



Process Control and Building Management Systems

EME501

Lec5 Classic Control

INSTRUCTOR

DR / AYMAN SOLIMAN



أغلب المعلومات فى المحاضرة مقتبسة من شرح

المرحوم م/ محمود طه

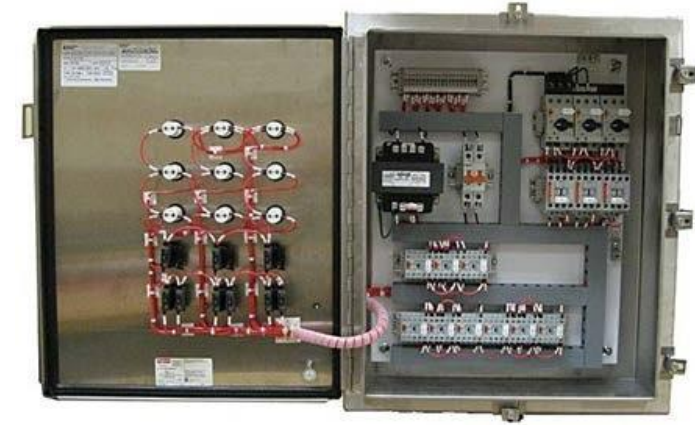
اللهم اغفر له وارحمه واجعلها فى ميزان حسناته

➤ **Classical Control**

- It also called Hard Wiring

which consisted mainly of:

- Contactors and relays
- timers
- counters
- Limit Switches and Digital Sensors
- Switches as PB and Selectors
- Wires, wires and ... wires



❖ Any Control Panel have 2 circuits: Power & Control

1-power Circuit:

- It is the circuit which responsible for delivering power from the source to the load, whether motor or heater or any kind of loads .
- It usually consist of :
 - I. Load Break Switch
 - II. 3pole C.B or 3 Fuse
 - III. 3 main Contact of Contactors
 - IV. Thermal Overload Relay
- All these components and the used cable must be withstand the current value which dissipated by load.

2- Control Circuit:

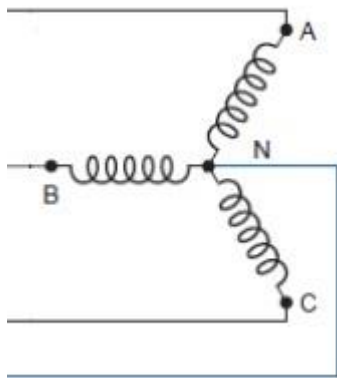
- It is the circuit which responsible for connecting the current to the coils of contactors in the circuit by the way or the time required.
- It usually consist of :
 - I. 2 Terminals including the Contactor Coil Voltage
 - II. Miniature C.B or Fuse
 - III. Normally Close Contact of the Overload Relay
 - IV. Start & Stop PB's
 - V.A number of Auxiliary Contacts
 - VI.The Contactors Coils
- All these components and the used cable must be withstand only the current value of Contactor Coil or Signal Lamps.
- Sometimes it contains the following:
 - I. Control Relays
 - II. Timers or Counter Relays
 - III. Discrete Sensors as Proximity Sensors & Limit Sw and Float Switches.

➤ Components of Power & Control Circuits

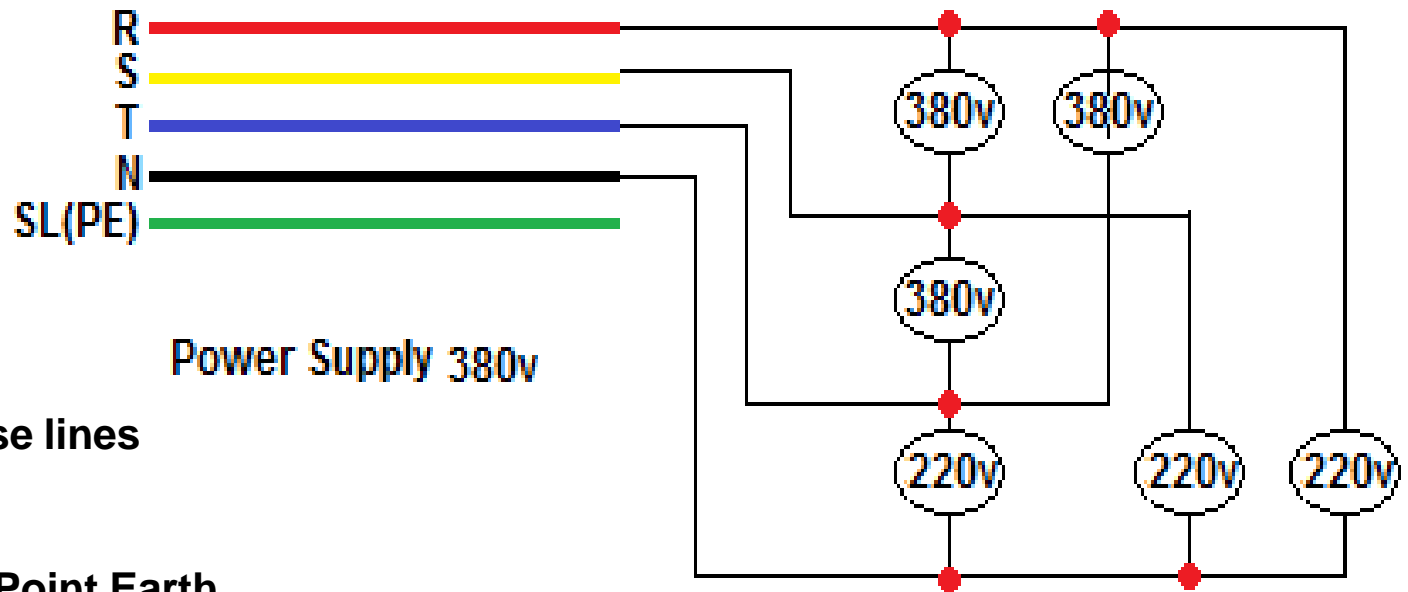


➤ Power Source or Supply

- It's the main Power supply which supply the power to the Load
- It can be DC Supply or AC 1 Phase or 3 Phase Supply which depends on the Load Type.
- 3Phase Induction Motors is the most commonly used in Industries so the 3Phase AC Supply will be used.



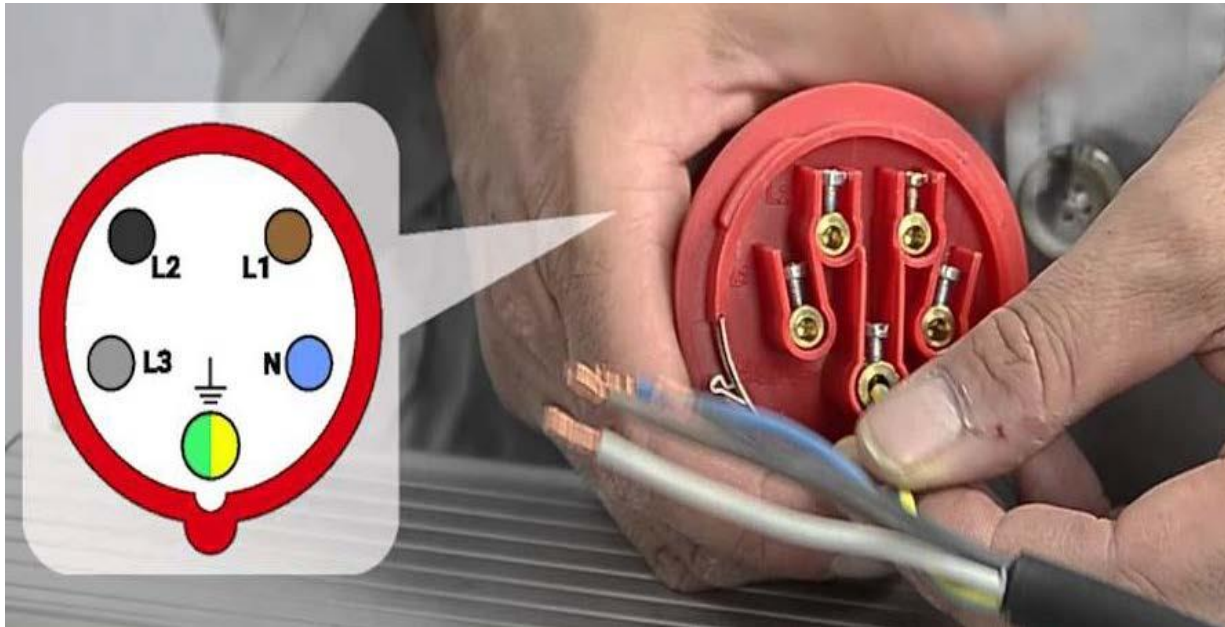
- ❑ (R S T) represent 3phase lines
- ❑ N Neutral point
- ❑ SL (PE) Safety Line or Point Earth



➤ 3 Phase Plug and Socket

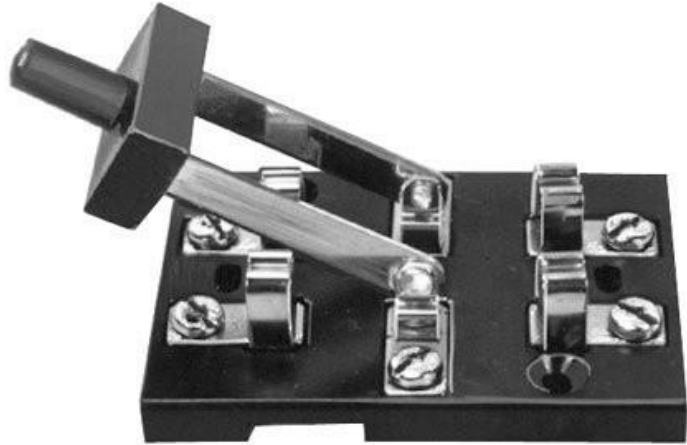


➤ 3 Phase Plug



➤ Power Circuit Components

Knife Switches



- This device has **isolation capability**
- It is a type of **switch** used to control the flow of **electricity** in a **circuit**.
- Can not be used **on load**
- It does **not include** any protection mechanism

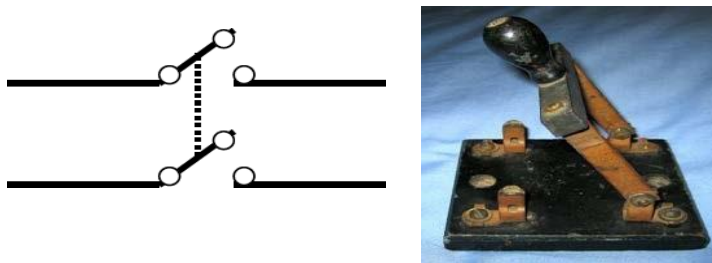
➤ Power Circuit Components

● Knife switches can take several forms

➤ **Single pole single throw (SPST)**



➤ **Double pole single throw (DPST)**



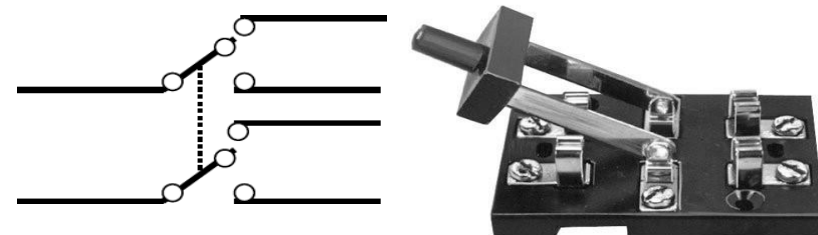
➤ **Triple pole single throw (TPST)**



➤ **Single pole Double throw (SPDT)**



➤ **Double pole Double throw (DPDT)**



➤ **Triple pole Double throw (TPDT)**



➤ Power Circuit Components

Knife Switches

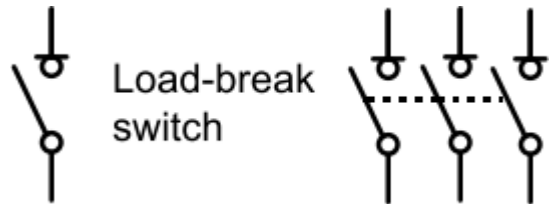
- Specification of Knife Switches “How to select Knife Switch ?”
 - Rated Current
 - Rated Voltage
 - No. of Poles



- Rated Current = 100 A
- Rated Voltage = 250 V
- Triple pole single throw (TPST)

➤ Power Circuit Components

The load break switch / isolator

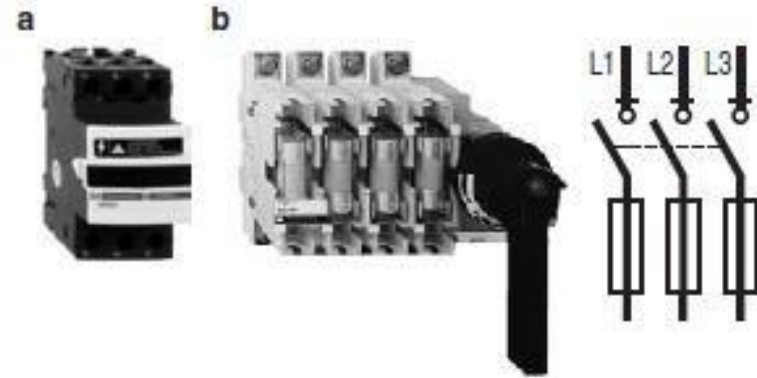


- This device has **disconnection and isolation capability**
- Can be used safely « **on load** »
- It does **not include** any protection mechanism
- May be used as an **emergency stop** button (with yellow cover and red handle)
- It has the same **Specification** as Knife Switches

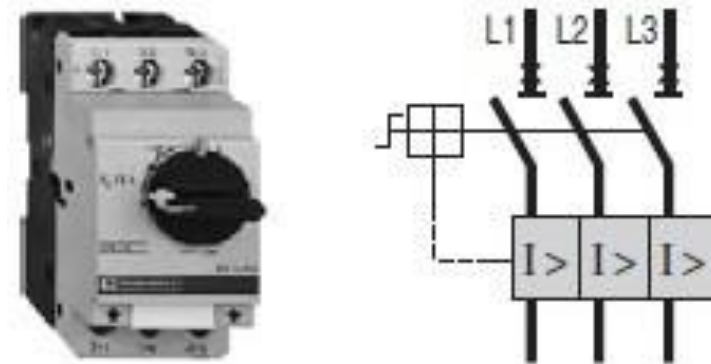
➤ Power Circuit Components

SHORT CIRCUIT PROTECTION

A. FUSES

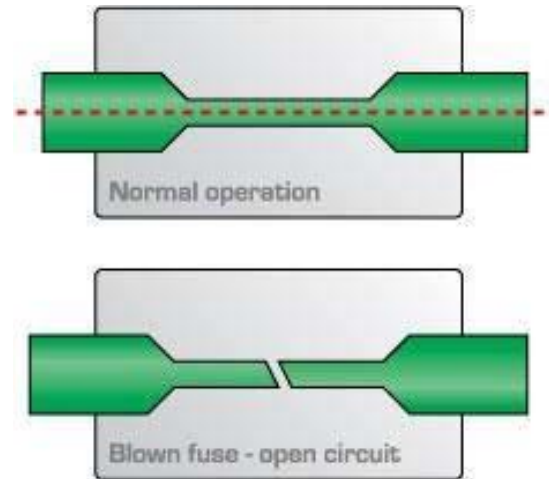


B. CIRCUIT BREAKERS.



A) Fuse

- The **fuse** is a **reliable overcurrent protective device**, primarily used as a circuit protection device for overcurrent and short-circuits.
- A "fusible" link or links encapsulated in a tube and connected to contact terminals comprise the fundamental elements of the basic fuse.
- Electrical resistance of the link is so low that it simply acts as a conductor. However, when destructive currents occur, the link **very quickly melts** and opens the circuit to protect conductors and other circuit components and loads.
- It is the **cheapest** form of protection.

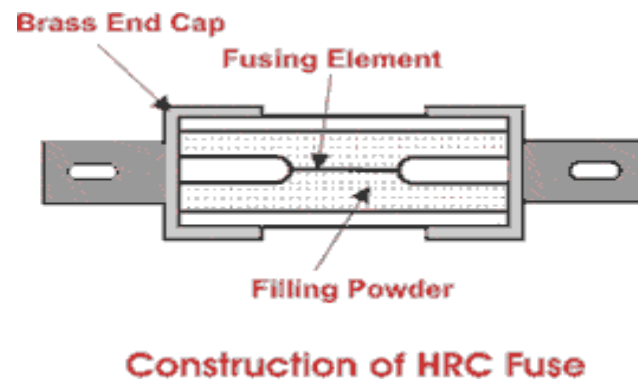


- Fuse characteristics are **stable** and does not require **periodic maintenance or testing**.
- The modern fuse has an extremely "**high interrupting**" rating-can withstand very high fault currents without rupturing.
- A fuse provides **optimum component protection** by keeping fault currents to a **low value**... They are said to be "**current limiting**."
- The common types of Fuse:
 - ❖ **Cartridge Fuses**
 - ✓ Cartridge fuses are cylindrical in shape and have contacts points at each end.
 - ✓ They are available in a wide variety of sizes, amp and volt ratings up to 600Vac and 600 amps
 - ✓ It usually filled with quartz sand to absorb the Arc.



➤ High Rupturing Capacity

- ✓ The enclosure of HRC fuse is either of glass or some other chemical compound.
- ✓ The ceramic enclosure having metal end cap at both heads, to which fusible silver wire is welded.
- ✓ The space within the enclosure, surrounding the fuse wire or fuse element is completely packed with a filling powder.
- ✓ This type of fuse is reliable and has inverse time characteristic, that means if the fault current is high then rupture time is less and if fault current is not so high then rupture time is long.



Fuse

- Specification of Fuse “How to select Fuse?”
 - **Rated Carrying Current**
 - **Fusing Current**
 - **Rated Voltage**
 - **Interrupting Capacity**



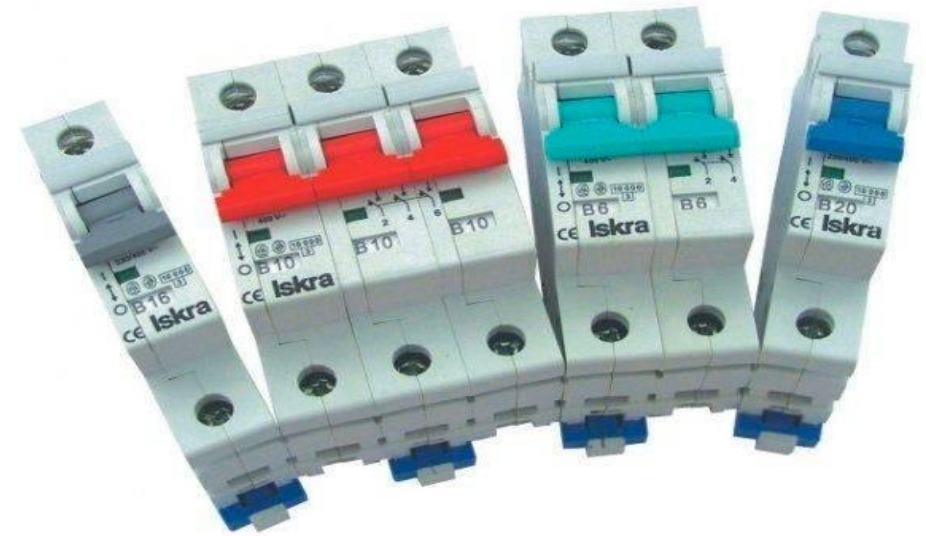
- ❑ **Maximum Size of Time Delay Fuse = 300% x Full Load Line Current.**
Ex: Maximum Size of Time Delay Fuse = 300% x 6 = 19 Amp.
- ❑ **Maximum Size of Non Time Delay Fuse = 1.75% x Full Load Line Current.**
Ex: Maximum Size of Non Time Delay Fuse = 1.75% x 6 = 11 Amp.
- ❑ **For DC Motor = 150%**

The Magnetic Circuit Breaker



- Device which provides **short-circuit protection**. It detects and break high levels of short circuit currents up to the limit of their breaking capacity.
- Has disconnection capability
- **Reset** after fault can be done **manually** by operating the rotary switch, or remotely using optional module
- For relatively **low fault** currents, the operation of a **circuit breaker** is **faster** than that of **fuses**

- MCBs or **Miniature Circuit Breakers** are electromechanical devices which protect an electric circuit from an overcurrent. The overcurrent, in an electrical circuit, may result from *short circuit, overload or faulty design*.
- An MCB is a better alternative to a Fuse since it **does not require replacement** once an overload is detected.
- Unlike fuse, an MCB can be easily operated and thus offers improved operational safety and greater convenience without incurring **large operating cost**.
- MCB are used to protect **lower current circuits** .
- Miniature Circuit Breakers are usually available in the range of **2A to 125A**.



Circuit Breaker Ratings

10	16	20	25	32	40	50	63	80	100	125	160	200	250	400	630	800	1000	1250	1600	2000	2500	3200	4000	5000	6300	CB (A)
MCB											ACB															
MCCB																										



- MCBs (Miniature Circuit Breakers) are categorized into B, C and D types.
- These three ratings are determined by the level of overload which causes the MCB to trip.
 - ❑ B type MCBs operate at an overload of 3 to 5 times the rated current. Type B MCBs are usually used in domestic installations where the inrush currents and surges are low .
 - ❑ C type MCBs operate at an overload of 5 to 10 times the rated current. These MCBs are used in commercial and industrial installations where high inrush current are likely due to motor starting or due to large no of fluorescent lighting.
 - ❑ D type MCBs operate at an overload of 10 to 20 times rated current and used in special applications such as x-ray machines and transformers which can draw heavy inrush current.



Circuit Breaker

- Specification of C.B “How to select C.B?”
 - Operating voltage of C.B
 - Rated current of C.B (I_r or I_n) Amp
 - Rated breaking capacity (I_{cu}) KA
 - Type of C.B
 - No. of poles

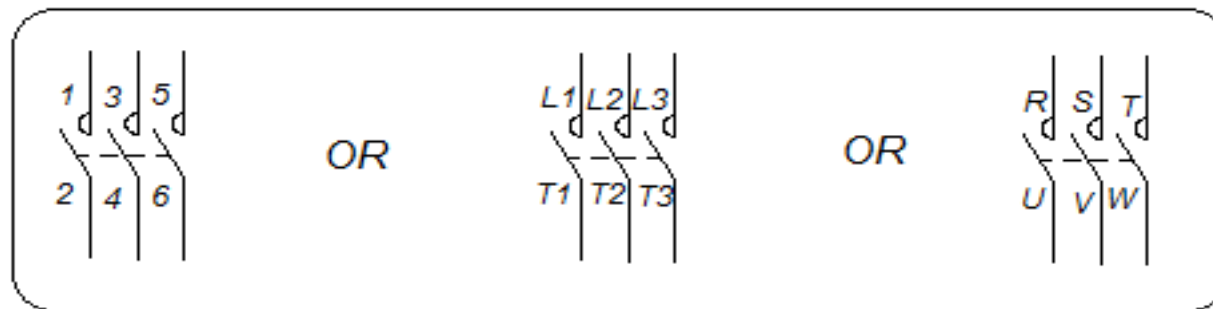
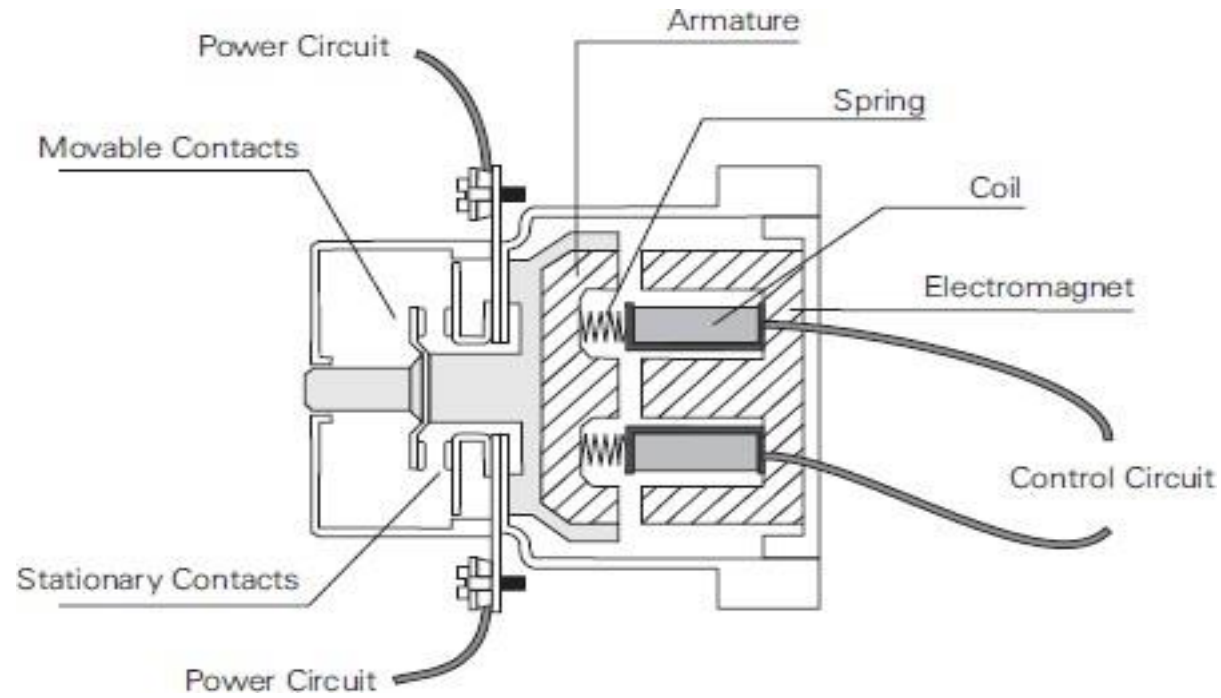


- Rated Voltage = 240 V/ 415 V
- Rated Current = 6 A
- Rated breaking capacity = 6 KA
- Type B
- Single Pole

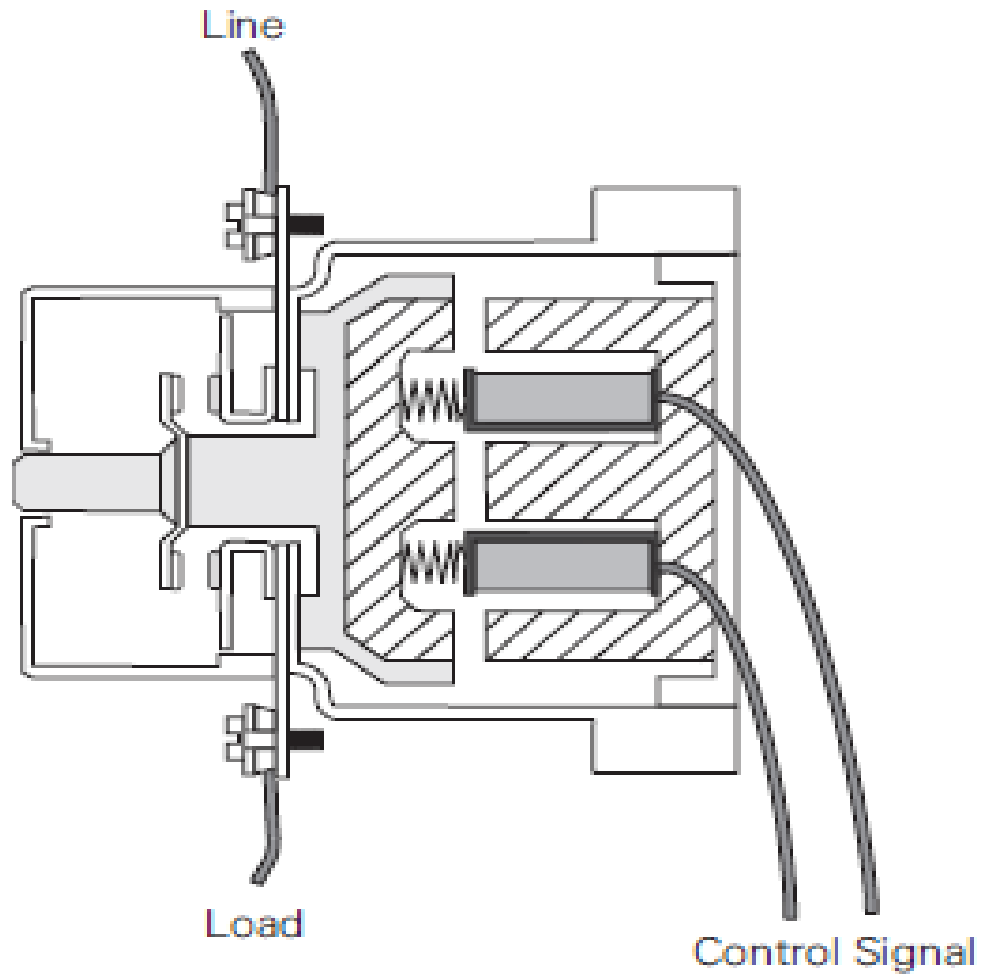
The Contactor

- It represents a **mechanical coupling** between Power circuit and Control Circuit by using electric signals.
- Makes and breaks current on loads – Switching capacity
- Operated remotely using an electromagnet and a separate control circuit
- When the coil of the electromagnet is energized, the mobile part of the contactor moves and current can flow from the supply network to the load.
- Auxiliary contacts are included and moving simultaneously with the mobile part of the contactor

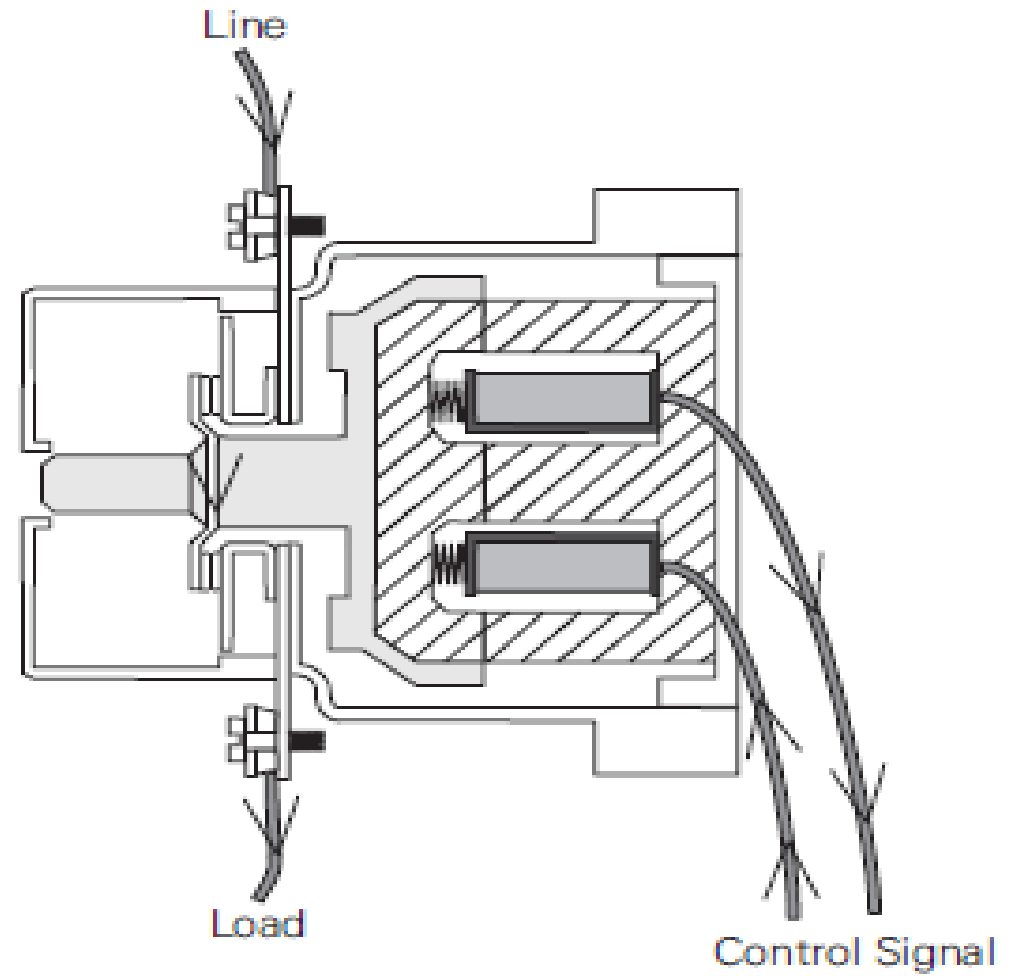




Main Contacts OF Contactor.



Contactor De-energized



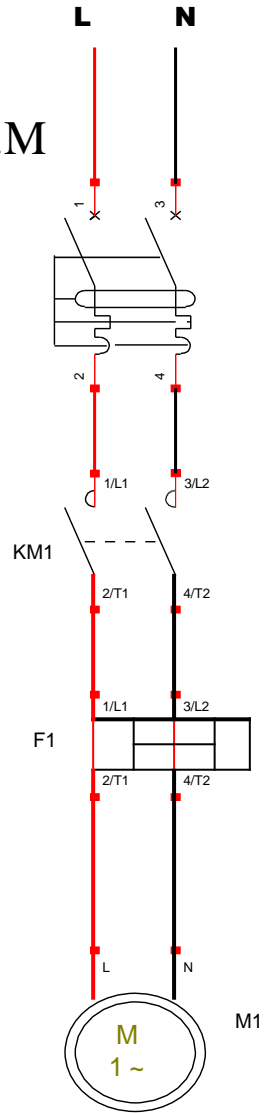
Contactor Energized

Contactor

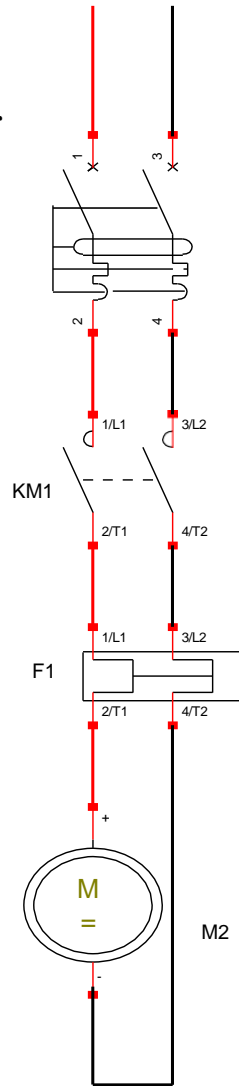
- Specification of Contactor “How to select Contactor?”
 - **Operating voltage of Coil and Frequency**
 - **Rated current of Contactor**
 - **Switching Voltage AC/DC**
 - **Type of Contactor**
 - **No. of Auxiliary Contacts**

Power Circuit Examples

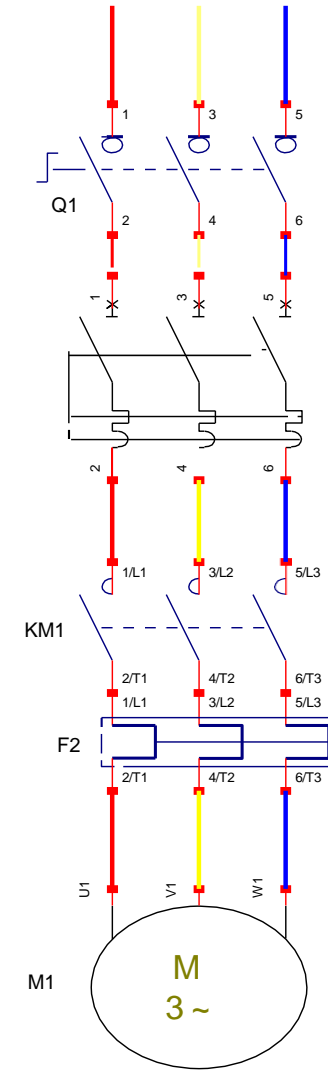
1phase I.M



DC Motor



3 Phase I.M



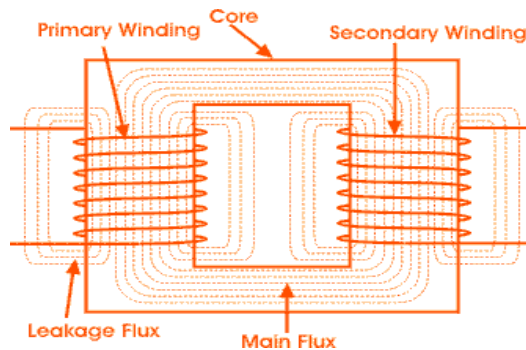
➤ Control Circuit Components

Control Supply

- The Control voltage can be 24 or 48 or 110 or 220 or 380 v.
- All Relays, Contactors Coils and Signal Lamps must have the same operating voltage (control voltage).
- Single phase transformers to feed control circuit with needed voltage 24, 48, 110 v.

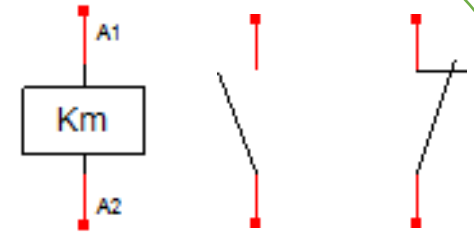
There are 2 types Step up and Step down

- One secondary winding One output
- More one secondary winding Many output



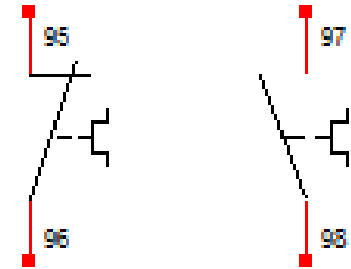
Auxiliary Contact of Contactor

- Auxiliary contact are mainly used for Taking Feed back when motor get ON or Off.
- It used in control circuit only.
- Auxiliary Contact in Contactor Are Specified x3 -x4 normally open contact & x1 -x2 for Normally closed auxiliary contacts.
- It can be 2 contact or more .



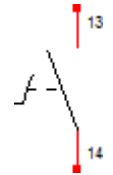
Auxiliary Contact of Overload Relay

- thermal overload relays contain a normally closed (NC) and normally open contact..
- The N.C contact used to disconnect or trip the power of contactor coil.
- The N.O contact used to indicate fault trip



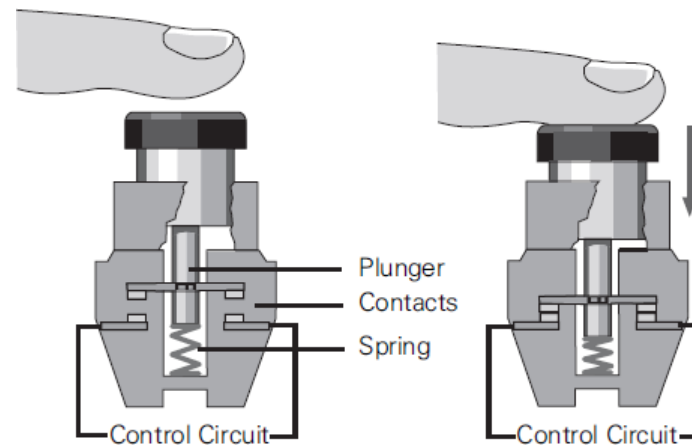
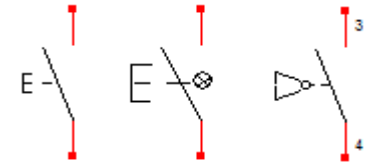
Start/ Stop Switch

- It used as Start / Stop Switch to pass or disconnect the current to the control circuit
- It changes it's contact from open to close if pressed and vice versa.
- It held or maintained to the new position after releasing it.



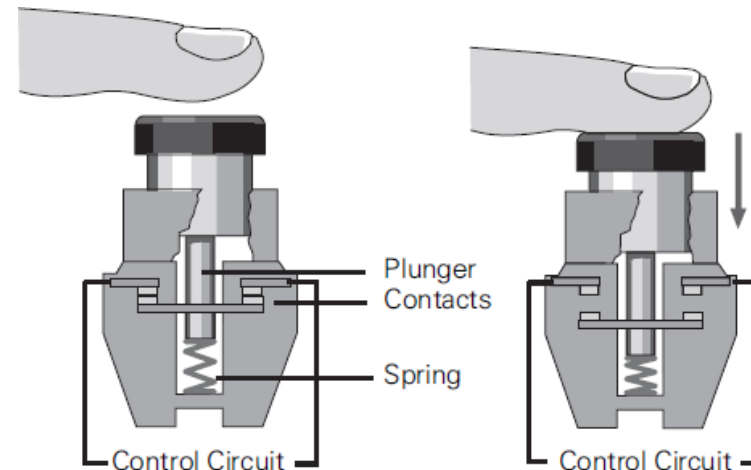
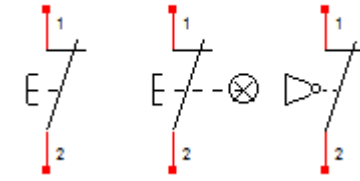
Start PB SW

- It used as Start Switch to pass the current to the control circuit
- It must be Normally Open Contact
- It changes it's contact from open to close if pressed.
- It returns to it's normal position after releasing it.



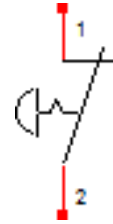
Stop PB Switch

- It used as Stop Switch to disconnect the current from the control circuit
- It must be Normally Close Contact
- It changes it's contact from Close to Open if pressed.
- It returns to it's normal position after releasing it.



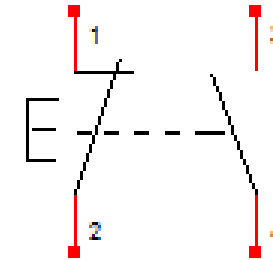
Emergency Stop Switch

- It called a fail-safe control switch or Kill SW.
- These switches are used to stop equipment and facilities in emergencies
- It must be Normally Close Contact
- It must be highly visible in color and shape, and must be easy to operate in emergency situations.
- It changes it's contact from Close to Open if Pressed.
- it is held in that position until you twist it.



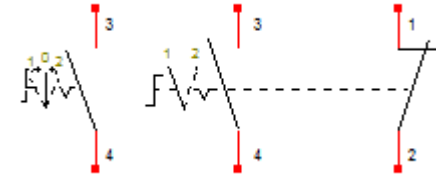
Double pole Switch

- It has one contact N.O and an other one N.C
- It returns to it's normal position after releasing it.
- It used to connect circuit or pass and disconnect an other one.



Selector Switch

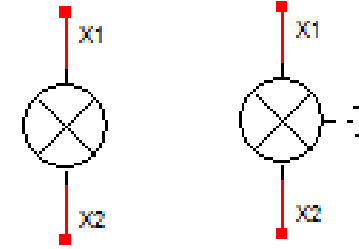
- It has more than one position to be selected.
- It maintained at the selected position until the operator change it.
- It used to select the mode of operation.



Signal Lamp

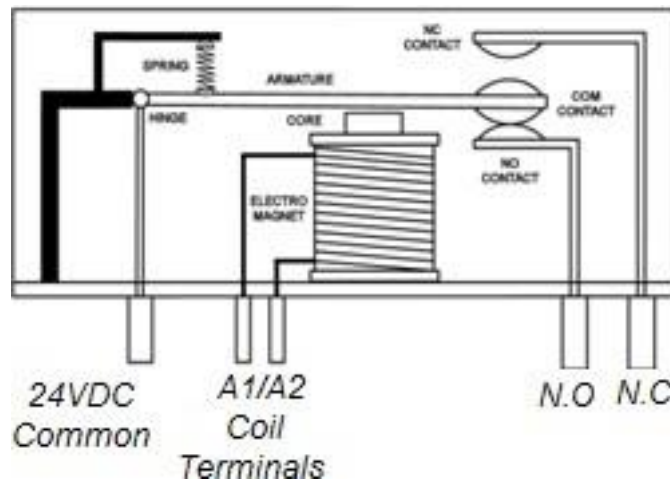
- It's a colored LED Power Indicator Pilot Single Light Lamp
- It used as indicator for current passing or status of motor
- Robust and with low power consumption

- Specification of Indication Lamp
 - ❑ Operating Voltage
 - ❑ Consumption Power
 - ❑ Diameter for installation
 - ❑ Colours available
 - ❑ Designated normal life time

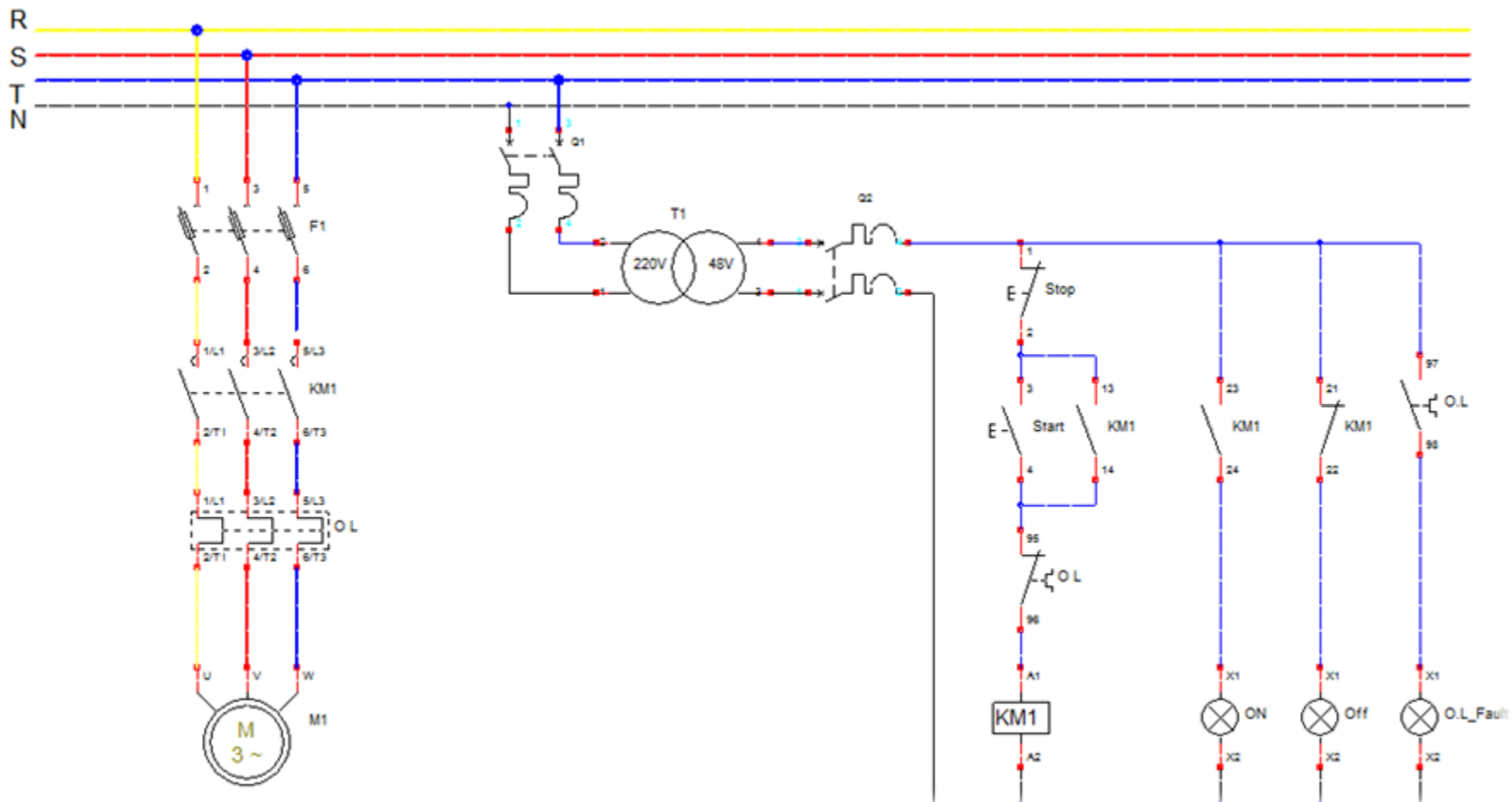


Relay

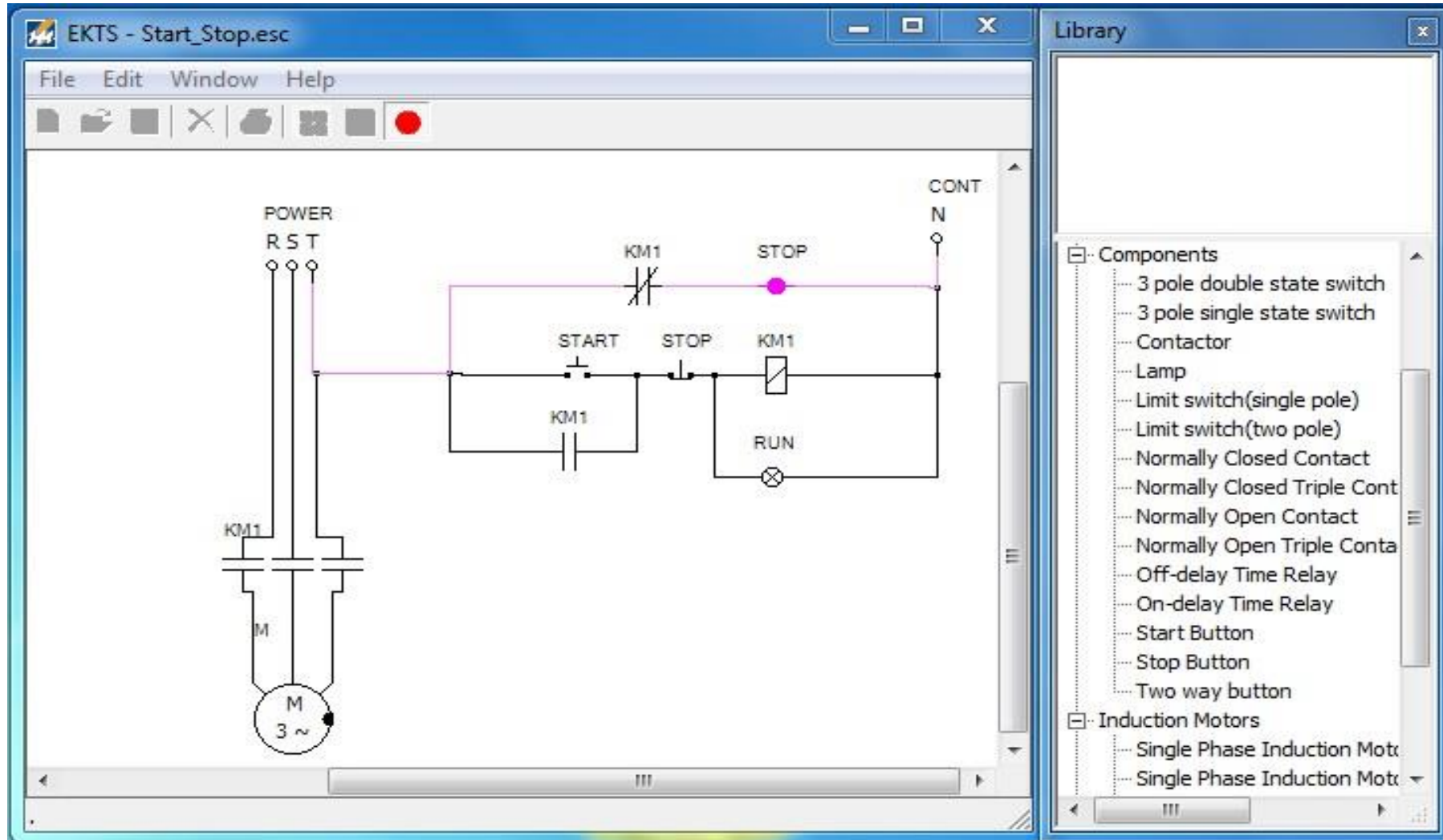
- Contactors and Relays perform the same task of switching a circuit.
- A relay is an **electromagnetic** switch.
- Relays are usually cheaper and lower in their performance capabilities for signal switching and load handling than contactors.
- A Relay is similar to a Auxiliary contactor, which is used in generally control circuit
- relays are always used in a low current carrying circuits. it comes with a rating from 5–20 Amps.



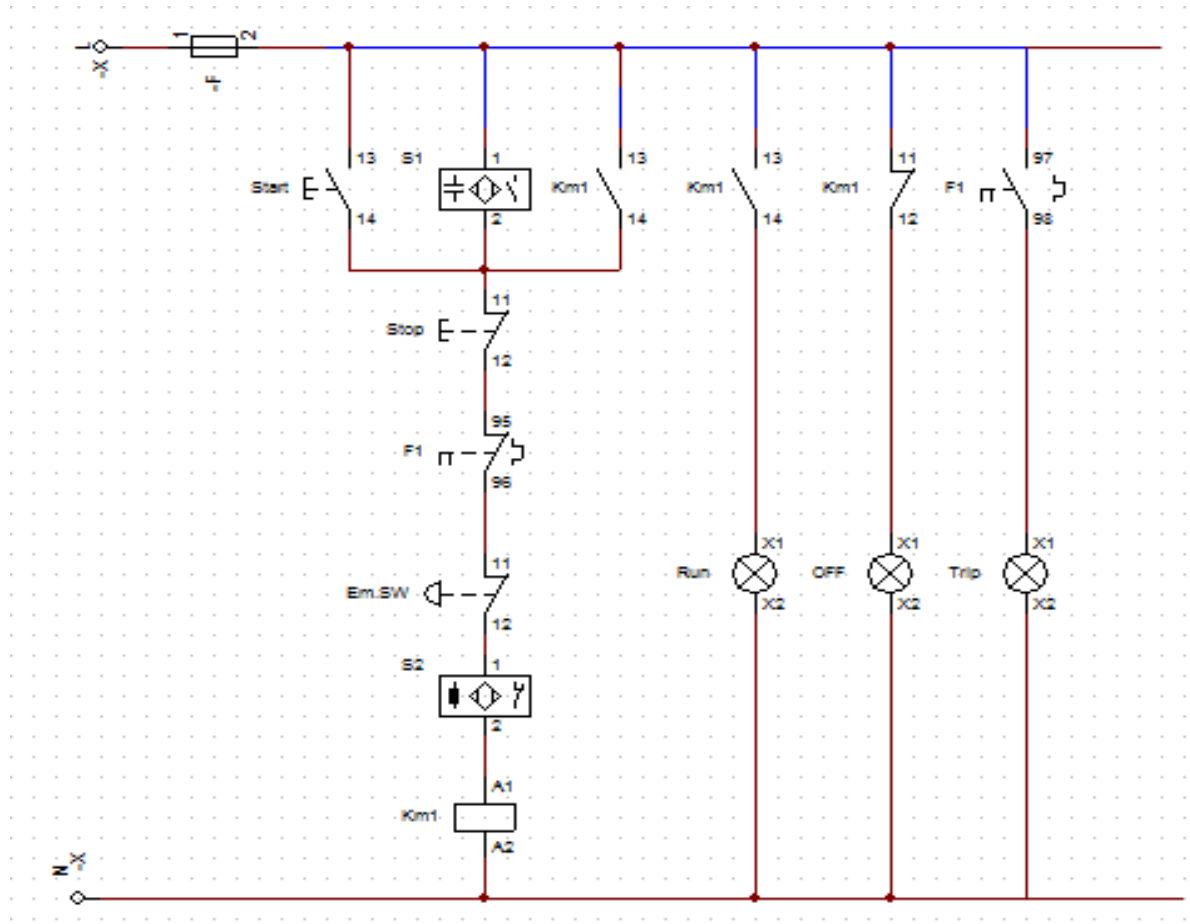
➤ Start Stop Circuit for 3phase I.M



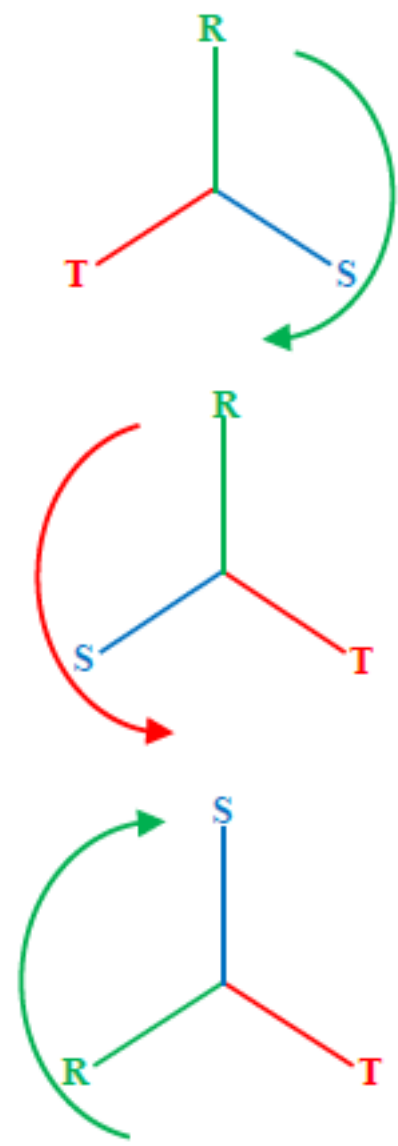
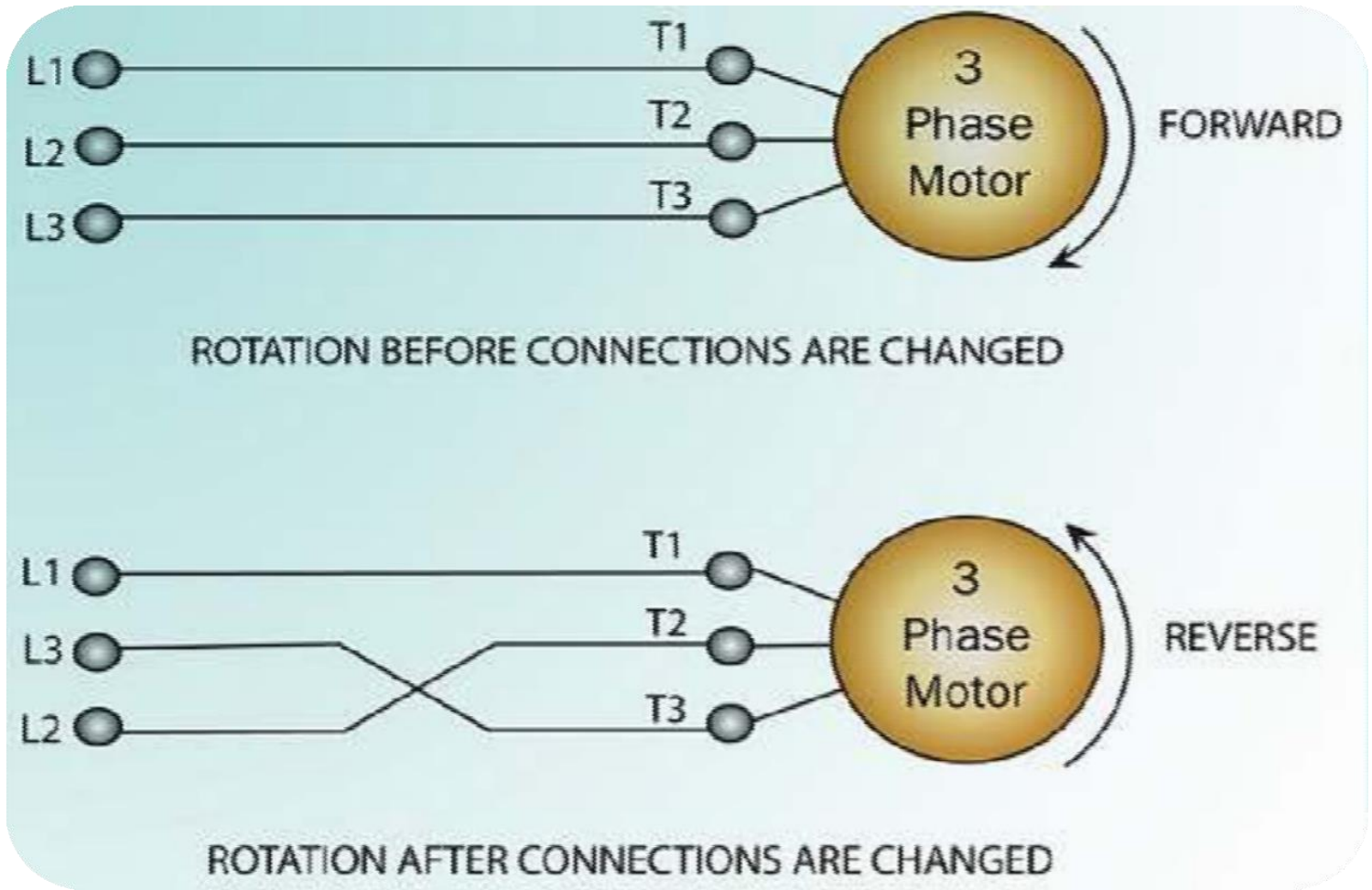
➤ Simulation using EKTS program



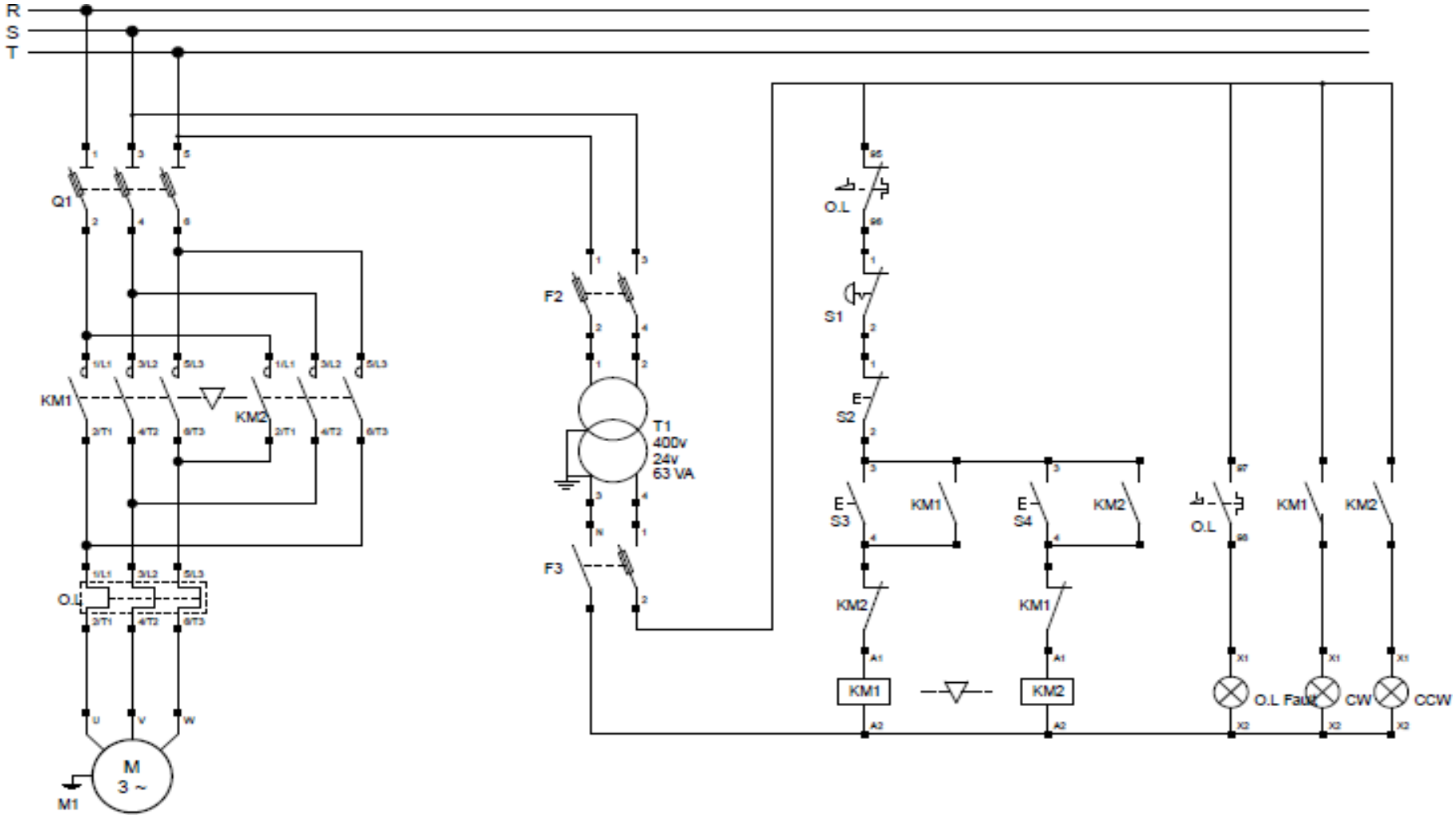
Design Control Circuit to Start 3Phase I.M using more than one PB Switch and Stop it using more than one PB Switch.



➤ Reverse Direction Circuit for 3phase I.M



➤ Reverse Direction Circuit for 3phase I.M



Thank

you

