SPEED CONTROL OF INDUCTION MOTOR USING VFD

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Abstract: Industrial applications are manly based on the controlled movements and processing of the material. In these operations huge material and processes are handled with accuracy. Many industrial applications include the use of motors for such operations. In more than 80% applications industrial motors are inductions motors. The performance of the motor has made is popular in industries**.** The motor is capable for variation in speed over the wide range and hence it is important to control the speed of motor. The change in speed with variation of torque was proposed by the researchers during ninety's but this method was not so popular later as the power consumption is depended on the torque. It is also observed that if speed of motor is reduced then the consumption of power will be less by considerable amount. Authors have presented the speed control of induction motor using variable frequency drive.

Index Terms **- VFD, PWM, Induction Motor, Speed Control, Converters.**

I. INTRODUCTION

Indian industries have grown fast in last decade. Many industrial operations and processes were automated as a part of industrial revolution and still many industries are waiting to completely replace the present methods to be updated through automation. Industrial processes needs to move the material to process it from one place to other. Some operations need movement of parts with precision from one place to other. Such operations are completed with motors. It is observed that the performance, low maintenance need and the fulfillment of torque-speed requirement have made the induction motor popular over the years. These motors have contributed the most in industrial operations than other motors. The applications are mainly in mechanical and manufacturing industries.

The induction motors being variable speed motors suitable for many applications. In early ninety's the research has been started for various methods of speed control with direct control of torque. The torque control methods are used in various drives. Later, it was suggested that the torque control methods are not suitable as power consumption can be reduced if the torque is kept constant with variation in speed of the motor. Following figure shows the basic blocks of implemented system.

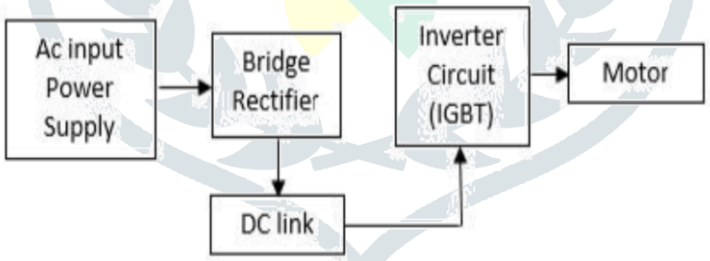


Fig. 1: VFD Control for I.M. (Basic Blocks)

Converter performs AC to DC conversion of three phase supply which is then fed to DC bus. The DC bus voltage then filtered and connected to inverter. Modulation of pulse width takes place in inverter to control voltage input of induction motor. Microcontroller controls and coordinated between converter and inverter for getting required output from the system.

The speed (synchronous) of the motor is given as below.

$$N_s = \frac{120\,F}{P}$$

From above relation, it is witnessed that, the speed varies with change in frequency as number of poles are constant once the motor is constructed.

II. OBJECTIVES AND MOTIVATION FOR WORK

The work is carried out for fulfillment of primary objectives to:

- Design speed control system for induction motor using variable frequency.
- Develop hardware to demonstrate speed control.
- Saving electricity through reduction in power consumption of motor
- Maintain the same performance after implemented to accomplish application requirement.

Developing hardware for fulfillment of industrial and agricultural applications for Indian companies and agriculture sector is main motivation behind this work. Enhancement in performance of motor leads to improvement of industrial processes.

III. CIRCUIT COMPONENTS USED

Following circuit represents the executed arrangement of VFD based control of speed. The main control circuit consists of microcontroller based PWM control of inverter output.

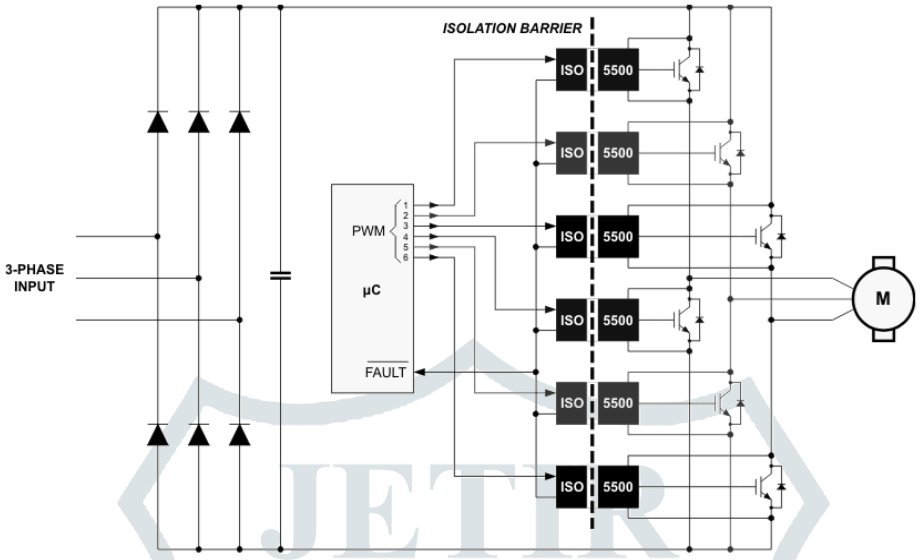
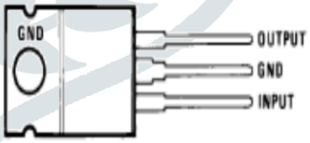
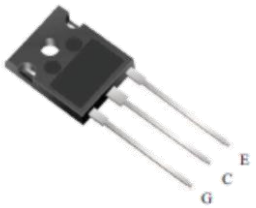


Fig. 2: Basic Circuit of VFD for I.M.

The specifications of major components used and other details are as below.

Table 1: Major Components used

Sr. No.	Component Details	Picture of Component
1	Rectifier (General Purpose) 30A, 400V,-55 to +175 ºC	
2	Voltage Regulator (Positive) 500mA, 15V	
3	ATMega 328P (Microcontroller) 5.5V, 8Bit	
4	MOSFET 600V, 25A	

IV. EXECUTED MODEL

The voltage control stages of variable frequency drive are shown below. The Arduino controls the width of output pulse for three phase inverter. The freeware helps in controlling cost of system as no software need to purchase. Driver circuit controls the gate supply of inverter power electronics components.

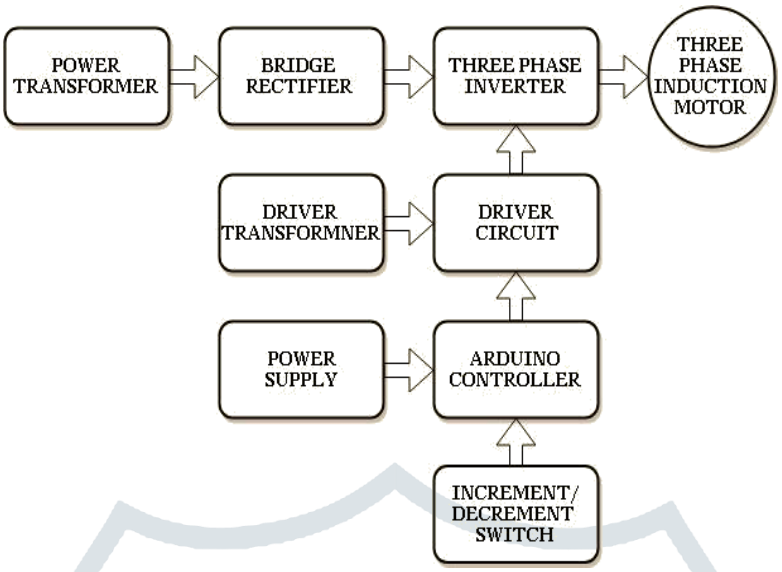


Fig. 3: Implemented model of VFD system for speed control

The developed hardware for circuit is shown below which is tested for the results represented in next section.

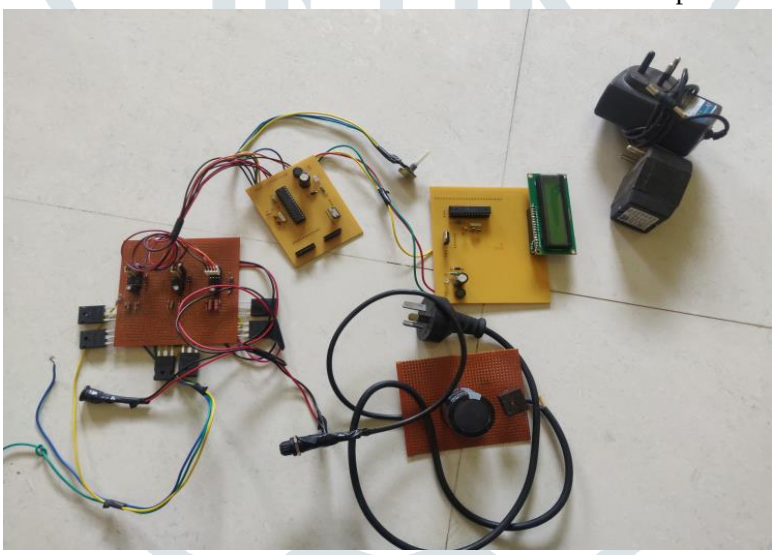


Fig. 4: Hardware of VFD system for speed

V. RESULTS AND DISCUSSION

The oscilloscope shows below the variation of frequency of pulse width for controlling output of inverter. The results of the prototype developed have shown that there is reduction in energy consumption when speed of motor is reduced with constant torque.

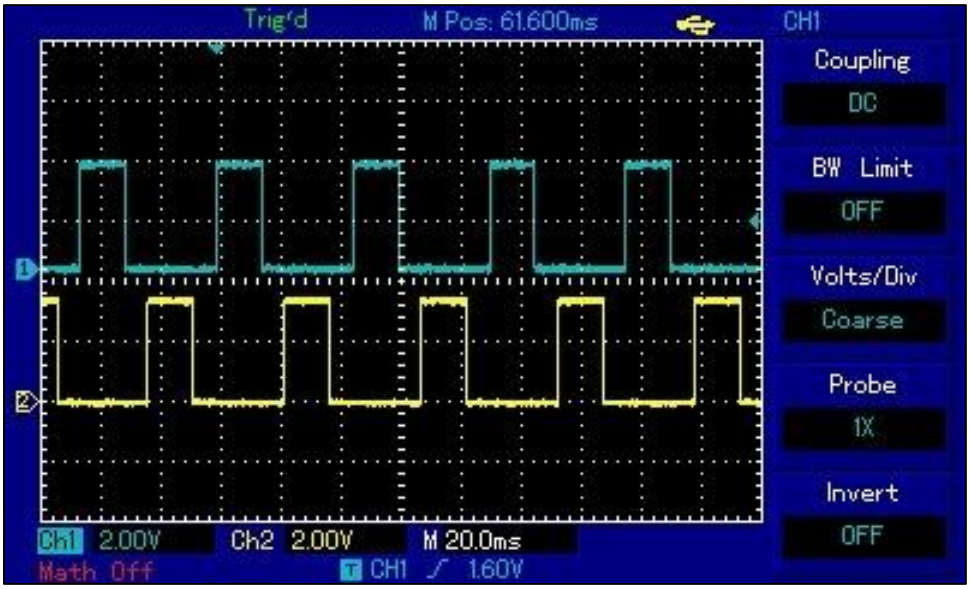


Fig. 5: Variation in frequency

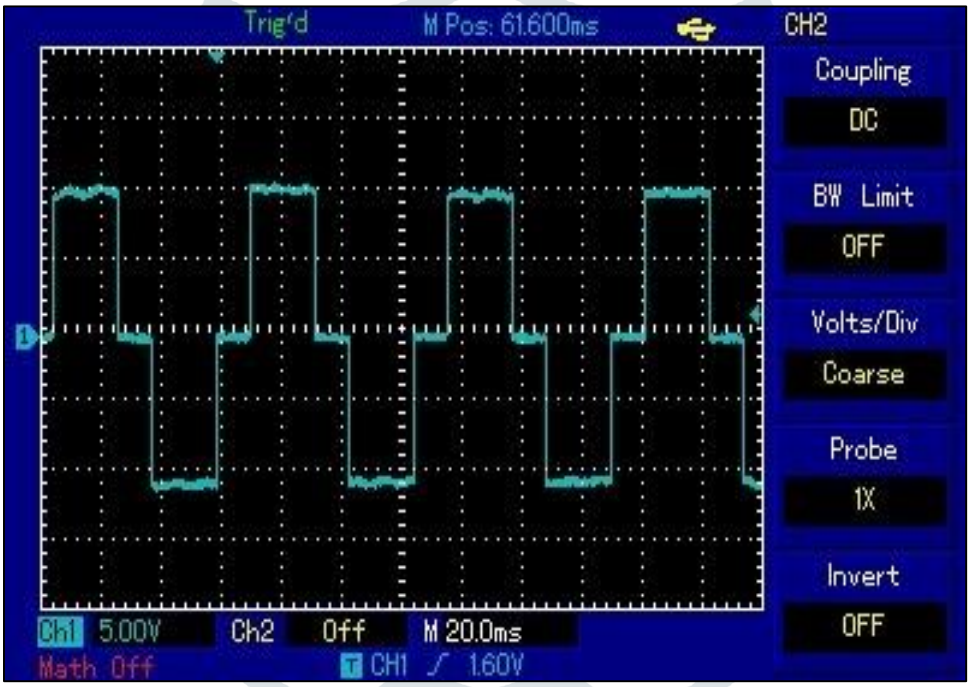


Fig. 6: Voltage output of the inverter

VI. CONCLUSION

Authors have presented the control of speed for induction motors through the variable frequency method. The system with variation is frequency is developed as hardware and the results for the same are discussed. The industrial applications of induction motor are spread over wide range and its contribution to industrial motor is huge. The overall contribution of these motors in application of industrial processes is holding the contribution of eighty percent. The objective achieved through this experimentation is to reduction in power consumed by the motor and control of speed by maintaining required torque level. This method is found suitable to be used for control of industrial motors where the frequency of input voltage is varied to control speed of motor. Motor control with variable frequency was implemented through the hardware consisting of rectifier, inverter, filter and controller.

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