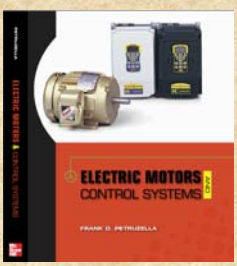


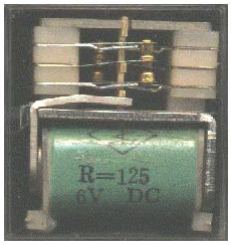
Chapter 7

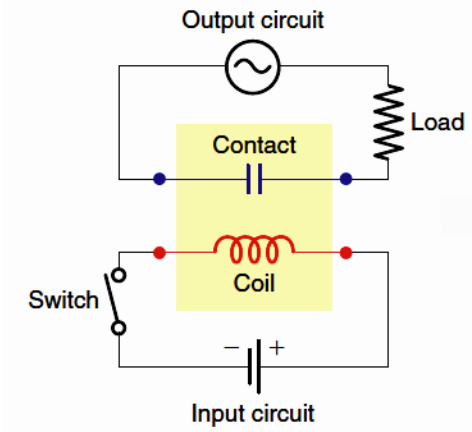
Relays

PART 1 Electromechanical Control Relays

RELAY OPERATION

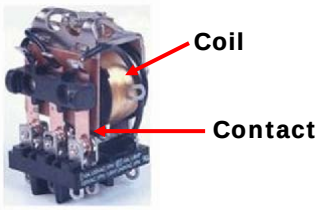
An electromechanical relay is a switch that is operated by an electromagnet.

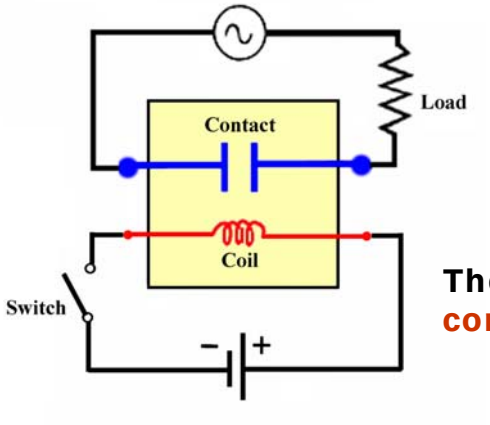




The relay turns a load circuit ON or OFF by energizing an electromagnet, which opens or closes contacts connected in series with the load.

A relay is made up of two circuits: the coil input or control circuit and the contact output or load circuit

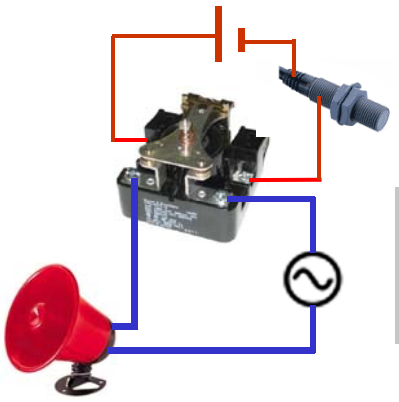




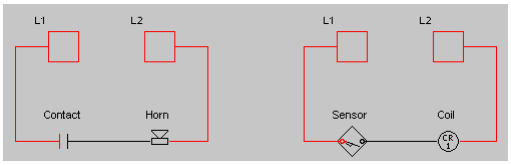
The contact output or load circuit.

The coil input or control circuit.

Relays are used to control small loads of 15 amperes or less. In motor circuits electromechanical relays (EMRs) are often used to control coils in motor contactors and starters.



Horn Relay Circuit



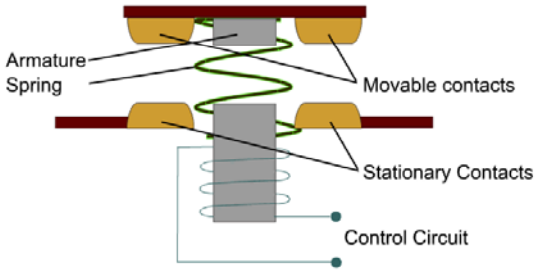
Operation of a relay is very similar to that of a contactor. The main difference between control relay and a contactor is the size and number of contacts.

Contactor

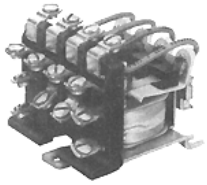
Control relay contacts are relatively small because they need to handle only the small currents used in control circuits. The small size of control relay contacts allows control relays to contain multiple isolated contacts.

Control Relay

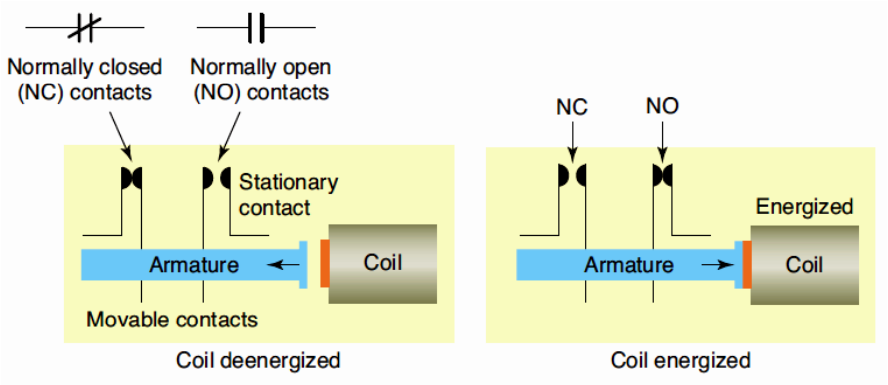
Electro-mechanical relays contain both stationary and movable contacts. The movable contacts are attached to the plunger.



A relay will usually have only one coil, but it may have any number of different contacts.

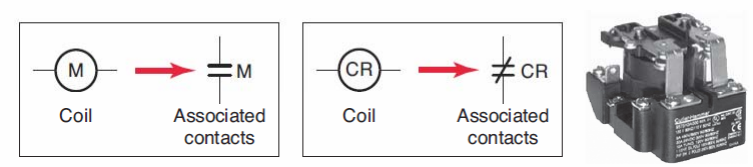


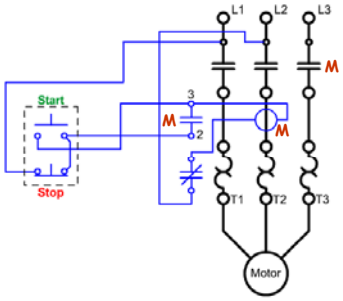
Contacts are referred to as normally open (NO) and normally closed (NC).



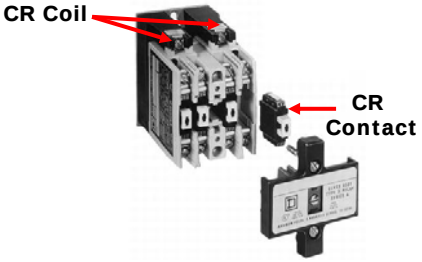
When the coil is energized, it produces an electromagnetic field. Action of this field, in turn, causes the plunger to move through the coil, closing the NO contacts and opening the NC contacts.

A letter is used in diagrams to designate the coil. The associated contacts will have the same identifying letters.



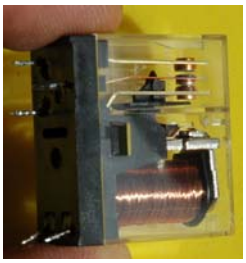


The letter "M" frequently indicates a motor starter.

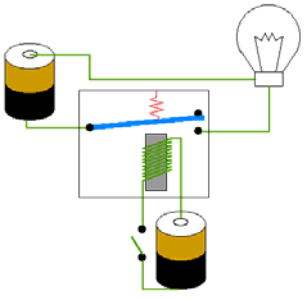


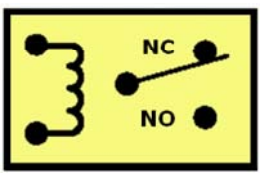
The letter "CR" is frequently used for control relays.

Normally Open (NO) contacts are open when the coil is de-energized and close when the coil is energized.

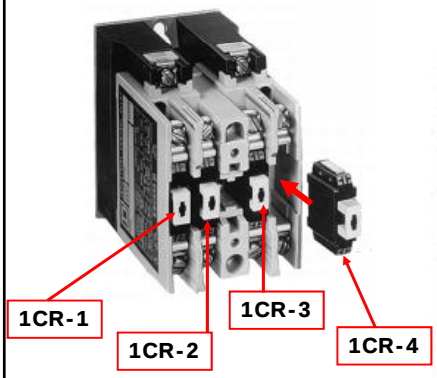


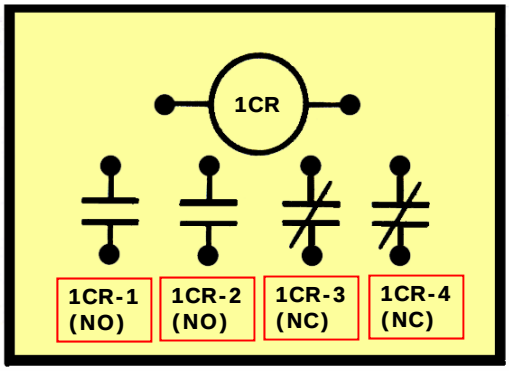
Normally Closed (NC) contacts are closed when the coil is de-energized and open when the coil is energized.



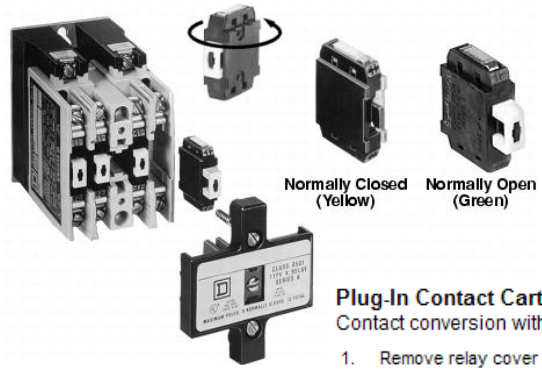


Each contact is normally drawn as it would appear with the coil de-energized.





Some control relays have some provision for changing contacts from normally open to normally closed types, or vice versa.



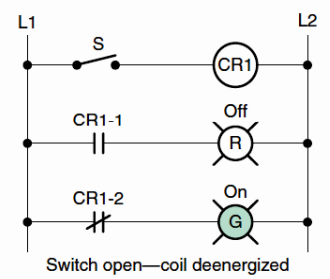
Contact conversion by rotation of the contact cartridge

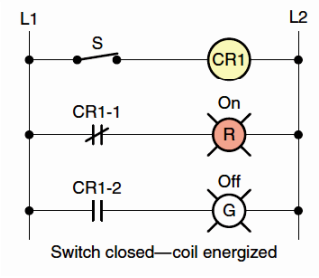
Plug-In Contact Cartridges

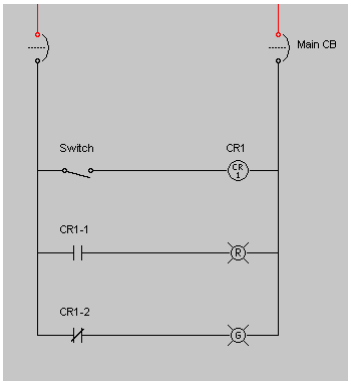
Contact conversion without removing terminal screws or wires

1. Remove relay cover and captive T-bar actuator.
2. Remove contact cartridge and rotate 180°.
3. Plug contact cartridge back in.
4. Replace T-bar actuator and cover.

Relay circuit used to control several switching operations by a single separate current.

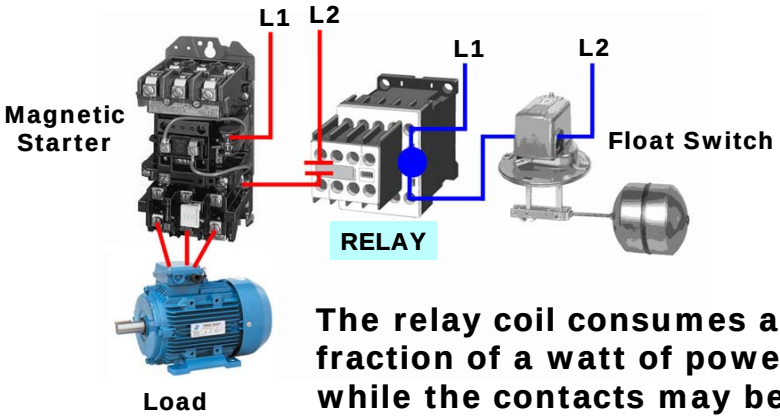






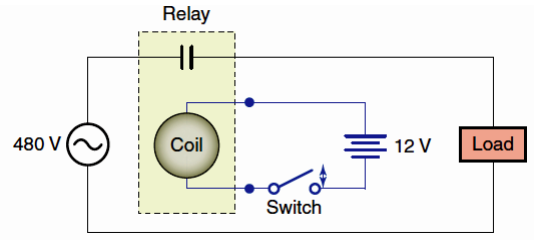
RELAY APPLICATIONS

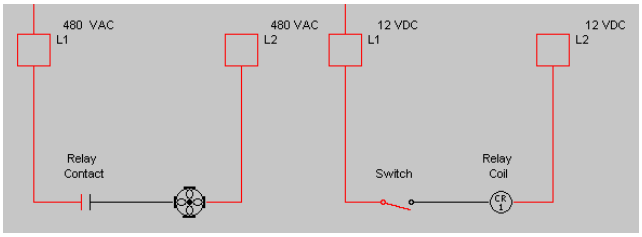
Relays are extremely useful when we have a need to control a large amount of current and/or voltage with a small electrical signal.



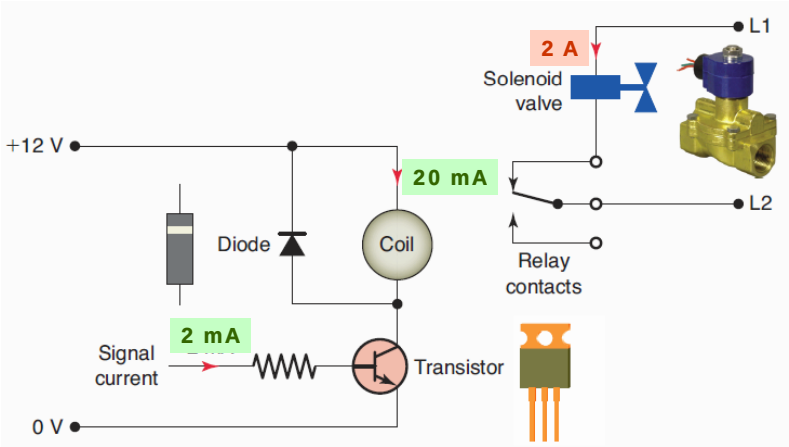
The relay coil consumes a fraction of a watt of power, while the contacts may be able to conduct hundreds of times that amount of power to a load.

Relay Used To Control A High-Voltage Load Circuit With A Low-Voltage Control Circuit





Relay used to control a high-current load circuit with a low-current control circuit.

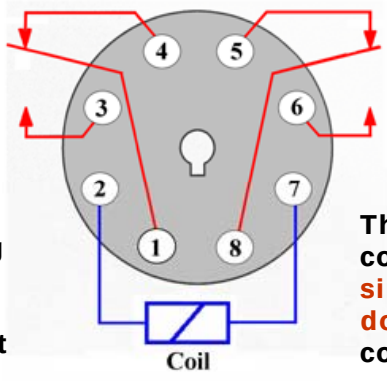


The current in the transistor control circuit and relay coil is quite small in comparison to that of the solenoid load.

RELAY STYLES AND SPECIFICATIONS

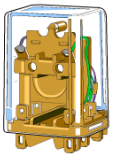
One popular type of relay is the ice cube relay, so named because of its size shape and clear plastic enclosure surrounding the contacts.

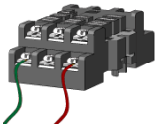
The relay is designed to plug into a socket making replacement fast and simple.



This relay contains two single-pole double-throw contacts.

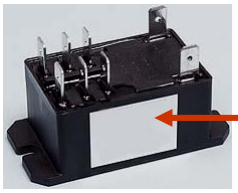
Wiring is connected to the socket, not the relay. The numbering on the socket base designates a terminal with the corresponding pin position.





An ON/OFF indicator may be installed to indicate the state of the relay coil.

A manual override button, mechanically connected to the contact assembly, may be used to move the contacts into their energized position for testing purposes.



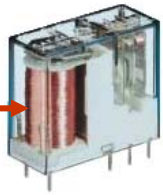
Relay coils and contacts have separate ratings.

Relay coils are rated for:

- type of operating current (DC or AC)
- normal operating voltage or current
- permissible coil voltage variation (pickup and dropout)
- resistance
- power.

The most common coil voltage ratings are:

- 12 VDC
- 24 VDC
- 24 VAC
- 120 VAC



Typical Relay Data Sheet

Specifications

■ Contact Data

Load	Resistive load (p.f. = 1)	
	NO	NC
Rated load	25 A, 220 VAC (24 A, 230 VAC), 25 A, 30 VDC	8 A, 220 VAC (7.5 A, 230 VAC), 8 A, 30 VDC
Rated carry current	25 A	8 A
Max. switching voltage	250 VAC,125 VDC	
Max. switching current	25 A	8 A
Max. switching capacity	5,500 VA, 750 W DC	1,760 VA, 240 W DC
Min. permissible load	100 mA, 24 VDC at 120 operations/minute, 23°C (73°F) ambient temperature)	

■ Coil Data

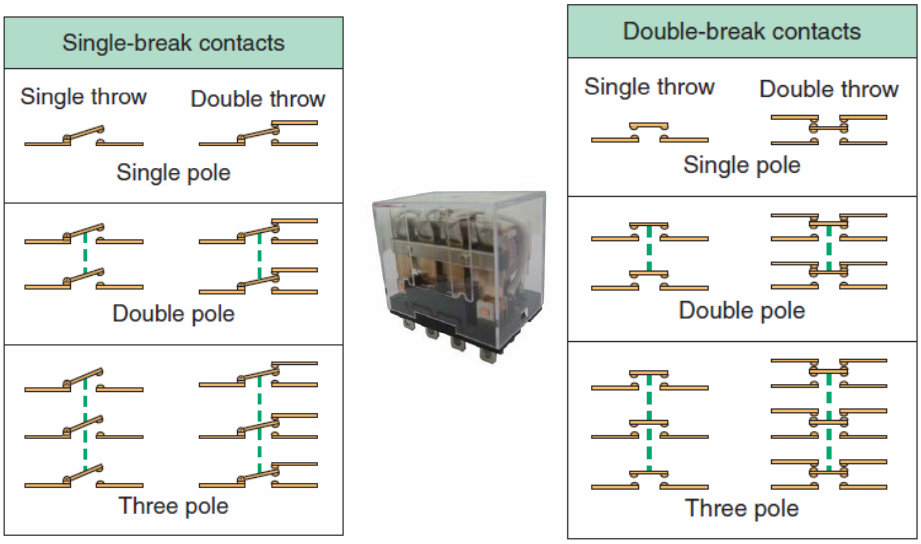
AC

Coil voltage	Rated voltage (VAC)	Rated current (mA)	Coil resistance (Ω)	Must operate	Must release	Max. voltage	Power consumption
				% of rated voltage			
24	24	75	—	75% max.	15% min.	110%	Approx.1.8 to 2.6 VA
50	50	36	—				
100/120	100 to 120	18 to 21.60	—	75 volts	18 volts	132 volts	
200/240	200 to 240	9 to 10.80	—	150 volts	36 volts	264 volts	

DC

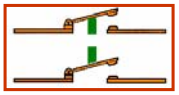
Coil voltage	Rated voltage (VDC)	Rated current (mA)	Coil resistance (Ω)	Must operate	Must release	Max. voltage	Power consumption
				% of rated voltage			
12	12	167	72	75% max.	10% min.	110%	Approx. 2.0 W
24	24	83	288				
48	48	42	1150				
100	100	20	5000				
110	110	18	6050				

Relay contacts are classified by their number of *poles*, *throws*, and *breaks*.



A pole is the number of completely isolated circuits that a relay contact can switch.


Single-Pole


Double-Pole

A throw is the number of closed contact positions per pole (single or double).


Single-Pole, Single-Throw (SPST)


Single-Pole Double-Throw (SPDT)

The term break designates the number of points in a set of contacts where the current will be interrupted during opening of the contacts.


Single-Pole Single-Break


Single-Pole Double-Break

Relay contacts are rated in terms of the maximum amount of current the contacts are capable of handling at a specified voltage level and type (AC or DC).

Current ratings specified may include:

- **In rush or "make contact capacity.**
- **Normal or continuous carrying capacity.**
- **The opening or break capacity**

The load-carrying capacity of contacts is normally given as a current value for a resistive load.

Lamp filaments are resistive, but change in value from their cold state to their operating state. As a result the inrush current can be many times greater than the steady-state value. Normal practice is to de-rate contacts to 20% of their resistive load capabilities for a lamp load.

Inductive loads can cause excessive contact arcing when the relay breaks the circuit. For inductive type loads contacts are normally de-rated to 50% of their resistive load capacity.

Relay contacts often have two ratings: AC and DC. To determine the maximum power capacity of a relay contact multiply the rated volts times the rated amperes.

A 5 Amp relay rated at 125 VAC can also switch 2.5 Amps at 250 VAC.

P = E x I
= 125 x 5
= 625 W

P = E x I
= 250 x 2.5
= 625 W

A 5 Amp relay rated at 24 VDC can switch 2.5 Amps at 48 VDC, or even 10 Amps at 12 VDC.

P = E x I
= 24 x 5
= 120 W

P = E x I
= 48 x 2.5
= 120 W

P = E x I
= 12 x 10
= 120 W