Motor Control

AC Motor Starting Methods

Direct On Line D.O.L

This uses a single contactor

STAR DELTA STARTERS:
This method requires the use of 3 contactors and a timer circuit

AUTO TRANSFORMER STARTERS
This method requires the use of contactors and a tapped autotransformer

RESISTANCE STARTERS
This method requires the use of contactors and specific resistances shorted out by the contractors during run up

SOFT STARTERS
This method mainly uses semiconductor devices to control the supply to the motor electronically

Variable Speed Drive (VSD)
Same as Soft Starters but with more functions that can also vary the speed of the motor

AC Motor Starting D.O.L

This type of starter configuration is called **Direct Online** and is the simplest most common method of starting motors

It consists of a contactor to supply the voltage directly through to the motor and some form of overload protection relay to protect the motor from excesses of current during overload situations

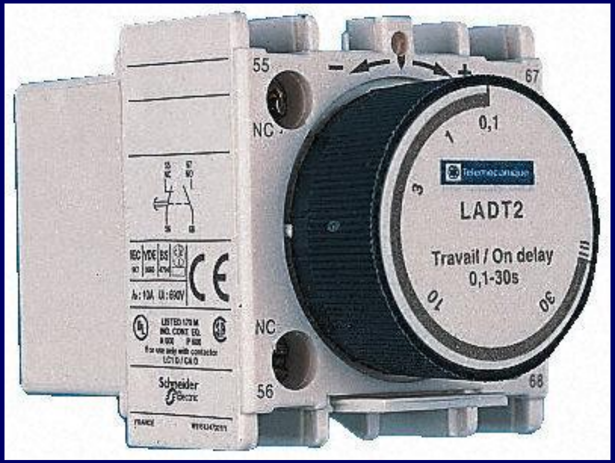
This configuration can be incorporated into one single device or by building modular starters using manufactured , type specific components

Reversing the motor can easily be done by swapping two phases around at the motor terminals.


LC1D09
Telemecanique
SQUARE D

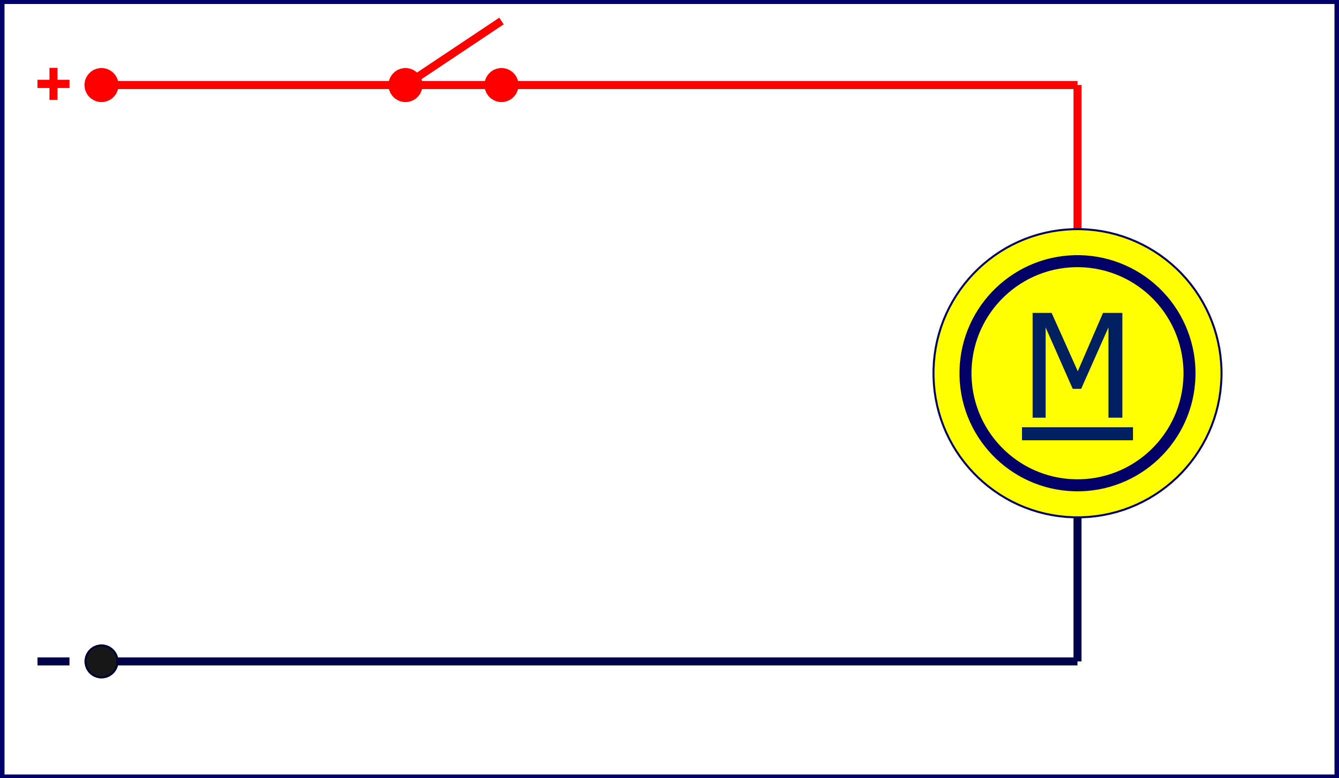

53 NO
61 NC
73 NO
83 NO
Telemecanique
SQUARE D
LADN31
54 NO
62 NC
74 NO
84 NO


53 NO
61 NC
Telemecanique
LADN11
LA1 DN11
54 NO
62 NC


55
67
NC
0,1
Telemecanique
LADT2
Travail / On delay
0,1-30s
NC
56
68

Motor Control

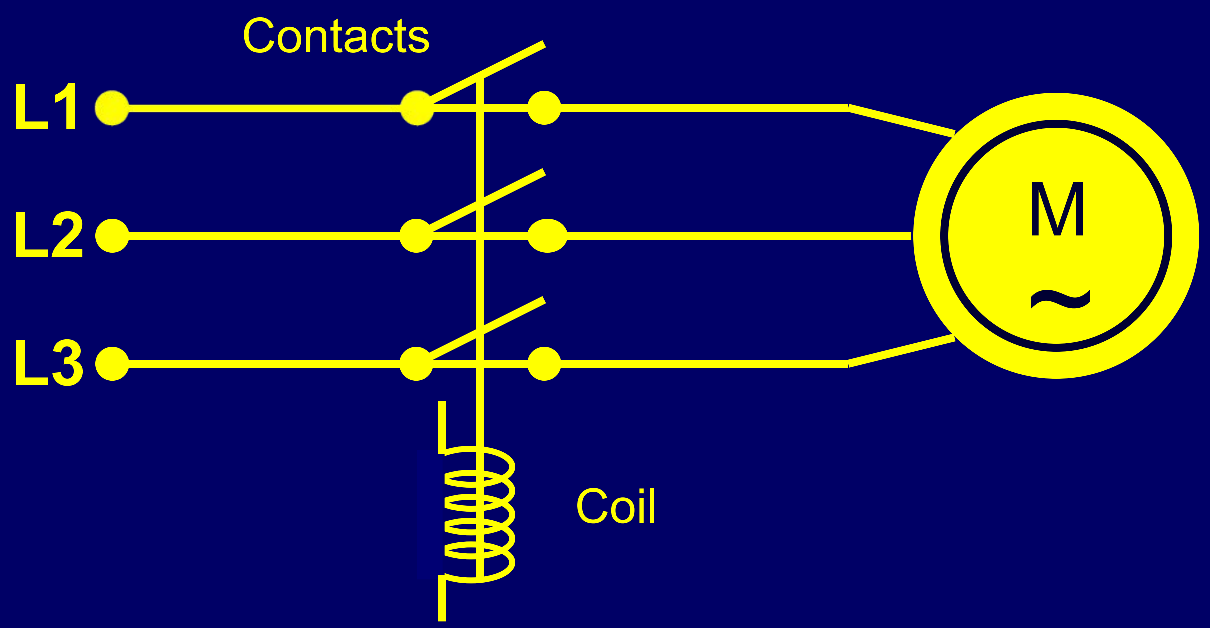
All electric motors require some form of starting method



In this DC case a simple switch would suffice

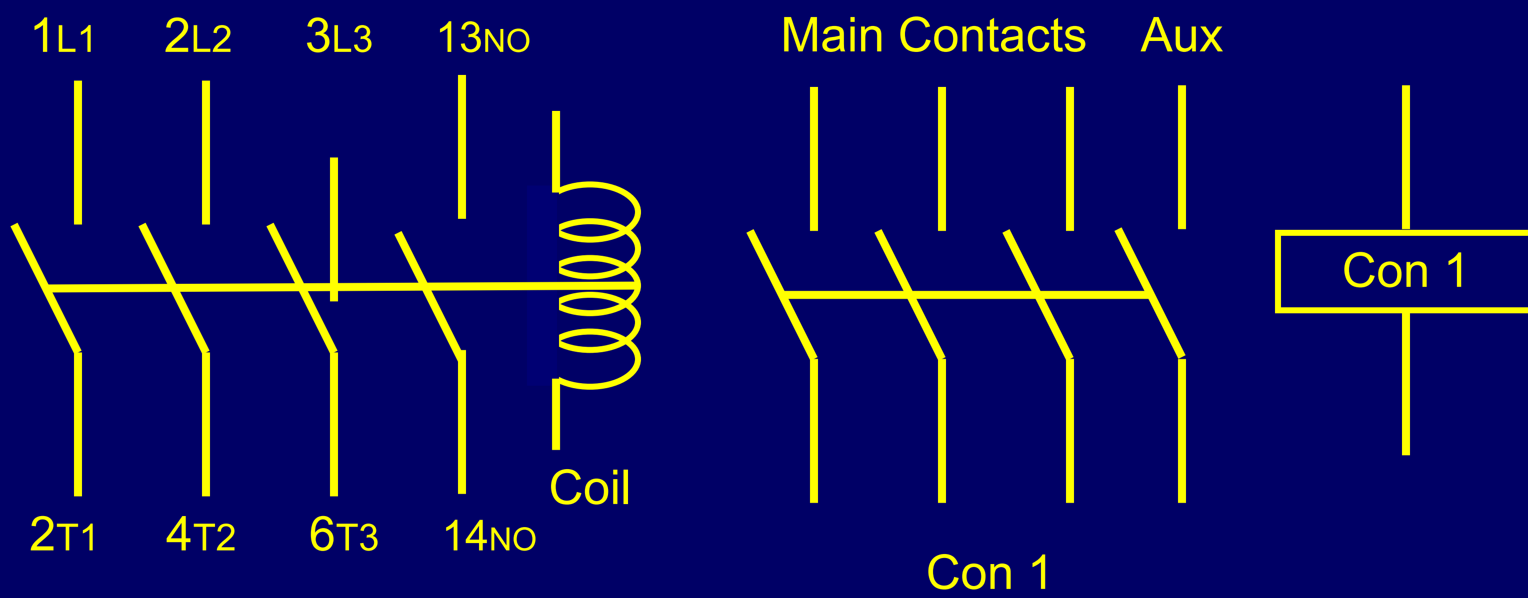
Three Phase AC Motor

With a three phase motor we need to switch all three live Lines on at the same time

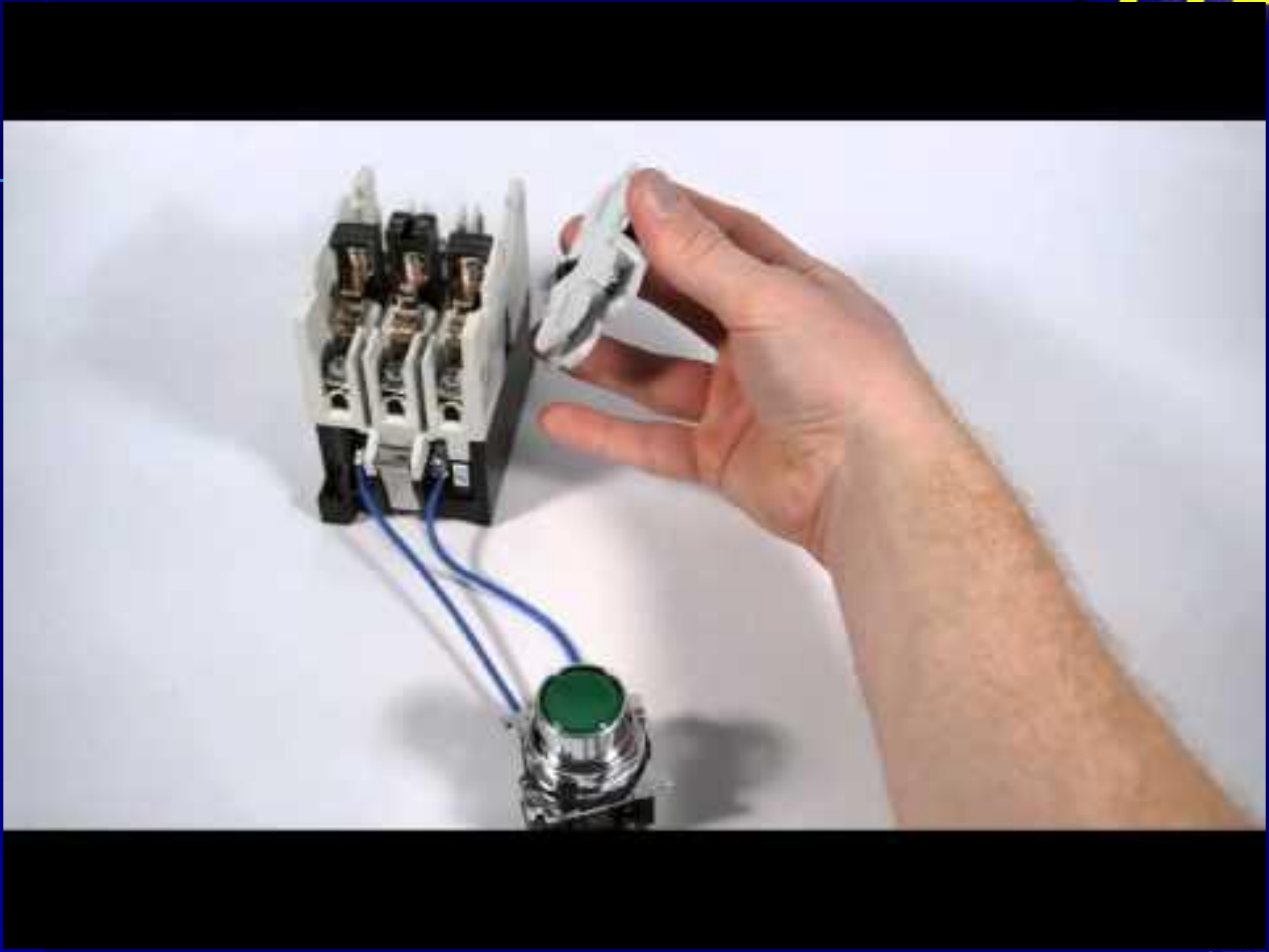


For this we can use a component called a CONTACTOR , this is an electrically controlled switch and consists of two main parts

Contactor Circuit Symbols
C1



Motor Control



Contactor / Relay

What Is The Difference Between a Contactor And Relay

Contactor

Larger when compared to relays

Used in circuits with higher current ratings

Used in the switching of a variety of loads including: motors, capacitors, lights etc.

Consists of a minimum of one set of three phase power contacts and in some cases additional auxiliary contacts are also provided.

Contacts and coil can be various ratings

Relay

Smaller in physical size than a contactor

Used in circuits with lower current ratings
Usually up to 10A

Mainly used in control and automation circuits, protection circuits and for switching small electronic circuits.

Consists of at least one NO/NC contacts

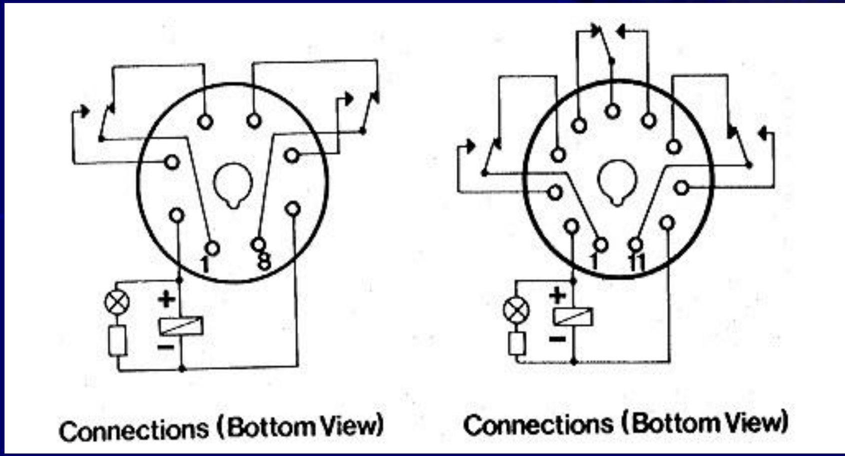
N/O (Normally Open) NC (Normally Closed)

Can come in many forms and pin configurations
Also come with a wide range of Voltage and current ratings

Contacts and coil can be various ratings

Relay Types

Basic Relay
Usually 8 pin 2N/C 2N/O
Or 11 pin 3N/C 3N/O



LATCHING RELAYS
There are two small wire coils called solenoids are on the sides of a magnet when one coil gets a pulse it will latch on when the other one gets a pulse it switches off.

REED RELAYS
Its contacts are important so these relays are kept under inert gas. They are well known for their switching speed.

SOLID STATE RELAYS
Fast no moving parts reliable.

Motor Overload Relay
with adjustable current setting

Overload Relay

The device limits the amount of current drawn and protects the motor from overheating.

The overload will trip for a variety of reasons including:

Motor running above full load amps,

An inrush current that is too long,

If one of the phases is pulling more than the others Phases not balanced,

Mechanical overload,

The basic working principle of thermal overload

A bimetallic device is made up of two strips of different metals.
The dissimilar metals are permanently joined. Heating the bimetallic strip causes it to bend.

The overload is able to monitor the current going to a motor and the amount of heat being generated by the current causes the bimetallic strip to bend, and opens the contacts.

Bimetal Strip Directly Heated or Indirectly heated

Bimetal Strip Directly Heated

The overload is able to monitor the current going to a motor and the amount of heat being generated by the current causes the bimetallic strip to bend, and opens the contacts.

Bimetal Strip Indirectly Heated

The bimetal strips may be indirectly heated through an insulated heating winding around the strip.

The insulation causes some delay of the heat-flow so that the inertia of indirectly heated thermal relays is greater at higher currents than with their directly heated counterparts.

Often both principles are combined.

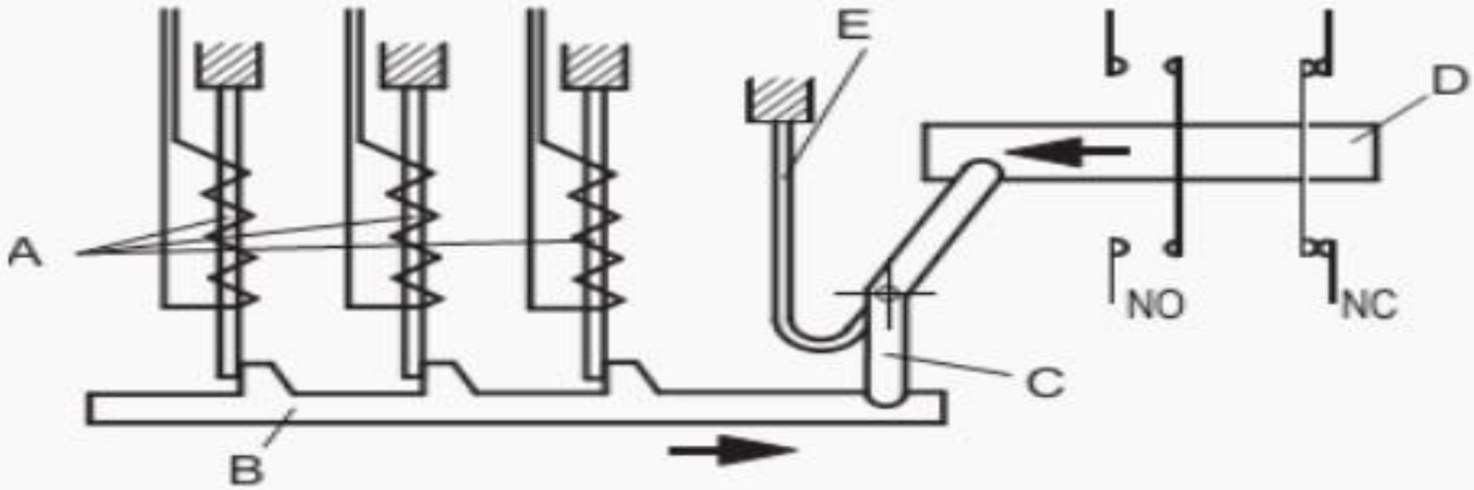


Figure 1 – Principle of operation of a three pole thermally delayed bimetal motor protection relay

A = Indirectly heated bimetal strips
B = Trip slide
C = Trip lever
D = Contact lever
E = Compensation bimetal strip

Thermal switch

A thermal switch - bi-metallic temperature switch that responds to temperature changes and does not need a temperature controller.

Thermal switch protectors are built into the windings of the motor. They act as a normally closed switch until the design temperature is reached at that point the switch will open

Normally there are two Thermal switches in a 3 Phase motor connected in series.

A typical class B motor winding maximum temperature is 130°C

Thermistor

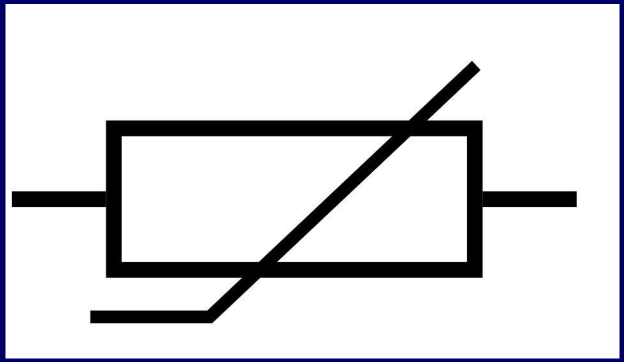
A thermistor needs a temperature controller and can be set at different temperatures and alarm settings.

A thermistor is a component that has a resistance that changes with temperature. There are two types of thermistor, those with a resistance that increase with temperature (Positive Temperature Coefficient – PTC) and those with a resistance that falls with temperature (Negative Temperature Coefficient – NTC).

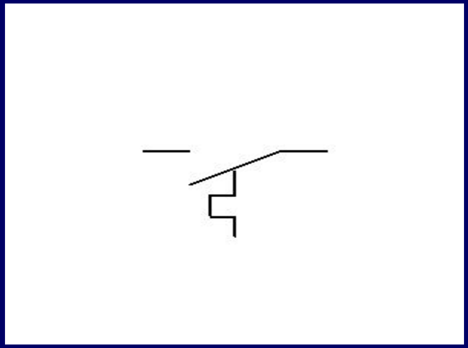
The PTC is used with a thermistor protection relay for motor protection

These thermistors have a "switch" temperature at which the resistance suddenly rises rapidly, limiting the current through the circuit. When used in conjunction with a thermistor relay, the PTC will switch off an electrical system at a desired temperature. Typical use is for motor overheat protection.

Thermistor



Thermal Switch



Why have built-in motor protection

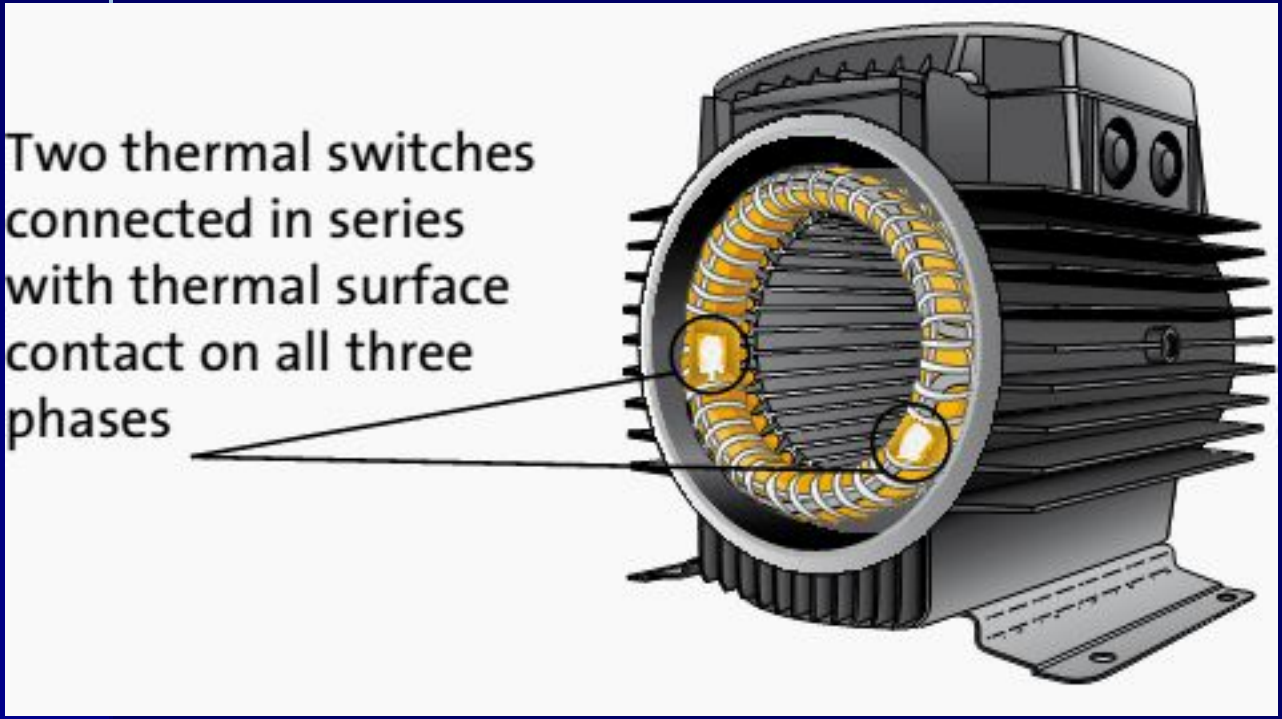
If the motor is covered and is slowly warmed up to a high damaging temperature.

High ambient temperature.

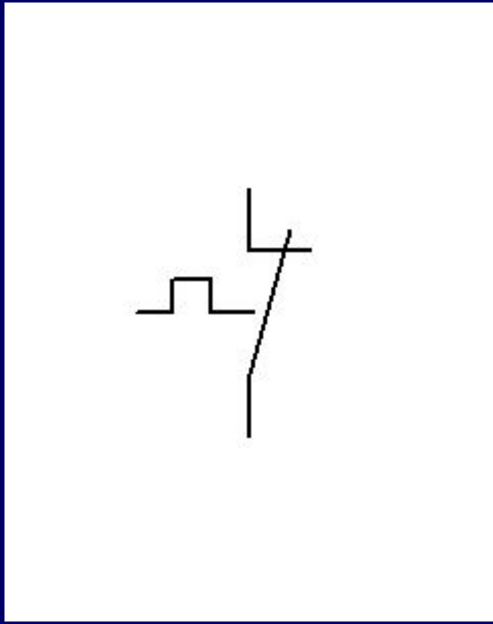
If the cooling fan fails

Dust blocking the fan or cooling fins

If a motor, within a short period of time, is restarted several times, and not allowed to cool down can cause the windings to overheat.



Thermal Switch



Star Delta Starting

Most induction motors are started directly on line, but when very large motors are started that way, they cause a disturbance of voltage on the supply lines due to large starting current surges.

To limit the starting current surge, large induction motors are started at reduced voltage and then have full supply voltage reconnected when they run up to near rotated speed.

Star Delta

During starting the motor windings are connected in star configuration and this reduces the voltage across each of the 3 winding. This also reduces the current and torque by a factor of three.

Star voltage across windings

supply voltage / root3

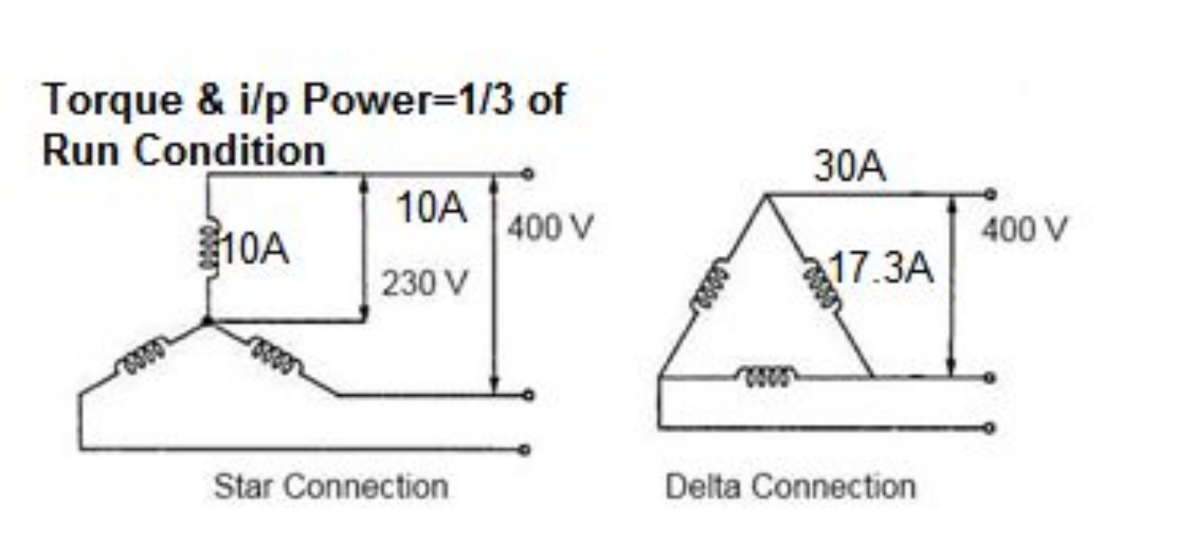
Or

supply voltage / 1.732

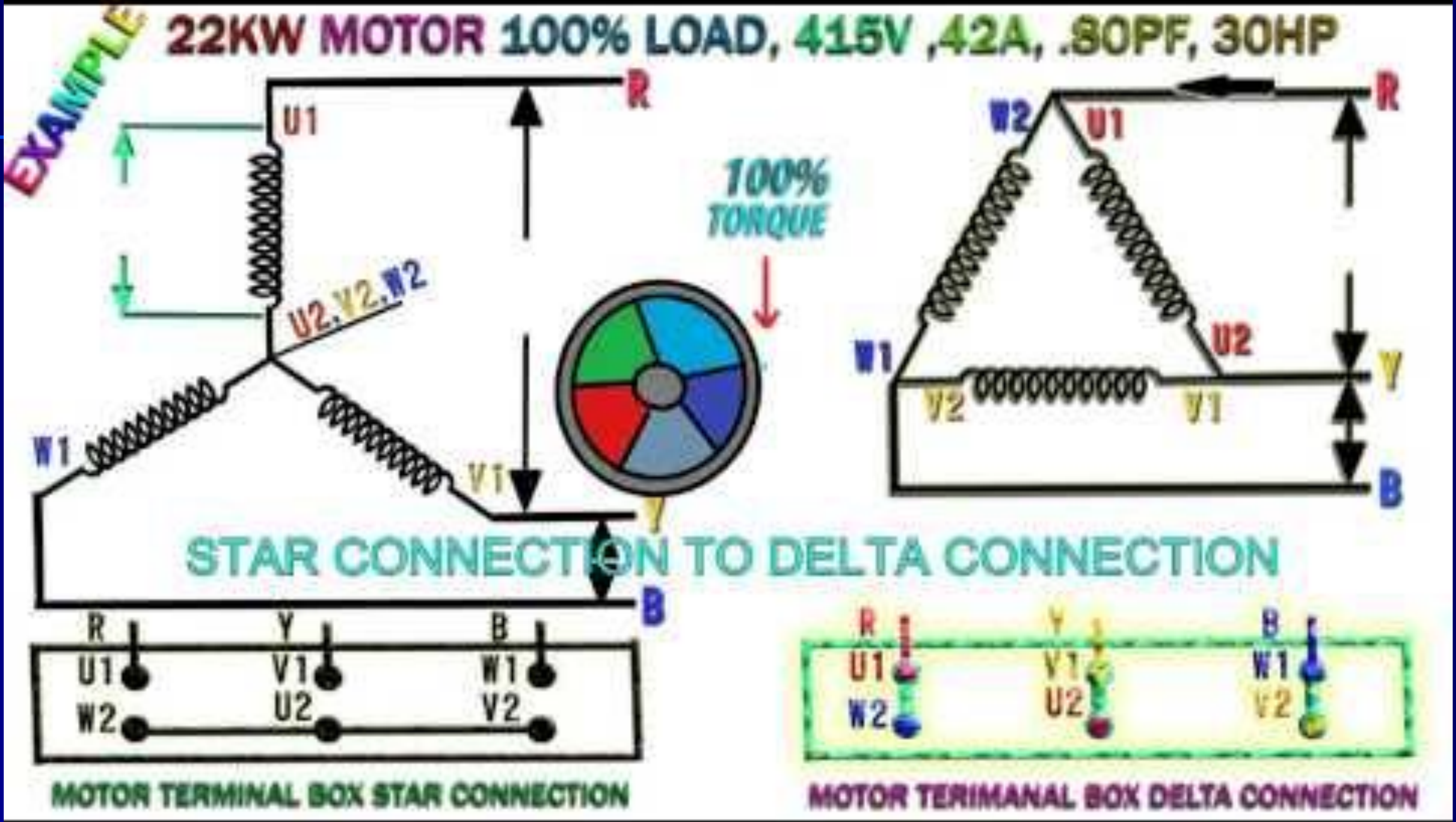
Star Delta

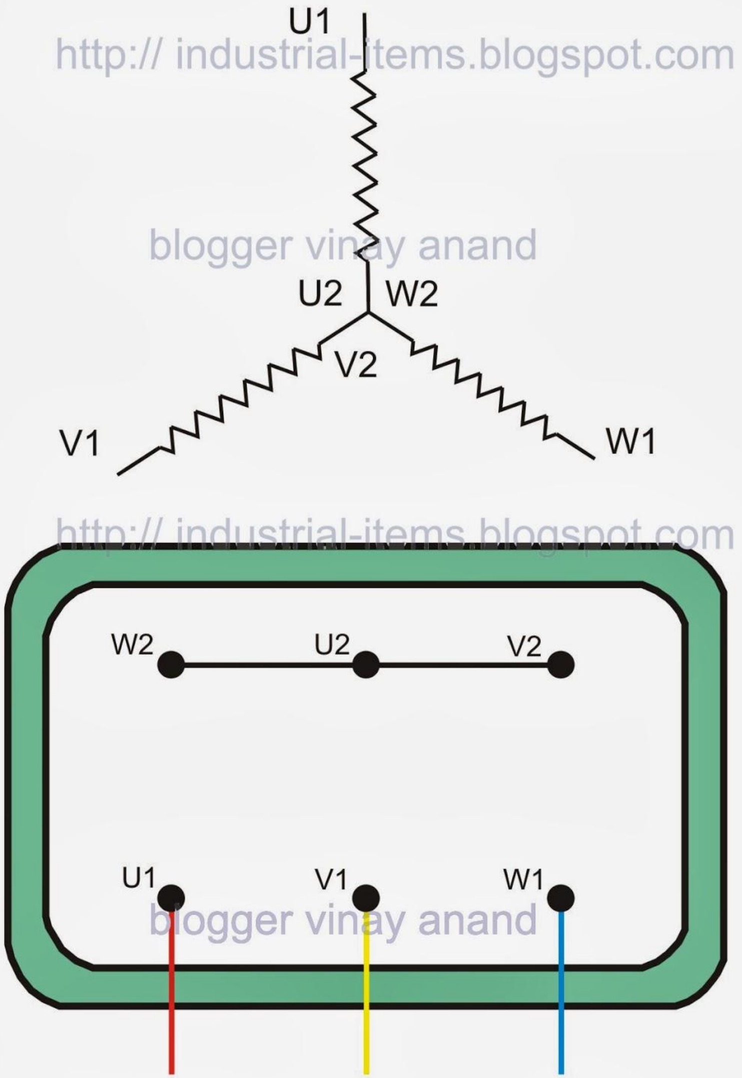
The contactors are smaller than the single contactor used in a Direct on Line starter as they are controlling winding currents only.
The currents through the winding are 1/root 3 (58%) of the current in the line when in delta.

Star - Delta

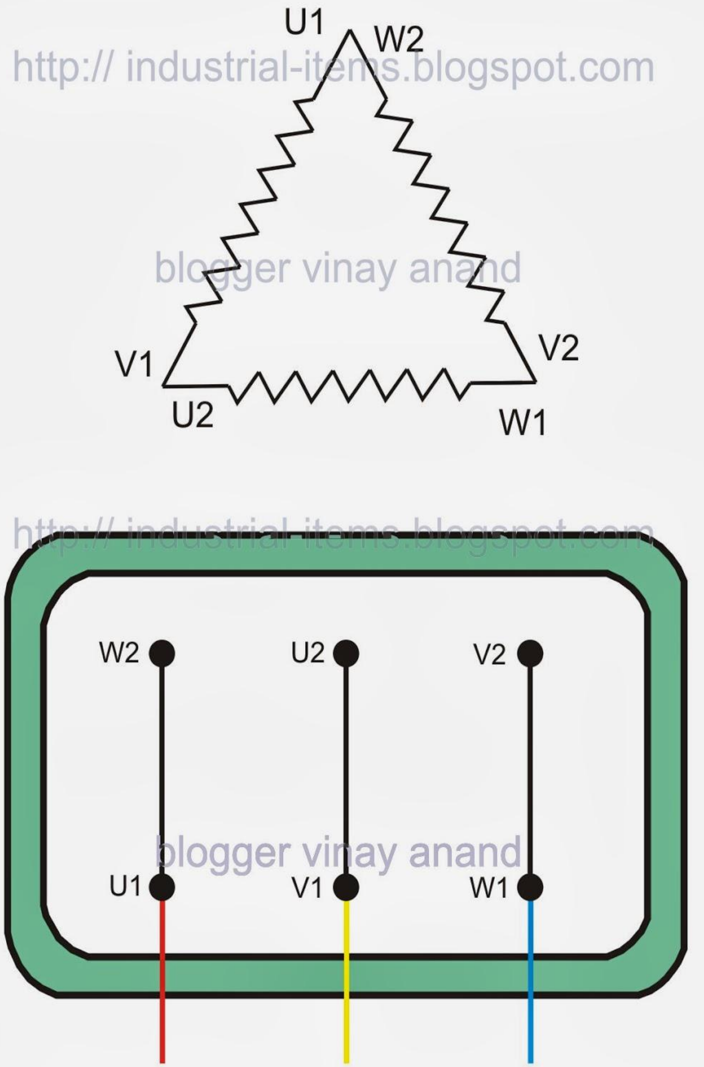


Torque & i/p Power=1/3 of Run Condition
10A
10A
230 V
400 V
Star Connection
30A
400 V
17.3A
Delta Connection

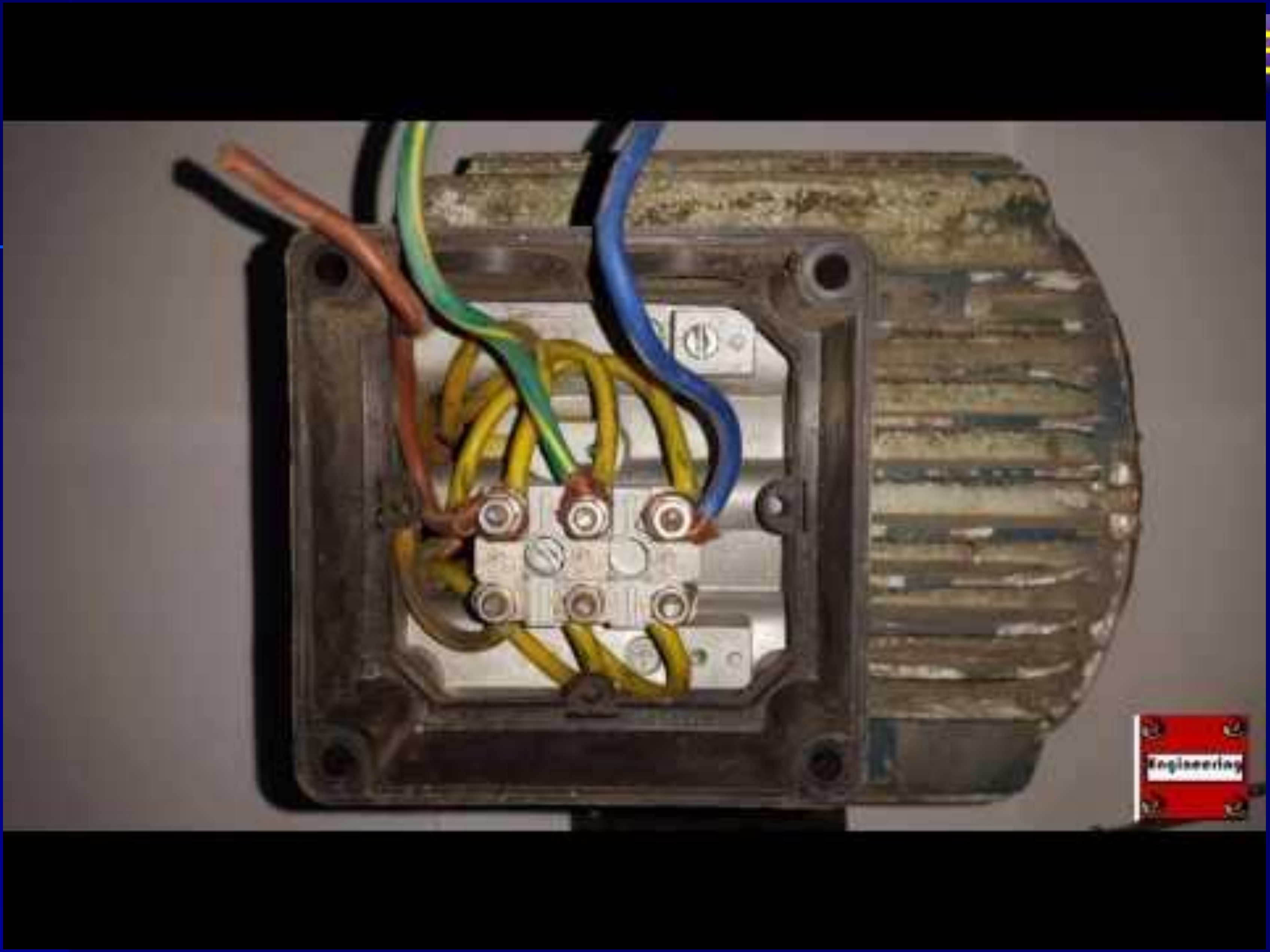

EXAMPLE
22KW MOTOR 100% LOAD, 415V ,42A, .80PF, 30HP
R
U1
U2,V2,W2
W1
V1
Y
B
100% TORQUE
W2
U1
W1
U2
V2
V1
Y
B
STAR CONNECTION TO DELTA CONNECTION
R
Y
B
U1
V1
W1
W2
U2
V2
MOTOR TERMINAL BOX STAR CONNECTION
R
Y
B
U1
V1
W1
W2
U2
V2
MOTOR TERIMANAL BOX DELTA CONNECTION



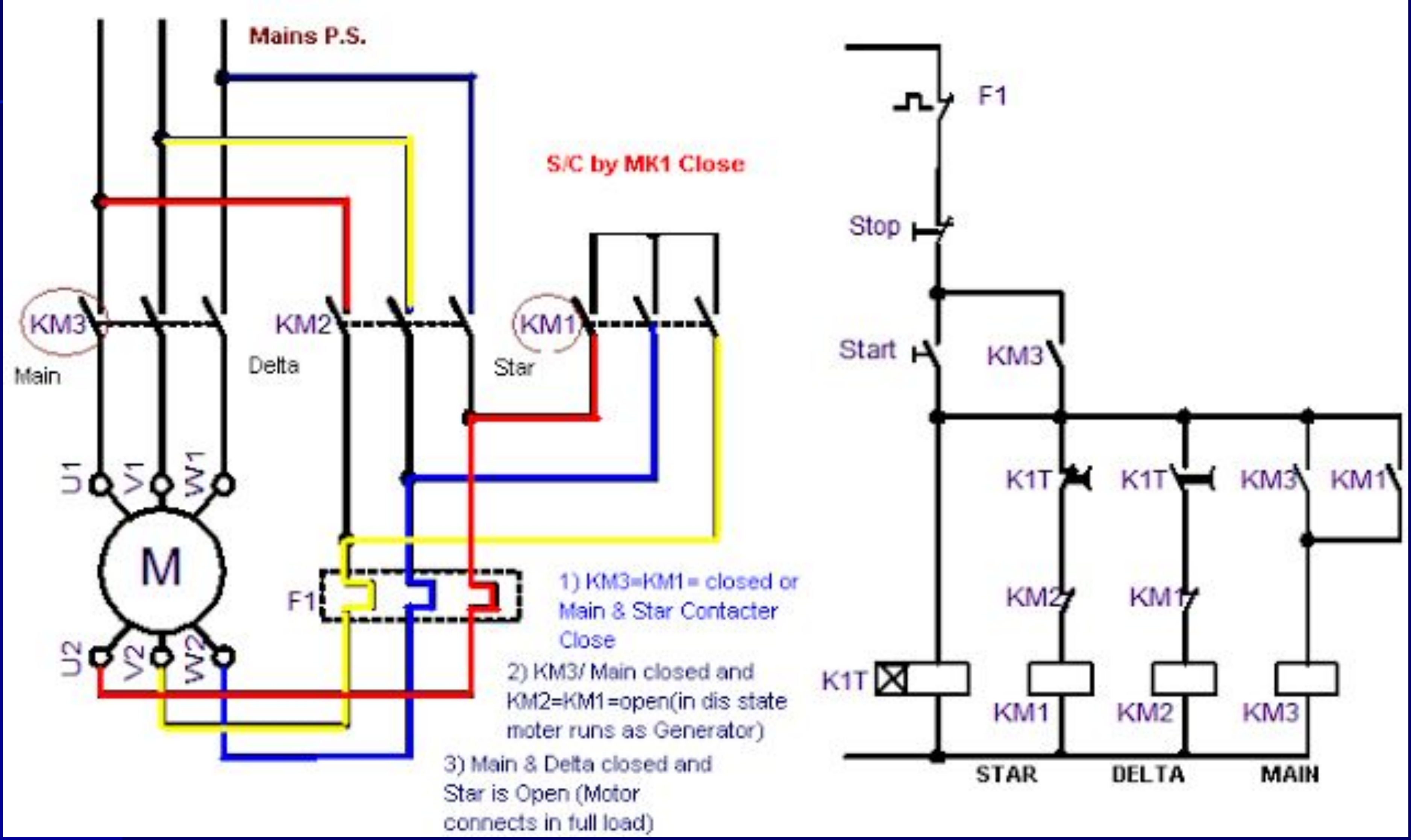
Star Connection of motor windings



Delta Connection of Motor Windings


Engineering

Star / Delta



Mains P.S.
S/C by MK1 Close
KM3
Main
KM2
Delta
KM1
Star
U1
V1
W1
M
U2
V2
W2
F1
1) KM3=KM1= closed or Main & Star Contacter Close
2) KM3/ Main closed and KM2=KM1=open(in dis state moter runs as Generator)
3) Main & Delta closed and Star is Open (Motor connects in full load)
F1
Stop
Start
KM3
K1T
K1T
KM3
KM1
KM2
KM1
K1T
KM1
KM2
KM3
STAR
DELTA
MAIN