ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An ISO 3297: 2007 Certified Organization)

Website: www.ijareeie.com

Vol. 6, Issue 5, May 2017

Multiple 3-Phase Motors Control With Password Protection

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ABSTRACT: Three phase induction motors are easier to maintain and so are widely used motor in the industrial applications because of its rugged construction. To operate this kind of motor, Star- Delta starters are used. But, because of its constant speed characteristics many times it is driven with the help of drive to have reliable operation its performance must be monitored continuously. Here design and fabrication of monitoring the control system for 3 phase induction motors based on Programmable Logic Controller (PLC) technology is implemented and also hardware and software for protection and speed control with the result is obtained from the test conducted on three phase induction motor for performance. The PLC correlates the operational parameters to protect motor and monitor the system during normal operational and under trip condition. Other performance parameters of three phase induction motors can also be monitored by other control devices. AC drives such as Variable Frequency Drive (or VFD) are also used to control motor rotation direction and rotation speed for three phase induction motors. All the required control or protection and motor performance data will be taken to personal computer via PLC for further analysis. Speed control from control side and protection from performance side will be a priority. The monitoring, Supervisory Control and Data Acquisition of three phase induction motors is done by SCADA software.

KEYWORDS: PLC, SCADA, Induction Motor, V/F drive , Fault diagnosis

I.INTRODUCTION

Induction motor (IM) is protected against possible problem such as over voltage, over current, overload, over temperature, under voltage, occurring in the course of its operation is very important because of it is used intensively in industry as an actuator. IMs can be protected using some components such as timers, contactors, voltage and current relay. This Method is known as classical method that is very basic and involves mechanical dynamic parts.

The implementation of a monitoring and control system for the induction motor based on programmable logic controller (PLC) technology is described. Also, the implementation of the hardware and software for speed control and protection with the results obtained from tests on induction motor performance is provided. The PLC correlates the operational parameters to the speed requested by the user and monitors the system during normal operation and under trip conditions. Tests of the induction motor system driven by inverter and controlled by PLC prove a higher accuracy in speed regulation as compared to a conventional V/f control system. The efficiency of PLC control is increased at high speeds up to 95% of the synchronous speed. Thus, PLC proves themselves as a very versatile and effective tool in industrial control of electric drives.

II. PROGRAMABLLE LOGIC CONTROLLER

Programmable Logic Controllers (PLCs), also referred to as programmable controllers, are in the computer family. They are used in commercial and industrial applications. A PLC monitor inputs, makes decisions based on its program, and controls output to automate a process or machine. This course is meant to supply us with basic information on the functions and configurations of PLCs.

A PLC is user-friendly microprocessor-based specialized computer that carries out control functions of many types and levels of complexity. Its purpose is to monitor crucial process parameters and adjust process operations accordingly. It

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can be programmed controlled and operated by a person unskilled in operating computers, but who is nonetheless PLC-literate.

III. VARIABLE FREQUENCY DRIVE

This drive is intended as a component for professional incorporation into complete equipment or system. `
System design, installation, commissioning and maintenance must be carried out by personnel who have the necessary training and experience. They must read this safety information and this guide carefully. The STOP and START controls or electrical inputs of the drive must not be relied upon to ensure safety of personnel. They do not isolate dangerous voltages from the output of the drive or from any external option unit.
In any application where a malfunction of the drive or its control system could lead to or allow damage, loss or injury, a risk analysis must be carried out, and where necessary, further measures taken to reduce the risk - for example, an over-speed protection device in case of failure of the speed control, or a fail-safe mechanical brake in case of loss of motor braking. By using a parameter setting of the drive, desired function be done like for speed control of motor set it to Minimum or Maximum speed.

1. SCADA(Supervisory Control & Data Acquisition) Software

As the name indicates, it is not a full control system, but rather focuses on the supervisory level. As such, it is a purely software package that is positioned on top of hardware to which it is interfaced, in general via Programmable Logic controllers.SCADA stands for Supervisory Control and Data Acquisition. SCADA refers to a system that collects data from various sensors at a factory, plant or in other remote locations and then sends this data to a central computer which then manages and controls the data. SCADA is a term that is used broadly to portray control and management solutions in a wide range of industries. One of the key processes of SCADA is the ability to monitor an entire system in real time. The main purposes for the use of a SCADA system would be to collect the needed data from remote sites and even the local site, displaying them on the monitor of the master computer in the control room, storing the appropriate data to the hard drive of the master computer and allowing the control of field devices (remote or local) from the control room. SCADA systems are equipped to make immediate corrections in the operational system, so they can increase the life-period of your equipment and save on the need for costly repairs.

2. OVERVIEW OF PROPOSED WORK METHODOLOGY

The drawbacks of previous work are with microcontrollers whichare not suitable for industrial environment, motor parameters were not possible to show on PC and motor control from PC was not possible. The proposed system is to monitor motor parameter on SCADA Screen.This system configuration of parameter monitoring of an induction motor system is shown in the figure below. This system Consists of different working arrangements which mainly consist of the induction motor, current sensor, VFD, PLC , CT and figure below shows the detail blocks which describe the working of the parameter monitoring of an induction motor system.

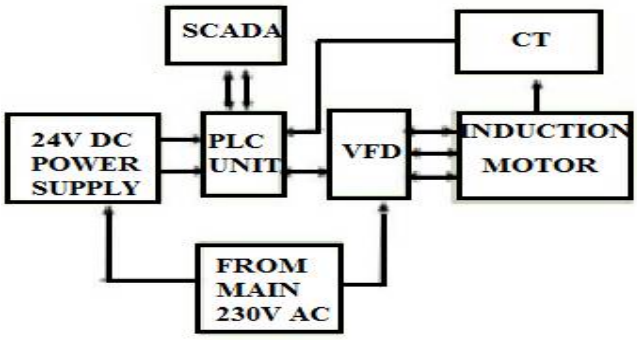

Fig.1 System overview

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ISSN (Online): 2278 – 8875

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Vol. 6, Issue 5, May 2017

As seen from above figure Induction motor is last element whose parameter we has to be monitored on SCADA. The Induction motor receives AC main power through AC Drive or VFD. To see current consumed by an induction motor on SCADA screen, we use CT which is connected in between the motor and PLC. Output of CT is given to PLC through which value of current is shown on SCADA screen. VFD plays vital role in protecting motor from various faults like overload, over voltage, over current, etc. Whenever faults occur, VFD indicates the same on its display. By referring code user will be able to find solution same within a short period of time. Here the system is set to sense motor parameters, to show them on SCADA screen also to control motor from SCADA. Once the parameters are sensed, PLC will decide whether measured parameters are within limit or not. If the parameter crosses the limit set by the user, SCADA screen will give warning message on its screen. So at supervisory level, users will be able to see motor condition, it parameters whether they are crossing threshold or not. User also will be able to control the motor.

IV. EXPEREMENTAL SETUP

The Fig.2 shows an overall hardware model of this work. The Power supply is a reference to a source of electrical power. A device or system that supplies, electrical or other types of energy to an output load or group of load is called a power supply unit or PSU to control the speed of induction motor, a motor drive and control system with different methods can be used.

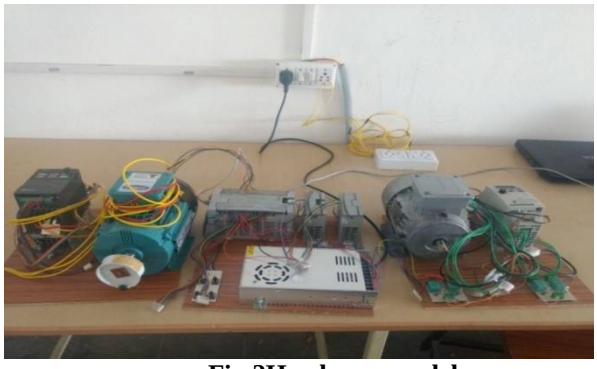

Fig.2Hardware model

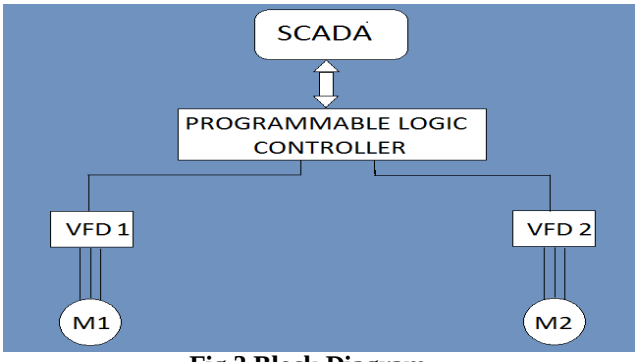

Fig.3 Block Diagram

The control system is implemented and tested for rotor induction motors having a technical specification given in below Table. The induction motor is attached to variable frequency drive. The three-phase power supply is connected to a three- phase main switch and then to variable frequency drive. The terminal of VFD is supplied to the induction motors. The VFD is interfaced to the PLC-based controller. As a microprocessor based system, the PLC system hardware is designed and built up with certain modules, having a technical specification given in Table-2.The system consist of three phase main switches ,induction motors, variable frequency drives, PLC based controller. Block diagram of the experimental setup is being shown in Fig.3. The program is downloaded into the PLC from a personal computer with RS-232 serial interface. The status of motor is being displayed on Real time software SCADA which provides a supervisory control for the system.

Connection type	Δ
Amb. temperature	50 45oC
Input voltage	415volts +/-10%
Input current	4.5Amp
Rated power	2kW
Input frequency	50Hz
Pole number	4
Rated speed	1500rpm
Efficiency	0.85

Table-1 Induction Motor specifications

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Power Source	100-240V AC or 125VDC
Output Source	30 watts total 15 watts 5 V 15 watts 24 V Relay 20 watts 24 V isolated 24VDC Output Current Capacity: 0.8

Table-2 PLC Power Module specification

V. SOFTWARE DESCRIPTION

PLCs can be programmed using programming languages. A graphical programming notation called sequential function charts is available on certain programmable controllers. Initially, most plc's utilizes ladder logic diagram programming, a model which emulated electromechanical control panel devices (such as the contact and coils of relays) which PLCs replaced. This model remains common today.The developed ladder logic is shown in figure4. Power flows through these contacts when they are closed. The normally open (NO) is true when the input or output status bit controlling the contact is 1. The normally closed (NC) is true when the input or output status bit controlling the contact is 0.

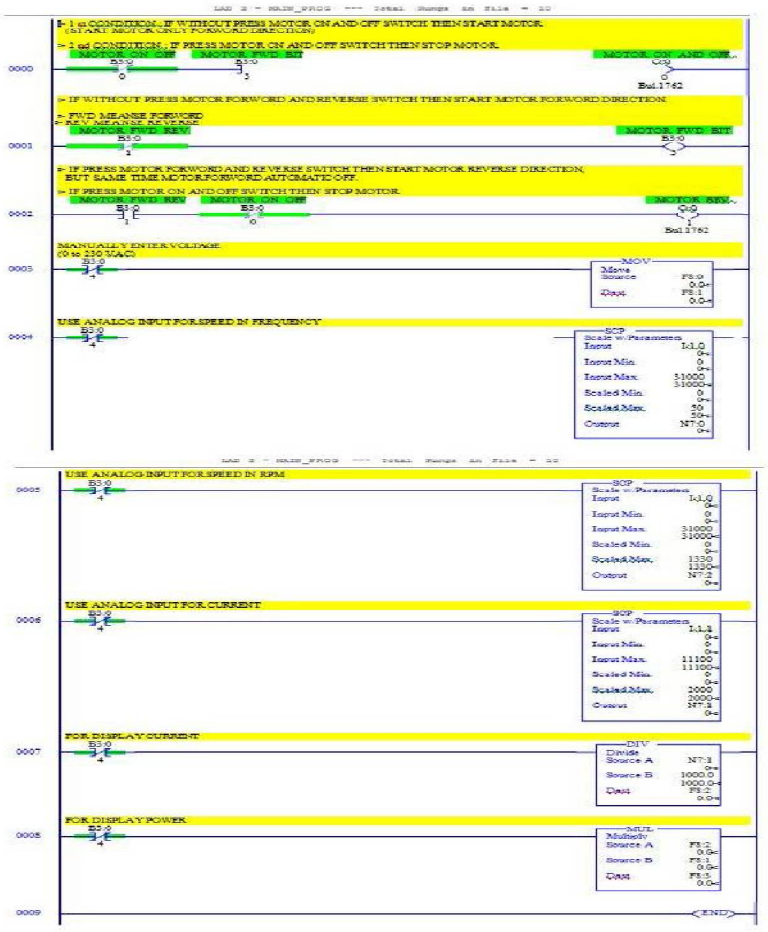

Fig.4 ladder diagram

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International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

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Vol. 6, Issue 5, May 2017

V. EFFECT OF DRIVE FREQUENCY

The major effect of change in supply frequency is on motor speed. If supply frequency drops by 10%, then motors speed also drops by 10%. We know that speed of three phase induction motor is given by equation

N= (120*f)/P

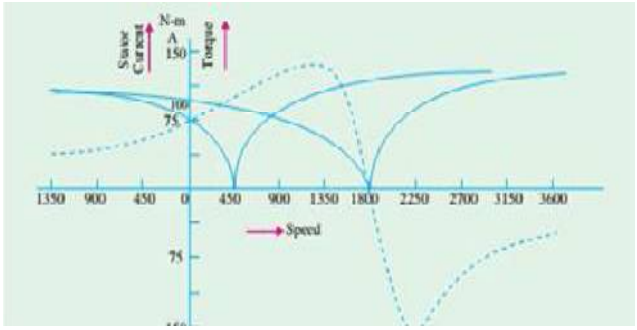
Where N= Speed of Motor, F=Supply Frequency & P=No. of the Poles.

From equation, it is clear that, N α f i.e. Speed is directly proportional to Frequency.

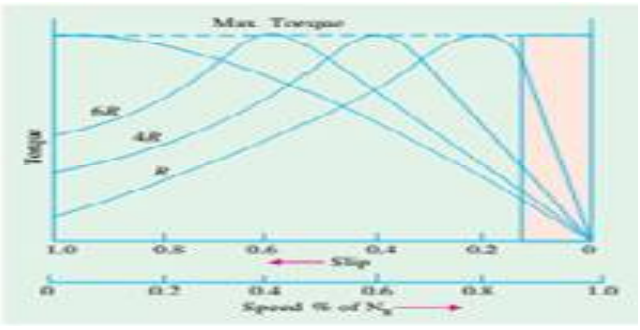
S.No.	Drive Freq.	Speed of motor	Current	Power
1	10	273	0.92	210
2	15	395	1.01	236
3	20	529	1.08	250
4	25	651	1.12	257
5	30	800	1.15	262
6	40	918	1.18	270
7	50	1067	1.19	275

Table-3 Analysis of Motor operation with change in f.

We know that T α s, where T= Torque & s=Slip. As seen from the graph above, for low values of slip, the torque-slip curve is approximately straight line. As slip increases (Load Increases), Torque also increases up to 'pullout' or 'breakdown' torque only. After that with an increase in slip (i.e. motor speed falls), with increase in motor load. Hencefor large value of slip T α (1/s). The corresponding relation is shown in a graphical manner as shown in graph 2.



Graph.1 Speed Vs Current & Torque



Graph.2 : Torque Vs Slip characteristics

VI. PASSWORD PROTECTION

The other concept of the paper is password protection, whenever the SCADA screen is in runtime we can't able to move any sliders in the SCADA control panel and also jogging operation but we can enable emergency stop buttons this is because, the whole SCADA control panel is protected with password. If we want to enable that set

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Vol. 6, Issue 5, May 2017

password go to **special –security-log on and type name as GNIT, password–GNITEEE.** Figure below shows the SCADA control screen when protected with password.

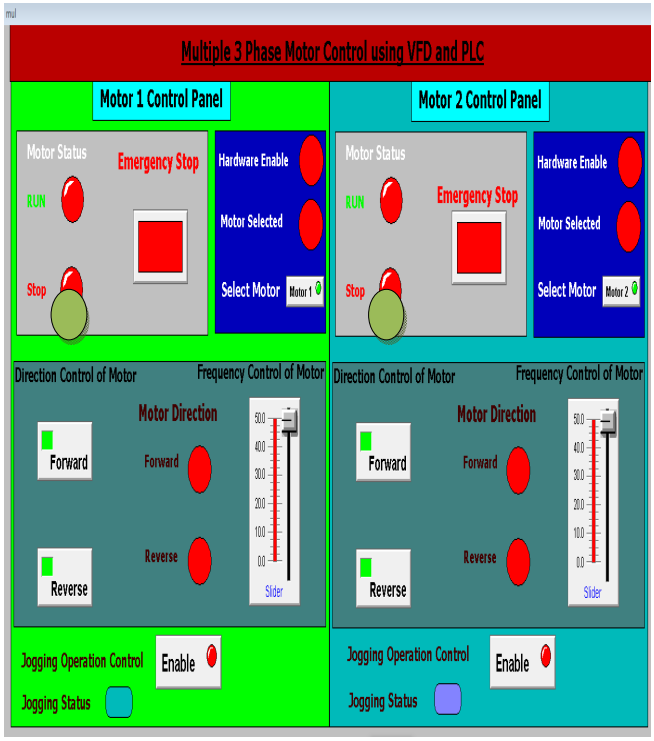

Fig.5 SCADA Control Screen when protected with password

VII. SCADA RESULTS

To monitor the motor condition, SCADA Screen was provided with various control buttons like Motor ON/OFF, Motor Forward/Reverse and associated indicators. If the condition is true, the indicator glows GREEN and if the condition is False, the indicator glows RED.

Name Of Indicator Unit	Colour	Comment
MOTOR ON	GREEN	YES; Motor ON
	RED	NO; Motor NOT ON
MOTOR OFF	GREEN	YES; Motor OFF
	RED	NO; Motor NOT OFF
MOTOR FWD	GREEN	YES; Motor Running in Forward Direction
	RED	NO; Motor is NOT Running in Forward Direction
MOTOR REV	GREEN	YES; Motor Running in Reverse Direction
	RED	NO; Motor is NOT Running in Reverse Direction

Table-4 Summary of SCADA display

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9.1 PROCESS SCADA SCREEN

A SCADA screen is designed as per the requirement of the ladder logic program and also that would be clearly understood by the operator who is sitting in the control room to control the process remotely. Figures below shows the SCADA control screen at different operating conditions of induction motor.

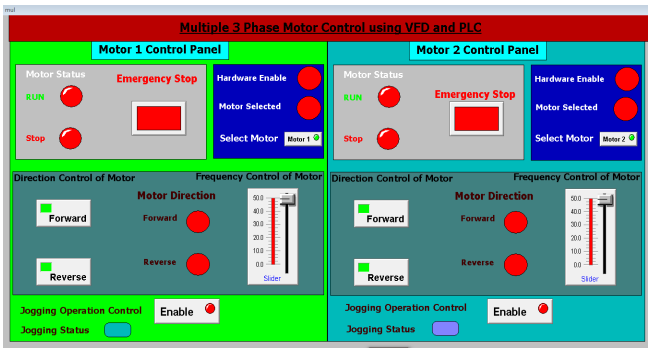

Fig.6 Initial SCADA Control Screen for induction motor

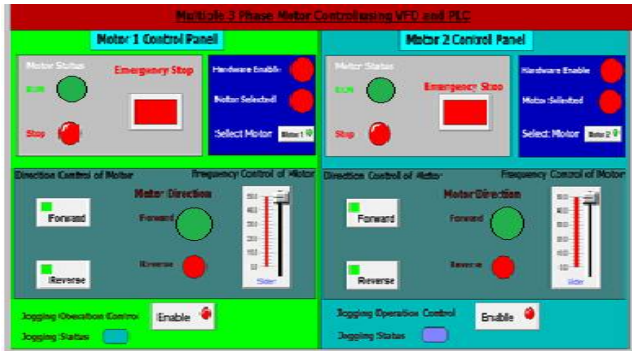

Fig.7 SCADA Control Screen when induction motor runs in forward direction

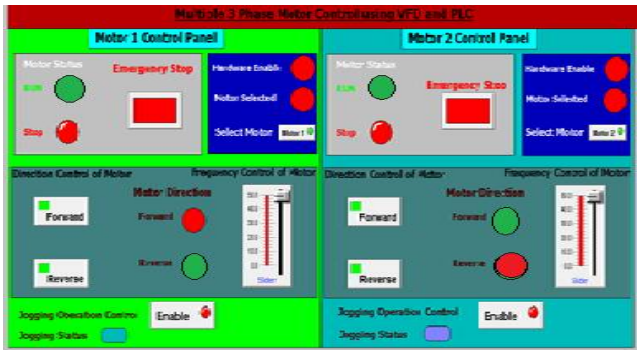

Fig.8 SCADA Control Screen when induction motor runs in reverse direction

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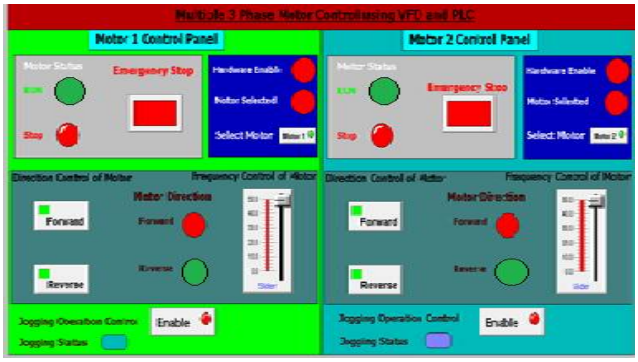

Fig.9 SCADA Control Screen when induction motors in reverse and forward direction

Here Induction Motor is fed by three phase AC Supply through PWM Inverter. When an Induction motor starts, it is governed by PLC through sensors. The reading from the sensors is sent to the PLC. PLC communicates with SCADA &displayed parameters of the motor like Voltage, Current, Power, Speed & Drive Frequency on SCADA Screen effectively. The parameters of motor are used to compare with specified threshold values and according to control program stored in memory, certain decision is taken, like to warn message was given on SCADA screen like overload /over current.

VIII. CONCLUSION

From the result, it is seen that with the increase of load current the speed either in a clockwise or anticlockwise direction, in the both cases the speed decreases. This justifies the performance of an induction motor. The curve drawn is almost a linear straight line which is in accordance with the performance characteristics of an induction motor. In this project, the software Rockwell has been successfully used for PLC and Wonderware In Touch for SCADA.

In this project, the monitoring and control system is designed for three phase induction motors. The system is successfully implemented and tested. After detailed experiment, it is observed that the proposed system is a feasible method for controlling of an induction motor. With the use of PLC & SCADA, the control system is more reliable. The control system design is based on the most advanced technology which give a high amount of flexibility and efficiency. Monitoring system gives facility of analysing the operation of an induction motor in online / offline mode, which make the system to be safe from fault/error conditions.

There are various other methods for the control of induction motor control like GSM, ZigBee based parameter monitoring which can also be used for monitoring and control system of an Induction Motor. The monitoring system can be connected to the web, making the system control from any place from any corner of around the world. The system would be more adaptive so that it can be configured for different type of applications such as servo motor, stepper motor, etc. In this project software Rockwell &WonderwareInTouch has been successfully used. However, another type of software may also be employed & comparative analysis can be done. In this project, the other parameters like power factor, harmonics, vibration, etc. have not been considered. So it is further suggested to consider these parameters and design circuit for improving power factor, reduction of harmonic contents in order to improve motor performance.

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