

# Single Phase Induction Motor

Akash kumar (16193), Akshay dutt (16195), Gautam saini (16211)

Department of ECE Dronacharya College of Engineering Khentawas, Farrukh Nagar-123506

Gurgaon, Haryana

Email- [gautamsaini1996@gmail.com](mailto:gautamsaini1996@gmail.com)

## ABSTRACT

*The increasing importance of fuel saving has been responsible for the revival of interest in so-called alternative source of energy. Thus, the drive towards the decentralization of power generation and increasing use of non-conventional energy sources such as wind energy, bio-gas, solar and hydro potential, etc. has become essential to adopt a low cost generating system, which is capable of operating in the remote areas, and in conjunction with the variety of prime movers. With the renewed interest in wind turbines and micro-hydro-generators as an alternative energy source, the induction generators are being considered as an alternative choice to the well-developed synchronous generators because of their lower unit cost, inherent ruggedness, operational and maintenance simplicity. The induction generator's ability to generate power at varying speed facilitates its application in various modes such as self-excited stand-alone (isolated) mode; in parallel with synchronous generator to supplement the local load, and in grid-connected mode. The research has been underway for the last three decades to investigate the various issues related to the use of induction generator as potential alternative to the synchronous generator to utilize the small hydro and wind energy to accomplish the future energy requirement, and to feed the power to remote locations and far flung areas, where extension of grid is economically not feasible. This paper, therefore, reviews the progress made in*

*induction generator particularly, the self-excited induction generator (SEIG) research and development since its inception. Attempts are made to highlight the current and future issues involved in the development of induction generator technology for its large-scale future applications.*

## KEYWORDS

Induction generator; Renewable energy source; Voltage and frequency regulator; Self-excited induction generator; Mini-hydro and wind energy

## INTRODUCTION

For lightning and general purposes in homes, offices, shops, small factories single phase system is widely used as compared to three phase system as the single phase system is more economical and the power requirement in most of the houses, shops, offices are small, which can be easily met by single phase system. The single phase motors are simple in construction, cheap in cost, reliable and easy to repair and maintain. Due to all these advantages the single phase motor finds its application in vacuum cleaner, fans, washing machine, centrifugal pump, blowers, washing machine, small toys etc.

The single phase ac motors are further classified as:

1. Single phase induction motors or asynchronous motors.
2. Single phase synchronous motors.
3. Commutator motors.

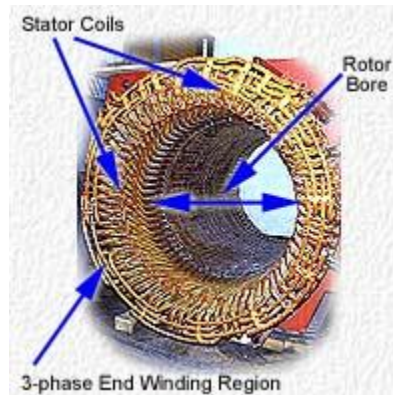
Single Phase Induction Motor Akash kumar (16193), Akshay dutt (16195), Gautam saini (16211)

This article will provide fundamentals, description and working principle of single phase induction motor.

## CONSTRUCTION OF SINGLE PHASE INDUCTION MOTOR

like any other electrical motor asynchronous motor also have two main parts namely rotor and stator.

2. .
- 3.



2. **Rotor:** The rotor is a rotating part of induction motor. The rotor is connected to the mechanical load through the shaft. The rotor in single phase induction motor is of squirrel cage rotor type.

## STATOR OF SINGLE PHASE INDUCTION MOTOR

the stator of the single phase induction motor has laminated stamping to reduce eddy current losses on its periphery. The slots are provided on its stamping to carry stator or main winding. In order to reduce the hysteresis losses, stamping are made up of silicon steel. When the stator winding is given a single phase ac supply, the magnetic field is produced and the motor rotates at a speed slightly less than the synchronous speed  $N_s$  which is given by

1. **Stator:** As its name indicates stator is a stationary part of induction motor. A single phase ac supply is given to the stator of single phase induction motor



The construction of single phase induction motor is almost similar to the squirrel cage three phase motor except that in case of asynchronous motor the stator have two windings instead of one as compare to the single stator winding in three phase induction motor.

$$N_s = (120.f)/P$$

The construction of the stator of asynchronous motor is similar to that of three phase induction motor except there are two dissimilarity in the winding part of the single phase induction motor.

Firstly the single phase induction motors are mostly provided with concentric coils. As the number of turns per coil can be easily adjusted with

the help of concentric coils, the mmf distribution is almost sinusoidal.

Except for shaded pole motor, the asynchronous motor has two stator windings namely the main winding and the auxiliary winding. These two windings are placed in space quadrature with respect to each other.

## ROTOR OF SINGLE PHASE INDUCTION MOTOR

the construction of the rotor of the single phase induction motor is similar to the squirrel cage three phase induction motor. The rotor is cylindrical in shape and has slots all over its periphery. The slots are not made parallel to each other but are bit skewed as the skewing prevents magnetic locking of stator and rotor teeth and makes the working of induction motor more smooth and quieter. The squirrel cage rotor consists of aluminum, brass or copper bars. These aluminum or copper bars are called rotor conductors and are placed in the slots on the periphery of the rotor. The rotor conductors are permanently shorted by the copper or aluminum rings called the end rings. In order to provide mechanical strength these rotor conductor are braced to the end ring and hence form a complete closed circuit resembling like a cage and hence got its name as "squirrel cage induction motor". As the bars are permanently shorted by end rings, the rotor electrical resistance is very small and it is not possible to add external resistance as the bars are permanently shorted. The absence of slip ring and brushes make the construction of single phase induction motor very simple and robust.

## WORKING PRINCIPLE

NOTE: We know that for the working of any electrical motor whether its ac or dc motor, we require two fluxes as, the interact of these two

fluxes produced the required torque, which is desired parameter for any motor to rotate.

When single phase ac supply is given to the stator winding of single phase induction motor, the alternating current starts flowing through the stator or main winding. This alternating current produces an alternating flux called main flux. This main flux also links with the rotor conductors and hence cut the rotor conductors. According to the Faraday's law of electromagnetic induction, emf gets induced in the rotor. As the rotor circuit is closed one so, the current starts flowing in the rotor. This current is called the rotor current. This rotor current produces its own flux called rotor flux. Since this flux is produced due to induction principle so, the motor working on this principle got its name as induction motor. Now there are two fluxes one is main flux and another is called rotor flux. These two fluxes produce the desired torque which is required by the motor to rotate.

## WHY SINGLE PHASE MOTOR IS NOT SELF STARTING?

According to double field revolving theory, any alternating quantity can be resolved into two components, each component have magnitude equal to the half of the maximum magnitude of the alternating quantity and both these component rotates in opposite direction to each other. For example – a flux,  $\phi$  can be resolved into two components

$$\frac{\phi_m}{2} \text{ and } -\frac{\phi_m}{2}$$

Each of these components rotates in opposite direction i. e if one  $\phi_m / 2$  is rotating in clockwise

direction then the other  $\phi_m / 2$  rotates in anticlockwise direction.

When a single phase ac supply is given to the stator winding of single phase induction motor, it produces its flux of magnitude,  $\phi_m$ . According to the double field revolving theory, this alternating flux,  $\phi_m$  is divided into two components of magnitude  $\phi_m / 2$ . Each of these components will rotate in opposite direction, with the synchronous speed,  $N_s$ . Let us call these two components of flux as forward component of flux,  $\phi_f$  and backward component of flux,  $\phi_b$ . The resultant of these two component of flux at any instant of time, gives the value of instantaneous stator flux at that particular instant.

$$\text{i.e. } \phi_r = \frac{\phi_m}{2} + \frac{\phi_m}{2} \text{ or } \phi_r = \phi_f + \phi_b$$

Now at starting, both the forward and backward components of flux are exactly opposite to each other. Also both of these components of flux are equal in magnitude. So, they cancel each other and hence the net torque experienced by the rotor at starting is zero. So, the single phase induction motors are not self-starting motors.

## METHODS FOR MAKING SINGLE PHASE INDUCTION MOTOR SELF STARTING

From the above topic we can easily conclude that the single phase induction motors are not self-starting because the produced stator flux is alternating in nature and at the starting the two components of this flux cancel each other and hence there is no net torque. The solution to this problem is that if the stator flux is made rotating type, rather than alternating type, which rotates in one particular direction only. Then the induction

motor will become self-starting. Now for producing this rotating magnetic field we require two alternating flux, having some phase difference angle between them. When these two fluxes interact with each other they will produce a resultant flux. This resultant flux is rotating in nature and rotates in space in one particular direction only. Once the motor starts running, the additional flux can be removed. The motor will continue to run under the influence of the main flux only. Depending upon the methods for making asynchronous motor as Self Starting Motor, there are mainly four types of single phase induction motor namely:

1. Split phase induction motor.
2. Capacitor start inductor motor.
3. Capacitor start capacitor runs induction Moto.
4. Shaded pole induction motor.

## COMPARISON BETWEEN THREE PHASE AND SINGLE PHASE MOTORS

1. Single phase induction motors are simple in construction, reliable and economical for small power rating as compared to three phase induction motors.
2. The electrical power factor of single phase induction motors is low as compared to three phase induction motors.
3. For same size, the single phase induction motors develop about 50% of the output as that of three phase induction motors.
4. The starting torque is also low for asynchronous motors.
5. The efficiency of single phase induction motors is less as compare it to the three phase induction motors.

## REFERENCES

1. Babbage, C.; Herschel, J. F. W. (Jan 1825). "Account of the Repetition of M. Argo's Experiments on the Magnetism Manifested by Various Substances during the Act of Rotation". *Philosophical Transactions of the Royal Society* 115 (0): 467–496. doi:10.1098/rstl.1825.0023. Retrieved 2 December 2012.
2. Thompson, Silvanus Phillips (1895). *Polyphase Electric Currents and Alternate-Current Motors* (1st Ed.). London: E. & F.N. Spon. p. 261. Retrieved 2 December 2012.
3. Baily, Walter (June 28, 1879). "A Mode of producing Argo's Rotation". *Philosophical magazine: A journal of theoretical, experimental and applied physics* (Taylor & Francis).
4. A b Vučković, Valadon (November 2006). "Interpretation of a Discovery". *The Serbian Journal of Electrical Engineers* 3 (2). Retrieved 10 February 2013.
5. Ferraris, G. (1888). "Atti Della Reale Academia delle Science di Torino". *Atti Della R. Academia delle Science di Torino*. XXIII: 360–375.
6. Alger, P.L.; Arnold, R.E. (1976). "The History of Induction Motors in America". *Proceedings of the IEEE* 64 (9): 1380–1383. doi:10.1109/PROC.1976.10329.
7. Froehlich, Fritz E. Editor-in-Chief; Allen Kent Co-Editor (1992). *The Froehlich/Kent Encyclopedia of Telecommunications: Volume 17 - Television Technology to Wire Antennas* (First ed.). New York: Marcel Dekker, Inc. p. 36. ISBN 0-8247-2902-1. Retrieved 2 December 2012.
8. *The Electrical Engineer* (21 Sep 1888). . . . a new application of the alternating current in the production of rotary motion was made known almost simultaneously by two experimenters,

Nikola Tesla and Galileo Ferraris, and the subject has attracted general attention from the fact that no commutator or connection of any kind with the armature was required. . . . Volume II. London: Charles & Co. p. 239.

9. Ferraris, Galileo (1885). "Electromagnetic Rotation with an Alternating Current". *Electrician* 36: 360–375.

10. Tesla, Nikola; AIEE Trans. (1888). "A New System for Alternating Current Motors and Transformers". *AIEE* 5: 308–324. Retrieved 17 December 2012.

Single Phase Induction Motor Akash kumar (16193), Akshay dutt (16195), Gautam saini (16211)