



AC voltage from the power grid is rectified using the power bridge and capacitor is used as a filter, the output of filter gives pure DC to the three phase inverter as DC source. Depending upon the frequency generated by microcontroller, the power supplied to the motor is varied. And the error between actual speed and reference speed is minimized.

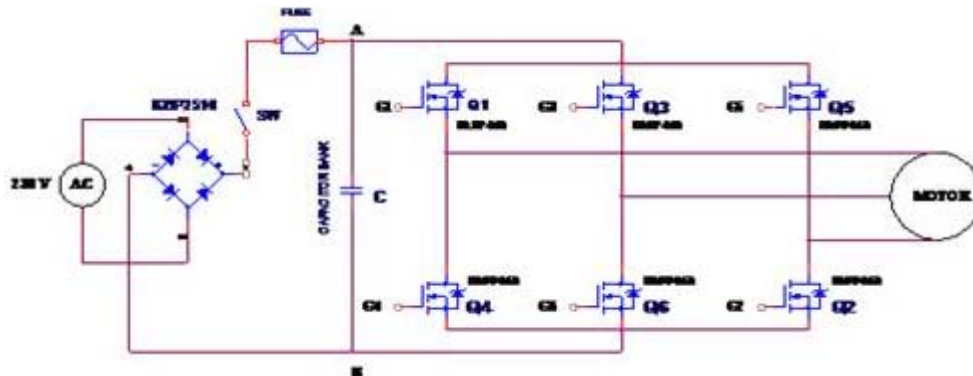


Figure 2: Three Phase Inverter Design

**B. Isolation Circuit**

opto-coupler is an electrical component that is used to isolate high power circuitry to digital or control devices by optical means. It is a combination of light emitting diode (LED) and a silicon phototransistor. The input signal is applied to an LED and the output is taken and output is taken from the phototransistor. An opto-coupler connects input and output sides with a beam of light modulated by input current.

When any variations in input side voltages, it can produce changes in the LED current, which changes the current through the phototransistor. Thus a signal voltage is coupled from the input circuit to the output circuit. The circuit arrangement with internal structure for the opto-coupler is as shown in fig. The big advantage of an opto-coupler is the electrical isolation between the input and output circuits. Opto-coupler devices are essentially digital or switching devices, so they are best for transferring either on-off control signals or digital data

Q<sub>1</sub>, Q<sub>3</sub> and Q<sub>5</sub> and the negative terminal is connected to terminals of MOSFET Q<sub>2</sub>, Q<sub>4</sub> and Q<sub>6</sub>. Output from the gate drive circuit is connected to the Gate terminals of the MOSFET. Only two MOSFETs remain on at any instant time. The conduction sequence of MOSFET is 61, 12, 23, 34, 45, 56, and 61. This gating sequence is generated so that MOSFETs of the same branch cannot be conduct at the same time. There must be some short time delay between turn off MOSFET and turn on MOSFET.

**A. Three Phase Inverter Design**

Three phase inverter designed using power MOSFETs is as shown in fig.2. The inverse diode associated with the device is sufficient to operate the circuit at higher frequencies. MOSFET technology promises to use much simpler and efficient drive circuits with significant cost benefits compared to bipolar devices. . The positive terminal of the DC voltage is applied at the Drain terminals of MOSFET

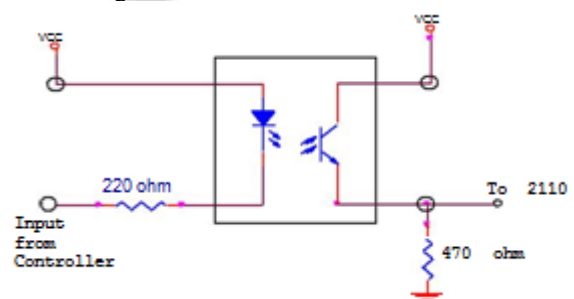


Figure 3: Real Time Controlling of three Phase Induction Motor

**C. Microcontroller PIC 16F877A**

The role of PIC16F877A is to generate PWM of desired frequency using timer/ counter module [4, 6]. It also monitors the sensed speed by Hall Effect sensor and sends it serially to Simulink designed for PID and Fuzzy control technique. According to present speed the Simulink model will generate three control signal which is fed back to microcontroller for PWM variation. Microcontroller also displays the current speed in RPS (Rotation per Second) on 16x2 LCD.

**D. Hall Effect Speed Sensor**

When a current-carrying conductor is placed into a magnetic field, a voltage will be generated perpendicular to both the current and the field. This principle is known as the Hall Effect. Hall effect sensor is used to measure the speed of motor in rps to get maximum resolution. Accuracy is +-1% at 12000rpm

**A. PID Controller Simulink Design in MATLAB**

Actual tuned PID output response and real-time speed of induction motor. Depending upon set speed and error in speed is generated which is applied to the PID controller and depending on this error PID gives the output which is passed over to PIC microcontroller to maintain the speed. Program in microcontroller develops a decision signal such that if

speed of motor is increasing the PID Algorithm gives large error output and depending upon error the three phase half-bridge inverter frequency is accordingly decreased to slow down the motor speed. In the same way, if speed is found to be decreasing then frequency for inverter is increased. .

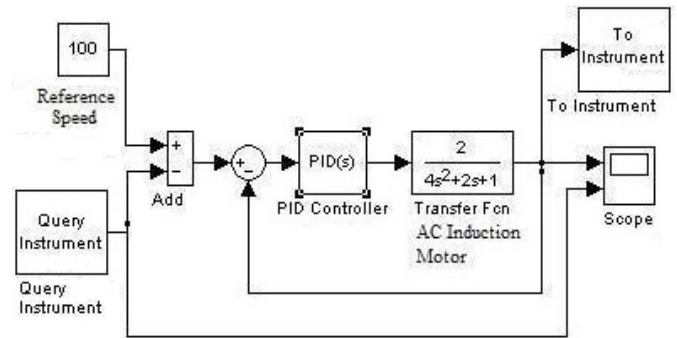


Figure 4: PID Simulink Model

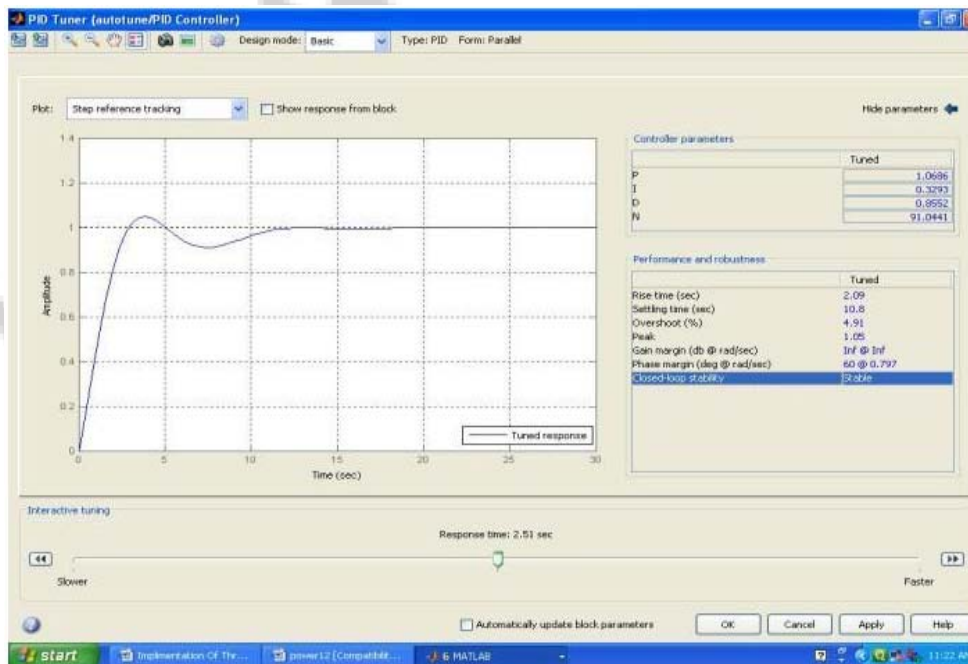


Figure 5: PID response

**B. PID Controller Simulink Design in MATLAB**

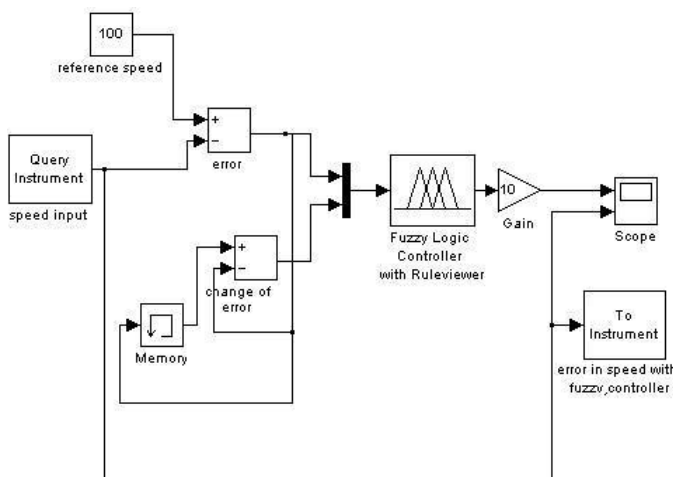


Figure 6: FUZZY Simulink Model

Fig.6 shows Simulink design model for Fuzzy Controller. It contain query instrument for accepting the real time present

speed of motor through serial port of PIC. The *constant* is set to a reference speed. *Error* block generates the output which is the error between actual speed and set speed. This is error applied to one input of Fuzzy controller and other to store the error in memory to provide it to *change of error block* which gives error between previous error output and actual error at present state. Multiplexer combine both input and gives it to Fuzzy controller. Real time scope is used to observe actual behavioral of a system. *To instrument block* is used to send output of Fuzzy Controller to PIC microcontroller. The Fuzzy Inference Scheme (FIS) for Fuzzy controller is design using Mamdani method. It contains structure of minimum and maximum operation. Direct method operates on an inference rule such as-

“IF x is A and y is B THEN z is C” Where A, B and C are fuzzy sets. In this rule there are two main parts, the part following IF called premise and part following THEN is called consequence. Hence x and y are called premise variables and z is the consequence variable

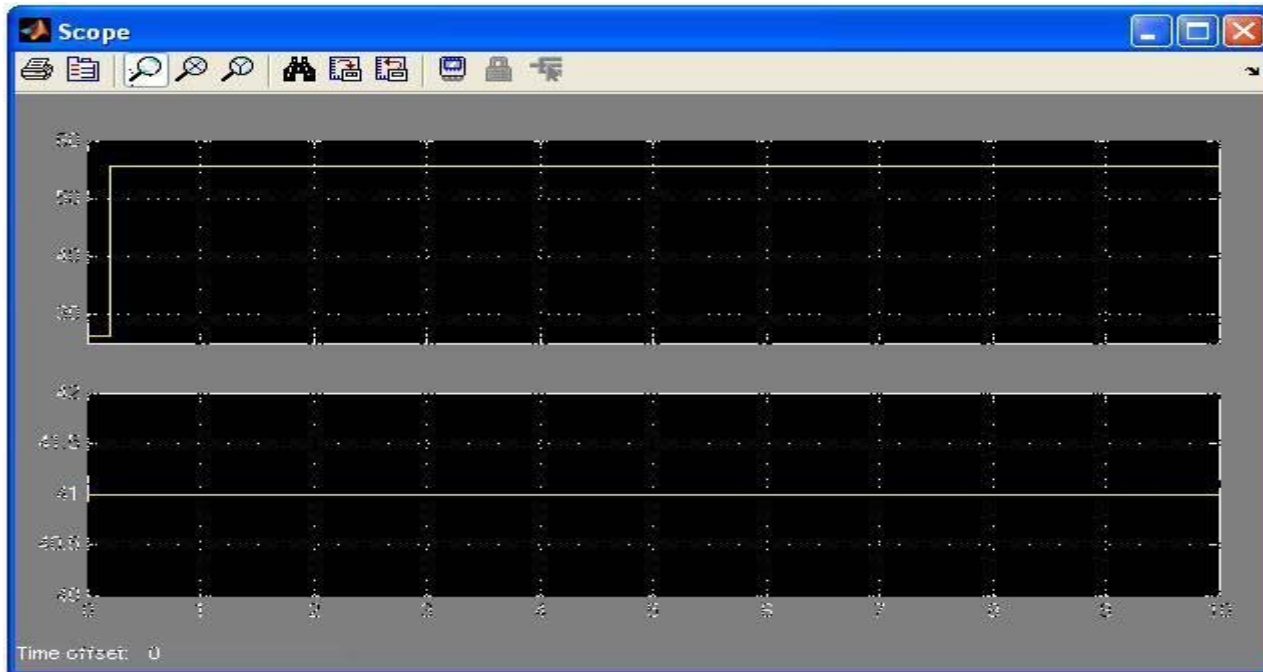


Figure 7: FUZZY response

### 3. Results and Discussion

Many conventional control strategies are useful for speed controlling purpose. Instead of all conventional strategies, PID and FUZZY controllers are very different in nature and are efficient for speed controlling of three phase ac induction motor. They provide precise controlling action within their limits. PID controller is very much useful because it uses auto tuning. Once it is tuned it tracks the output according to the provided input. But it has a limitation that it has more settling time. Still it is used as a standard reference for comparison with other control strategies. Fuzzy controlling is another mean for this application. The main advantage is that it provides minimum settling time than PID controller. The designing of Fuzzy Controller is particularly rule based which simplifies the implementation. The experimental results of both the controllers are compared and analyzed as shown in Table 1. It is found that speed controlling by FUZZY controller is better than PID controlling method. Also, it is real time matlab interface for such non-linear application in linear fashion.

As we observe that the controlling speed of three phase induction motor by using variable frequency drive. The motor speed varies from zero to the base speed, in constant torque operation up to the base speed while in constant power the speed of motor is above base speed.

### References

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