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Monitoring And Control Of A Plc Based Vfd Fed Three Phase Induction Motor

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Abstract

The implementation of a monitoring and control of three phase induction motor using PIC with Driver circuit by using level sensor placed in fluid tank which is managed by PLC technology. The PLC controls speed of induction motor using software support (programs) and sensors. Induction motor are widely used in many industrial processes due to its low cost reliability low maintenance and squashed size. Monitoring and control of an IM is important for an industrial automation in which unexpected failures can be eliminated. The efficiency of a PLC control is increased at variable speeds and thus increases the power consumption. Thus, the PLC proves as a resourceful and effective tool for controlling industrial electric drives. Here we are using two types of sensor i.e., level sensor to sense the level and temperature sensor to sense the temperature of the running motor.

Keywords- Plc,3-Phase Im,Sensors, Driver Circuit, Pic.

Introduction

In general an IM is not controlled nor its speed is monitored resulting in unwanted failures due to either stator and rotors .these failures can be overcome by using switches and using A/D converter with PIC. Due to limitation of PIC we opt for PLC with SCADA for graphical representation. We make use of PIC and Driver circuit to get work of a VFD. The Driver circuit consist of IC's, Diodes, Capacitors, Optocoupler, Transistor and Resistors.

In this project we design a 3 phase induction motor running on the basis of level of fluid which is sensed by Level sensor.when sensed level of fluid is low the motor runs at low speed and as level is increased by immersion of level sensor manually the speed of motor increases.Now-a-days many industries use PLC for automation due to their flexibility, simple wiring and easy to troubleshoot [6]. The Level sensor, temperature sensor are connected to the input module of the PLC. The output module

of the PLC is connected with 3-phase IM. Because, of the communication capability, high reliability with lower cost the PLC are used for an industrial automation [6]. The controlling of system is done by PLC and is monitored by SCADA in combination with a driver circuit. The PLC runs according to ladder logic program. We also use a temp. sensor to sense the temp. of motor to check for excessive temp. These are monitored in screen using SCADA.

Project Description

The speed of motor is varied according to level of Fluid in tank which is pre fixed at 3 levels low,medium,high. The speed is varying according to the level sensed by Level sensor. This control action is completed by a PLC in combination with PIC & Driver Circuit by programming & SCADA for graphical representation. And thus, power consumption will be reduced.

Three Phase Induction Motor

Three phase induction motor(IM) are widely used in many processes due to its low cost, reliability, low maintenance and squashed size[1],[2]. Monitoring and control of an IM is important for an industrial automation in which the unexpected failures can be eliminated [3]. It is estimated that 37% of failures in IM are due to stator faults. These faults can be monitored by using electrical and mechanical switches. But, because of their limitations like low efficiency, less life and failures of the system these techniques were eliminated.

Fig 1- Three Phase Induction Motor

Programmable Logic Control

A PLC or a programmable logic controller is a specialized computer used to control machines and process. It uses a programmable memory to store instructions and specific functions include on/off control, timing, counting, sequencing, arithmetic and data handling.

A PLC can be programmed to sense, activate, and control industrial equipment and, therefore, incorporates a number of I/O points, which allow electrical signals to be interfaced. Input de-vices and output devices of the process are connected to the PLC and the control program is entered into the PLC memory.

Here we are using DELTA DVP-20EX type PLC.

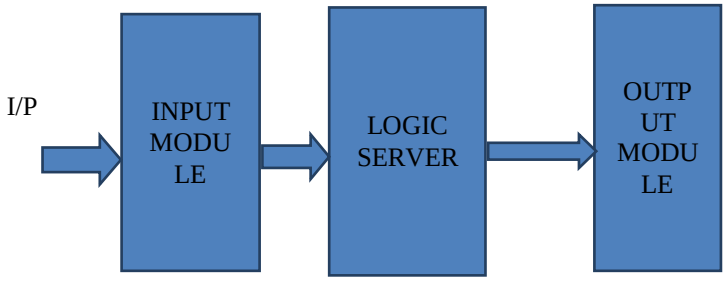

Fig 2- PLC Basic Block Diagram

Fig 3-Delta PLC DVP 20EX

Developed Software

Delta PLC module is used for the system. Ladder diagram (LAD) was used as programming languages. Software of the PLC was developed on the computer and loaded on the PLC by RS 232 PC/plan-position indicator (PPI) cable. While the program prepared is being loaded on the PLC from the computer, the most important point is the baud rate between the PLC and the computer. The baud rate must be appropriate to switch setup on the bound cable in manual.

Power Supply

Here we are using two step down transformer to get 50v and 12v step down voltage. Firstly we are giving single phase supply to transformer which will step down to 50V, then rectifier circuit is used to convert A.C. supply to D.C. supply and after that it will pass through, 6 MOSFETs in three phase inverter circuit which will convert D.C. supply to three phase A.C. supply and then it is given to IM. And other

transformer step downs to 12V and this 12V is given to Driver Circuit. And 5V is given to PIC microcontroller. 230v A.C. supply is given to PLC.

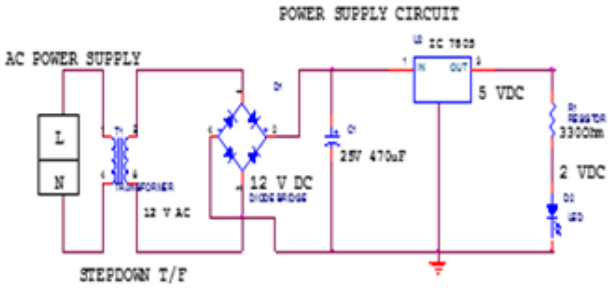

Fig 4-Power Supply Circuit

Driver Circuit

It is used to provide 9 to 12 volts to switch the MOSFET Switches of the inverter. Driver amplifies the voltage from microcontroller which is 5volts. Also it has an optocoupler MCT2E for isolating purpose. So damage to MOSFET is prevented.

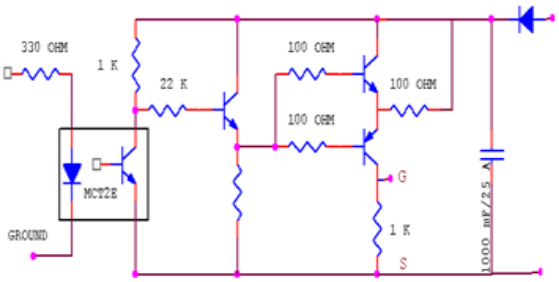

Fig 5- Driver Circuit

The driver circuit forms the most important part of the hardware unit because it acts as the backbone of the inverter because it gives the triggering pulse to the switches in the proper sequence. The diagram given above gives the circuit operation of the driver unit. The driver unit contains the following important units Optocoupler, Capacitors, Transistors, Resistors, Diode.

PIC Microcontroller

Here we are using PIC 16F877A for producing switching pulses to multilevel inverter. so as to use those vectors which do not generate any common mode voltage at the inverter poles. This eliminates common mode voltage Also it is used to eliminate capacitor voltage unbalancing. The microcontroller are driven via the driver circuit so as to boost the voltage triggering signal to 9V.To avoid any damage to micro controller due to direct passing of 230V supply to it we provide

an isolator in the form of optocoupler in the same driver circuit. Pulse width modulation means to control the switching of the active devices in each of the multiple voltage levels in the inverter. The most efficient method of controlling the output voltage is to incorporate pulse width modulation control (PWM control) within the inverters. In this method, a fixed D.C. input voltage is supplied to the inverter and a controlled A.C. output voltage is obtained by adjusting the on and–off periods of the inverter devices. Voltage-type PWM inverters have been applied widely to such fields as power supplies and motor drivers. This is because: (1)such inverters are well adapted to high-speed self turn-off switching devices that, as solid-state power converters, and (2) they are operated stably and can be controlled well.

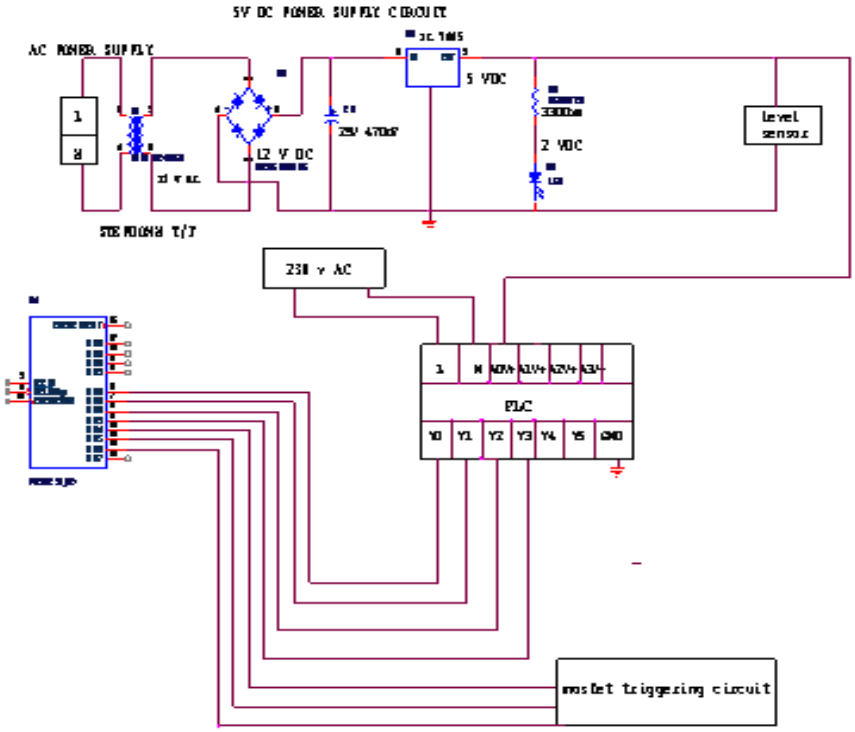

Fig 6-Circuit Ofpic 16f877a Microcontroller

Circuit Diagram

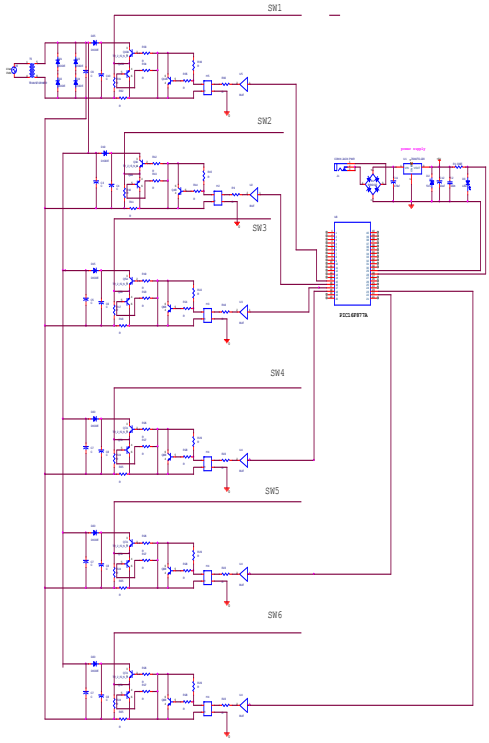

Fig 7 - Circuit Diagram

Inverter Circuit

The voltage coming from step down transformer is then given to the rectifier, which converts A.C. supply into D.C. supply. So as to convert single phase supply into 3 phase supply. As induction motor requires 3 phase supply to run. Inverter circuit will convert single phase D.C. supply into 3 phase A.C. by the help of 6 MOSFETs used in the circuit and this 3 phase ac supply is given to induction motor.

In our project the MOSFET switch is connected to the main circuit. Here we have two switches namely

- Main switch Sm
- Auxiliary switch Sa

The pulse to these switches is given using micro controller PIC16F877A through a driver circuit. In PIC16F877A the pulse of 5V is generated which is sent to driver circuit, these signal is amplified to about 12V DC, that is sent to the MOSFET switch Sm and Sa respectively.

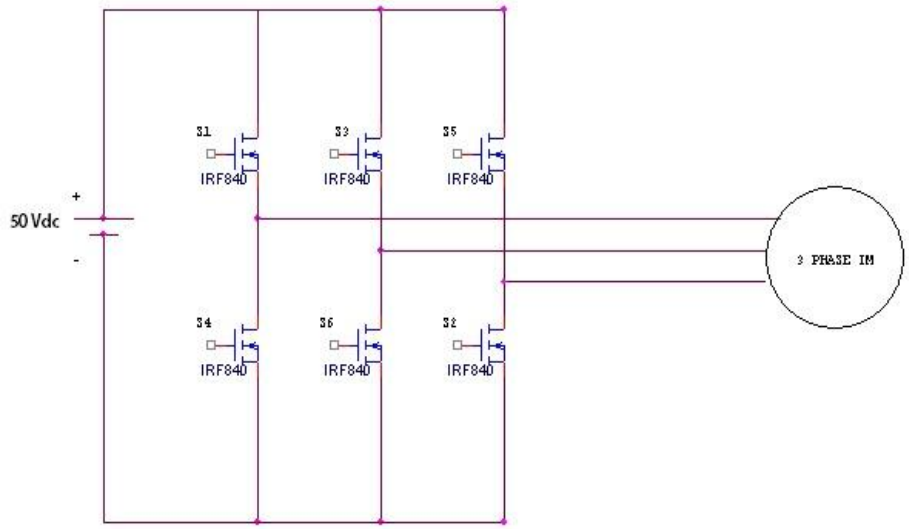

Fig8- Inverter circuit

Sensor Used

Temperature Sensor (LM35)

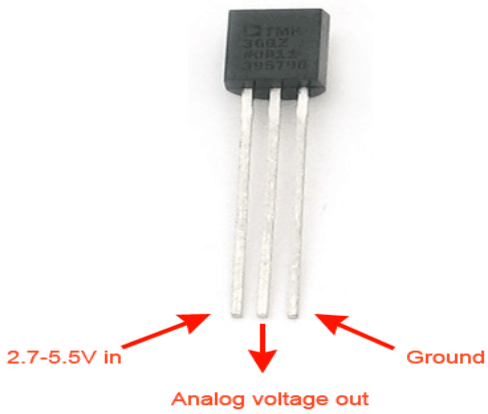

Fig 9- Temperature Sensor LM35

These sensors use a solid-state technique to determine the temperature. That is to say, they don't use mercury (like old thermometers), bimetallic strips (like in somehome thermometers or stoves), nor do they use thermostats (temperature sensitive resistors). Instead, they use the fact as temperature increases, the voltage across a diode increases at a known rate. (Technically, this is actually the voltage drop between the base and emitter - the Vbe - of a transistor. By precisely amplifying the voltage change, it is easy to generate an analog signal that is directly proportional to temperature. There have been some improvements on the technique but, essentially that is how temperature is measured.

Because these sensors have no moving parts, they are precise, never wear out, don't need calibration, work under many environmental conditions, and are consistent between sensors and readings. Moreover they are very inexpensive and quite easy to use.

Level Sensor (Capacitive Type)

Level Sensor, used for a variety of liquids or solids (powder, granular, aggregate, etc.) in a storage tank/vessel. It can be integrated with electronics for continuous or point (switch) level indications.

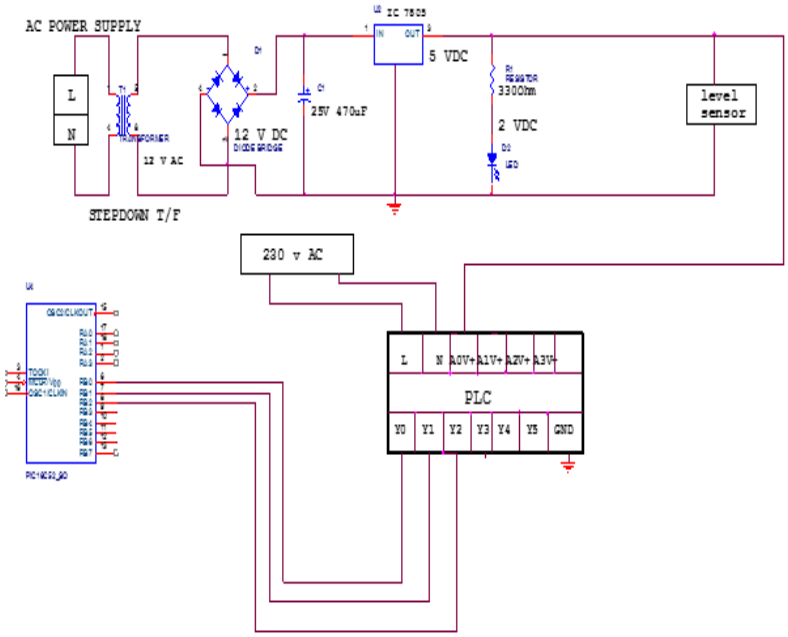

Fig 10- Level Sensor circuit diagram

Fig 11-Capacitive Type Level Sensor.

Software Description

Using DELTA WPL Soft software the ladder programming was developed for monitoring and controlling of three phase induction motor. The ladder program will execute the operation of the induction motor as per the rung developed.

The each step of operation will be monitored using human machine interface (HMI). In ladder diagram the program is written in high level language. As the random access memory (RAM) or flash memory erasable programmable read only memory (EPROM) can admittance the binary instruction the ladder should be converted into binary instruction. Each binary instruction is executed by the CPU. A PLC program is sequentially executed from the first rung to the last rung, which is called scan. This sequential processing is called cyclic operation. Cyclic operation of the PLC continues as long as conditions do not change for interrupt processing during program execution. The developed ladder diagram is shown in Figure.

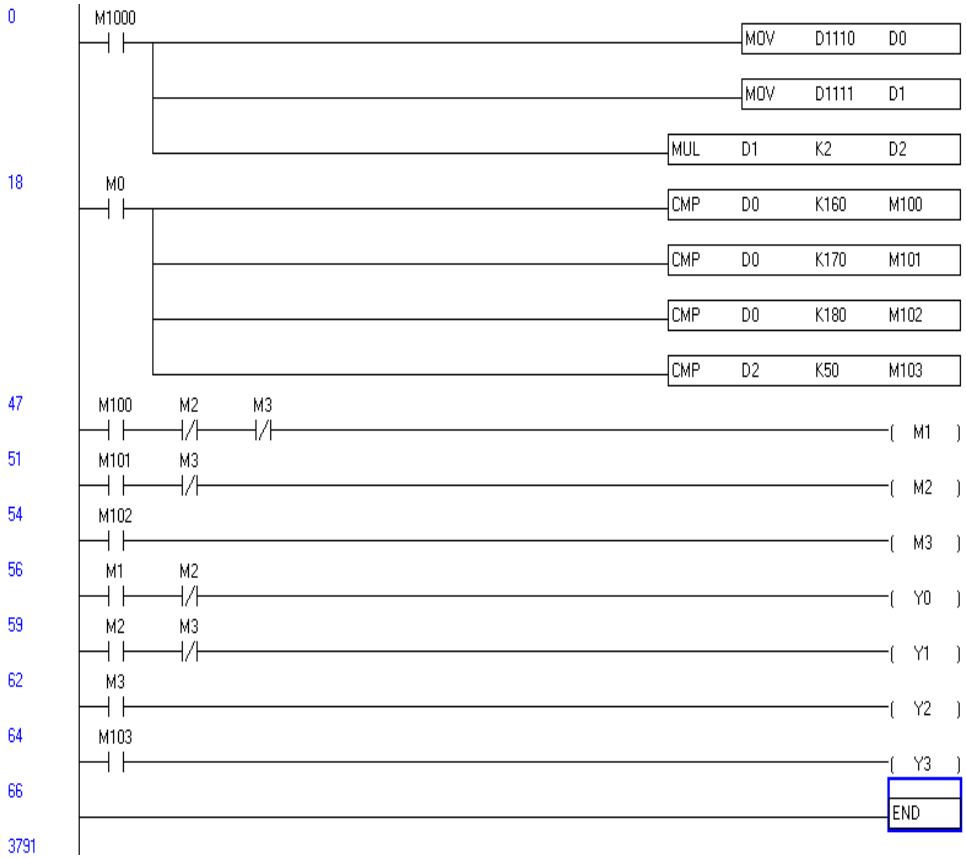

Fig 12- Ladder Logic diagram for induction motor

Applications

Washing Machine, Food Processing Industries, Mixing of Chocolate with Cream in industries.

Fig 13– Hardware Model

Conclusion

In this study, the speed of induction motor is controlled and automated using ladder logic in PLC with the help of level sensor. Thus the power consumption has been reduced which will increase the life of of induction motor. And it also reduces certain motor failures. Feedback system provides high efficiency for the process.

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