3 Phase Motor by using 3 Phase Star Delta Starter Voltage Reducing Method with Inverter

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Abstract

Normal loaded current is not able to start a motor, at starting time every motor need 1.8 to 2 time greater current from normal loaded current, that's why needs some for providing that amount current. There are two methods are use for starting a motor, auto transformer starting and star delta starting. This paper presents the most popular three phase motor starting process, 3 phase star delta starter voltage reducing method as well as it also presents that, by using AC to AC inverter how can get the proper output voltage, current, torque and frequency. Also will know the way of inverter how to able protect the circuit from over load and how the way can get accurate output 3 phase star delta starter motor control board with using inverter.

Keywords - *Methodology, Star Delta Method, Inverter, Block Diagram, Algorithm*

I. INTRODUCTION

In general, most of the induction motors are started directly on line, but when very large motors are started directly on line, on that time they face problem of voltage on the supply lines due to large starting current ripple [1, 2]. To limit the starting current ripple, where need to reduce the voltage and increase the current for large induction motors [3, 4]. When motor are rotate full load speeds, then we reconnects the supply voltage [5]. There are two methods used for reduction of starting voltage [6]. Here we have to use star delta starting method for reducing the voltage and also use an inverter for proper output frequency, voltage, current and starting torque [7, 8].

II. METHODOLOGY

Star delta starter method reduced the voltage. For reduced the voltage it's needed:

- 3 magnetic contactor for starting star delta starter motor
- Timer gives selecting time for star delta connection
- MCCB or MCB for protecting the circuit from over current flow
- Inverter for proper output frequency, voltage, current and starting torque

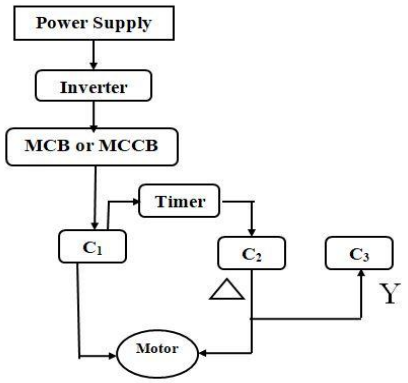

Fig 1: Methodology of star delta starter

III.THEORY OF STAR DELTA STARTER METHOD OF STARTING OF INDUCTION MOTOR

The star delta starter is very useful as well as simple type of starter, it used widely as compared to the different types of starting methods of the induction motor. Normally a star delta is used for a frame motor designed to run on the delta connected stator winding [9-11]. When the switch is in the star position, the stator windings are connected in the star as shown in Fig 2:

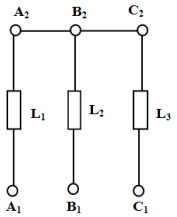

Fig 2: Star connected stator windings

When the motor reached near the full load speed, about 80% of its rated speed, that time switch is immediately put into the run position. As a result, a stator winding changed connection into delta. When

the stator winding connected the delta as shown below:

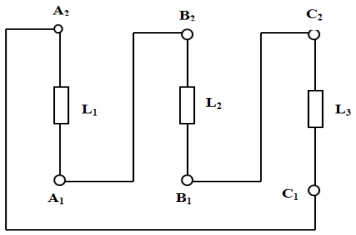

Fig 3: Delta connected stator windings

Starting time, the stator winding is connected in star and then in delta. So, the starting line current of the motor is reduced to one-third as compared to the starting current with the windings connected in delta. At the starting of an induction motor when the windings of the stator are star connected, each stator phase gets a voltage $V_L/\sqrt{3}$. Here, V_L is the line voltage, since the developed torque is proportional to the square of the voltage applied to an induction motor. Star delta starter reduced the starting torque to one-third that is obtained by direct delta starting [12].

At the starting of the induction motor, if stator windings are connected in star that time voltage across each phase winding is equal to $1/\sqrt{3}$ times the line voltage.

Let,

- V_L = line voltage
- I_{styp} = starting current per phase with the stator windings connected in star
- I_{styl} = starting line current with the stator winding in star

During star connection, line current and phase current are equal.

Therefore,

$$I_{styl} = I_{styp}$$

If,

- V_1 = phase voltage
- V_L = line voltage
- $I_{st\Delta p}$ = starting current per phase by direct switching with the stator windings connected in delta
- $I_{st\Delta l}$ = starting line current by direct switching with the stator windings in delta
- $I_{sc\Delta p}$ = short circuit phase current by direct switching with the stator windings in delta
- Z_{e10} = standstill equivalent impedance per phase of the motor, referred to stator

$$I_{styp} = \frac{V_1}{Z_{e10}} = \frac{V_L}{\sqrt{3}Z_{e10}}$$

$$I_{sy\Delta p} = \frac{V_1}{Z_{e10}}$$

For delta connection, line current is equal to the root three times of the phase current.

Therefore,

$$I_{st\Delta l} = \sqrt{3} I_{st\Delta p} = \frac{\sqrt{3}V_L}{Z_{e10}}$$

So,

$$\frac{\textit{Starting line current with star delta stating}}{\textit{Starting line current with direct switching in delta}} = \frac{I_{styp}}{I_{st\Delta l}} = \frac{\frac{V_L}{\sqrt{3}Z_{e10}}}{\sqrt{3}\,\frac{V_L}{Z_{e10}}} = \frac{1}{3} - - - (1)$$

Thus, with star delta starter, the starting current from the main supply is one-third of that with direct switching in the delta.

Also,

$$\frac{\textit{Starting line current with star delta stating}}{\textit{Starting line current with direct switching in delta}} = \frac{\left(\frac{V_L}{\sqrt{3}}\right)^2}{V_L^2} = \frac{1}{3} - - - (2)$$

Hence, with star delta starting, the starting torque is reduced to one-third of the starting torque obtained with the direct switching in the delta.

IV. REASON OF USING INVERTER

A power inverter is an electronic device or circuitry that changes direct current (DC) to alternating current (AC). 3 phase star delta starter motor control board and 3 phase inverters are used for variable frequency drive applications and for high power applications.

- Inverter provides proper frequency, voltage, current and starting torque
- Inverter also able to detect fault
- The input voltage, output voltage and frequency, and overall power handling depend on the design of the specific device or circuitry
- Inverters convert low frequency main AC power to higher frequency for use in induction heating

V. BLOCK DIAGRAM

The block diagram of 3 phase star delta starter motor control board with using inverter is shown in below:

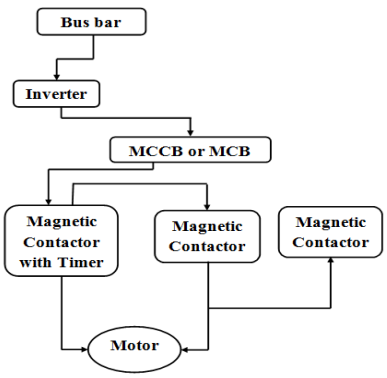

Fig 4: Block diagram of star delta starter

To limit the starting current surge, large induction motors are started at reduced voltage.

There are two methods used for reduction of starting voltage are: star delta starting, auto transformer starting. In here we use star delta starting method. The operation of the star delta method is simple and rugged. It draws two times starting current of the full load ampere of the motor connected. It is relatively cheap compared to other voltage reduction methods, also has necessary torque and current as well as the performance are better than others. In 3 phase star delta starting motor without using inverter, we are not able to get accurate frequency, voltage, current and starting torque. In this case, inverter works as a filter.

VI. WORKING PRINCIPLE

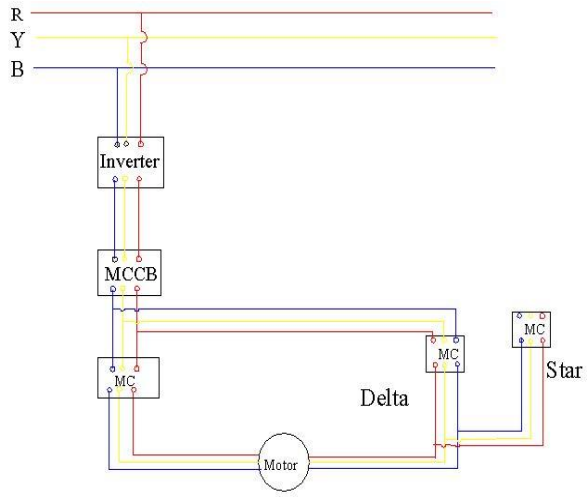

Fig 5: Schematic diagram of 3 phase star delta starting motor control board with inverter

In 3 phase star delta starting motor control board, current enter the inverter from bus bar, then current enter the MCCB then the magnetic contactor (MC), where three magnetic contactors are connected by star delta connection. Contactor coil C_3 and Timer coil (I_1) is energized at once and the motor winding then connected in star. When C_3 is energized, its auxiliary open links will be closed and vice versa (i.e. close links would be open). Thus C_1 contactor is also energized and three phase supply will reach to the motor. Since winding is connected in star, hence each phase will get $\sqrt{3}$ times less than the line voltage i.e. 230V. Hence motor starts safely. The close contact of C_3 in the delta line opens because of which there would be no chance of activation of contactor 2 (C_2). After leaving the push button, Timer coil and coil 3 will receive a supply through timer contact (I_a), holding contact 3 and the close contact 2 of C_2. When contactor 1 (C_1) is energized, then the two open contacts in the line of $_{C1}$ and C_2 will be closed. For the specific time (generally 5-10 seconds) in which the motor will be connected in star, after that the timer contact (I_a) will be open (change by rotating the timer knob to adjust the time again) and as a result. Contactor 3 (C_3) will be off, because of which the open link of C_3 will be close (which is in the line of C_2) thus C_2 will also energize. Similarly, when C_3 is off, then star connection of winding will also open. And C_2 will be closed. Therefore, the motor winding will be connected in delta. In addition, Contact 2 (which is in the line C_3) will open, by which, there would not be any chance of activation of coil 3 (C_3) Since the motor is connected in delta now, therefore, each phase of the motor will receive full line voltage (400V) and the motor will start to run in full motion.

VII. ALGORITHM

- Inverter takes the power supply from Bus bar
- Then inverter provides the proper frequency, voltage and current
- MCCB or MCB takes power from inverter. MCCB or MCB has fixed rating
- Magnetic contactor 1, connected with Timer. Here we use 3 magnetic contactors
- Magnetic contactor takes the power supply from MCCB or MCB. In that case, MCCB or MCB are use the protection of motor from over load
- Starting time magnetic contactor 1 and 3 are connected by star connection
- In case of full load speed motor connected by delta connection, that time magnetic contactor 1 and 2 are connected by delta connection. Timer changes the connection.

VIII. ALGORITHM

In case of this system, if we use inverter that time we can get the proper frequency, voltage, and current as well as it will be more efficiency and also able to detect fault. Using inverter with star delta starting motor control board, it will be more safety for this motor.

XI. CONCLUSIONS

The 3 phase star delta motor control board use for start very large motors by reducing the voltage and we will also use an inverter for proper output frequency, voltage, current and starting torque. It also gives protection of motor from over load current. Inverter provides more accurate value. So 3 phase star delta motor control board is very important for us.

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