IF : 3.62 | IC Value 70.36

Volume-5, Issue-10, October - 2016 • ISSN No 2277 - 8160

Original Research Paper | Engineering

Design Development & Implementation of Prototype Six Phase Induction Motor

Satish Chand Modi M.Tech (Power System) Ph.D. Pursuing Sunrise University

Dr. Rajeev K. Chaturvedi B.E.,M.E.,Ph.D. Director Nagaji Institute of Technology & Management - Gwalior (M.P.)

ABSTRACT *From many types of electrical motors, induction motor is more popular since last decades due to its advantages like robustness, low cost and low maintenance. In this latest era multiphase induction motor is more popular now a day in multiphase induction motor no of phase is more than 3. This type of motor is used in automobile application aeronautical applications also. I have tried to elaborate design procedure of 6 phase induction motor which I have designed during my doctorate time. I have also faced many problems during this implementation.*

KEYWORDS : Magnetic Induction, Robustness, Efficiency

INTRODUCTION

From many induction motor drives being analysed, and after this analysis we found advantage for the dual-3-phase induction motor is having 2 stator winding sets shifted by thirty electrical degrees with separated neutral is: The dual-3-phase solution can Result high torque as compared to ordinary three phase motor. This advantage makes them convenient in high power and/or high current applications, like ship propulsion, automobile applications, and aerospace applications.

Total Output Torque of six Phases induction motor is more than three faze Induction Motor. Emil Levi [1] gives a view of the new developments in the era of six phase induction motor control. In this Research paper Vector control and direct torque control (DTC) are two methods described and utilization of the additional degrees of freedom that gives in six phase machines.

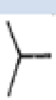
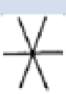
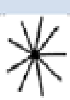
ACTUAL DESIGN OF PROTOTYPE SIX PHASE INDUCTION MOTOR

To start with, an n-phase symmetrical induction motor, in spatial displacement between any two consecutive stators fazes equals $\alpha = 2\pi/n$, is given. Stator winding is treated as n–phase and it is assumed that the windings are sinusoidal, so that all higher spatial harmonics of the magneto-motive force can be neglected. The phase number n can be either odd or even.

When the number of phases is six, i.e. n= 6, there are 2, 3 phase windings. The, 2, 3 phase windings are displaced by 600 in symmetrical design motor but there is a problem of magnetic circulating currents.

So asymmetrical design is developed in which 2, 3 phase windings are displaced by 300, which eliminates (6m + 1) order harmonics, where m = 1, 3, 5………. [1].

Phase belt into two portions each spanning 300.The winding distribution factor increases from 0.9650 for three phases to 1.0 for 6 phases for split phase belt connection. A true 6 phase that retains the same winding pitch and distribution factor is shown in the table1 below.

Phase angle	120	60	60	40	30
No of phase per pole	1.5	3	3	4.5	6
No of stator terminals	3	3	6	9	6
Connection name	3 phase	Semi 6 phase	6 phase	9 phase	6 phase
Schematic					

The 6-phase motor uses the same magnetic frame with the baseline motor. So initially the stator dimensions, stator size, rotor size kept same as 3 phase, 3 HP induction motor. And the same stator is rewound for making 6 phases.

Stator design depends upon number of stator slots. The emfs induced in coil sides placed in neighbouring slots are thus phase shifted by an angle, αes, expressible in electrical radians as follows:

$\alpha_{es} = \pi p / S_s$ [1]

General expression for number of stator slots is given by,

$S_s = n/2.p\,[2+K]$ Slots [2]
Where, Ss = No. of Stator Slots
n = No. of machine phases
p = No. of machine poles
K = 0,1,2…..
For Symmetrical ac winding: K = 0,2,4…..
For Asymmetrical ac winding: K = 1,3,5….
In our case no. of poles = 4, so putting the values of m, p, K in equation [2] we get,
$S_s = (6/2).4[2+1] = 36$ [3]

Problems faced in development of motor

Motor developed with these parameters (used same dimensions as per three phase motor) have very compact winding.

Initially two three phase sets of developed motor are tested alternatively one by one from three phase supply and following points are noted:

1. Overheating is experienced even under no load condition.
2. Overheating has also lead to failure of insulation.

With these specifications, when one of the three phase sets was fed with three phase AC supply, the motor started vibrating.

Also because of high input voltage i.e. 415 V to one of the three phase sets say ABC, after sometime motor started burning.

Also there was a problem of Body earth because of complicated winding and proper insulation not done at the time of actual winding.

Solution to the Problem:-

To overcome above said problems following steps are taken:

Overheating is caused due to I^2R losses. If the heat dissipating area can be increased and at the same time number of conductors and conductor size changed, it will affect the current. Thus the frame size of the motor is increased as per the calculations shown in next section. Also number of conductors is increased as per the slot. And conductor size is changed from 24 SWG to 22 SWG.

To avoid insulation failure due to overheating, the insulation class is changed from class B (130^0) to class F (155^0).

Vibration is experienced because of high torque. To overcome vibration, frame size is increased. This increases the mechanical strength of motor and eliminates third harmonic current injection.

The motor voltage is increased gradually up to 200 Volts, to overcome burning problem.

As frame size is increased slot area is increased thus there is no compact winding.

3. 5 Actual Development of Prototype Six phase Induction motor

A stator lamination having diameter 125 mm is pressed into a cylindrical frame as per the stack length of 100 mm.

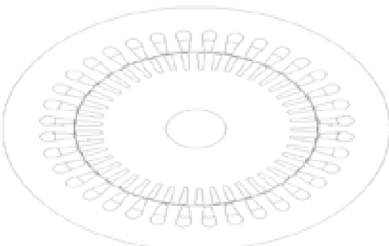


Fig 1 A stator lamination for 36 stator slots

Rotor laminations as per the dimension are also pressed for 28 rotor slots.

Then windings are formed as per the number of turns per phase shown in the figure

22 SWG Copper conductors is used for winding.

Class F insulation is used.

Photograph 2. Six phase stator after winding

REFERENCES

[1] Emil Levi, "Recent Developments in High Performance Variable-Speed Multiphase Induction Motor Drives" Sixth International Symposium Nikola Tesla, Belgrade, Serbia. 18th – 20th October, 2006.

[2] Design, Development of Six Phase Squirrel Cage Induction Motor and its Comparative Analysis with Equivalent Three Phase Squirrel Cage Induction Motor Using Circle Diagram Dr. Archana Nanoty1, Dr. A.R.Chudasama International Journal of Emerging Technology and Advanced Engineering Website: www.ijetae.com (ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 8, August 2013)