

Simulation of 3 phase Induction Motor at different loading and protection against single phasing and temperature.

Prof.H.B.Sarvaiya¹, Mr. Shubhanshu Meshram², Mr. Swapnil Rawade³, Mr. Swapnil Birdu⁴,
Mr. Shubham Bawanthade⁵, Mr. Vinay Gajbhiye⁶

¹Faculty Electrical Engineering Department & PCE, Nagpur

²⁻⁶Students B.E. 8th semester Electrical Engineering Department & PCE, Nagpur

Abstract - This paper covers the essential characteristics of induction motor i.e. Torque –speed characteristics and its complete working at different loading. In order to protect the motor against temperature and single phasing. In order to achieve this a hardware model is implemented and simulation is done through MATLAB Simulink. Further recommendation is suggested to prevent motor and to allow motor to work efficiently.

Key Words: Microcontroller, PCB design, MATLAB Simulink and 3 phase IM.

INTRODUCTION

An electrical motor is an electromechanical device that converts electrical energy into mechanical energy. In the case of three-phase AC (Alternating Current) operation, the most widely used motor is a **3 phase induction motor**, as this type of motor does not require an additional starting device. These types of motors are known as self-starting induction motors.

To get a good understanding of the working principle of a three-phase induction motor, it's essential to understand the construction of a 3 phase induction motor. A 3 phase induction motor consists of two major parts:

- A stator
- A rotor

In recent days the use of three- phase induction motor is increasing tremendously. Number of places are there in industries and outside industries where induction motors are used. Three- phase induction motor generally suffers from some disturbances we term it faults. Some out of these disturbances are under voltage, overvoltage, overheating, and single phasing problems. When the three phase Induction motor supply with higher voltage than rated then induction motor starts overheating. In our project a variable resistance is used, when supply voltage is lower than rated then it is called under voltage fault. Variable resistance is used to set a reference value with which we can compare the actual voltage value. When supply voltage is higher than reference voltage it is considered as over voltage fault.

Three phase appliances generally suffer from under voltage, overvoltage or tripping of any phase. It is of paramount importance to monitor the availability of the three-phase supply and switch with the availability of all phases of the supply with certain time delay in order to avoid surges and momentary fluctuations. Induction motors are a constant speed machines which account for 90% of the electrical drives used in Industry. Induction motors are usually constructed to work with a small value of slip, normally less than 5% at full load. Therefore the deviation of the motor speed from the synchronous speed is practically very small. However, there are

certain applications that require enormous variation of the motor speed.

1. RESEARCH METHODOLOGY

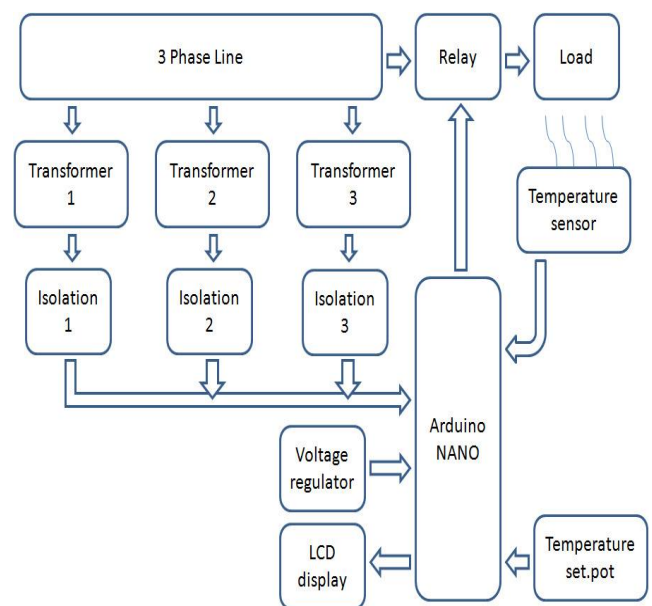


Fig. 1 Block diagram of complete model

Working: In the above block diagram the arduino Nano is man brain of system which is a Atmega 328p microcontroller is used. When three-phase available then isolation circuit will sense three-phase available voltage via step-down transformer, the Arduino will read isolation circuit data. If the data will correct the Arduino will ON relay circuit and the motor will be ON. If the motor will be heated int this condition temperature sensor sends motor temperature data to Arduino, the Arduino will check the temperature is greater than reference value the Arduino will OFF relay circuit and relay will OFF. The all status will show on 16x2 LCD Display. The user will capable for set temperature reference point via using POT. The Arduino required to operate 5V supply but our incoming supply is 12V DC supply, so we used voltage regulator to provide constant and stable voltage.

2. CONVENTIONAL TECHNIQUE OF SPEED CONTROL

Conventionally, the rotor resistance is controlled manually And in discrete steps. The torque is proportional to product of Rotor current and fundamental magnetic flux cutting rotor. The Maximum torque is independent of rotor resistance, but the value of slip at which maximum torque occurs is directly Proportional to the added rotor resistance. Increase in the rotor

Resistance does not affect the value of maximum torque but Increases the slip.

$$T = \frac{K_s E_z^2 R_2}{R_2^2 + s^2 X_2^2} \text{-----(1)}$$

Torque speed characteristics is as shown below

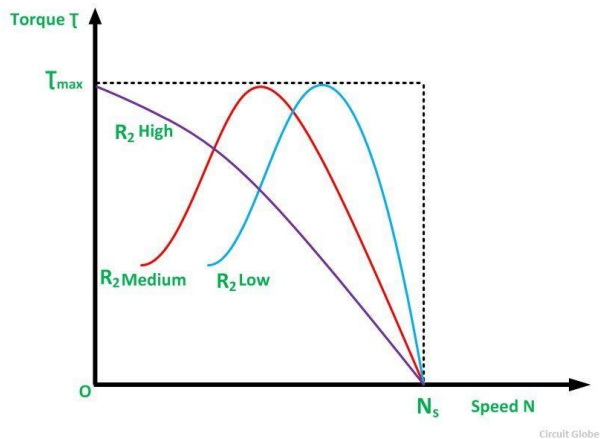


Fig.2 Torque speed characteristics

3. COMPONENT REQUIRED FOR SIMULATION

Sr. No.	Component	Quantity
1.	Asynchronous motor	1
2.	AC source	3
3.	Powergui	1
4.	Scope	4
5.	Measurement(Current and voltage)	3
6.	Sum	1
7.	Bus Selector	3
8.	Gain	1
9.	Display	3
10.	Step	4

4. MATLAB SIMULINK Model

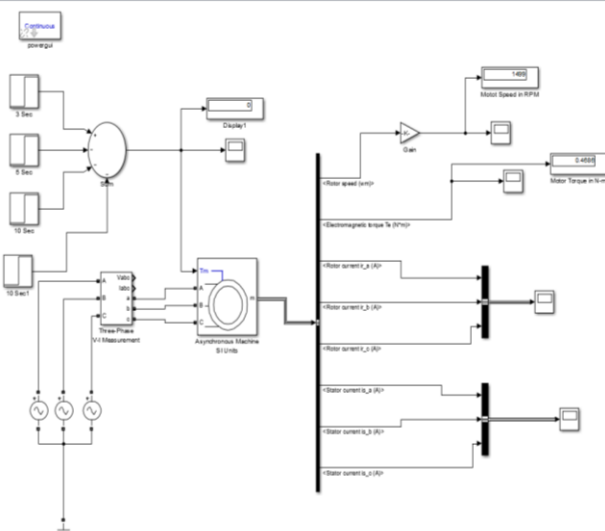


Fig.3 MATLAB Simulation Model of 3Ø IM

5. MATLAB SIMULINK Result

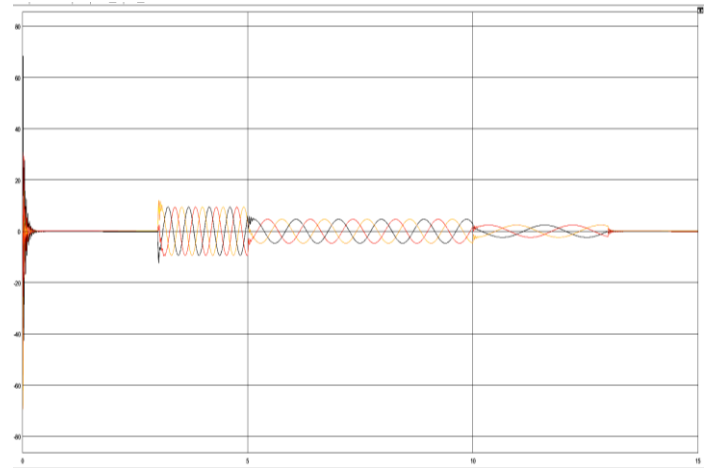


Fig.4 Rotor Current Vs Time of 3Ø IM

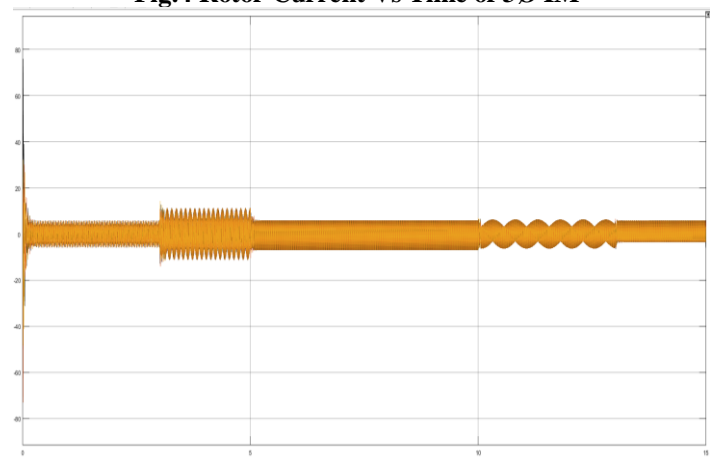


Fig.5 Stator Current Vs Time of 3Ø IM

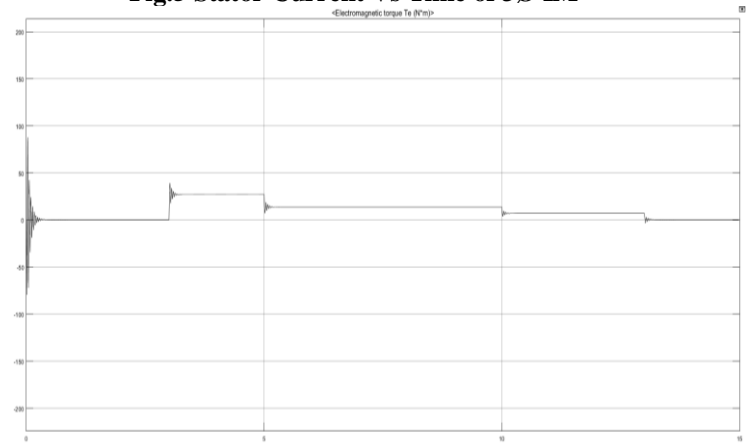


Fig.6 Speed Vs Time of 3Ø IM

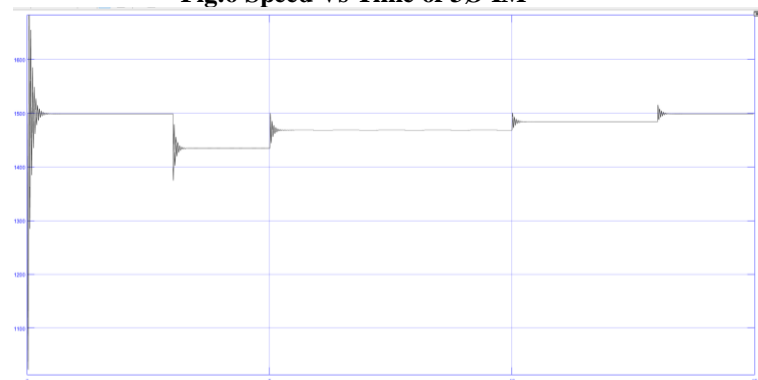


Fig.7 Speed Vs Time of 3Ø IM

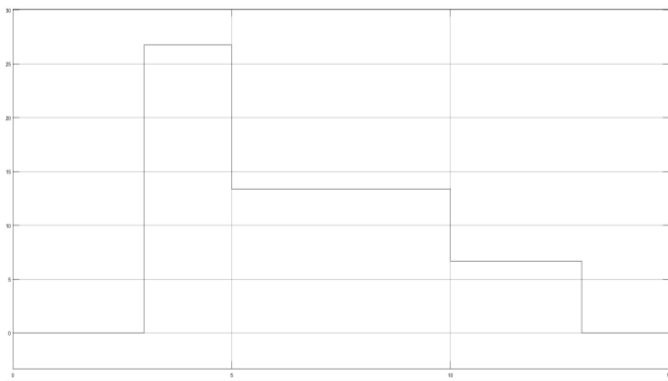


Fig.8 Load Torque Vs Time of 3Ø IM

6. List of Component for Hardware Design

1. Three Single phase 12-0/500mA Step-down transformers.

The Transformer gives outputs of 12V, 12V and 0V.

Input Voltage: 230V AC
 Output Voltage: 12V, 12V or 0V
 Output Current: 500mA
 Mounting: Vertical mount type.

2. IC 7805

Current IC Rating = 1A.
 Input Voltage range 7V-35V.
 IC 7805 is a 5V Voltage Regulator that restricts the output voltage to 5V output for various ranges of Input.
 Output Voltage range: $V_{max} = 5.2V$, $V_{min} = 4.8V$.

3. 5V/SPDT relay

This is a Single pole double throw (SPDT) type relay with 5 pins in a cube type package and rated to work at 5VDC.
 Load Current Max.: 7Amps 250V AC or 10Amps 28V DC.
 Coil Resistance: 65-75 Ohms.

4. Temperature Sensor DS1820

Power Supply Range: from 3.3V to 5V. Temperature Sensor Output Leads: yellow (VCC), red (DATA), black (GND). stainless steel waterproof probe. Soft sensor wires, which has better oxidation resistance ability. Has better thermal conductivity. Replacement for Arduino and Raspberry Pi. Specifications: Material: PCB Chip: DS18B20 Voltage: 3.3V, 5V Temperature: -50~125c Cable Length : Approx. 1m / 39.37in Stainless steel Probe Size: 50 6mm / 1.97 0.23in Item Size: 23 20mm / 0.91 0.79in Item Weight: 25g / 0.88oz Package Weight: 25g / 0.91oz Package Size: 11.5 9.5 0.5cm / 4.53 3.74 0.20in Package.

5. Microcontroller ATmega328P (Arduino NANO)

High Performance, Low Power AVR 8-Bit Microcontroller Family. Advanced RISC Architecture.
 • 131 Powerful Instructions - Most Single Clock Cycle Execution.
 • 32 x 8 General Purpose Working Registers.

- Fully Static Operation.
- Up to 20 MIPS Throughput at 20MHz.
- On-chip 2-cycle Multiplier.
- 32K bytes of in-system self-programmable flash program memory
- 1Kbytes EEPROM
- 2Kbytes internal SRAM
- Write/erase cycles: 10,000 flash/100,000 EEPROM

6. LCD Display [16x2]

An electronic device that is used to display data and the message is known as LCD 16x2. As the name suggests, it includes 16 Columns & 2 Rows so it can display 32 characters ($16 \times 2 = 32$) in total & every character will be made with 5×8 (40) Pixel Dots.

7. Optocoupler 817

The **PC817 Optocoupler** is small in size and comes in multiple packages. It can be directly connected to any low voltage dc device or microcontroller. The input voltages will have the same effect from every side on the optocoupler, it will just transfer the signal to the receiver and then the receiver will give the logic signal as output. The optocoupler has many uses due to its small and compact size as a control operation.

7. SOFTWARE

1. PROTEUS PCB DESIGN SOFTWARE

Proteus is a software used for electronic design automation; mainly used for preparing schematics and designing PCBs. It has many tools which are not only easy to use but are helpful in PCB designing and learning about PCB designing. It takes use of an integrated auto-router, and allows for the full schematic capture, configurable design rules, supports power planes, has an interactive circuit stimulator, follows industry standard CAD/CAM and ODB++ output, and allows 3D viewing. Dotted PCBs have dots available on the surface and components are inserted in these holes accordingly. The components are then attached with wires and soldered together. Designing such PCBs is complex and can have many errors. For example, connecting the pins and avoiding error in shot connections. Layout PCBs, on the other hand, are simpler to design. We design our circuit's layout using designing software, then the copper layout is prepared by etching and then solder the various components onto the board. It is simpler and has lesser chances of error, and takes lesser time to manufacture.

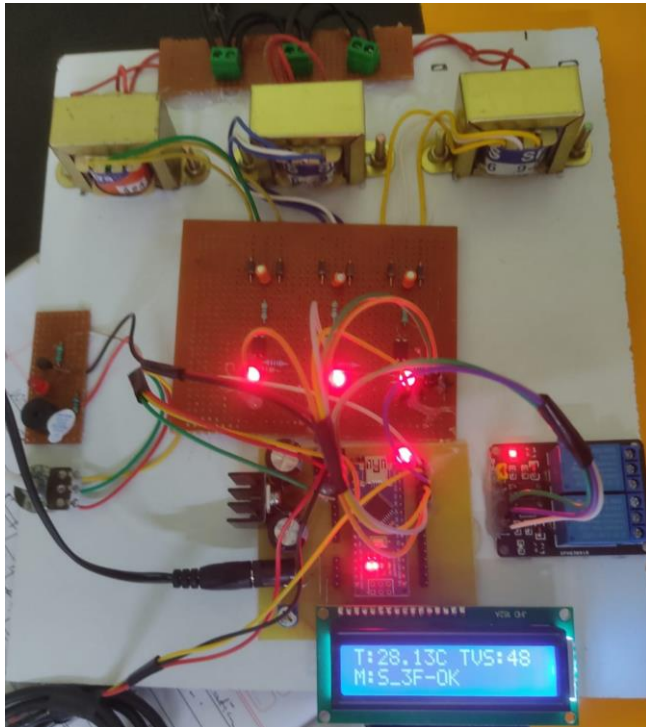
2. ARDUINO IDE

The Arduino IDE is an open-source software, which is used to write and upload code to the Arduino boards. The IDE application is suitable for different operating systems such as Windows, Mac OS X, and Linux. It supports the programming languages C and C++. Here, IDE stands for Integrated Development Environment.

The program or code written in the Arduino IDE is often called as sketching. We need to connect the Genuino and Arduino board with the IDE to upload the sketch written in the Arduino IDE software. The sketch is saved with the extension '.ino.'

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

8. Hardware model with output



Conclusion

Finally we have concluded that different speed vs torque characteristics are found by simulation and the results were seen. At different load one can observe the result and changes in different parameters. The hardware model is implemented and motor is being protected against single phasing and temperature. The hardware model is designed through both software and hardware. This is further being modified for different purpose.

References

1. Javed A. and Izhar T., "An improved method for detection of faults in induction motor." Third International Conference on Electrical Engineering, 2009, ICEE09, pp.1-6, 9-11 April 2009, Lahore.
2. C. Grantham and D. McKinnon "Rapid Parameter Determination for Induction Motor Analysis and Control", IEEE Transactions On Industry Applications, Vol.39, no.4, pp.1014-1020, August 2003.
3. Sudha M. and Anbalagan P., "A Novel Protecting Method for Induction Motor Against Fault to Voltage Unbalance and Single Phasing," 33rd Annual Conference of the IEEE Industrial

- Electronics Society, 2007, pp.1144-1148, 5-8.
4. Dinesh Pai A, L Umanand, N J Rao "Direct torque control of induction motor with extended Kalman filter", IPEMC Power Electronics and Motion Control Conference, Vol.25, no.7, 2000.
5. Ramazan Bayindir, Ibrahim Sefa, Ilhami Colak, Aslin Bektas, "Fault Detection and Protection of Induction Motors Using Sensors," IEEE Transactions on Energy Conversion, vol. 23, No. 3, September 2008.
6. Pillay P., Hofmann P. And Manyage. "Derating of induction motors operating with the combination of unbalanced voltages and over or under voltages," IEEE Transactions on Energy Conversion, Vol.17, no.4, pp.485-491, Dec.2002.
7. Nuno D. Simoes, Joao L. Goncalves, Maria L. Caeiro, Miguel J. Boavida, Fillipe D. Cardoso, "a" Arduino/GPS Tracking System for Rowing Races," a International Conference on Advances in Mobile Computing and Multimedia, Paris, France, Nov.2010.
8. S. Siddique, G.S. Yadhava, and B. Singh, "A review of stator fault monitoring techniques of induction motors," IEEE Transactions on Energy Conversion, vol. 20, No. 1, pp-106-114, March 2005.