Project Report

on

Control Of Boiler Operation Using PLC-SCADA

Submitted by

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Under the Guidance of

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DECLARATION

I hereby declare that the project work entitled "Control of Boiler Operation using PLC-SCADA" is an authentic record of my own work carried out at Automation Systems, Ludhiana as requirement of six months project semester for the award of degree of B.E Electrical Engineering Thapar University, Patiala under the guidance of Mr. Gurpartap Singh, and Mrs Manbir Kaur, during January to June, 2018.

Date: _____

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Certified that the above statement made by the student is correct to the best of my knowledge and belief.

Mrs Manbir Kaur
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Mr Gurpartap Singh
Host Mentor

ACKNOWLEDGEMENT

A lot of efforts and time were put in this project by me, however, without the kind support of many individuals and organisation, the project was not possible.. I want to express my gratitude towards all of them.

I am highly thankful to Mr Gurpartap Singh as well as Amandeep Kaur for their constant supervision along with their guidance and also for providing the required information for this project which made it possible to complete the the project.

I want to extend my sincere thanks towards Mrs Manbir Kaur, our faculty supervisor, without whose support and inputs, I could not have completed this project.

Lastly, my sincere thanks to my parents, family and my colleagues at Automation System for their reassured support and motivation throughout the six months.

Contents

ABSTRACT

Automation in industry is the control of process, operation in without human assistance. To reduce dependency on humans and thereby decreasing human errors in an operation, it is necessary to have proper control system. One of the ways to control is by using Programmable Logic Controller(PLC). PLC is first programmed using Ladder Logic and sequence is designed. Operation or process will now take place according to this program and conditions defined.

For monitoring of the process, Human Machine Interface (HMI) or Supervisory Control and Data Acquisition (SCADA) are used. In this project, SCADA has been used which basically uses computers, graphical user interface and network data communication for improved process supervision and management. In industrial setting, a peripheral device such as PLC is typically used for interfacing to the process area.

A boiler is basically a closed container where heat is given to water for steam formation. A suitable fuel such as coal, natural gas or husk. It is widely used in a lot of different industries where steam has various applications. In a cloth-dyeing industry, the boiler is used to produce high-pressure and high-temperature steam which is further used in a closed cabinet to dye clothes at different temperatures.Here, Automation is important at various points for proper and efficient operation of boiler and steam production. Further, it is also used to for dyeing process in the cabinets.

This project involves designing a program to control the boiler operation in the dyeing industry using Schneider Electric's M-340 PLC using the ladder logic. The software used is Unity Pro and for monitoring process SCADA has been used.

CHAPTER 1

ORGANISATION PROFILE

Organisation- Automation Systems

1.1 About

The company has a team of well equipped and technically skilled specialist engineers to provide optimal engineering solutions. They give solutions that are upgradable and customizable with proper system integration. The company specialises in Automotive Test Solutions. The group is dedicated towards providing the best time and cost effective solutions.

The company is the authorized System Integrator automation and control for for the Schneider Electric-a global leader in automation and control technology and an international manufacturer of electrical equipment. Some products are produced under Square D and Telemecanique brand names. A wide range of industrial control components, variable speed drives,programmable logic controllers, interface terminals and communications software combine to offer reliability and efficient solutions to the global markets of industry, process control and OEM. Innovative products and technology, clubbed together with comprehensive and complete support and service, from initial planning to after-sales support results in Automation and Control enterprise that can provide solutions to meet the customers expectations.

1.2 History

A brief history is shown in figure 1.1, important points are:

- Began with System Integration Business.
- In 1995, Automation Systems was selected as an Authorized system integrator for M/S Schneider Electric.
- What started with small PLCs, drives and SCADA system, grew into a company of reputation in the industrial automation sector in India.

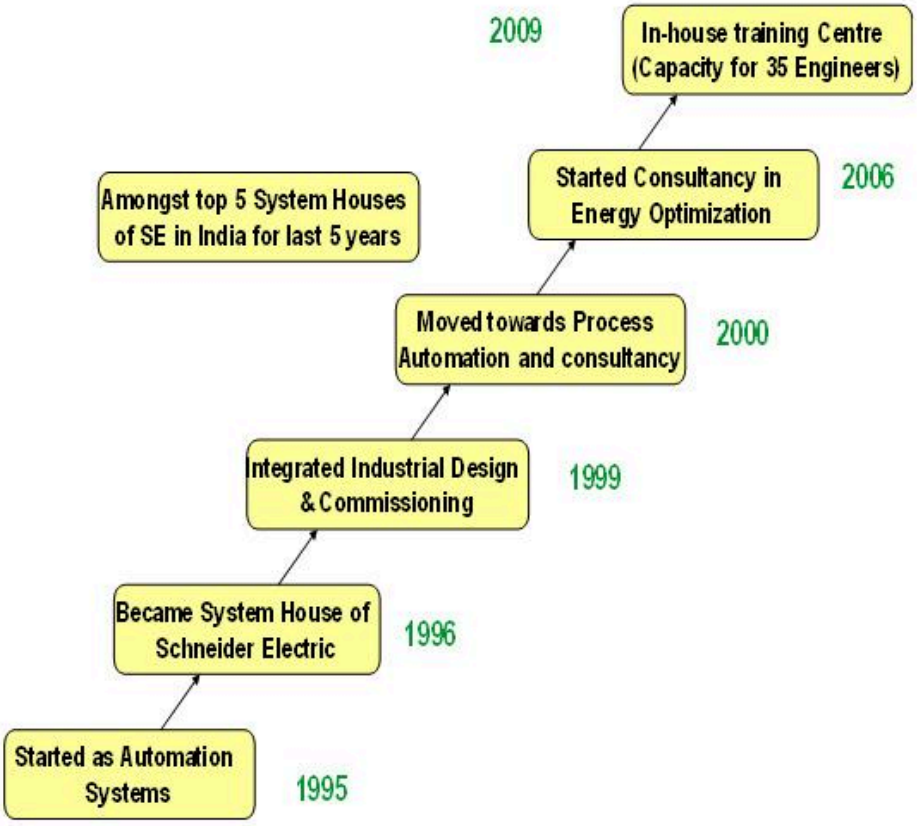


Fig1.1 History of automation systems

1.3 Vision/Mission

To bring innovation in the automation solution provided, and adding values in every customer's life by supplying right product or services, at the right time and at the right price.

1.4 Industries catered

- Textile Industry

- Paper Industry
- Sugar Mills
- Food and Beverage Industry
- Pharmaceutical Industry

CHAPTER 2

INTRODUCTION

2.1 Engineering Problems/Opportunity Being Addressed

The world's ever increasing competition in industrial sector demands top grade and most reliable product carrying a low fee tag. The demand is being addressed by a number of industries who are thinking numerous potential designs and integrated strategies in manufacturing alongside the usage of automation machinery.

2.1.1 Industrial Automation

Industrial Automation is one of the most striking and influential happening to get the solutions of the above challenge. Its objective is increasing product standard, speed of production and consistency at the same time as decreasing manufacture and designing cost by adoption of latest innovation and integration in services and techniques.
Automation has taken a positive stride in the right direction with mechanization which makes use of a certain mechanism to support process managing personnel in performance of a process. This mechanization can be described as the usage of power machines which depend on human responsiveness and decisiveness for the manual working of the process..
From another perspective, worker interference gets substituted with automation substitutes the human involvement by employing commands using a PLC and ultra-powerful machines.

Basically, Automation is replacing human thinking and decision making with computer programme and machine. Automation, as a term, get its derivation from Greek language, Auto which means self and Matos which means movement giving the meaning 'self dictating' or 'mechanism moved by itself.'

In an overview, industrial automation is the usage of certain techniques and automation controlling machinery while resulting in the self working along with process control of industry tasks lest any excessive worker interference all the while getting improved performance as compared to manually controlled operation. Examples of an automation device are PC, PAC and PLC. Example of technology are numerous communication systems like SCADA.

2.1.2 Advantages of Automation System

Following are the major benefits of automation technology:

- **Increased production-** The speed of production is increased by automating manufacturing or a certain process by an improved production control. Producing on a large scale is greatly helped by vast reduction in grouping time per every product alongside a higher product standard. Thus, for the same labour inputs, output production is greater.

- **Provides optimal operational costs**- Integrating different tasks in industrial plant using automation machines reduces sequence time and efforts, thus, dependency on working personnel is decreased. Therefore, costs of human resources are reduced to some extent using automated devices.

- **Improves product quality-** As the system minimizes the worker interference, there is a sharp reduction in the frequency of errors. Consistency with a greater quality is sustained using automatic devices by monitor and control of all the industry tasks during all steps from initiation of the products to the final products.

- **Reduces regular checking-** It vastly decreases the requirement of inspecting manually the diverse variables involved in a process. The task parameters can be adjusted on their own by industry tasks to the required value by usage of closed loop control procedures, thus benefiting from automation techniques.

- **Raises safety level**- The safety level for workers is increased with a good margin using automation as it substitutes humans with automation machinery in a potentially

dangerous work environment. Typically, robotic systems have been prefered in such unpredictable or threatening conditions.

2.2 Boiler Operation Control using PLC

Currently, PLCs are substantially being utilized in factories for controlling and allowing recurring tasks like managing production unit, nuclear plant shutdown system etc. An important application is automation in an industrial setting including various automatics tasks. One inclusion here is of boiler system that requires knowledge of various physical variables like temperature and pressure. The variables are then used to enable boiler to start/stop or to work in the prefered way, on its own, not involving personnel.
Monitoring the Boiler is a difficult process in the power generation system. It is also a procedure where careful attention of lot of workers is required. Also in many cases it is tough where the generations are in remote areas, and also where it has bigger size and difficult for people to be near the boiler all the time. Hence, there is a requirement of a system that can reduce the manpower required and also increase the efficiency of the system.

2.3 Project Objectives and Goals

The objectives of the proposed system are as follows:

- Learning the basic concepts of automation which including basics of PLC, PLC programming and PLC architecture.
- To study different industrial sensors involved in the automation process,
- To study the ladder programming of different PLCs such as Zelio, twido, M340, M218 etc.
- To study the programming of communicating softwares such as SCADA and HMI and interfacing them with PLCs.
- To review the extensive literature of the PLC and SCADA
- Software implementation of a Boiler operation control in a cloth dyeing plant using PLC (M340).
- Monitoring of the proposed system using SCADA system.

CHAPTER 3

LITERATURE SURVEY

3.1 Boiler and Steam Generation

Boiler is basically an enclosed container where water is heated till it is converted into steam at the desired temperature/pressure. Essentially an enclosed area where water is kept for heating is a boiler. Burning of fuel inside a furnace causes production of flue gases which are very hot. These flue gases after coming in touch with the water container, heat energy of these gases transfers to water and consequently generating steam inside the vessel.

This steam, then is further transported for usage depending on the process and industry. In case of thermal plant, it is piped to the turbine. For various applications, numerous boiler types are available for utilisation. These applications could be anything like warming up an area, sanitatizing of an area, running a production unit or sterilizing equipment, etc.

3.2 Boiler in Dyeing Process

Dyeing factory involves the process of textile printing and dyeing, and sometimes even sizing. The process of imparting color to textile products like yarns,fibres and fabrics is called

dyeing..The plant boiler provides steam for heating these products for the dyeing and drying.Different boilers used in fabric dyeing factories are oil and gas boilers, biomass boiler and large environment friendly coal-fuel boilers. The fuels used for the production of thermal energy in general are coal, natural gas,diesel oil, LPG, heavy oil coal, and solid fuels such as rice husk, palm oil shell, and other biomass fuels.

3.3 Literature Review

Talware *et al.* have designed Boiler Drum Automation using PLC and SCADA and implemented it in respective softwares for live monitoring. Different sensors and field devices are used to measure the crucial parameter such as water flow, steam flow rate water level. SCADA visuals are used to monitor the parameters and PLC is utilized for process control. If steam flow or water level exceeds preset value, the complete system stops and automated safety valves open to release the water steam, thus causing reduction in pressure.
Kalaivani *et al.* focussed on giving input to boiler at certain temperature, for continuously maintaining a constant boiler temperature. SCADA was utilised for monitoring water level inside the boiler alongside its pressure and temperature through sensors.The resulting values were delivered to the controller that changes the boiler temperature, pressure and water level. If any of the parameters in boiler exceed the preset values, the full system is stopped automatically. During emergencies various automatic safety valves were opened for releasing steam also setting off alarm for human workers. Boiler automation ladder diagram is designed using WPL software and SCADA design is done by Intouch wonderware.

Ghule *et al.* outlined the designing and setup of automated boiler operation utilizing sensory equipment and PLC. A basic pathway for moving in automation direction at bigger scale and completely digitizing industrial setting was designed to get higher efficiency in reduced times. PLC was used to design and implement the boiler operation. Sensors measured the pressure and helped with maintenance. Temperature or pressure exceeding the preset values caused complete system to stop and supply getting shut off automatically. Pressure was released and maintained. When the pressure went back to lower value than the preset value then the complete system switched on and supply was switched on.

CHAPTER 4

METHODOLOGY

4.1 Overview

In order a to have a complete understanding of PLC and SCADA and thereby be able to build a program for controlling boiler operation in a dyeing plant, it was important to learn and work on different PLCs. A brief description of topics covered in the six months to reach the final stage of preparing the program is given below:

4.1.1 Study of Programmable Logic Controllers (PLC)

A PLC is a device used in industries which can manage inputs/outputs, and make predefined logical decisions during automation process. It can be programmed lest any extra difficulty because of its quite easy to understand programming languages. It consists of a central processing unit (CPU), a device for program, memory and input/output interface. The CPU is the main intelligence hub of the PLC. It can accept data, status information (viewable from the status

chart) from various sensory devices like proximity switches, limit switches, also executing the user defined program as stored within memory and giving proper instructions to output devices like switches, gates or valves. PLCs used in six months are Zelio, Twido, M218 and M340 all developed by Schneider Electric.

4.1.2 Study of HMI (Human Machine Interface) system:

A HMI (human machine interface) is an interface connecting a human user to the PLC for performing a plant process. The interface has electronic parts for signals and control of automated system. Schneider Electric's HMI technology is brilliantly designed for meeting the complexity of tasks of industrial machinery and setups. HMI of Modicon M218 and Twido are perfected for meeting unique HMI requirements by usage of open and high preset standard interface in softwares and hardwares, allowing greater integration in an industrial automation system.

4.1.3 Study of SCADA system

Software used was Vijeo Citect for SCADA supervision. SCADA system is a combination of hardware and software which helps users in:

- Controlling and monitoring industry tasks from closely or remotely.
- Interacting with devices including motors, pumps, valves, sensors and even more with HMI directly.
- Recording data and happenings in record files.

4.1.4 Industry Visit

To understand the Boiler operation better, an industry, HC Dyeing Works (Ludhiana) was visited. There, process of steam generation and cloth dyeing was studied. Help was taken from the engineer in charge.

4.2 Programmable Logic Controllers (PLCs)

For a Technical person, a PLC is a computer system which takes data from input devices like a switch or a sensor, then processes them according to a saved set of instructions, and gives

output data to for machine and process control. Basic PLC diagram is shown in figure 4.1 with various parts of PLC described in the next topic.

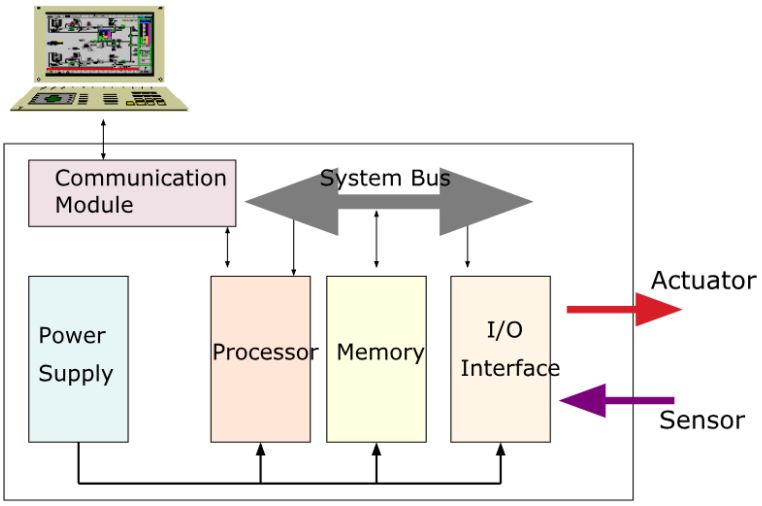


Fig 4.1 Basic PLC diagram

A PLC has three major sections

- Input/output Module
- Central Processing Unit Section
- PM(Programmer/Monitor) device

4.2.1 Input/Output Module

This section section forms an interface of the physical device available out of the Programmable Logic Controller with the digital module present in the controller. Functions of the Input/Output module are:

- Condition
- Isolating
- Terminating
- Indicating

4.2.2 Central Processing Unit Section

The Central processing unit is the intelligent hub of the entire system. It contains following parts:

- Memory

- Processor
- Power Supply

4.2.2.1 Memory

That area of CPU where information and data are kept and obtained.The memory system is classified in following subparts:

- Executive Memory- stores executive program or the system software
- Data Memory- Main purpose is for storing number data needed for mathematical calculations, barcodes etc.
- User Memory- Containing the user-defined set of instructions.
- Input/Output Image Memory- This type of memory consist of location of memories that keep ON/OFF states of all outputs and inputs.They are kept in output status file and input status file respectively.

4.2.2.2 Processor

Processor has the following functions:

- To read and store the data. It could be the update of external inputs and input modules.
- To carry out maths and logical operation as defined by user instructions
- To perform external device communication and performs self-diagnosis.

4.2.2.3 Power Supply

Function of power supply is:

- To provide electrical power the complete system
- To convert the high AC voltages to different working DC voltage levels for electronic circuits
- To filter as well as regulate DC voltage thus ensuring systematic computer processes

4.2.3 PM Device

The PM(Programmer/Monitor) device is utilized for communication with PLC circuits. Users can use the programming area of this device for entering or editing of set of instructions to be executed.

4.2.4 Operating cycle of a PLC

The operation of PLC involves three steps as explained in figure 4.2.

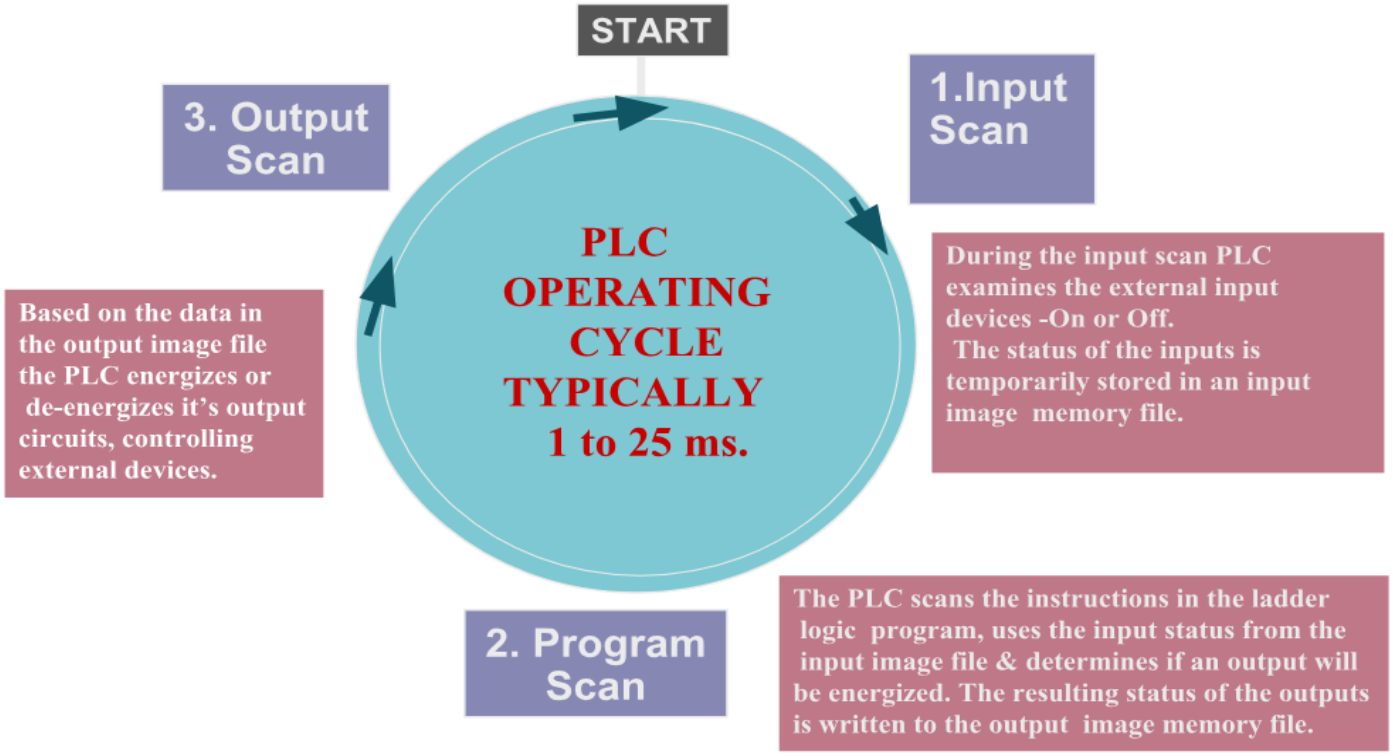


Fig. 4.2 Operating cycle of a PLC

4.2.5 Input/Output Devices

Table 4.1 and table 4.2 depicts the input and output devices (both discrete and analog) commonly used with a PLC respectively.

Input Devices	Output Devices

DIGITAL	ANALOG
Pushbuttons	Transducers/Transmitters
Selector Switches	Encoders
Proximity Switch	Level Transducers
Limit Switches	Pressure/Temperature
Photoelectric Switch	Potentiometers
Relay Contacts	
Motor Starter Contacts	

Table 4.1 PLC input devices

DISCRETE	ANALOG
On/Off Valves	Analog Meters
Motor Starters	Electric motor drives
Solenoids	Proportional valves
Control Relays	
Alarms	
Lights	
Fans	
Buzzers	
LED Displays	

Table 4.2 PLC output devices

4.2.6 Programming Language

A sequence or a set of commands/instructions entered by a human to set a controller to perform tasks can be described as a program. On the other hand, a Programming Language is a set defined rules for entering these commands. Ladder Logic is the highest prefered languaage. Other Languages occasionally used to program the PLC's include:

- Functional Block Diagram (FBD)
- Statement/Instruction List (IL)
- Grafcet
- Structured Text (ST)

4.2.7 Ladder Logic

- Ladder language is a graphic language composed of contacts, coils and links between these elements
- This language is derived from a wiring diagram of the electrical relay thus commonly called as a 'ladder diagram'
- It basically is a system containing various specific terms and symbols and quite easily learnt.

The basic instruction list in ladder logic is given in table 4.3

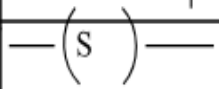
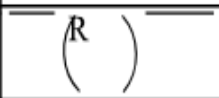
S.no:	Instruction List	Description	Symbol
1.	LD (Load)	Begins the logic operation with normally open contact.	
2.	LDN (Load Not)	Begins the logic operation with normally close contact.	
3.	AND	Adds the normally open contact serially	
4.	ANDN (And not)	Adds the normally close contact serially	
5.	OR	Adds the normally open contact in parallel way.	
6.	OR NOT	Adds the normally close contact in parallel way.	
7.	OUT	Output	
8.	SET	Latch	
9.	RESET	Unlatch	

Table 4.3 Ladder logic instructions list

4.3 Zelio

The most basic PLC, zelio is the easiest to understand and program. It is a very good first step in learning PLC programming. However, it has its limitations and cannot handle complex processes. Zelio is shown in figure 4.3.

Fig. 4.3 Zelio

4.3.1 Serial Number of Zelio

Serial number of a zelio plc gives us the following information:

SR 2 D 20 1 FU

1 2 3 4 5 6

1- SR= Smart Relay
2- Family(2=compact, 3=Modular)
3- Type (A = Having display but without clock, B = Having display as well as a clock, D = Not having clock or display, E = Having clock display but not display)
4- No. of I/Os. (10, 12, 20, 26)
5- Input/Output type(1 = Relay output, 2 = Transistor output)
6- Power supply(BD=24VDC, JD=12VDC, FU=100-240VAC, B=24VAC)

Zelio Logic is programmable using the Zelio Soft program in Ladder language.
Here, simulation is available on PC itself. It is easiest and simplest software to use and design.

A no of applications were done using ladder logic on zelio out of which one is shown in the next section.

4.3.2 Zelio application

Star delta operation of motor:
On pressing start (I1), motor main(Q1) is switched on currently running in star mode(Q2). After a considerably delay (say 15 seconds), motor mode changes to delta(Q3). To accomplish this, A timer(TT1) is used which is activated when we start the motor. When time set on this timer is completed, it switches off Q2 and turns on Q3. Ladder logic of the program is shown in figure 4.4.

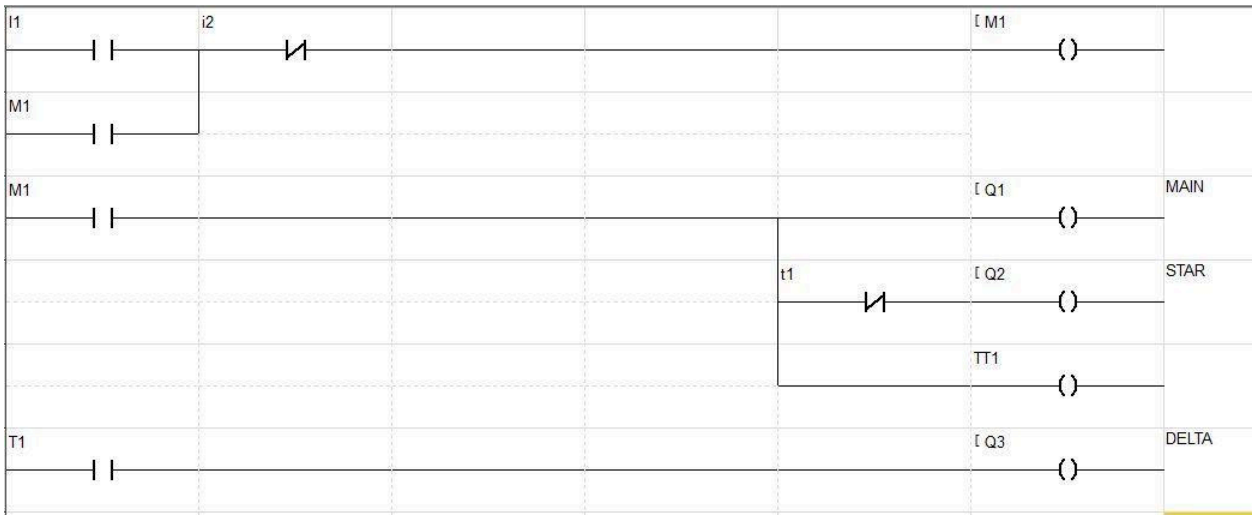


Fig 4.4 ladder logic using zelio of star-delta motor

4.4 Twido

Twido PLCs have a greater flexibility and a reliable automatic device, crafted by Schneider Electric specifically for increase in the performance of panel building and machinery building. It contains two types-modular processing unit and compact processing unit, and a single variety of expansion units, (analog I/O as well as digital I/O) programming application.
In these PLCs processors greatly decrease panel spacing, giving 40 Input/Output sets muddled in very small space. Input/Output module and PLC give a variety of options for making easy connections using wires. These are, spring type connectors, Twidofast(pre-wired) and adjustable terminal blocks. In this PLC, control solution has an option to be customised to fit exactly what the application requires.

The option module can give improved RS 232 and RS 485 communicating capacity, support for HMI, memory of up to 32 K along with expansions of up to 64 K, a clock(real time), a collection of wires, some pre-wired units and simulators.

Twido PLC is of two types:

- Compact model
- Modular model

4.4.1 Compact model

Compact model of Twido PLC gives a complete PLC solution at a larger footprint as compared to modular giving at best 3.2*3.5*2.8 inches. There are 3 base PLCs under this category having variations in combination of 24 Volts DC input and output. These type of PLCs use a 100 to 240 Volts DC supply. Various models under this category are:

a. 10 I/O Logic Module – 6 inputs and 4 outputs.
b. 16 I/O Logic Module – 9 inputs and 7 outputs.
c. 24 I/O Logic Module – 14 inputs and 10 outputs.

4.4.2 Modular model

Modular model of Twido PLC gives a to the point type of PLC solution, with smaller footprints maximum at 1.9*3.5*2.8 inches. There are 5 different base PLCs under this category that vary in their 24 volts DC input and relay combination, transistor sink and source output. To improve performance of Modular models usage of the 18 expansion Input/Output modules available by Schneider Electric can be made. These PLCs use a 24 Volts DC supply. Various models under this category are:

a. 20 I/O Logic Module – 12 inputs and 8 outputs.
b. 40 I/O Logic Module – 24 inputs and 16 outputs.

4.4.3 Serial Number of Twido

Serial Number:

TWD	**L**	**C**	**D**	**A**	**40**	**D**	**T**	**K**
(Twido)	1	2	3				4	5

1- Model

C means Compact Twido Model

M means Modular Twido Model

2- Power Supply

Sr.	Type	Description
1.	D	24 V D.C.
2.	A	230 V A.C.

3- Ethernet Compatibility

Sr.	Type	Description
1.	A	Without Ethernet
2.	E	With Ethernet

4- Output Type
R means Relay output
T means Transistor source
U means Transistor sink
5- Terminal Type
F/T means Terminal Block
K means HE -10 Connector

Model Used - TWDLCAA24DRF (shown in figure 4.5)

Fig.4.5 Twido

4.4.4. Some Features of Twido

- Mathematical operations can be performed using OPERATOR block.
- More flexible and compact.
- Can be easily installed and maintained.
- Less coverage area (space) in a panel.
- Cost effective solution for automation.
- Can communicate with SCADA.
- Simulation not available.

4.4.5 Twido Application

Room Automation

In this application different electrical appliances installed in the room get turned on and off depending upon the number of persons in the room. Sequence of this application is as follows for this kind of applications counters are used to keep the count of persons entering in the room. When the person enters into the room photosensor gets turned on and gate opens automatically. After the person has entered in the room the door gets closed.On entering of second person same process takes place, but on entering of third person fan gets on. If one person is present in the room then only the tubelight i switched on. If three persons are present, fan switches on alongside the tubelight. If 5 or more are present air conditioner switches on. On decrease in number of persons, corresponding appliance gets switched off. The ladder logic on Twido of this problem is shown in figures 4.6 and 4.7.

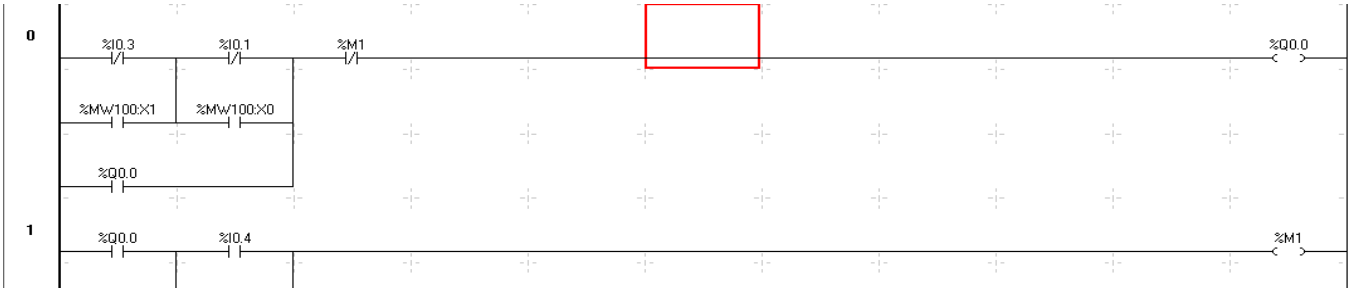


Fig. 4.6 Room Automation using ladder logic on Twido

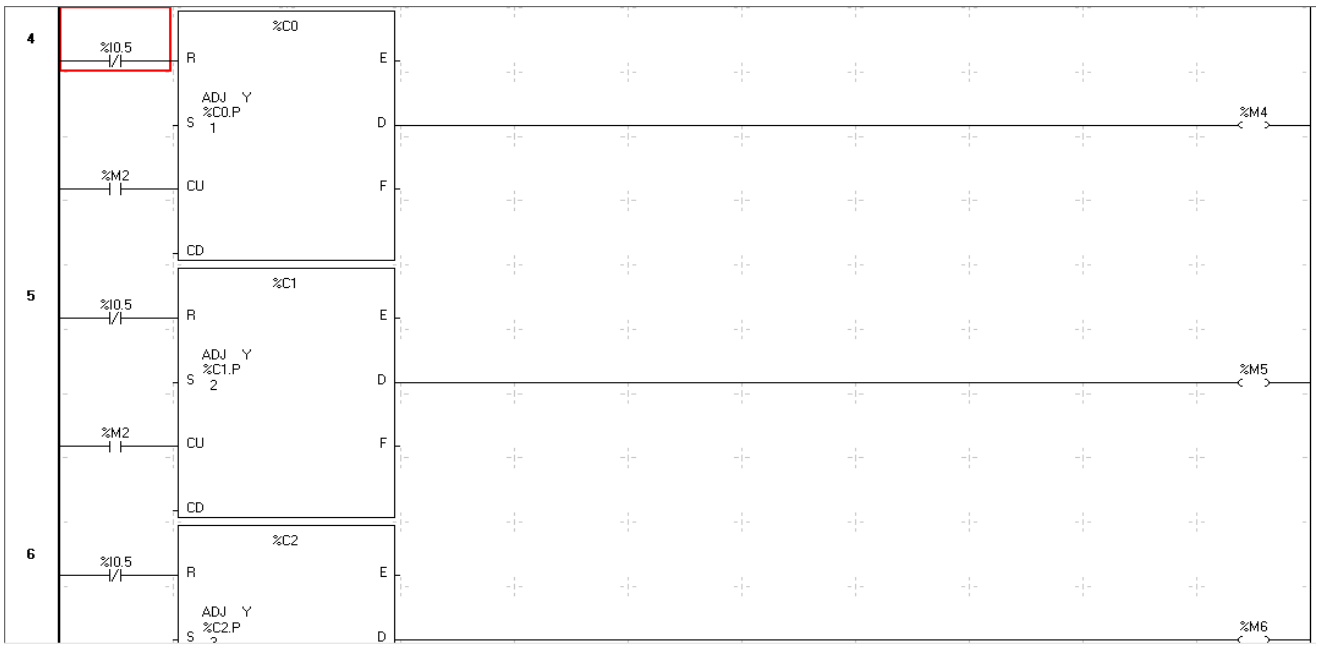


Fig. 4.7 Room Automation using ladder logic on Twido

4.4.6 Human Machine Interfacing in Twido

It shows graphically designed visual elements designed by a technician of a manufacturing task or a system for controlling process. The HMI model used was **XBTR400.** The software used was vijeo-designer lite for the making of different panels of the HMI. It is the simplest of HMI without touch-screen facility.

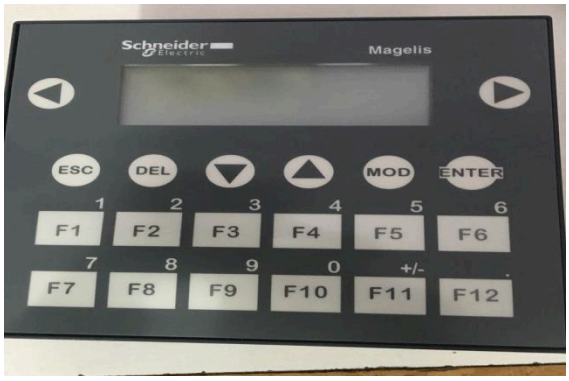


Fig. 4.8 Twido HMI (XBTR400)

4.5 Modicon M218

The M218 Logic Controller was the most powerful PLC used, having numerous functions. This PLC has the ability to serve a huge variety of applications. For developing a program,'So Machine' software was used .This PLC has the capacity for managing 7 processes(one MAST and six others). power supply of M218 PLC is 100-240 Volts AC. Schneider Electric M218 is shown in figure 4.9.

Model Used- TM218LDA40DRPHN

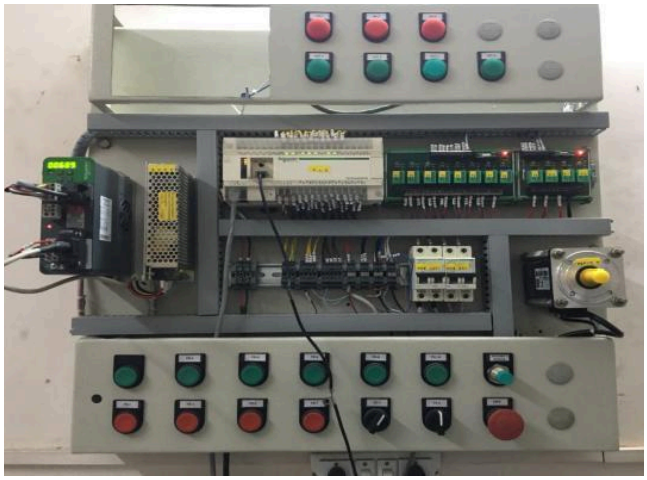


Fig. 4.9 Modicon M218

4.5.1 Some features of M218

- No analog inputs or outputs
- HMI more advanced
- Simulation not available.
- Availability of fast inputs and outputs.

4.5.2 M218 Application

Slide Program

In slide program, there is a movement of slider in forward direction or reverse direction. When start is pressed, it moves in the forward direction till limit switch 2 where it automatically changes direction to reverse back to starting position. Ladder logic using M218 is shown in figure 4.10

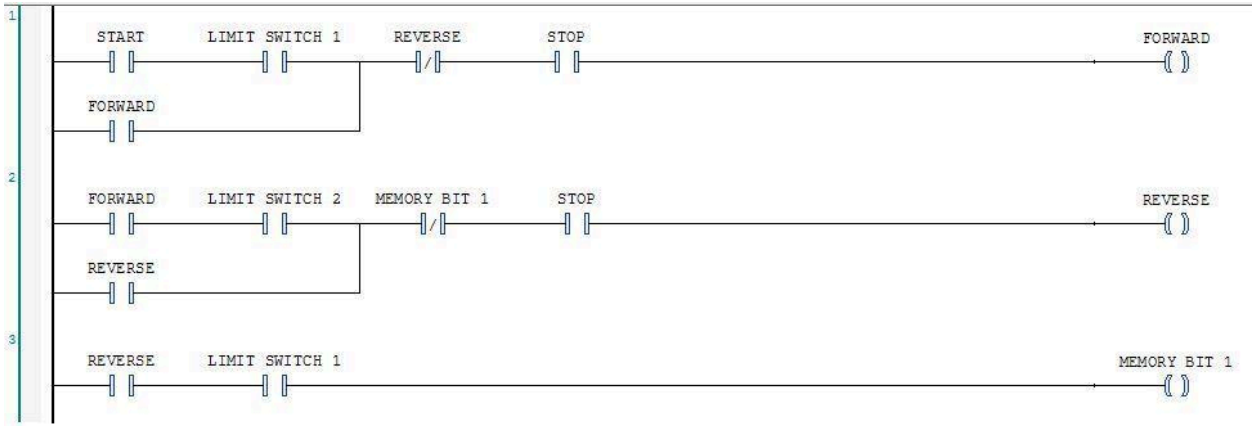


Fig 4.10 Slide program using ladder logic on M218

4.5.3 HMI in M218

The HMI model used was **HMIGXU3512**(figure 4.11).It is a more advanced HMI with a 7 inch touch-screen. It runs on 24V DC and 9.2W which is more than Twido HMI. The software used is Vijeo Designer Basic 1.1 (figure 4.12) for panel making. Additional features like Security login, Output detection are also available in this HMI.

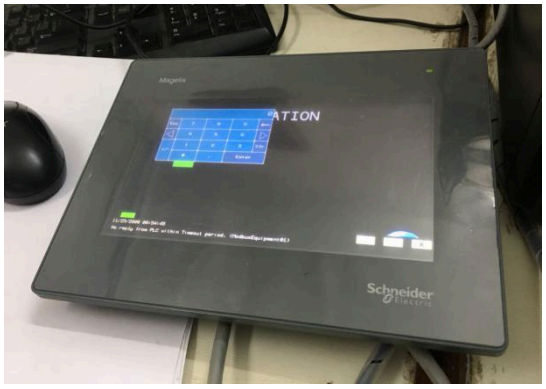


Fig. 4.11 M218 HMI(HMIGXU3512)

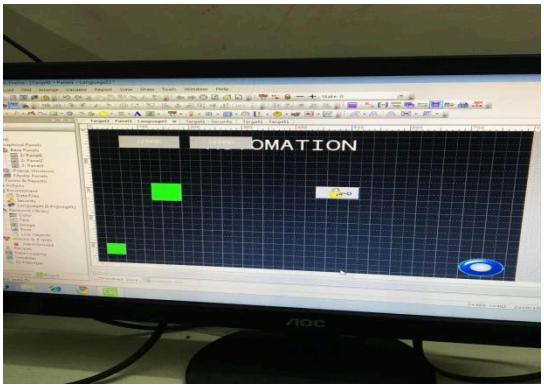


Fig. 4.12 Vijeo Designer Basic

4.6 Modicon M340

The Modicon M340 PLC is one of the most powerful, reliable and compact controller equipped with top notch features and provides very high performance. Its high performing processor is capable of handling all the latest industrial applications. Most importantly this PLC is used for communicating with SCADA and even the simulation of boiler automation in the dyeing industry was carried out by making the ladder programming on this PLC.

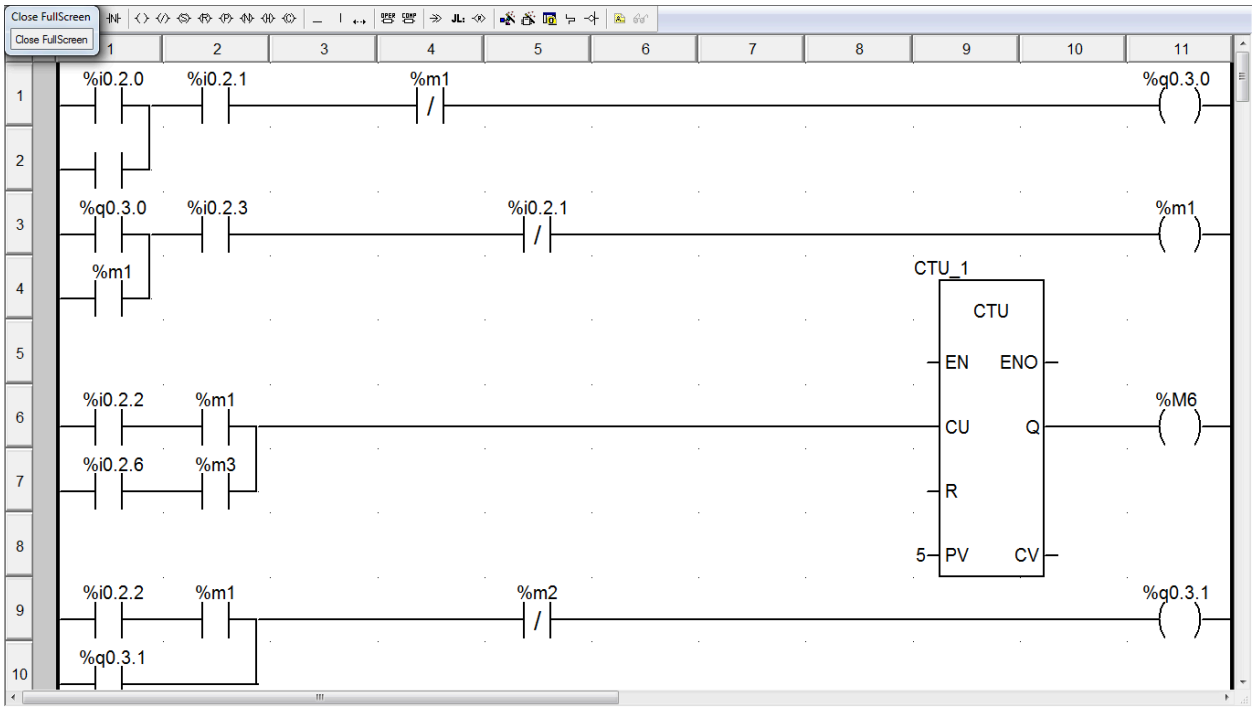
4.6.1 Features of M340 PLC

- 4 MB programming memory is available
- Processor is capable of handling 7 instructions in millisecond
- file storage of 128 MB
- USB programming port

4.6.2 M340 Application

Car Parking program

An underground parking has capacity for 5 Cars. When full, red light is on otherwise green. There is a entry gate which opens on detection of a car and closes as soon as car has entered. Similarly, there is an exit gate with same sensors. The program for this situation is given in figure 4.13 made using ladder logic on M340.



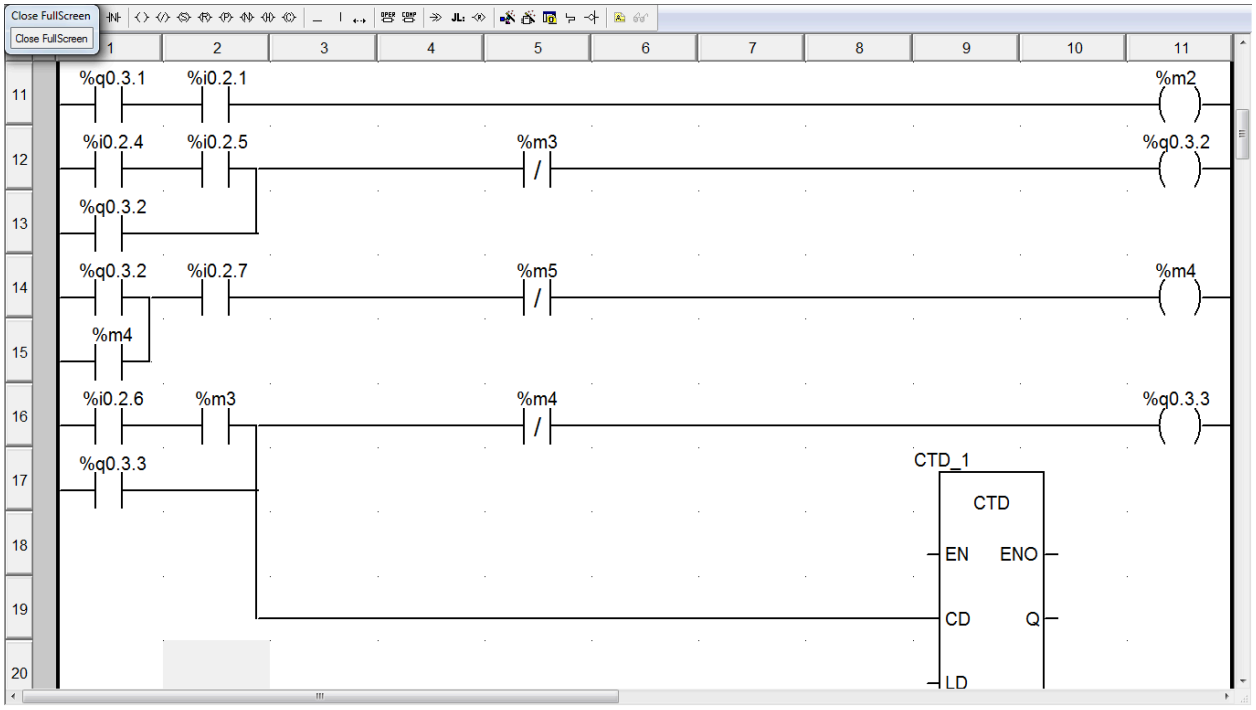


Fig 4.13 Car parking program using ladder logic on M340

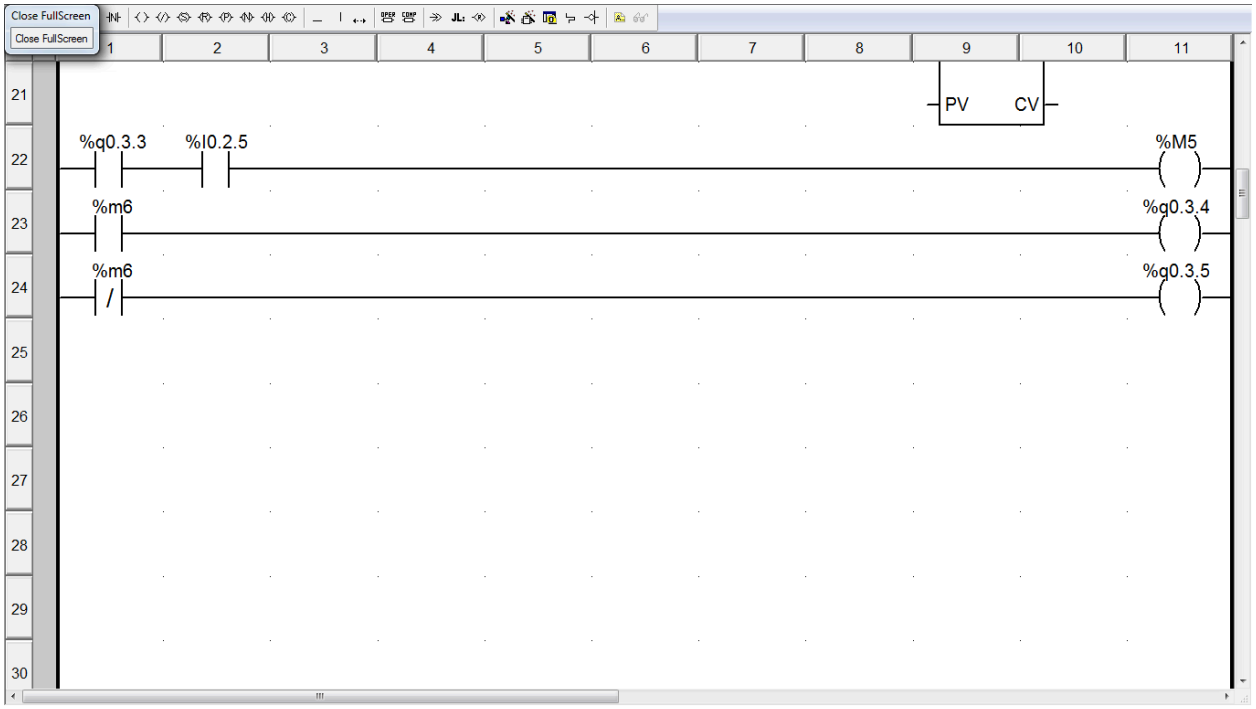


Fig 4.14 Car parking program using ladder logic on M340

4.7 Programs developed using PLCs

- Paint industrial process
- Automatic school bell
- Continuous flashing of LEDs
- Automation of room appliances
- Underground car parking
- Fastest Finger first contest
- Traffic lights application
- Powder industrial process
- Automatic drilling process
- Direct On-Line Starter
- Bottle labelling process
- Star-delta motor start
- Fruit packaging control

4.8 AC Drives

ALTIVAR31 controller was used for controllimg the asychronous motors in AC Drives. ALTIVAR belongs to the family of adjustable frequency Drive. This controller can be used for performing the different types of operations on motors namely starting, stopping, braking and frequency control.

Fig4.15 ALTIVAR31

While controlling the motors using ALTIVAR driver then there are number of menus available in this controller and each menu has significant functions which are selected to perform various operation on the motor these menus are listed below:

- Speed reference -ref
- Settings- set
- Motor Control-drC
- Inputs/Outputs cgf -(I-O-)
- Command-CtL
- Application function-FUn
- Fault management-Flt
- Communication-com
- Monitoring-SUP

4.8.1 Configuration

Before operating the controller everytime it has to be reset because otherwise it will contain all the previously set up instructions along with the drive is also set in auto-tuning mode where it operates as per the default settings.

4.8.1.1 To factory reset the driver

- Open the FUn menu and scroll the jogger until it reaches the FCS option then press the jogger.
- After pressing the jogger select the InI option and keep the jogger in pressed position until the nO appears on the display screen.
- Repeat the above steps for drc, I-O and ctL menu.

4.8.1.2 For auto-tuning the Drive

- Go to drC menu and croll the jogger till it reaches the tUn option.
- Press the jogger until the tUn option blinks on the screen.

4.8.1.3 Operating modes of drive

There are mainly three operating modes in drives namely

- Local wire control
- Three wire control
- Two wire control

Two and three wire control are external controls whereas jogger is used for the local operating mode. Steps for setting up the local control are as follows

- Open I/O menu
- Open tCC for selecting 2 or 3 wire control or local control.
- Open CtL(command menu) and click fr1 (referencing channel one)
- A dial named AIUI is selected.
- Open reference menu and again AIUI dial is selected
- Check once and press run
- For reducing the motor noise, select todrC menu and open Sfr (switching menu), then input desired frequency
- To run the motor at 100 Hz select drC and open Tfr and give its value 100 Hz
- For displaying the speed of drive select the setting menu (set) and select the option of Sds

4.8.2 Two wire and three wire control

In Two wire control state of inputs whether they are open or closed controls the running, stopping and direction of motor. Two wire control is mainly used for having the toggle switch control over the motor

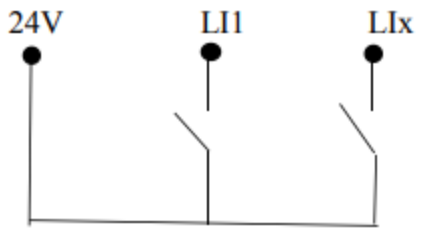


Fig. 4.16 two wire control system

For running the motor in forward direction 24V wire is connected to LI1 wire and for running it in reverse direction 24V wire is connected to LIX wire where X can take any value from 2 to 6.

Three wire type system of connection (figure 4.17) is used when the requirement is to use push button for controlling the motor. For running motor in forward direction connect the 24V wire to logic input 1(L1) as well as to logic input 2(L2). For running the motor in reverse direction just replace the connection from logic input 2 to LIX here X can be from 3 to 6. In this case motor will continue to run even after the wire is removed. In order to stop the motor just disconnect the Logic input 1 wire.

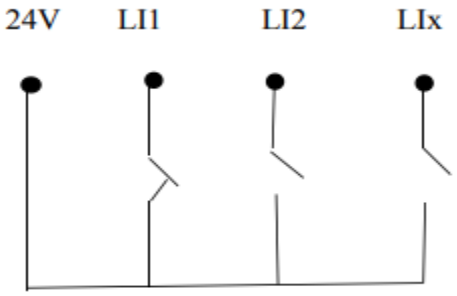


Fig. 4.17 three wire control system

4.8.3 Types of stop for motor

There are namely four stops in the controller which are:

- Ramp stop

- Fast Stop
- Freewheel Stop
- DC injection Stop

For selecting different stop option for the motor steps are:

- Open the menu ‘fUn’ and scroll the jogger for ‘ stc’ option
- Press the jogger and again scroll the jogger until the ‘stc’ appears on the display
- Under the ‘stc’ menu select the type of stop
- ‘Rmp’ for ramp stop, ‘fst’ for fast stop ,’nst’ for freewheel stop and ‘dcf’ for DC injection stop.

4.9 SCADA

Supervisory Control and Data Acquisition system is pretty important in industries as they preserve efficiency and also notify about any system errors to reduce shutdown time.

The architecture structure of SCADA starts with PLCs or it could be RTUs. Both of these are computers (PLCs explained above) that have the ability for communicating with a wide range of devices like industrial machinery, human interface, sensory equipment and transfer this data from these devices to systems containing SCADA. SCADA can process, distribute, and display this information, enabling workers as well as technicians and engineers to understand and learn from this information and decide the required adjustments.

To understand better, a situation is taken where SCADA system instantly communicates to the worker about a sample of products having larger deficiencies. The worker immediately stops the working and checks the data using a user interface to find the problem. The worker, on reviewing sees that fault was in machine-2. So, SCADA’s function to instantly inform the worker resolved the problem avoiding more losses.

Simple SCADA diagram is shown in figure 4.18

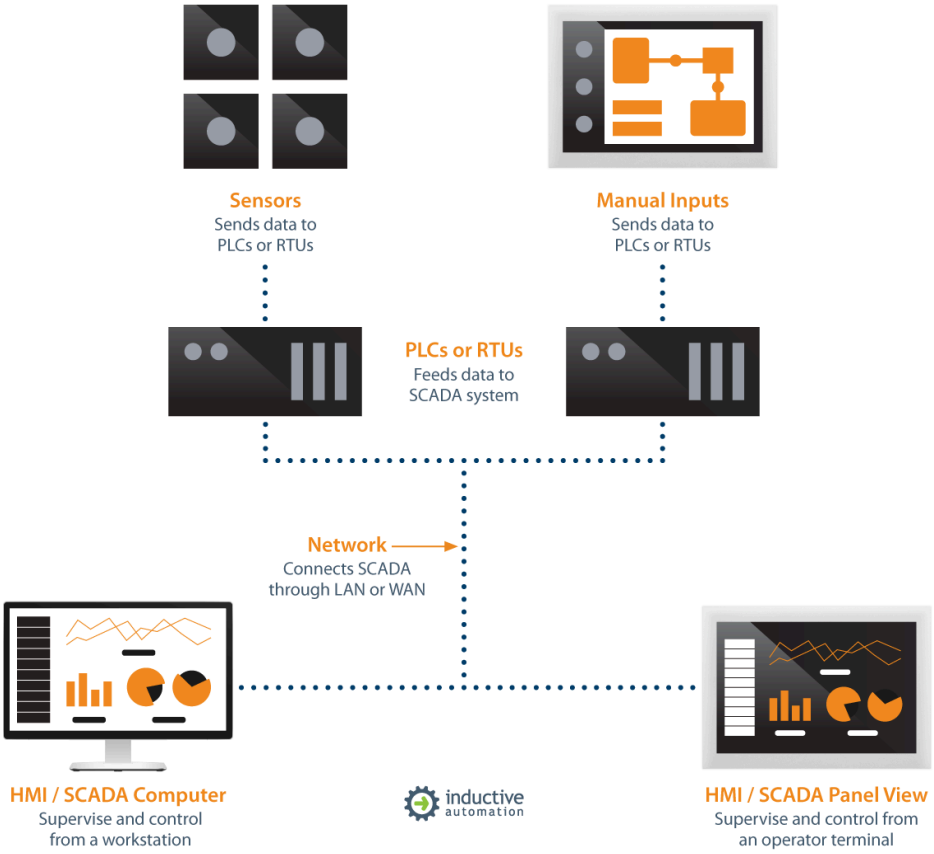


Fig. 4.18 Basic SCADA diagram

4.9.1 SCADA Programming using Citect

Vijeo Citect has three starting windows. First is Citect project editor whose main purpose is communication. Second Vijeo Citect Explorer that creates or deletes a project.Third is Citect graphic builder is used for creating an animation pages and project (design of project).

- Open the citect explorer and from the file menu select the option of new project.
- After selecting the new project expand it and new options will become available after its expansion
- Go to systems option and select users. Fill any desired name in the user window and click on add button once.
- Then under the project option go to communications and select the option of express and new window will appear. No further changes until the option of select PLC module appears select the modbus TCP protocol from PLC module.
- Then fill the I.P. address use 127.0.0.1 for simulation mode and 90.0.0.1 for standard mode. Finish the setup.

- Again open the communication option available under the project menu and select the cluster option which appears after clicking on the communications option. Fill any desired cluster name.
- Then select the option of tags available on the side of the display window of citect explorer under the project menu.
- After clicking on tabs fill the variables name such as start, stop or sensor etc and fill the address as set in ladder programming done in Unity ProXL software and select the data type as digital.
- Click on the add option for each variable being defined.Click on the graphics option on the left side of display window of citect explorer
- After clicking on graphics option of pages will appear and create a new page and draw the animation on it.
- Select the option of button option available on the right side toolbar and after selecting the button new window will appear. From the new window select the input option for the button and insert tag according to variables defined in the M340 ladder programming.
- Similarly repeat the same step for output by selecting it from tools menu.
- After completing the animation save the project and then compile it.
- Check for any errors and correct it and after that open the option of tools available on the top bar.
- Select the computer setup wizard from the tools menu and finish the setup.

4.10 Types of Boiler

Boiler, mainly can be classified as follows:

- Fire tube
- Water tube

4.10.1 Fire Tube Boiler

As evident from term itself, this type of boiler generally involves tubes for the passage of flue gases. The flue gases tube is submerged in water present inside the main boiler. So, basically in this type, there is an enclosed container filled with water,in which hot pipes are immersed. Heat from flue gases transfers to water causing the generation of steam and which is ejected using a valve. In this case, steam as well as water are present in the same container so this type of boiler is unable to generate steam at higher pressures. Usually, it has the ability to generate till 17.5 kg/cm^2 along with a net capacity of nine metric tons of steam production every sixty minutes.

4.10.1.1 Advantages of Fire Tube Boiler

- Miniature design and setup
- Capable of meeting fluctuating steam requirement
- Cost reducing option

4.10.1.2 Disadvantages of Fire Tube Boiler

- Long timers are required for steam to rise at desired pressure as quantity of water needed for boiling process is huge.
- Steam cannot be generated at higher pressures.
- Generated steam with this type is quite moisturised

4.10.2 Water Tube Boiler

In water tube boiler water passes through tubes getting its heat from flue gases that surround the pipes. So, in effect, water tube boiler is exact opposite of fire tube in which flue gases pass in pipes and water surrounds them.

4.10.2.1 Advantages of Water Tube Boiler

- Highly suitable for power generation in thermal power plants due to its capacity and efficiency.
- Heating area can easily be increased by usage of higher number of pipes for water.
- Here, water speed is quicker than that of other type due to convectional flow, hence efficiency is vastly improved as rate of heat transfer increases
- Higher pressure steam of upto 140 kg/cm^2 is generated easily in water tube boiler

4.10.2.2 Disadvantages of Water Tube Boiler

- Complex design and construction.
- Expensive to setup.
- Difficulty in transportation and construction due to size.

4.11 Dyeing Process

Airtight cabinets (figure 4.19) are used to dye the cloth. Cloth is hanged tightly together inside a cabinet by workers. After complete checking, workers close the cabinet door. They then put the required color in the sprayer. Depending on the color, they set the cabinet temperature using a PLC (figure 4.20) which thus controls the cabinet temperature. When the required temperature is reached, color is sprayed using the sprayer thus imparting the color to the cloth.

Fig 4.19 Dyeing Cabinet

Fig 4.20 Temperature control PLC

CHAPTER 5

BOILER OPERATION CONTROL

5.1 Overview

Industry visited was HC Dyeing works situated in Ludhiana. The company used a boiler for steam production which was further used to dye cloth in closed cabinets.
To design the ladder diagram or the logic of the project SoMachine software created for designing programmes for Modicon M340. The important variables to take care of are pressure, level of water inside boiler and temperature. The program is designed to accept the data from 4 sensors (one each pressure and temperature sensor along with two water level) available inside boiler, process these to make required signal that is finally utilized turning the water pump or the heater ON or OFF.

5.2 Certain Parameters

Fuel- Fuel used for burning was rice husk, fixed amount of which was added to furnace after regular intervals of time.

Boiler used- his type of boiler generally involves tubes for the passage of flue gases. The flue gases tube is submerged in water present inside the main boiler. Hot gases are generated from burning of fuel. The boiler had a capacity of 10 kg/cm^3 of pressure.

Sensors- Two level sensors are used inside boiler alongside one pressure and one temperature sensor. One temperature sensor exists inside cloth cabinet where dyeing takes place.

Safety Valve- Used only in case of emergencies.If a fault occurs and the system is not working properly , pressure can rise to more than the set value reaching close to boiler capacity which can

cause the boiler to explode causing widespread damage to both life and property. Hence safety valve is used which detects pressure reaching capacity , immediately shutting of system and releasing stream and also sounding an alarm.

5.3 Flow Chart of the Involved Processes

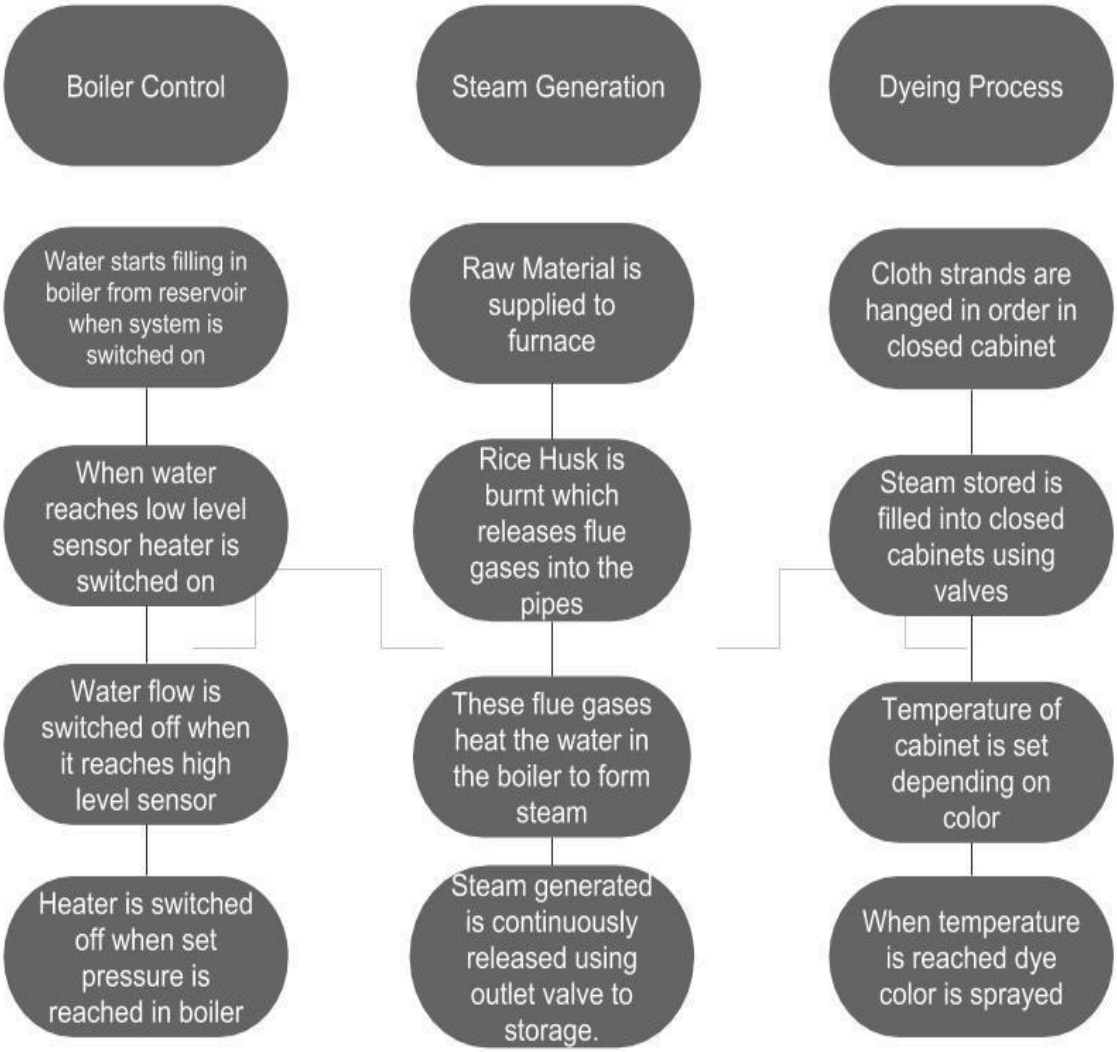


Fig 5.1 Flow chart depicts the entire processes involved in dyeing industry

For convenience, the project is divide into two parts:

- Boiler Operation
- Dyeing Process

5.4 Boiler Operation

5.4.1 I/O list

Inputs	Outputs
Start(m1)	Water inlet valve(m2)
Upper level sensor(m7)	Safety valve (m16)
Lower lever sensor(m6)	Steam outlet valve(m9)
Pressure sensor	Fuel gate(m3)
Stop(m10)	

Table 5.1 Inputs and outputs in Boiler Operation

5.4.2 Ladder logic (using M340)

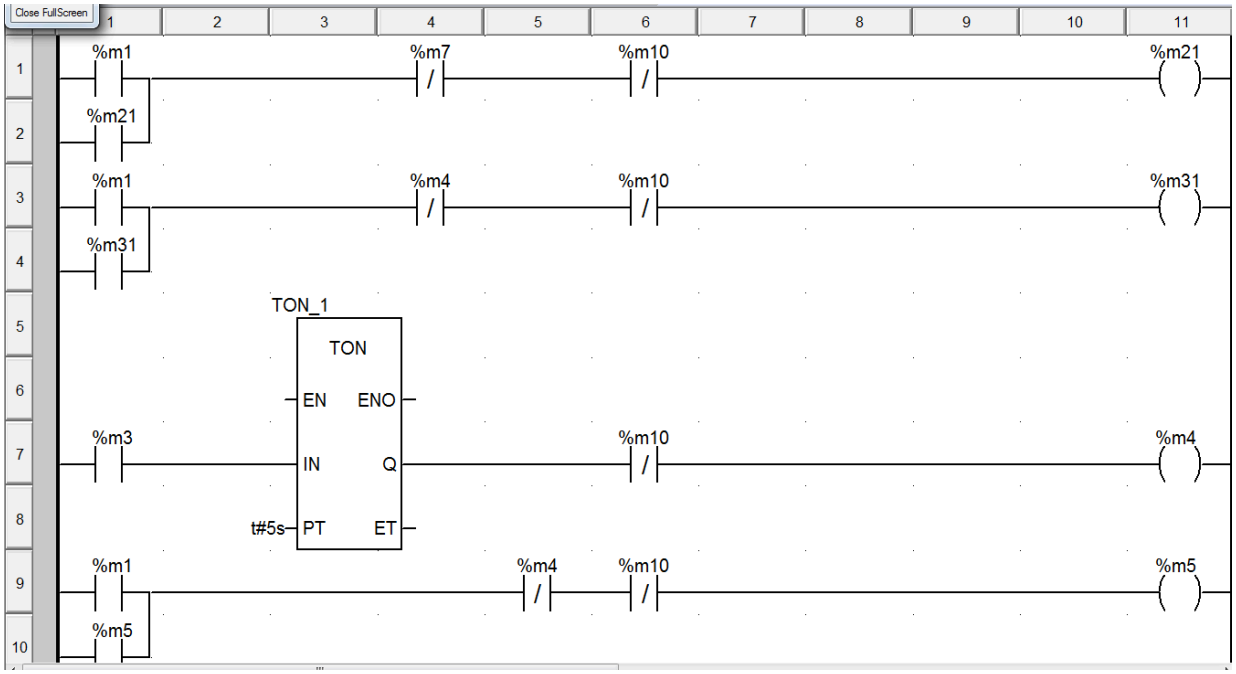
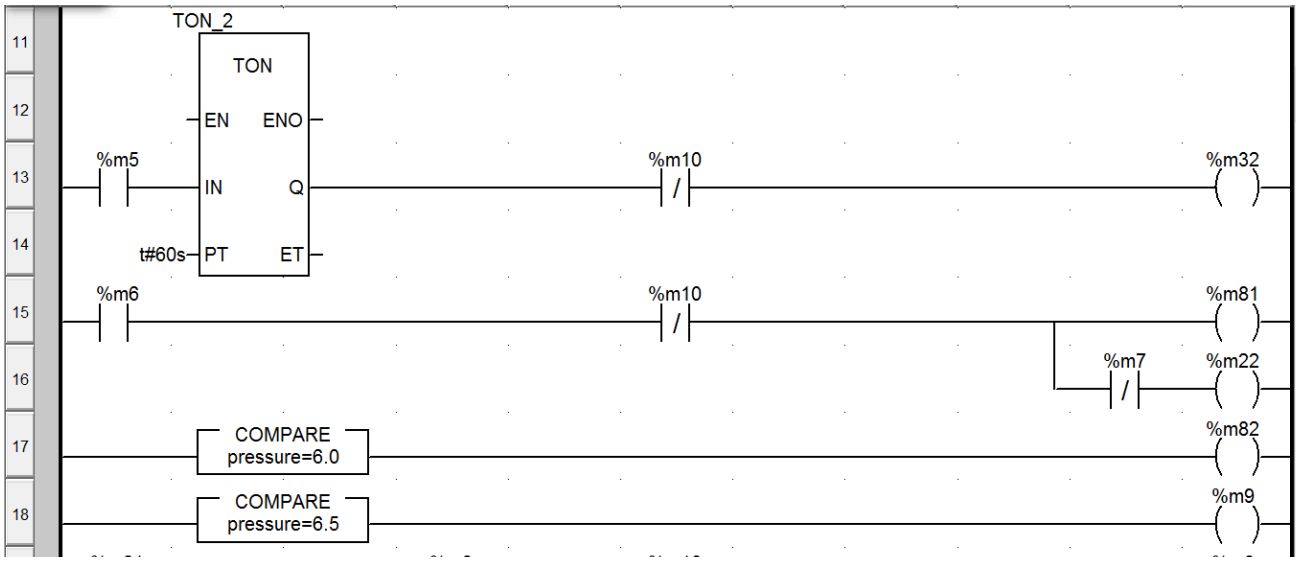


Fig. 5.2 ladder logic of boiler operation using M340



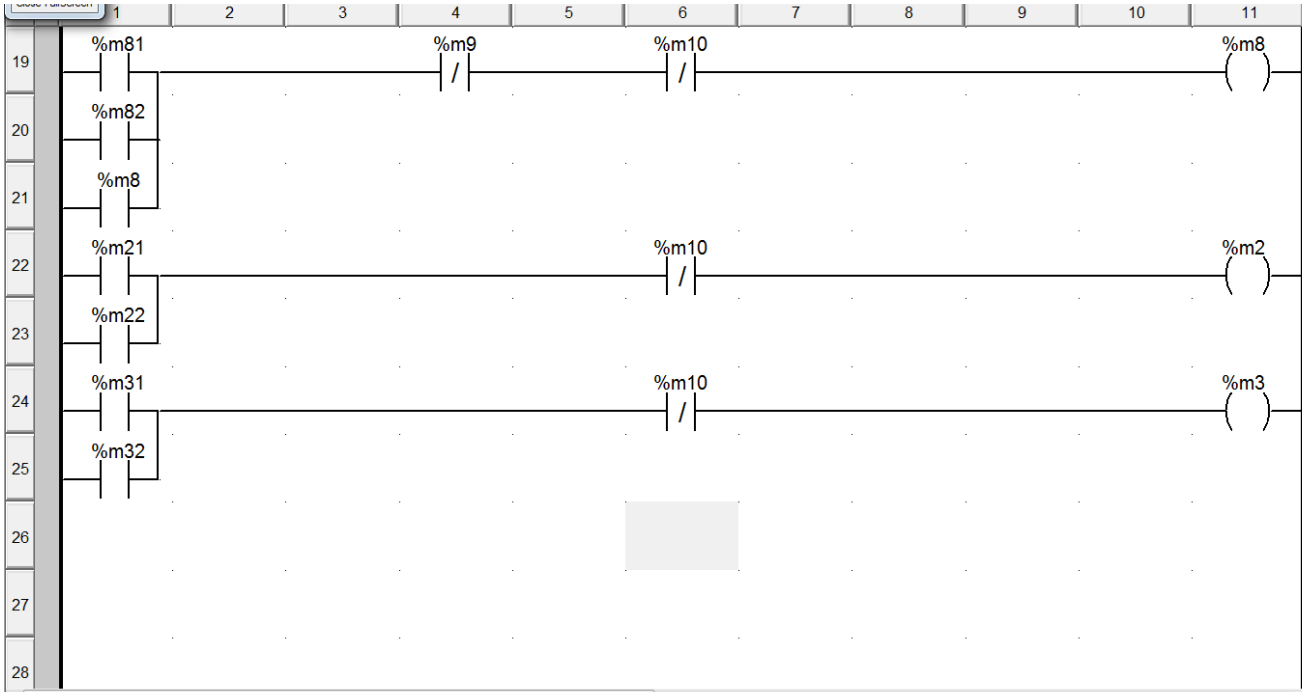


Fig. 5.3 ladder logic of boiler operation using M340

5.4.3 SCADA Representation

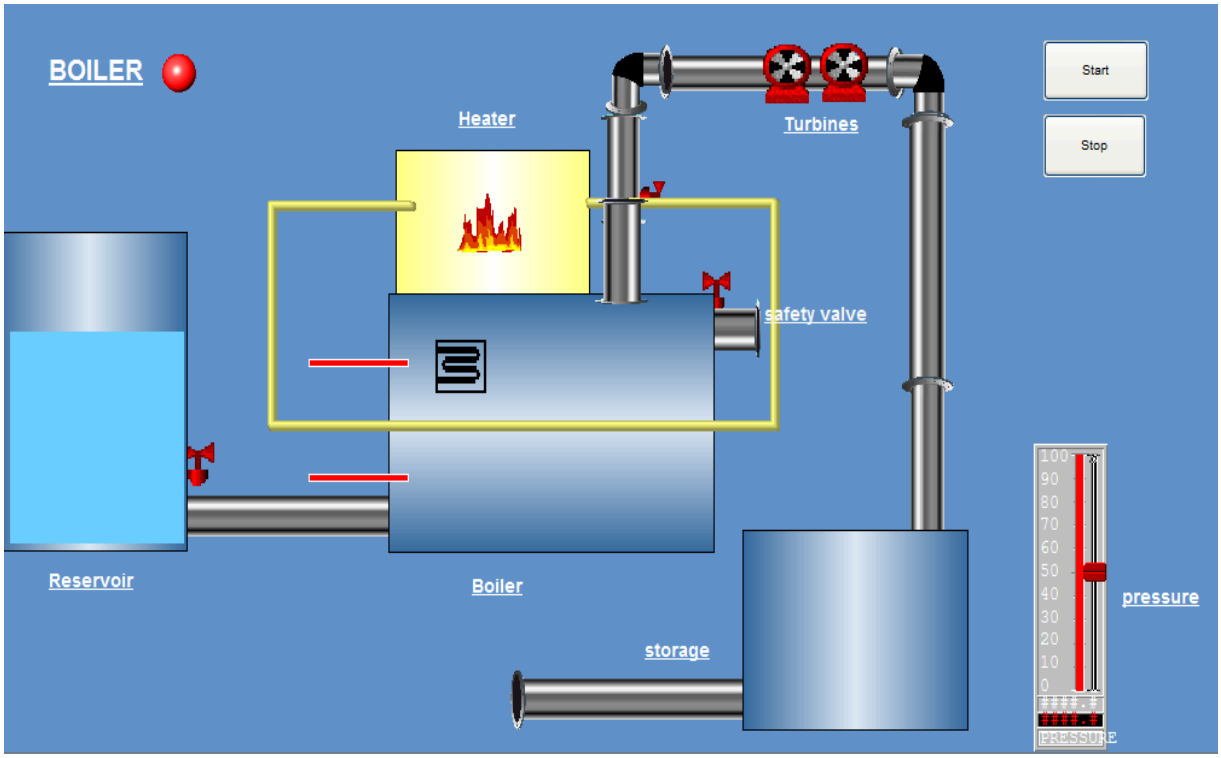


Fig. 5.4 SCADA representation of boiler operation

5.4.4 Working

When start is pressed water inlet valve opens and water starts filling up in the boiler. When lower level sensor detects water, heater is turned on. Water keeps rising in the boiler till upper level sensor which upon detection results in closing of inlet valve. Heater remains on till a pressure sensor senses a pressure of 6.5 kg/cm^3.At this point steam outlet valve opens and steam is continuously released. Pressure remains in the 6.0 to 6.5 bracket as heater turns back on at 6.0. As water decreases in the boiler till lower level sensor, inlet valve opens and water starts filling up. The fuel gate opens after a fixed amount of time for fixed time to allow in fuel in the furnace. This process continues until stop is pressed.

5.5 Dyeing Process

5.5.1 I/O list

Inputs	Outputs
Red button (m11)	Red color
Yellow button (m12)	Yellow color
Blue button (m13)	Blue color
Stop(m15)	Steam valve

Table 5.2 Inputs and outputs in dyeing process

5.5.2 Ladder Logic (using M340)

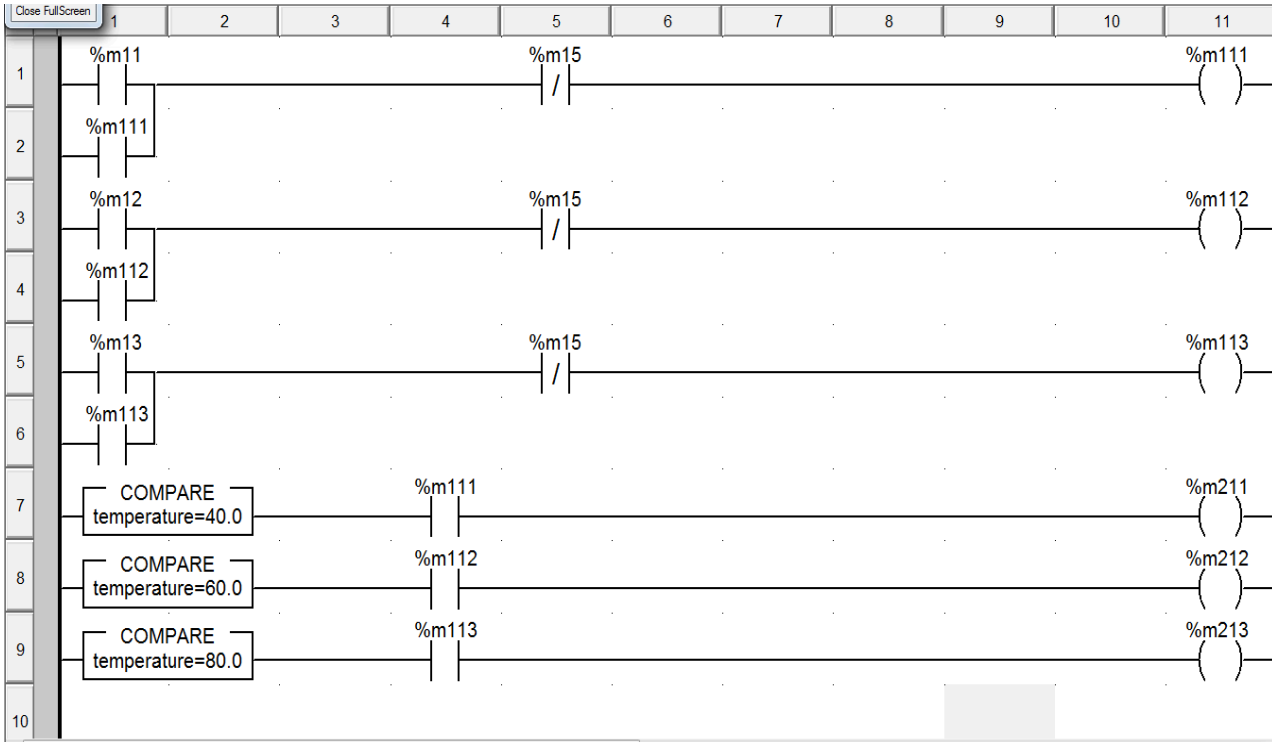


Fig. 5.5 Ladder logic for Dyeing process using M340

5.5.3 SCADA Representation

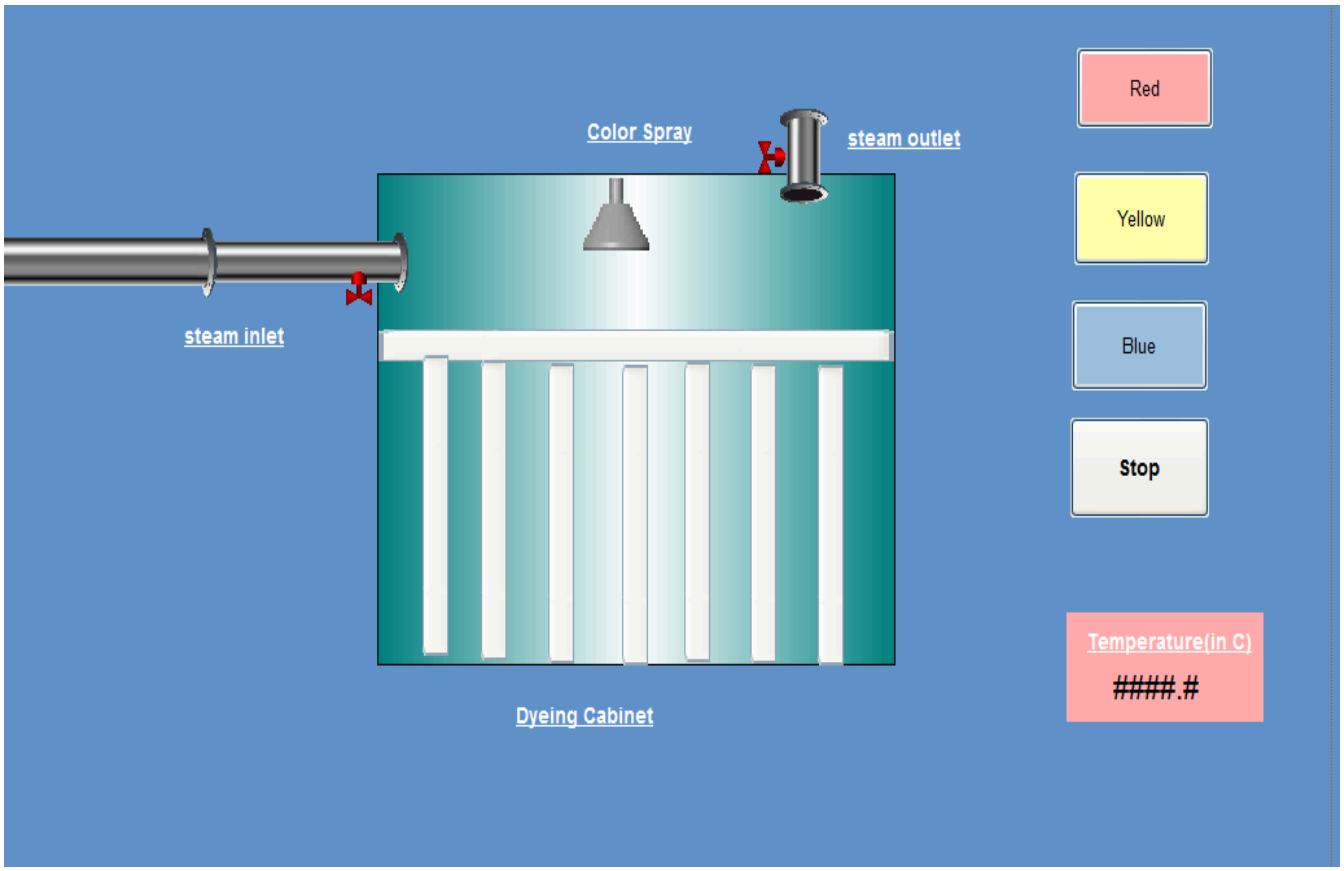


Fig. 5.6 SCADA Representation of dyeing process

5.5.4 Working

Steam from storage is used via pipes to fill the cabinets. For cloth to be dyed , workers hang the cloth properly in the cabinet before closing it. Then after adding color in the sprayer, plc is used. Temperature is set depending upon the color, then on pressing the respective color button, temperature starts changing to the desired temperature. Only if the color button pressed and temperature set are matching will the dyeing process take place. This has been programmed in order to avoid any error. Color and corresponding temperatures(in ℃) are given in table 5.3.

Color	Temperature(in ℃)
Red	40
Yellow	60
Blue	80

Table 5.3 Temperature presets for different colors

CHAPTER 6

OBSERVATION AND RESULTS

6.1 OBSERVATIONS AND RESULTS

2.1.1 PLCs better suited for industrial applications as compared to microcontrollers

The following is a comparison between PLCs and microcontrollers:

- Scalability: PLCs can handle larger amounts of inputs/outputs.
- Modularity: Editing a PLC's design can be done even after it has started working alongside its capacity according to customer preference. The same is not at all possible in microcontrollers.
- Industrial grade: PLCs have a strong hardware designed to maintain shape during shocks or vibrations, in other words capable to handling all challenges found in an industry setting. Microcontrollers suffer in this. PLCs can also handle high temperatures and corrosion.
- Distributed architecture: For bigger level usage a distributed system can easily be implemented by communicating between different logic controllers using protoCols like Modbus.
- Protection: PLC makers also always ensure safety providing certain important functions according to SIL certification in accordance with user need of Protection/Emergency Shutdown System.

Therefore microcontrollers are fantastic as teaching tools and for experiments. They are also cheap and make the difficult concepts of programming and automation much easier to learn. However, if the task at hand is keeping manufacturing running effectively, efficiently and

safely then PLCs deliver a wide variety of capabilities with reliability that has been tested and used for decades.

6.2 Boiler Automation

Boiler is not an easy place place to work at considering high temperature at heat involved. To get the best results and efficiency of boiler, usage of plc has become a necessity. It has vastly reduced the load on manual labour, who without plc would have to continuously run around looking at pressure and temperature meters to change settings accordingly. Benefits of using plc programming are listed below

- Efficiency is vastly improved
- Safety of work personnel is improved
- Cost saving system as fuel required for same output is less
- Reduces dependency on humans thus reducing human errors
- SCADA makes it easy to manage system
- Easier to recognise fault if it occurs and workers can respond immediately.

6.3 Future Scope of Automation

As automation is responsible for reduced costs and time consumption, focus of a lot of companies has shifted towards developing automation to increase dependency on automation and less on humans.

The perspective of total automation industrial units exists in this tech savvy world we live in. For example, users order a product on internet specifying its each and every detail from size to color and even ordering in small quantities. The job now falls on the smart robots and complex machinery to manufacture the required variety of products as demanded by the user in a smooth and rapid manner.This vision of fully automatic control is atlast progressing in the right direction. The yesteryears mission of automation and robotics and reducing the work of humans had a major flaw as they lacked focus given on communications. All this is being rectified today as communication and network intelligence is touching new heights and is widely accessible.

Although it has a downside, automation technology threatens to kill millions of jobs which is a problem because of the ever increasing population.A recent research by HfS has predicted that Indian Information Technology industry can lose about 6.4 lakh “low-skilled” jobs due to advancements in automation in the coming few years.

6.4 Conclusion

Automation technology for industries is rapidly expanding. Dependency on human workers is decreasing. The six months at automation system were very educative and helped to learn new skills and acquire knowledge regarding automation industry.

Outcome of project semester:

- Understanding Automation and its wide applications.
- Basic understanding of different PLCs developed Schneider Electric
- PLC programming using Ladder Logic.
- Monitoring of a process using HMI and SCADA
- Practical experience through industry visit understanding PLCs better.

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Appendix-I

Reflective Diary

Date 24/1/18

Zelio

Module

SR 2A 10 2 BD

Smart relay
Family
2: Compact
3: Modular

Product type
A: with disp. unit, no clock
B: with disp. unit & clock
D: without disp. or clock
E: without disp. but with clk.
XT: Extension module

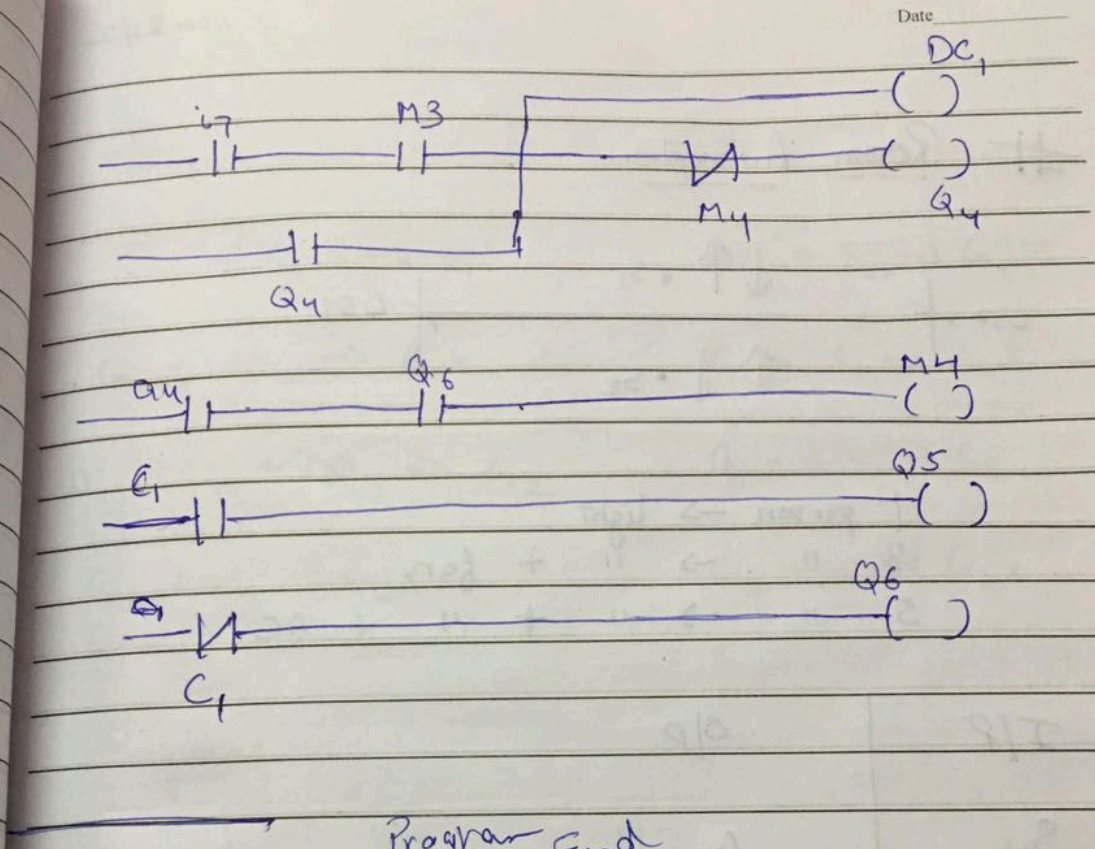
Power supply/inputs
BD: 24 V DC
JD: 12 VDC
FU: 100-240 VAC
B: 24 VAC

I/O type
1: Relay output
2: transistor output

No. of inputs
10: 10 I/O
12: 12 I/O
20: 20 I/O
26: 26 I/O

Signature of Mentor

Signature of Student



Program End

Signature of Mentor

Signature of S

Department of Electrical and Instrumentation Engineering, Thapar Institute of Engineering & Technology, Patiala

Date

M340

Specifications

File extension → always save as .XEF

Machine selected BMX P34 20302

↓↓

→ PLC Bus

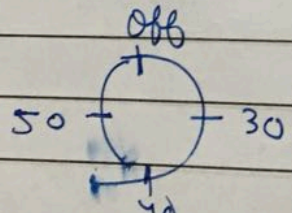
Power supply BMX CPS 2010

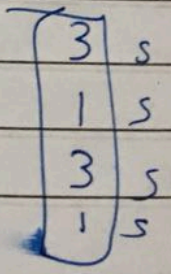
Input BMX DDI 1602

Output BMX DRA 1605

4 slots Backplane.

Washing M/C





Signature of Mentor

Signature of Student

Date 23/1/18

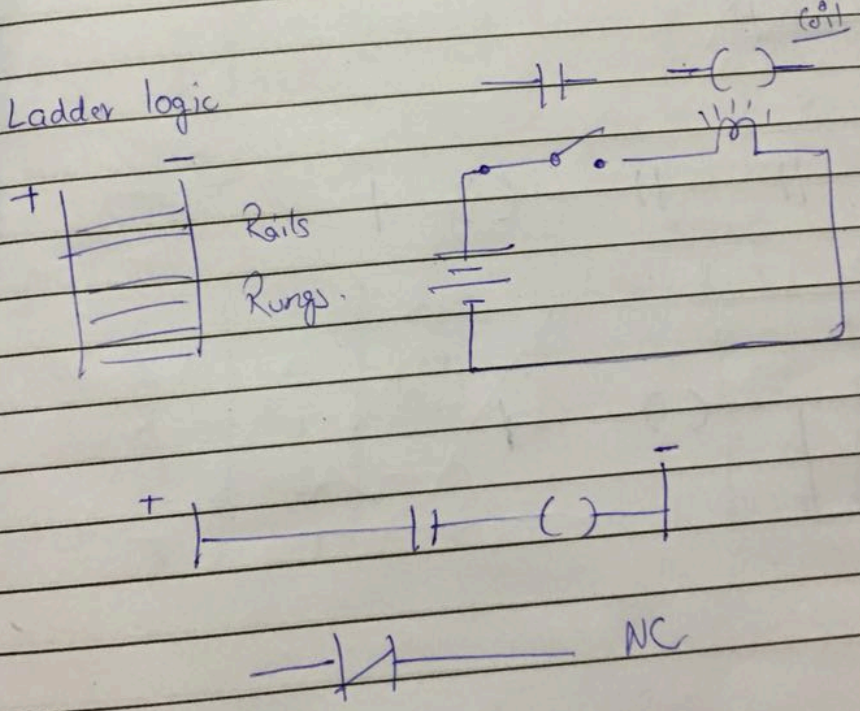
Zelio - Software

Twido - HMI - AC drive.

M340 - SCADA

M218 - HMI

Ladder logic

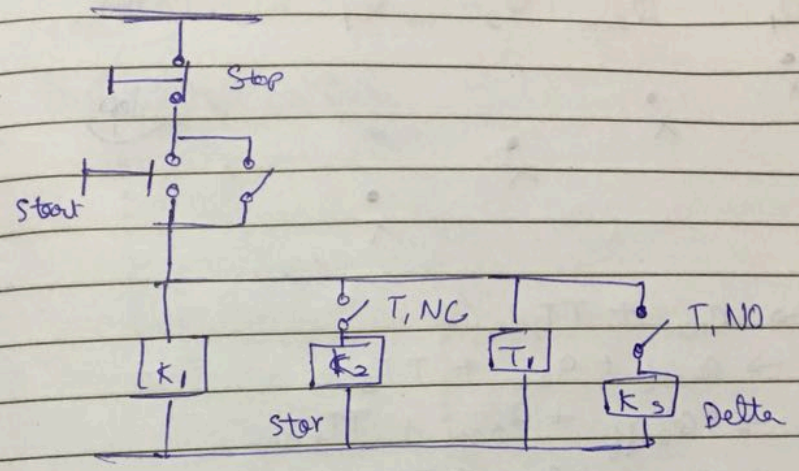


Signature of Mentor

Signature of Stud

Date 6/2

Star - Della Starter < 5 H.P



I/P dist

Sequence

I_1 → start T_1 → timer (15 secs)

I_2 → Stop

Ø Q_1 → ~~start~~ Main k_1

Q_2 → star k_2

Q_3 → Delta k_3

Signature of Mentor

Signature

Date

17) for Dox starter → draw button → properties
→ appearance → add type start in text
input → down push button
start = 1 insert tag
select up → insert tag
start = 0
data type → digital

18) for output → select symbol set
insert tag meter = 1

19) save → then complete.

20) Tools → computer setup wizard
click on next → next - finish

21) Run Unity Pro then SCADA.

28-5-18

Signature of Student

Signature of Mentor