Implementation of single phasing protection with Star Delta Starter

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***Abstract*- Most of the induction motor are started directly online, but when large rated motors are started that causes disturbance of voltage on the supply lines due to large starting current. To limit the starting current large induction motors are started at reduced voltage and then have full supply voltage reconnected when they run upto near rated speed. Most of the time three phase supply is suffer with the problem of single phasing in such a condition if induction motor is continuously running during single phasing fault in such a condition motor get heated and chances of burning of winding .For the protection of motor in such a condition we have implemented single phasing protection with automatic star delta starter. Automatic star delta starter provides one by square root three reduced starting current in starting condition. After that starter contacts are changes from star to delta induction motor reaches when 80% of it's rated speed. In running condition if any one of the phase failure in three phase supply then motor will be protected from the damage and stop the motor safely.**

***Index Terms*— Motor, Contactor, Single Phase Protection, Timer, Main Contactor,Star contactor,Delta contactor**

I. INTRODUCTION

A three phase induction motor continuous to run even if one of the supply line is disconnected. The whole power is then supplied through the two windings and they are likely to get overheatetd. The single phasing causes unbalanced stator currents. The negative sequence component of unbalance current causes heating of rotor and temperature rise. If motor is stalled due to losses of one phase, severe damage to rotor is possible while starting.Therefore,a separate single phasing protection is desirable. Single phasing is extreme unbalance condition for a three phase motor. Such a condition can be caused by blowing of fuse in the supply circuit or due to improper contact in a switch or a contactor.During single phasing ,the current in healthy phases increases by root three times.This increases the heating in motor windings.The unbalanced stator currents have a negative sequence component.This component causes magnetic flux rotating in opposite direction to the main flux.Their by double frequecncy currents are induced in rotor body and rotor conductors .Rotor heating caused by these currents is very high.This heating is not detected by thermal relay protecting the stator winding.Hence single phasing causes major damage to motor rotor,it cannot give instantaneous protection against single phasing.In some application like elevator motors, where it is dangerous to eliminate plugging and reversing ,the motor should be disconnected instantaneously when single phasing occurs. . Star/Delta starters are probably the most common reduced voltage starters in the 50Hz industrial motor world. Star delta is used in an attempt to reduce the start current applied to the motor then after sometime full load current is applied to the motor. Since in star connection current is same in different phases while line voltage is the root three times the phase voltage. So the voltage is reduced (results to reduce current) if motor is started as star. And also in delta connection the voltage is same as that of phase voltage so full voltage is applied if we run the motor as delta connection. This is the reduced voltage starting method. Voltage reduction during star-delta starting is achieved by physically reconfiguring the motor windings as illustrated in the figure below. During starting the motor windings are connected in star configuration and this reduces the voltage across each winding 3. This also reduces the torque by a factor of three. After a period of time the winding are reconfigured as delta and the motor runs normally.

II. METHODS OF STARTING INDUCTION MOTOR ARE.DESCRIBED BELOW

Adding external resistance to the rotor of a squirrel cage motor is not possible. Starting in-rush current in squirrel cage motors is controlled by applying reduced voltage to the stator. For this purpose, following methods are used:

1. By using primary resistors or reactors
2. Autotransformer
3. Star-delta switches

III. CONSTRUCTION AND HARDWARE EQUIPEMENTS OF AUTOMATIC STAR DELTA STARTER

Three contactors(Main, Star,Delta)(415Volt,16Amp),Auxillary relay(500 Volt),Timer(6-12sec),stop push button, start push button,3ph induction motor

a.) Wiring Diagram:

The main circuit breaker serves as the main power supply switch that supplies electricity to the power circuit.The main contactor connects the reference source voltage R, Y, B to the primary terminal of the motor U1, V1, W1.In operation, the Main Contactor (KM3) and the Star Contactor (KM1) are closed initially, and then after a period of time, the star contactor is opened, and then the delta contactor (KM2) is closed. The control of the contactors is by the timer (K1T) built into the starter. The Star and Delta are electrically interlocked and preferably mechanically interlocked as well. The star contactor serves to initially short the secondary terminal of the motor U2, V2, W2 for the start sequence during the initial run of the motor from standstill. This provides one third of DOL current to the motor, thus reducing the high inrush current inherent with large capacity motors at start up. Controlling the interchanging star connection and delta connection of an AC induction motor is achieved by means of a star delta or wye delta control circuit

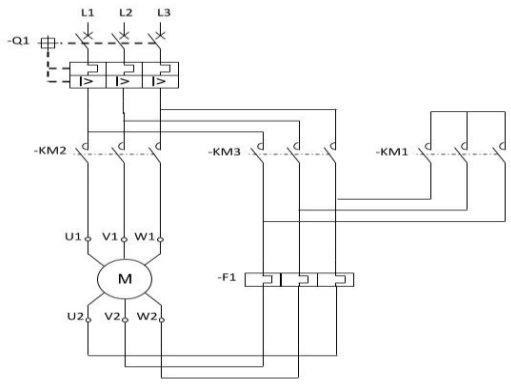


Fig. 1.1 Power Circuit Diagram of Star-Delta Starter

b.) Control circuit

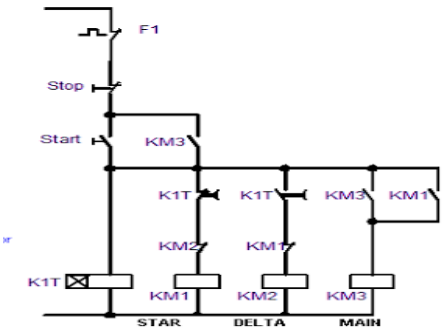


Fig. 2.1 Control Circuit Diagram of Star-Delta Starter

3.1 ON push button starts the circuit by initially energizing Star Contactor Coil (KM1) of star circuit and Timer Coil (KT) circuit.

3.2 When Star Contactor Coil (KM1) energized, Star Main and Auxiliary contactor change its position from NO to NC.

When Star Auxiliary Contactor (1)(which is placed on Main Contactor coil circuit)became NO to NC it's complete The Circuit of Main contactor Coil (KM3) so Main Contactor Coil energized and Main Contactor's Main and Auxiliary Contactor Change its Position from NO To NC. This sequence happens in a friction of time.

After pushing the ON push button switch, the auxiliary contact of the main contactor coil (2) which is connected in parallel across the ON push button will become NO to NC, thereby providing a latch to hold the main contactor coil activated which eventually maintains the control circuit active even after releasing the ON push button switch. When Star Main Contactor (KM1) close its connect Motor connects on STAR and it's connected in STAR until Time Delay Auxiliary contact KT (3) become NC to NO. Once the time delay is reached its specified Time, the timer's auxiliary contacts (KT)(3) in Star Coil circuit will change its position from NC to NO and at the Same Time Auxiliary contactor (KT) in Delta Coil Circuit(4) change its Position from NO To NC so Delta coil energized and Delta Main Contactor becomes NO To NC.

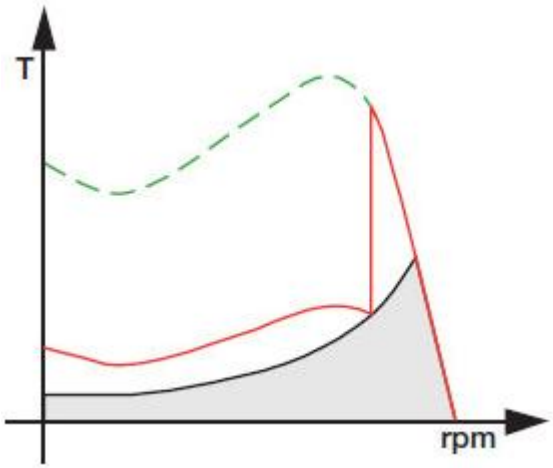
Now Motor terminal connection change from star to delta connection. A normally close auxiliary contact The from both star and delta contactors (5&6)are also placed opposite of both star and delta contactor coils, these interlock contacts serves as safety switches to prevent simultaneous activation of both star and delta contactor coils, so that one cannot be activated without the other deactivated first. Thus, the delta contactor coil cannot be active when the star contactor coil is active, and similarly, the star contactor coil cannot also be active while the delta contactor coil is active. The control circuit as shown

in fig.3 above also provides two interrupting contacts to shut down the motor. The OFF push button switch break the control circuit and the motor when necessary. The thermal overload contact is a protective device which automatically opens the STOP Control circuit in case when motor overload current is detected by the thermal overload relay, this is to prevent burning of the motor in case of excessive load beyond the rated capacity of the motor is detected by the thermal overload relay. At some point during starting it is necessary to change from a star connected winding to a delta connected winding. Power and control circuits can be arranged to this in one of two ways – open transition or closed transition.

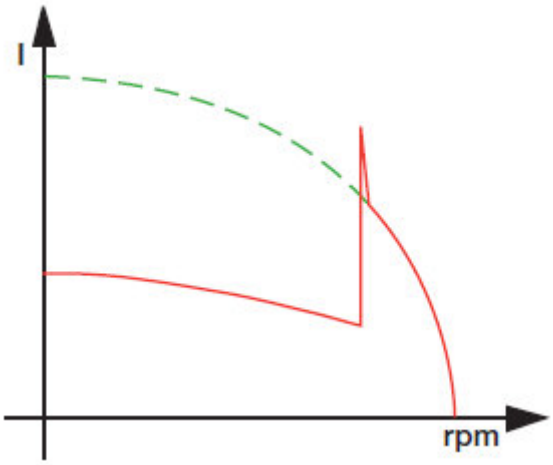
DIFFERENCE BETWEEN DOL AND STAR DELTA STARTER

SR.NO	DOL STARTER	STAR DELTA STARTER
1.	It is used upto 5HP IM	It is used between 5HP to 20HP IM
2.	Less expensive	Moderate at cost
3.	The motor is directly feed from the line.	The motor is started initially from star and later during running from delta.
4.	It takes 6 times its rated current to start the IM.	It starting current reduces to 1/3.

TORQUE SPEED CHARACTERISTICS



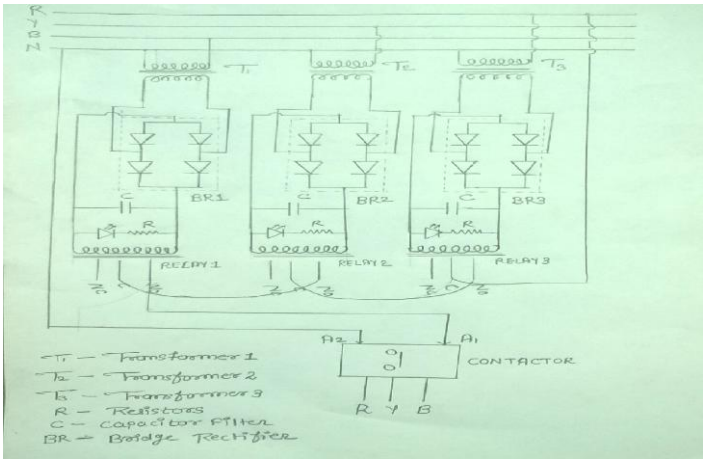
3.1 CURRENT SPEED CHARACTERSTICS



4.1 HARDWARE EQUIPEMENTS OF SINGLE PHASING PROTECTION

Transformers, bridge rectifier, Capacitor, LED, Resistor, Relays, Contactor

IV. WORKING OF SINGLE PHASING PROTECTION



5.1 WIRING DIAGRAM OF SINGLE PHASING PROTECTION

A three phase induction motor continuous to run even if one of the supply line is disconnected. The whole power is then supplied through the two windings and they are likely to get overheated. The single phasing causes unbalanced stator currents. The negative sequence component of unbalance current causes heating of rotor and temperature rise.

Such a condition can be caused by blowing of fuse in the supply circuit or due to improper contact in a switch or contactor. During single phasing, the current in healthy phases increases by root three times. This increases the heating in motor windings. This heating is not detected by thermal relay protecting the stator winding. Hence single phasing

causes major damage to motor rotor, it cannot give instantaneous protection against single phasing.

For this protection three single phase transformer are used which are connected in each phase with neutral. After that bridge rectifier is used for converting ac into pure dc with the help of filters. After that for indication each of presence of each phase we use three LEDs in series with resistor .The three relays is used for the checking the continuity of supply. And then the main relay is connected to the terminals of the starter.

V. SINGLE PHASING PROTECTION SCHEME

Supply is given to the three single phase transformer which step down the voltage at 12v (a.c.) than by using bridge rectifier this 12v a.c is converted into pulsating d.c .This pulsating d.c voltage is filtered by connecting filter circuit. Now three LEDs glow at the same time if the 3ph are present. Contacts of three relay are connected in series which is normally in closed position and common point for this three relays are connected to the main relay contacts.

If any one of the phase is disconnected from the supply than the transformer is connected to that particular phase is disconnected from the supply. And the LEDs connected to with respective phase is off. Therefore all series connection of three relays are disconnected. And it will break the main relay and the circuit is off. After this the main relay is connected to the automatic star delta starter

In some application like elevator motors, where it is dangerous to eliminate plugging and reversing, the motor should be disconnected instantaneously when single phasing occurs.

RATINGS OF EQUIPEMENTS

SR.NO	EQUIPEMENTS	QUANTITY	RATINGS
1.	TRANSFORMER	03	230/12V
2.	RECTIFIER	03	12V DC
3.	CAPACITOR	03	1000 uF
4.	LED	03	1.5V,100ohm
5.	CONTACTOR	01	230V,10A
6.	RELAY	03	230V

MOTOR STARTING CHARACTERISTICS OF STAR DELTA STARTER

1. Available starting current: 33% Full Load Current.
2. Peak starting current: 1.3 to 2.6 Full Load Current.
3. Peak starting torque: 33% Full Load Torque.

ADVANTAGES AUTOMATIC SATR-DELTA STARTER

1. It is widely used due to their relatively low price.
2. There are no limit to the no of times they can be operated.
3. The component required very little space .
4. Starting current is reduced to approximately 1/3.
5. The operation of the star-delta method is simple and rugged
6. It is relatively cheap compared to other reduced voltage methods.
7. Good Torque/Current Performance.

VI. DISADVANTAGES AUTOMATIC SATR-DELTA STARTER

1. The starter can only be applied to motors where the six leads or terminal can be accessed.
2. The supply voltage must be the same as the rated motor voltage for delta connection.
3. Because the starting current is reduced to approximately one-third of the rated current, the starting torque is also reduced to one-third.
4. Break in Supply.
5. It required 2 set of cables from starter to motor.

VII. CONCLUSION

We have designed the entire circuit of single phasing protection with automatic star delta starter .If one of the phase goes off single phasing circuit comes into action and the circuits gets disconnected from the main supply and protect the motor from damage. Automatic star delta starter changes the contacts from star to delta with specific time setting in the timer according to the rated current and motor rating. It is also provide with auxiliary relay for over loading protection.

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