presenting a control voltage (AC or DC) to a coil, which in turn creates a magnetic field that activates a mechanism which closes (NO) or opens (NC) a set (or sets) of contacts through which a particular load is then connected. When the control voltage is removed, initial conditions return with the relay reset to begin its operation.

Due to relative mechanical standardization and the simplicity of operation, electro–mechanical relays are particularly suited for ease of replacement, as long as certain guidelines are maintained.

Generally, care in handling relays is advised – do not drop or mishandle them, nor open the case of enclosed units, nor subject them to chemical atmospheres or extremes of temperature. Do not exceed the maximum voltage or current ratings, and, in the case of DC relays, observe its polarity.

AC–Switching Relays

The coil temperature of the AC–switching relay rises because of resistance losses in the shading coil, magnetic eddy–current losses, and hysteresis losses. Also, a phenomenom known as "chatter" may occur if an AC relay operates on a voltage lower than that rated, sometimes causing contact burning if not prevented.

Inrush current (the current generated when the armature of the relay is initially released) is higher than the rated level and should be considered with respect to power consumption, especially when using several devices in parallel.

DC–Switching Relays

If the device is used as a "marginal" (i.e., turns ON or OFF if the voltage or current reaches a critical value) relay, then the control output may not satisfy the stated ratings, because the current gradually increases or decreases, thus slowing down the speed at which the contacts move. The coil resistance of the DC–switching relay changes by about 0.4% per °C change in the ambient temperature. It also changes when the relay generates heat. This means that the pickup and dropout voltages may increase as the temperature rises.

Coils

A relay coil consists of copper wire wound many times around an iron–core bobbin. As such it will exhibit resistance to the flow of electric current according to Ohm's Law, $I = E/R$ (I is current, E is the rated voltage, and R is the stated coil resistance).

Relay coils are designed to operate on either AC or DC voltages, with the "pick–up" (the point at which the coil begins to energize) voltage typically 80% of the stated relay value.

This pick–up voltage can also be affected by the operating temperature of the relay, and in the case of remote devices, by the wiring to the device; and so, in replacing relays these elements should be considered.

It is impractical to use an AC relay in a DC circuit, because they are so constructed that the armature, in its seated position, "touches" (magnetically) the core (DC relays have a pin to prevent this): after the release of coil power no residual magnetism will hold the armature seated– if an AC voltage is used. But, a DC voltage could cause at worse, the armature to hold, and at least, a reduction in the pick–up voltage. Secondarily, the coil power rating ($P = E^2/R$) would dictate that a DC voltage of a smaller scale be used to prevent overheating the coil.

Similarly, DC relays operated on an AC voltage will cause the armature to bounce with each half–cycle, and the applied voltage would have to be ***increased*** to compensate for power losses and ensure current flow. Attempts to use a rectifying diode in parallel with the coil will surely result in the destruction of the diode!

Magnetic action causes the opening and closing of the contacts when power is applied to the coil. The applied voltage, therefore, should be sufficient to energize the coil (and thereby the contacts) at all times, since malfunctions of the relay could occur if it is allowed to drift too low; but not higher than the rated maximum voltage to prevent over–heating and possible short–circuits. If the relay is expected to operate at a higher than usual temperature, it may be necessary to increase the coil drive slightly to compensate for the increase in the coil resistance. Generally, the coil's design will affect relay sensitivity, operating speed, and power consumption.

Contacts

The contacts in a relay make or break connections in electrical circuits; and so, have physical and electrical properties. Performance physically will depend on the switching arrangement, the overall mechanical construction of the relay, and the choice of material for the contacts. Electrically, the magnitude of the load current and its open circuit voltage, along with any special characteristics of the applied circuit (such as inrush current), are usually considered.

Contact material is of two forms: low–level or power. Low–level contacts require maintainence, since contamination can prevent signals from being switched. Power relays, however, have self–cleaning contacts that arc and burn off oxidation and contamination. The following table describes these characteristics (See Table 1).

Table 1 – Contact Material Characteristics

Contact	Applications	Typical Ratings	Comments
Palladium or platinum, Bifurcated, gold–plated, or gold overlay	"Dry" and low current. Measurement and signal switching	0 to 2A Rated to 120VAC, but best for 24V or less.	Low, steady contact resistance.
Silver	Communications, Alarm systems	2 to 5A	Oxidizes easily. Should be gold–flashed for storage protection.
Silver cadmium oxide	Power, inductive and capacitive loads. Motor and incandecent lamp loads. High inrush currents.	5A and up	Resists welding. Good arc–extinguishing characteristics. Less suited below 12V.

For example, the NTE R12 series relays have a contact rating of 3A, 5A and 10 Amps, therefore, the contact material most suited would be silver.

NTE offers a wide selection of relays to fit practically any type of physical and electrical contact requirement. Expert engineering is yours for the asking.

Enclosures

Unsealed

These relays offer an unsealed dust cover but ***cannot*** be immersion cleaned because flux cleaning solvents will penetrate them.

Sealed

Sealed relays are similar to unsealed devices in that they offer a dust cover. But, in this version the cover is epoxy sealed, preventing penetration by cleaning solvents and solder flux when immersion cleaned.

Hermetically Sealed (R02 & R12 Series)

These relays offer total protection from the environment and are often used in harsh environments where gases or solvents may corrode them.

Relay Definitions and Glossary

• AC Operated Relays
These type of relays incorporate a shading ring on the pole face preventing total collapse of the magnetic field during zero voltage crossover.

• Armature
The moving magnetic member of an electromagnetic relay structure.

• Break
The opening of closed contacts to interrupt an electric circuit.

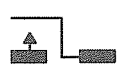
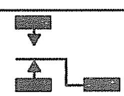
• Bounce Time
Duration from the first to last making or breaking of a relay contact during one operation.

• Coil
An assembly consisting of one or more windings with terminals and any other required parts such as a sleeve or slug. The windings may be self supporting but usually are wound around an insulated iron core or on a bobbin.

• Contact
1. A conductive connection of two elements.
2. A contact piece designed to ensure reliable current passage either in the form of a rivit or welded assembly.

• Contact Forms
Denotes the contact mechanism and number of contacts in the contact circuit.

• Contact Symbols

Form "A" Contacts (Normally Open Contacts)	
Form "B" Contacts (Normally Closed Contacts)	
Form "C" Contacts (Changeover Contacts)	

Form "A" contacts are also called N.O. contacts or make contacts.
Form "B" contacts are also called N.C. contacts or break contacts.
Form "C" contacts are also called changeover contacts or transfer contacts.

• Contact Life
The number of operations for a given contact load under specified conditions (e.g. duty cycle, maximum operating rate) without leading to permanent contact failure (e.g. contact welding, excessive contact wear/resistance or contact locking when switching DC loads).

• Contact Resistance
The electrical resistance of closed contacts.

• Continuous Current
The maximum current a relay may carry continuously without exceeding temperature limits.

• DC Relays
A relay with coils designed for operation from a DC supply.

• Dielectric Strength
The voltage which may be applied to two adjacent metal parts insulated from each other without causing electrical breakdown.

• Drop Out (Release) Time
The time from removal of voltage from the coil circuit to the first breaking or making of the relay contact.

• Drop Out (Release) Voltage
The voltage at which the relay returns safely to its unoperated position.

• Duty Cycle
The ratio of operated time to the total cycle time expressed as a percentage.

• Electrical Life
Refer to "Contact Life".

• Holding Current
Minimum coil current required to hold the armature in the operated position.

• Insulation Resistance
The resistance value between mutually isolated conducting sections of the relay (e.g. between coil and contacts, across open contacts, and between coil or contacts to any core or frame at ground potential). This value is usually expressed as "initial insulation resistance" and may decrease with time, due to material degradation and the accumulation of contaminants.

• Mechanical Life
The guaranteed number of operating cycles without load.

• Make
The closure of an open contact to complete an electric circuit.

• MBB Contacts
Abbreviation for make–before–break contacts. Contact mechanism where Form "A" contacts (normally open contacts) close before Form "B" contacts open (normally closed contacts).

• Normal Position
1. The de-energized, unoperated position of contacts (open or closed) due to spring tension, gravity, or magnetic polarity.
2. The home position for a stepping switch.

• Nominal Coil Resistance
The DC coil resistance measured at its terminals at a winding temperature of +23°C.

• Peak Make Current (Inrush Current)
The maximum current flowing through a relay contact immediately after closure.

• Power Consumption (Total)
Sum of nominal coil power consumption plus power consumed in any series resistor in Watts or VA.

• Pull In (Operate) Time
The time from application of voltage to the coil to first making or breaking of the relay contact.

• Pull In (Operate) Power
The power consumed by the relay coil in order to operate the relay.

• Pull In (Operate) Voltage
The minimum voltage required to operate the relay.

• Rated Current
1. For a relay coil – the nominal voltage divided by the coil resistance.
2. For a contact – refer to "Continuous Current".

• Rated Voltage
The reference voltage for the definition of other relay data.

• Relay Life
Refer to "Electrical Life" and "Mechanical Life".

• Relay Pole
A contact set comprising either a changeover or normally open, or normally closed contact. Relays with more than one pole can control more than one circuit.

• Switching Cycle
One cycle of energization and release of a relay.

• Switching Rate
Operating cycles per hour or per second.

• Switching Voltage
The voltage which appears on the contacts before their closing or after their opening after transients have disappeared.

• Temperature Compensation
With increasing temperature but constant coil voltage the magnetic field generated will be reduced due to a change in coil resistance (e.g. for enamelled copper wire approximately 4%/10°C). By incorporating a permanent magnet with an opposite temperature coefficient into the magnetic circuit, the pull in voltage of the relay may be kept stable over a wide temperature range.

• Thermal Resistance
Coil heating as a function of coil power consumption.

• Time Constant (Electrical)
The time until the current reaches 63% of its final value after energization (ratio L to R). DC load handling capacity and life figures are dependent on the L/R value of the DC load circuit.

• Total Contact Resistance
The sum of relay contact resistance plus resistance of connecting elements as measured on the relay terminals.