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SYNCHRONOUS MOTOR RUN IN FORWARD AND REVERSE DIRECTION

Sham Langave[1], Pooja Lambar[2], Rucha Kharat[3], Harshal Mundye[4], Gopal Rane[5],

Prof. H. A. Pawar[6]

[1, 2,3,4,5] Students, Dept. of Electrical Engineering, Yashwantrao Bhonsale Institute of Technology, Sawantwadi, India
[6]Lecturer, Dept. of Electrical Engineering, Yashwantrao Bhonsale Institute of Technology, Sawantwadi, India

Abstract- *In this project, synchronous motors can operate in both forward and backward directions. A motor that runs on a three-phase AC supply and has a rotor turning at the same speed as the stator winding's rotating magnetic field is known as a three-phase synchronous motor. The direction of the spinning magnetic field generated by the stator winding dictates the direction of rotation of the motor. The direction of the magnetic field generated by the stator winding likewise reverses with the direction of the field current. This has an impact on the magnetic field's rotational direction and, in turn, the motor's rotational direction. The key to operating three-phase synchronous motors in both forward and reverse directions is to adjust the phase sequence of the three-phase AC power source. The rotor's motion is guided by the direction of the rotating magnetic field, which is determined by this sequence.*

***Key Words*: synchronous motor, stator winding, phase sequence, manipulation, rotating magnetic field.**

1. INTRODUCTION

Three-phase synchronous motors, valued for their accurate control and dependable performance, are vital parts of many industrial applications. One important characteristic that enables flexible operation in machinery and systems is their capacity to operate in both forward and reverse directions. This introduction will cover the fundamental ideas that drive 3-phase synchronous motors and explain how to change the rotational direction to produce both forward and backward motion. The amazing ability of synchronous motors to spin at a speed that precisely matches the frequency of the alternating current (AC) power source gives them their name. The interaction of the magnetic fields in the rotor and stator causes this synchronization.

The three phases of the power supply often designated A, B, and C are connected to windings that make up the stator, the fixed portion of the motor. When these windings are powered by three-phase AC electricity, a revolving magnetic field is produced. Forward rotation is started using a particular phase sequence. A magnetic field that rotates in the same direction as the stator is created by connecting the phases in a specific order, such as A-B-C. The motor's rotor, which has magnetic poles oriented to face

this magnetic field, is situated inside the motor. As a result, the motor rotates ahead as the rotor synchronizes its speed with the rotating magnetic field.

A synchronous motor is employed in this project. All we have to do is adjust the input's phase sequence, and the synchronous motor will rotate both forward and backward. The synchronous motor is one of the panel's most crucial components. Synchronous motors, which are valued for their exact control and dependable performance, are crucial parts of many industrial applications and run in both directions. For this purpose, the synchronous motor is appropriate. Any two of the three motor supply lines can be switched to reverse the direction of rotation of a three-phase motor. Let's say the three-phase voltage delivered to the stator winding has the following phase sequence: X Y Z. It is noted that the field's rotational direction is reversed if this sequence is altered to X Z Y. Such that, instead of rotating clockwise, the field rotates counterclockwise the magnetic field's rotational speed and number of poles, however, do not vary.

Therefore, to alter the magnetic field's rotational direction, one need just modify the phase sequence. This can be accomplished with a three-phase supply by switching any two of the three lines. A three-phase motor rotates in a clockwise manner when it is coupled to a three-phase supply that has the phase sequence R Y B. The induction motor will rotate in the opposite direction of its original rotation that is, counterclockwise if the phase sequence is altered to R B Y.

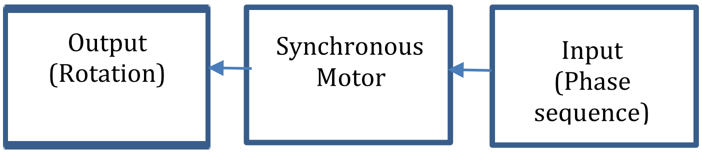

Fig-1.1 Block Diagram

METHODOLOGY

The project is 3 phase synchronous motor run in forward and reverse direction. In this we just need to manipulate phase sequence of input and it will make the rotation of synchronous motor in forward and reverse direction. The main important aspects of this of this panel is synchronous motor. The synchronous motor run in both direction which are essential components in various industrial applications, prized for their precise control and reliable performance. The synchronous motor is suitable for this project.

Synchronous Motor

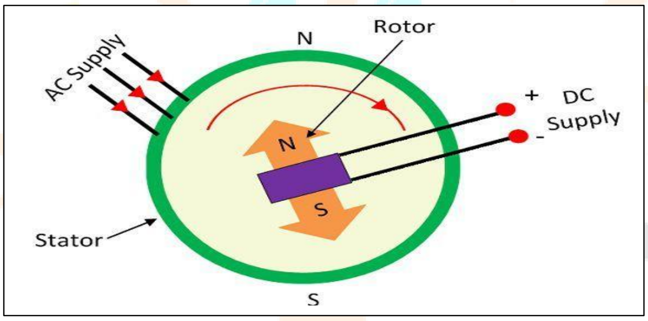

Fig-2.1 Synchronous Motor

An AC electric motor classified as synchronous means that, in a steady state, the shaft's rotation is precisely equal to an integer number of AC cycles, and it is synced with the supply current's frequency. Electromagnets, which serve as the motor's stator in synchronous machines, produce a magnetic field that rotates in step with the current oscillations. The second synchronized revolving magnet field is produced by the rotor with permanent magnets or electromagnets, which rotate in step with the stator field at the same rate. If a synchronous motor has independently stimulated multiphase AC electromagnets on both the stator and rotor, it is referred to be doubly fed.
The two most popular types of AC motors are synchronous and induction motors. Because synchronous motors generate the rotor's magnetic field without the aid of induction, their rotational speed is locked to the line frequency. Slip is necessary for induction motors to work; to generate current in the rotor, the rotor must rotate at a frequency that is somewhat slower than the AC alternations. Timing applications for small synchronous motors include synchronous clocks, appliance timers, tape recorders, and precision servomechanisms. These applications require the motor to run at a precise speed, and the accuracy of the motor depends on the power line frequency, which is precisely regulated in large, networked grid systems. There are self-excited, fractional to industrial synchronous motors available. Most synchronous motors operate in the fractional horsepower range. In the fractional horsepower range, most synchronous motors are used to provide precise constant speed. These machines are commonly used in analog electric clocks, timers and related devices.

Construction-

The two primary components of a synchronous motor are the rotor and the stator. The motor's armature winding is carried by the stator, which becomes immobile. The primary winding in the motor that causes the EMF is the armature winding. Carrying the field windings is the rotator. The rotor is subjected to the primary field flux.

The salient pole rotor and the non-salient pole rotor are the two designs for the rotor. The salient pole rotor is used by the synchronous motor. The rotor's poles that are oriented toward the armature windings are referred to as salient. Steel laminations are used to construct the synchronous motor's rotor. The transformer's winding experiences less eddy current loss thanks to the laminations. The salient pole rotor is mostly used for designing the medium and low-speed motor. For obtaining the high-speed cylindrical rotor is used in the motor.

Working-

The two primary components of a synchronous motor are the stator and rotor. The machine's rotor is its revolving component, and the stator is its stationary component. The motor's stator receives a three-phase AC supply. Both the rotor and the stator get distinct excitation. The technique of creating a magnetic field on a motor's components by using an electric current is known as excitation.

Between the stator and rotor gap, a spinning magnetic field created when the stator received a three-phase supply. The rotating magnetic field is defined as the field with moving polarity. The polyphase system is the only one in which a rotating magnetic field forms. On the stator, the north and south poles form as a result of the spinning magnetic field. The DC supply generates the rotor's energy. The rotor's north and south poles are induced by the DC supply. The rotor's induced flux stays constant as long as the DC supply doesn't change. The flux has a fixed polarity as a result. On one end of the rotor, the North Pole forms, and on the other, the South Pole does.

There is a sinusoidal AC. Every half cycle, the wave's polarity changes; that is, it stays positive during the first half cycle and turns negative during the second. The north and south poles of the stator are developed by the wave's positive and negative half cycles, respectively. On the stator, the north and south poles form as a result of the spinning magnetic field. The DC supply generates the rotor's energy. The rotor's north and south poles are induced by the DC supply. The rotor's induced flux stays constant as long as the DC supply doesn't change. The flux has a fixed polarity as a result.

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The primary mover is cut off from the motor when the rotor reaches its synchronous speed. Additionally, the rotor receives a DC supply, which causes the north and south poles to form at their ends. The rotor and stator's north and south poles are interlocked. As a result, the rotor begins to rotate at the magnetic field's speed. The motor operates at a synchronous speed as well. The only way to alter the motor's speed is to alter the supply's frequency. A synchronous motor cannot start itself.

2. Material used

Synchronous motor

The two main components of a synchronous motor are the rotor and stator, which are the rotating and stationary parts of the machine, respectively. The rotor and stator are excited independently of each other using an electric current to induce a magnetic field on the motor's parts. The synchronous motor's stator receives a three-phase AC supply, which causes a rotating magnetic field to develop between the rotor and stator gap.

Fig. 3.1 synchronous motor

Ammeter

An ammeter's operating principle is primarily dependent on both resistance and inductive reactance. Because there needs to be minimal voltage loss across it, this gadget has incredibly low impedance. Due to the constant current flow in a series circuit, it is connected in series. This device's primary purpose is to measure current flow using a series of coils. These coils exhibit inductive reactance and extremely low resistance. The term ammeter refers to a tool or apparatus used to measure current. Ampere is the unit of measure for current. Therefore, this gadget, also known as an ammeter or ampere meter, measures the current flow in ampere.

Fig. 3.2 Ammeter

Voltmeter

In simple electric circuits, a voltmeter is a tool used to measure the voltage or electrical potential difference between two points. A pointer on an analog voltmeter is moved proportionately to the circuit voltage on a scale. Voltmeters are used with voltages ranging from a fraction of a volt to several thousand volts, and they can have an accuracy of a few percent of full scale. Direct current (DC) and alternating current (AC) measurements of voltage are the two most prevalent types.

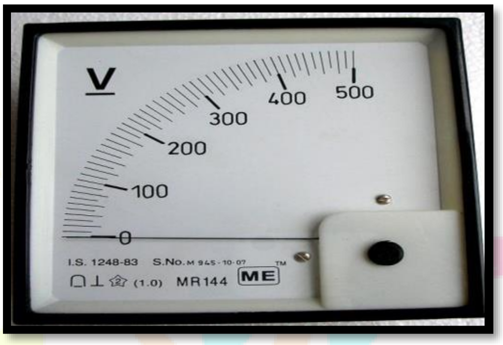

Fig. 3.3 Voltmeter

Two winding transformer

Transformers are used to alter the levels of AC voltage; they are referred to as step-up or step-down transformers, depending on whether the voltage is being increased or decreased. Transformers can also be used to couple stages of signal processing circuits and to provide galvanic isolation between circuits. Transformers are now necessary for the distribution, use, and transmission of alternating current electricity.

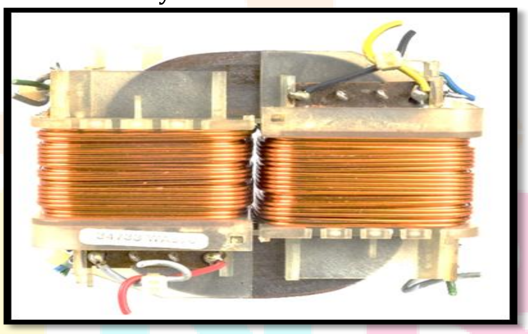

Fig. 3.4 Two winding transformer

Fuse

An electrical circuit's overcurrent protection is provided by a fuse, an electrical safety device. Its fundamental part is a metal strip or wire that melts when an excessive amount of electricity passes through it, halting or stopping the current. It is a sacrificial device; depending on the kind, a fuse that has operated indicates an open circuit and needs to be changed or rewired.

Fig. 3.5 Fuse

Miniature Circuit Breakers

After serving their intended purpose, all fuses should be swapped out for miniature circuit breakers, or MCBs, for increased safety and control. An MCB functions as an automated switch that opens when there is an excessive amount of electricity flowing through the circuit, unlike a fuse. Without requiring a manual replacement, the circuit can be closed once it has returned to normal. In the majority of circuits, MCBs are typically employed as fuse switch substitutes. These days, a large range of MCBs are employed as dependable forms of protection in residential, commercial, and industrial applications, with breaking capacities ranging from 10KA to 16KA.

Fig. 3.6 MCB

Connecting wires

Conductors called electrical wires carry electricity from a source, typically a nearby transformer, to an outlet in your house or place of business. In appliances and other electrical gadgets, they conduct electricity as well. To accommodate the diverse electrical loads and operating environments, electrical wires are available in a range of diameters, compositions, and casings.

Fig. 3.7 Connecting wires

3. HARDWARE IMLEMENTATION

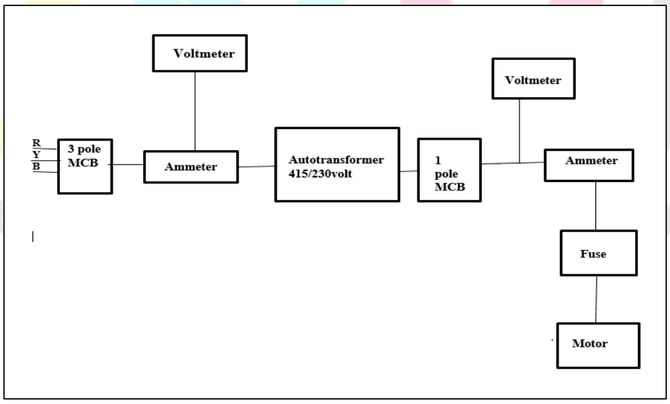

Fig.3.1 Block Diagram

Three-pole MCBs are fed the three phase supply in order to protect the panel from short circuits and excessive current. The three phase supply reading measure by using ammeter and voltmeter. The voltmeter is connected in parallel and ammeter is connected in series with electrical supply to measure voltage and current value respectively. According to motor specification we require 240 volt supply. Hence transformer step down 440 V into 240V for synchronous motor. The 240 volt from transformer is fed to motor through fuse. The ammeter and voltmeter is used to measure motor current and voltage respectively. The fuse is uses for protection of motor in case any hazard. The change over switch rotate motor in forward and reverse direction by manipulating the phase sequence of supply.

4. WIRING DIAGRAM

For this wiring of diagram, we use 2.5 sq. mm for panel wiring. The wiring of synchronous motor run in forward & reverse direction panel is simple and less complicating. We make it as simple as possible and its appearance is also good. For laying of wire, we use cleat wiring. It hold the wiring and also looks good. First connect the three pole MCB using 5 sq.mm wires. Then the ammeter and voltmeter connected to three phase supply side. An ammeter connected in series and

voltmeter connected in parallel with supply. To step down supply voltage from 440 into 240 volt we use transformer. The output of transformer is connected to motor through 6A fuse. The change over switch is placed to drive the motor in forward & reverse direction.

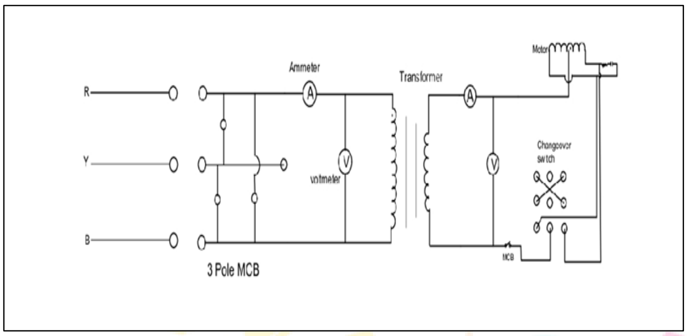

Fig.4.1 Wiring Diagram

5. HARDWARE IMPLEMENTATION

Fig. no. 4 Hardware Implementation

6. RESULT OF IMPLEMENTATION

Table No. 1

Sr. No.	Points (phase sequence)	Results (rotation)
1.	R-Y-B	Forward
2.	R-B-Y	Reverse
3.	Y-B-R	Reverse

7. CONCLUSIONS

In the project, a 3-phase synchronous motor was successfully operated in both forward and reverse directions. The direction of rotation of the motor was efficiently regulated by varying the phase sequence of the applied voltage. This experiment showed how versatile 3-phase synchronous motors are for a range of industrial applications where exact motor direction control is crucial. The project highlights how crucial it is to comprehend phase sequences and electrical connections in order to effectively operate motors. It also offers insightful information about the practical application of synchronous motors in many engineering contexts. A three-phase synchronous motor can be tested for synchronization with the power source by running it both forward and backward. This adaptability highlights the motor's dependability and flexibility and is beneficial for applications needing bidirectional rotation.

8. FUTURE SCOPE

Future enhancements or extensions, as connecting the IOT to the motor control system to enable remote control and monitoring. Create a remote control and use a web interface or mobile app to monitor the motor's operation from a distance. Future uses for three-phase synchronous motors operating in both forward and backward directions include electric cars, robots, and industrial automation. Accurate speed and direction control is made possible by sophisticated electronics and improved control algorithms, which lend these motors versatility. Their dependability and efficiency also support their continuous use in developing technologies.

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