PALESTINE POLYTECHNIC UNIVERSITY
College of Engineering
Department of Electrical Engineering

Graduation Project

**Project Name**

**Control Room For a Mixing Machine Of Plastic Raw Material**

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# الملخص

يتمثل المشروع في اعادة تصميم انظمة التحكم لخط انتاج متخصص في مزج المواد الاوليه المستخدمة في تشكيل بلورات البلاستك.

يعتمد المشروع على عدة مراحل في عملية الانتاج من حيث تحديد الكمية والمزج والتبريد ومن ثم التخزين على شكل مواد اولية للعملية الانتاجيه الاخرى.

سيتم استخدام احدى التقنيات المتعلقة بعملية التحكم والتعامل الالي مع وجود شاشه لاتمام عمليه التحكم والمراقبة.

# Abstract

The project is a redesign of the production line control system, specializing in blending the raw materials used in the formation of crystals plastic.

The project is based on several stages in the production process in terms of determining the quantity, mixing, cooling and then storage in the form of raw materials for other production lines.

One of the techniques will be used for the handling of automatic control of the process (Human machine interface).

The initial design with the examination of all stages of the manufacturing completion and the results were positive and will be verified in practice of building the actual system.

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## Abbreviations

| Description | Abbreviations |
|---|---|
| Supervisory Control and Data Acquisition | SCADA |
| programmable Logic Gate | PLC |
| Central Processing Unit | CPU |
| Light Emitter Diode | LED |
| Personal Computer | PC |
| Current Transformer | CT |
| Remote Terminal Unit | RTU |
| Human Machine Interface | HMI |
| Input/output | I/O |
| Communication Module | CM |
| Resistance Temperature Detector | RTD |
| Thermo Couple | TC |
| Infrared | IR |
| Analog to Digital converter | A/D |
| Negative Tempreture coefficient | NTC |
| Positive Temperatures coefficient | PTC |
| Communications Process | CP |
| Parallel Peripheral Interface | PPI |
| Present Time | PT |
| Meter/second | M/S |
| Equation | EQ |
| Emergency | EM |
| Limit switch | LSM |

## References

[1] S7-200 Programmable Controller System Manual

[2] https://w3.siemens.com/mcms/programmable-logic-controller/en/simatic-s7-controller/s7-200/Pages/Default.aspx

[3] Gregory K. McMillan, Douglas M. Clonidine (Ed), *Process/Industrial Instruments and Controls Handbook Fifth Edition*, McGraw-Hill, 1999 ISBN 0-07-012582-1 Section 3 *Controllers*

[4] SYSTEMctober 2004. "Supervisory Control and Data Acquisition (SCADA) Systems". NATIONAL COMMUNICATIONS SYSTEM.

[5] data-ftp-PLC-FBs_Manual-Manual_1-hardware-Chapter_1

[6] http://www.fatek.com/en/data/ftp/PLC/FBs_Manual/Manual_2/Chapter_12.pdf

# CHAPTER ONE

## INTRODUCTION

### 1.1 Review

### 1.2 Objective

### 1.3 Importance

### 1.4 Time table

### 1.5 Project Organization

# 1. Introduction

## 1.2 Review:

In this project, we are going to design a control room for mixing machine operates by traditional method.
This room designed to make the control more suitable and safety and avoid the dust which diffused around the machine room.

This control room consists of:

### 1. PLC (programmable Logic Control) :

It is the main part of the control system, which is a digital computer used for automation of typically industrial electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures.
PLCs are used in many industries and machines. It's designed for multiple analogue and digital inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory. A PLC is an example of a "hard" real-time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result.

### 2. SCADA System :

SCADA (Supervisory Control and Data Acquisition) is a system operating with coded signals over communication channels so as to provide control of remote equipment (using typically one communication channel per remote station). The supervisory system may be combined with a data acquisition system by adding the use of coded signals over communication channels to acquire information about the status of the remote equipment for display or for recording functions. It is a type of industrial control system (ICS). Industrial control systems are computer-based systems that monitor and control industrial processes that exist in the physical world. SCADA systems historically distinguish themselves from other ICS systems by being large-scale processes

That can include multiple sites, and large distances. These processes include industrial, infrastructure, and facility-based processes.

## 1.2 Objective:

The main objectives of this project are:

- Replace the traditional control by full automatic control.
- Reaching to the best accuracy in the mixing process.
- Remote control and monitoring without interference.

## 1.3 Importance:

This project is very important since it implements new techniques in the industrial field through the automated monitoring system:

- Allow worker monitor the production process using display screen, which connect with the control unit, so the process become more efficient and detection faults and errors shown on the screen easily.
- Make the process easy and modern.
- Reduce number of workers.
- Reduce the contact between worker and the mixing machine itself so workers become more protected from dangers and healthy problem.

## 1.4 Time table:

| activity | week | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *1st* | *2nd* | *3rd* | *4th* | *5th* | *6th* | *7th* | *8th* | *9th* | *10th* | *11th* | *12th* | *13th* | *14th* | *15th* | *16th* |
| [illegible] modules of S7-200 | ■ | ■ | | | | | | | | | | | | | | |
| [illegible] the technology | | | ■ | ■ | | | | | | | | | | | | |
| [illegible] programming | | | | | ■ | | | | | | | | | | | |
| programming | | | | | | ■ | ■ | ■ | | | | | | | | |
| [illegible] preparation | | | | | | | | | ■ | ■ | | | | | | |
| panel design | | | | | | | | | | | ■ | ■ | | | | |
| wiring | | | | | | | | | | | | | ■ | | | |
| [illegible] and fixing | | | | | | | | | | | | | | ■ | ■ | ■ |

**Table 1.1**

## 1.5 Project Organization:

The present thesis has been prepared in five chapters:

- In Chapter 1, the document is overview and objectives and problem state are focused.
- In Chapter 2, it will be exposed background (PLC, SCADA, Sensor's, Programs).
- In Chapter 3, general description about components of the project and designs all the Circuits of monitoring system.
- In Chapter 4, implementation the design in circuits and show result of the Work.

## 1.6 Project cost:

The main supplier in this project are the Royal factory . it could be cost 10,000$

# CHAPTER TWO

## Component of the system

### 2.1 PLC

### 2.2 SCADA

### 2.3 Sensors

### 2.4 Programs

Product line is based on the mixing of plastic raw materials, consisting of different types of materials, where they are put in the preparation container of the balance before Displaced to the mixer.

When displaced to the mixer the temperature will raise _as a result of the kinetic energy_ to the desired temperature to satisfy the homogeneity state of the materials and then transferred to cooler to decrease the temperature to store it at the right temperature.
All of these Processes were controlled by traditional control, in this project the control system will improved to full automatic control by using several techniques which will be described in this chapter

## 2 Component of the system:

The main purpose of our project is to convert the traditional control in the mixing machine to full automatic control; such as using the traditional control in this type of machine not safe for workers and machine itself.

## 2.1 PLC (Programmable Logic Control):

Using of relay-based switches to implement basic logical expressions and some examples of logic-based industrial system control. This type of control system detects the status of inputs like switches and other on-off logical devices (e.g. position detectors, liquid level detectors, etc.) and then uses relays, timers and counters to implement logic and drive outputs by energizing the output coil of some sort of valve or other actuator.

### 2.1.1 Introduction to Programmable Logic Controllers:

- A Programmable Logic Controller (PLC) is a microprocessor-based piece of hardware that is specifically designed to operate in industrial environments.
- Generally PLCs (as the name suggests) implement logic, determining outputs based on some logical combination of inputs.
- PLCs are programmable devices that are capable of taking inputs from sensors and activating actuators in order to control industrial equipment.

Fig 2.1.a Siemens SIMATIC ET 200S PLC (courtesy of Siemens)

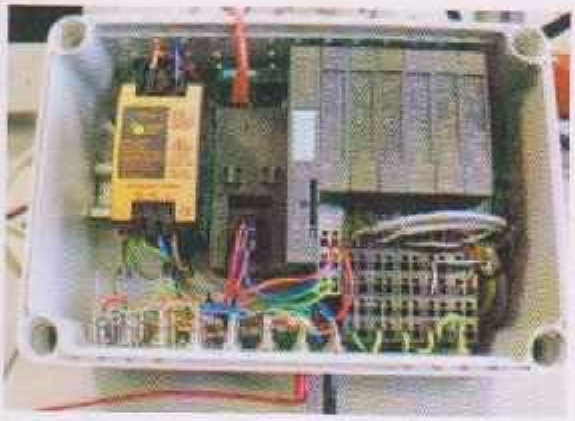


Fig 2.1.b Siemens SIMATIC ET 200S PLC (courtesy of Siemens)

The lack of a keyboard and other Input-Output devices is immediately apparent. On the front of a PLC the indications are normally limited to status lights used to indicate operating status and others that can be used for system debugging.

- Common LED Indicators include:
  - **Power On** - indicating that power to PLC switched on.
  - **Program Running** – (yes), it means a program is running in the PLC.
  - **Software Fault** – PLC code often has self testing code designed into it.
  - **Module Fault** – used by installed modules to show that a HW self-test has failed.
  - **Link Status**- modern PLCs often form part of a distributed control system and this indicator is used to show whether the local area network is OK.[1]

A number of pushbuttons/switches can also be provided as part of the PLC hardware:-

- Run/Program Switch used to switch between program mode usually used during maintenance activities and run mode when the unit is operating in its usual autonomous mode.

- PLCs are often protected by a mechanical KEY that stops unauthorized personnel altering a PLC program or stopping its execution.

- A PLC will usually not have an on-off switch or reset button on the front panel. This needs to be considered when designing/configuring systems.

### 2.1.2 Architecture of PLC Devices:

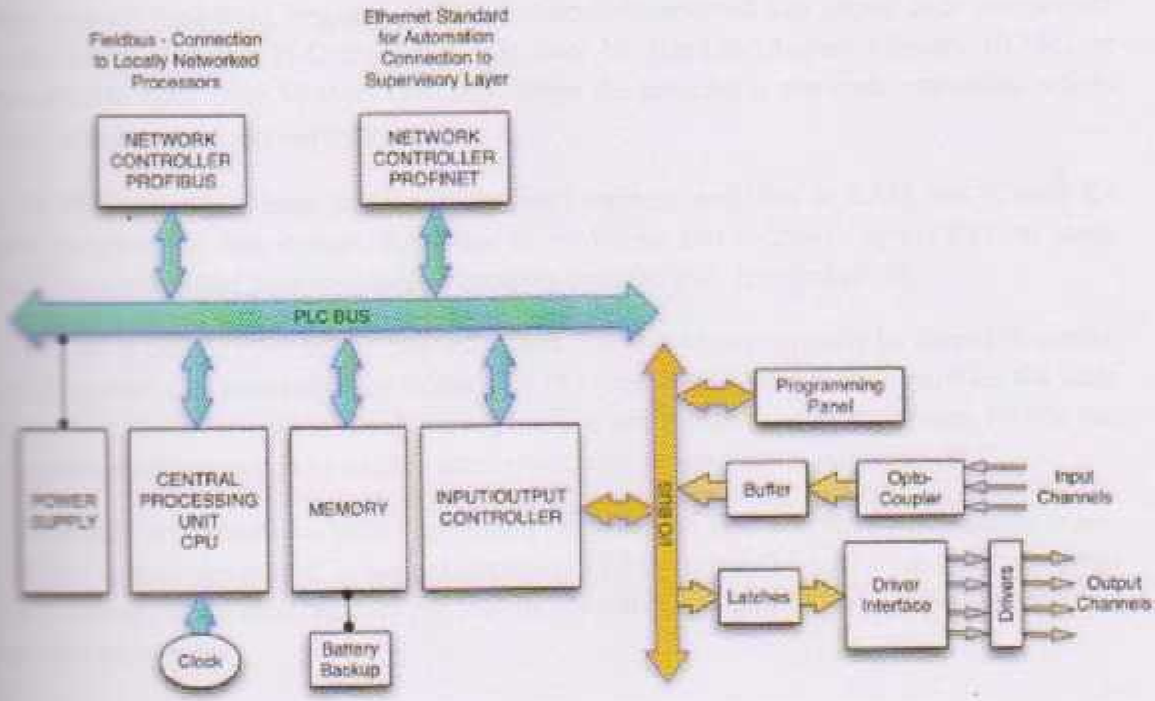



Fig 2.2: Typical Architecture of PLC

The figure above shows a typical PLC architecture – this consists of three main building blocks: A CPU, some memory and an Input / Output controller. These main blocks are then interconnected by a bus system that also connects to external network controllers. Thus the architecture is similar to other industrial computer based systems such as Remote Terminal Units

(RTUs) seen in SCADA systems and is not much different from conventional PC systems. There are however some differences in the technology used to implement each of the functional blocks. We will now look at the main PLC components in more detail.[1]

## 2.2.3 Central Processing Unit (CPU):

Compared to SCADA systems or PCs, PLCs typically have less processing power and memory. The central processing unit is usually an 8 bit or 16 bit microprocessor based system. The processor unit will usually contain a small amount of cache memory internal to the chip, but most of the memory will be external.

## 2.2.4 Memory:

Like all computers the behavior of the PLC is determined by a software program that is written in some high-level language and then compiled/converted into binary code instructions that are stored into the PLC memory. This may be Random Access Memory (RAM) or Programmable Read Only Memory (PROM). When the program is run each instruction is then fetched, decoded and executed by the CPU.

In PLC systems, a large portion of the total memory available is RAM that is used for general program and data storage. RAM can be read from and written to by the CPU as many times as required. RAM memory loses its contents once the PLC is switched off.

PROM is usually reserved for important data that should not normally be altered or erased. In a PLC system, it is primarily used to store the PLC operating system, which provides the basic structure that allows the user to develop programs and run applications on the device. PROM can also in certain circumstances be used to store application programs that run on the PLC.

Once data or instructions have been 'burnt' into PROM they are there permanently unless the PROM is re-programmed; in normal operation ROM can only be read from and not written to. Furthermore, ROM memory does not lose its contents once the PLC is switched off; the data is permanently stored.

## 2.2.5 Input & Output Controller & Devices:

The input/output controller provides the interface between the PLC processor and the outside world. It allows connections to be made, via input/output channels, to sensors and actuators.

In a PLC, the input/output controller and its interfaces provide important buffering, isolation and signal conditioning to enable direct connection of the sensors and actuators.

Typically the PLC will be designed to accept standard modules which plug directly into the I/O Bus and which provide appropriate levels of protection and conditioning.

### 2.1.6 Input Channels:

Typically PLC Inputs must convert a variety of input logic levels to standard 5Vdc logic levels. Fig 2.1.3 shows how this can be done for a DC or AC input.

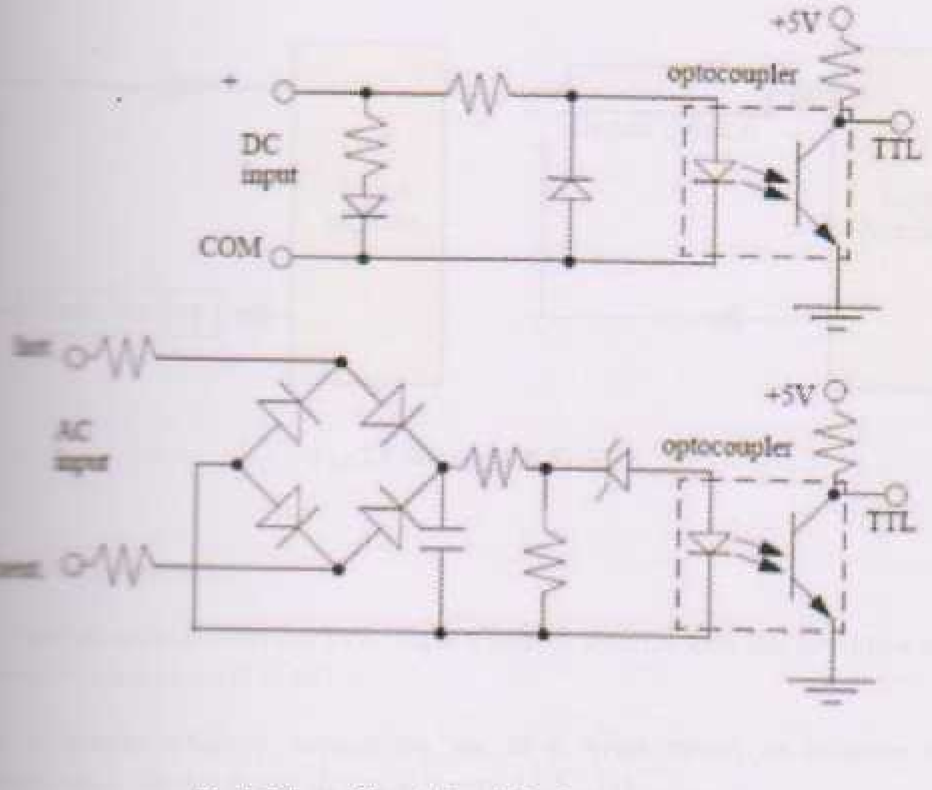



Fig 2.3 Input Signal Conditioning & Isolation

These circuits condition the input to drive an Optocoupler. This electrically isolates the external electrical circuitry from the internal circuitry. Other circuit components (i.e. diodes) are used to guard against excess or reversed voltage polarity.

Optocouplers often consist of an LED and a photo sensor in a single package. The LED converts the electrical input signal to light that the photo sensor detects and turns into an electrical output. Usually used for digital (on/off type) signals but with some advanced processing they can also be used for analogue signals.

## Sourcing & Sinking:

These are terms used to describe the way in which DC devices are connected to a PLC. Fundamentally, sourcing or sinking describes the direction of current flow between the input module on the PLC, and the externally connected input device. Both methods of connection are valid approaches.

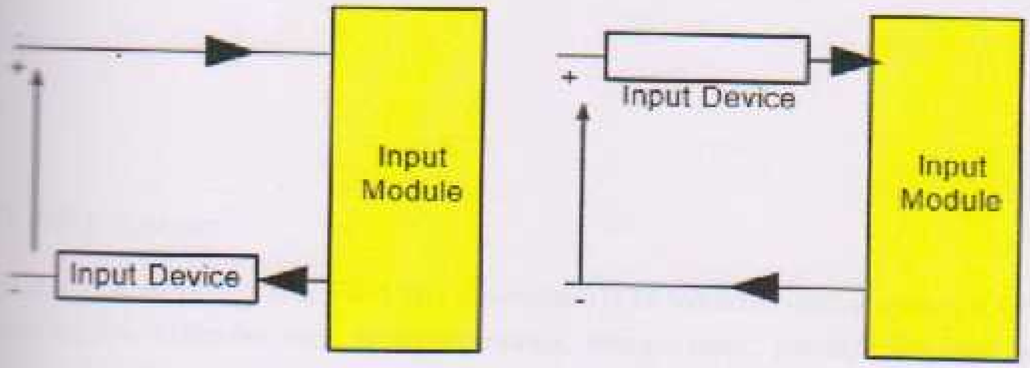



Fig 2.4 Sourcing & Sinking

## 2.1.7 Output Channels:

PLC outputs must convert the 5Vdc logic levels on the PLC data bus to whichever external voltage level is required – AC or DC.

This is usually achieved through the use of a driver circuit an isolation and signal conditioning circuit similar to that shown in Figure 2.1.5. [1]

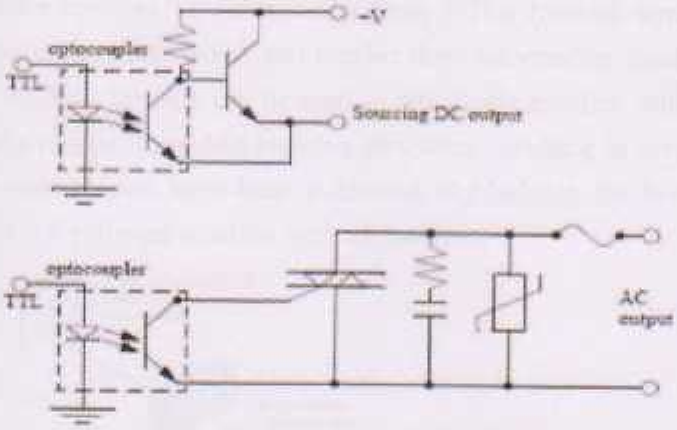



Fig. 2.5: PLC Output Module Circuits – DC and AC

Here, each circuit again uses an optocoupler to provide electrical isolation between internal and external circuitry. In AC circuits, a triac is often used – this can be thought of as two back to back transistors, which form a controllable bi-directional switch. Additional components are required for protection (e.g. fuses, thermistors etc.).

## 2.2 SCADA system:

SCADA (supervisory control and data acquisition) is an industrial control system at the core of many modern industries such as manufacturing, energy, water, power, transportation and many more. SCADA systems deploy multiple technologies that allow organizations to monitor, gather, and process data as well as send commands to those points that are transmitting data. Virtually anywhere you look in today's world, you will find some version of a SCADA system running, whether it's at your local supermarket, refinery, waste water treatment plant, or even your own home.

SCADA systems range from simple configurations to large, complex projects. Most SCADA systems utilize HMI (human-machine interface) software that allows users to interact with and control the machines and devices that the HMI is connected to such as valves, pumps, motors, and much more.

SCADA software receives its information from RTUs (remote terminal units) or PLCs (programmable logic controllers) which can receive their information from sensors or manually inputted values. From here, the data can be used to effectively monitor, collect and analyze data, which can potentially reduce waste and improve efficiency resulting in savings of both time and money. Numerous case studies have been published highlighting the benefits and savings of using a modern SCADA software solution such as Ignition.[4]

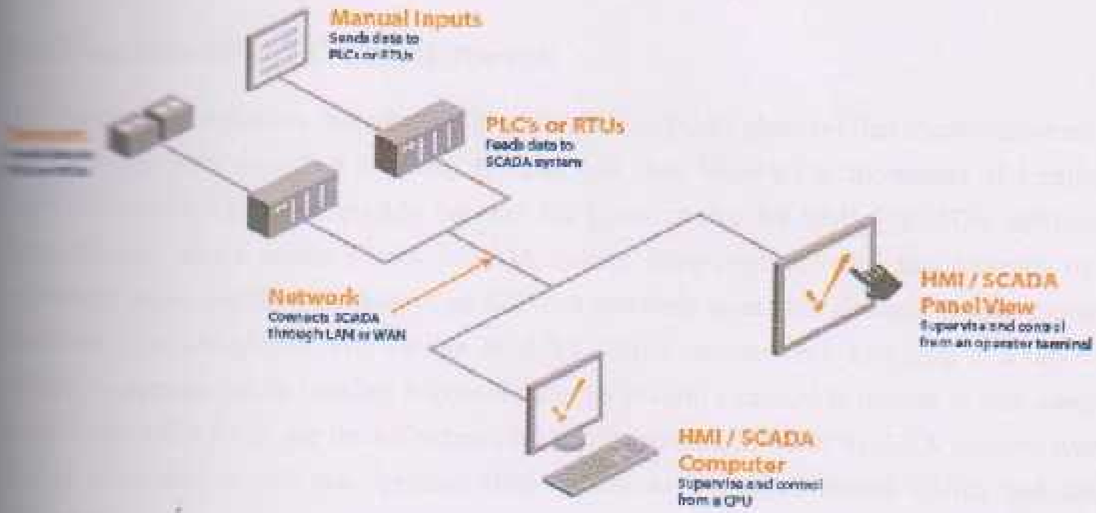



Fig. 2.6 Basic SCADA Architecture

### 2.2.3 Modern SCADA Systems:

Modern SCADA systems allow real-time data from the plant floor to be accessed from anywhere in the world. This type of access to real-time information allows governments, businesses and individuals to make data-driven decisions about how to improve their processes. These decisions would be either impossible or take substantial time and resources to complete without SCADA software. The introduction of modern IT standards and practices such as SQL and web-based applications into SCADA software has greatly improved the efficiencies, security, productivity and reliability of SCADA systems.

SCADA software that utilizes the power of SQL databases has a huge advantage over antiquated SCADA software solutions. One huge advantage of using SQL databases with a SCADA system is that it makes it easier to integrate into existing MES and ERP systems, allowing data to flow seamlessly through an entire organization. Historical data from a SCADA system can also be logged in a SQL database which allows for trending of data to make data analysis easier. [4]

### 2.2.2 Ignition HMI/SCADA Software:

Ignition by Inductive Automation is a SCADA software platform that many businesses and organizations have switched to using. Ignition has been installed in thousands of locations in over 70 countries and has quickly become the go-to choice for HMI / SCADA software. Its powerful and robust nature allows SCADA system integrators to reach the demands of their customers while costing less than other SCADA software solutions. Because it uses modern IT practices, it is compatible with current SCADA system components, resulting in a more cost-effective approach while yielding higher results. Its pricing structure is unique in that users only have to pay a flat fee to use the software, which is server-based. Other SCADA vendors typically charge per client or per tag. Ignition allows users to launch unlimited clients and monitor unlimited tags.

Inductive Automation's motto of "Dream it. Do it." is a perfect embodiment of what Ignition can do. While many people think that the software' power and bold claims are too good to be true, one demonstration of what the software can do is all it takes to change their mind. Once they see what's possible, they become believers and begin to dream how the software can fit their needs. If you are interested in seeing how Ignition can improve your organization, schedule a 30-minute demonstration with one of our reps or download the software for yourself and see what you can accomplish. [2]

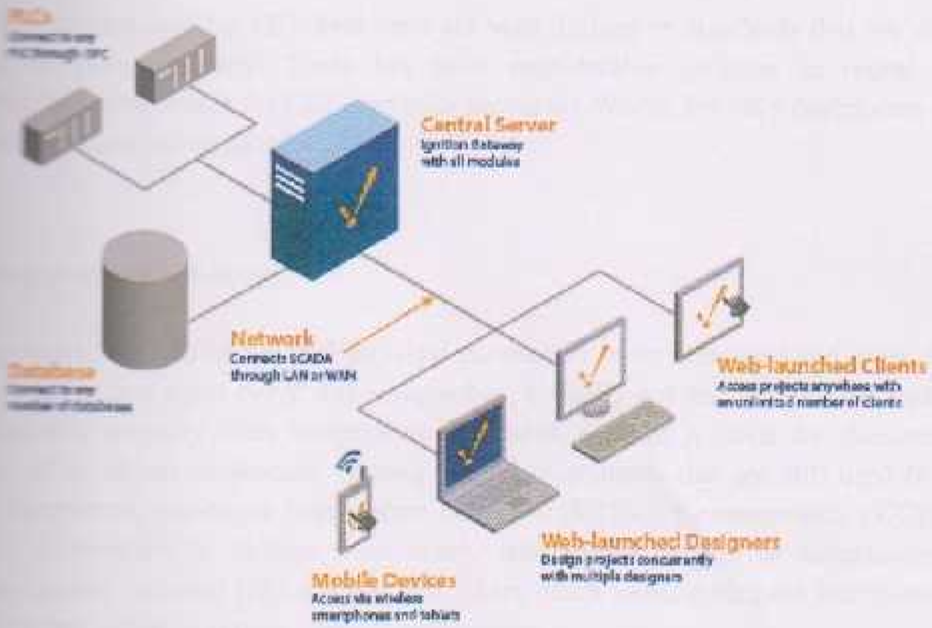



Fig.2.7 Ignition HMI/SCADA Architecture

## 2.3 Sensors:

We have different type of input device (sensors): such as analog input or digital input as the follow:

### 2.3.1 Load Cells:

A load cell is a device that is used to measure weight or force. When a force is applied to it in a specific manner, a load cell produces an output signal that is proportional to the applied force. Strain gage load cells are at the heart of the majority of weighing and force measurement devices produced today. One end of a load cell is typically supported on a rigid structure while the other end supports a load-receiving device through which the lond or force is applied. Load cells can be used individually or in combinations in weighing devices, as dictated by the geometry of the object to be weighed.

Load cells are available with various accuracy levels to suit an array of industrial and legal for trade (LFT) weighing applications. A LFT application is one where the load cell or scale is used in commercial transactions to determine the charge for goods or services rendered. The performance requirements for LFT load cells are well defined in standards that are adhered to within the weighing industry. There has been considerable progress in recent years in harmonizing the requirements for LFT load cells across the World; here is a description of two of the more widely accepted standards.

### 2.3.2 Temperature sensors:

Temperature was one of the first physical parameters to be measured and, over the years, has been sensed in just about every way imaginable .Virtually any sensing element that changes some measurable property with temperature has been used as a basis for determining the temperature of an object or process. Among the many methods that are still used in industry today are thermistors, resistance temperature detectors (RTDs), thermocouples (T/Cs), silicon PTCs, I.C. temperature to voltage transducers, temperature to current transducers, digital temperature sensors, infrared (IR) devices and others. Each sensing element has characteristics that make it better suited to certain types of applications.

### ✓ Selecting a temperature sensor:

The temperature sensor that is selected will be dependent upon the application and other factors including:

- Operating temperature range
- Accuracy needed
- Stability required
- Cost
- Ease of use
- Ability to package efficiently
- Circuitry available

## ✓ NTC Thermistors:

Metal oxide ceramic semiconductors that decrease in resistance as temperature increases. NTCs have a well-defined resistance versus temperature characteristic and are very sensitive to even the smallest temperature change. A typical temperature coefficient at 25°C is around -4.4%/°C.

Although the NTC curve is non-linear, advances in A/D converters and microprocessors allow for simple circuit design. The inexpensive NTC is now the preferred sensor for applications from -50°C to 300°C.

## ✓ Silicon PTC Thermistors:

Silicon PTC thermistors use spreading resistor technology to achieve a positive temperature coefficient in the +0.75%/°C range. Their primary advantages are long term stability, low cost batch processing, and excellent linearity. They have a useful temperature range from -55°C to +150°C.

The most common silicon PTCs have a resistance at 25°C of 1000 ohms and 2000 ohms. A resistance tolerance of ±1% at 25°C, which would be typical for a silicon PTC, translates to a temperature error of ±1.27°C.

## ✓ Integrated Circuit (Temp to Voltage) Sensors:

Integrated circuit temperature to voltage transducers generally provides a voltage output that is directly proportional to temperature. One class of sensors is calibrated in the Fahrenheit scale and provides an output of 10mV/°F and would have, as an example, an output voltage of 770mV at 77°F. The operating temperature range for these parts is from -50°F to 300°F. Another class of sensors is calibrated on the Celsius scale and provides an output of 10mV/°C and would have an output signal of 250mV at 25°C. The operating temperature range for these parts is from -55°C to 150°C.

## ✓ Integrated Circuit (Temp to Current) Sensors:

Temperature to current transducers is two-terminal integrated circuit devices that produce an output current of 1uA/K from -50°C to 150°C. They exhibit excellent interference rejection and are easy to calibrate for direct conversion to temperature.

## 2.4 programs:

There are two main software program in this project:

### 2.4.1 HMI Software

WinCC is powerful HMI system for use under Microsoft Windows 2000 and Windows XP. HMI stands for "Human Machine Interface", i.e. the interface between the human (the operator) and the machine (the process). The actual control over the process is performed by the automation system. WinCC communicates with both the operator and the automation system(s). [7]

The WinCC Project Development/Configuration Environment To develop and configure projects, special editors are provided that can be accessed from the WinCC Explorer. With each editor, a specific subsystem of WinCC is configured. The major subsystems of WinCC are:

- The graphics system - the editor for creating the screens is the Graphics Designer.
- The alarm system - the editor for configuring the alarms is named Alarm Logging.
- The archiving system - the editor for specifying the data to be archived is named Tag Logging.
- The report system - the editor for creating the report layouts is the Report Designer

## 2.4.2 PLC Software

This software package can be handled like a standard Windows application and includes all necessary tools for convenient programming of the SIMATIC S7-200.

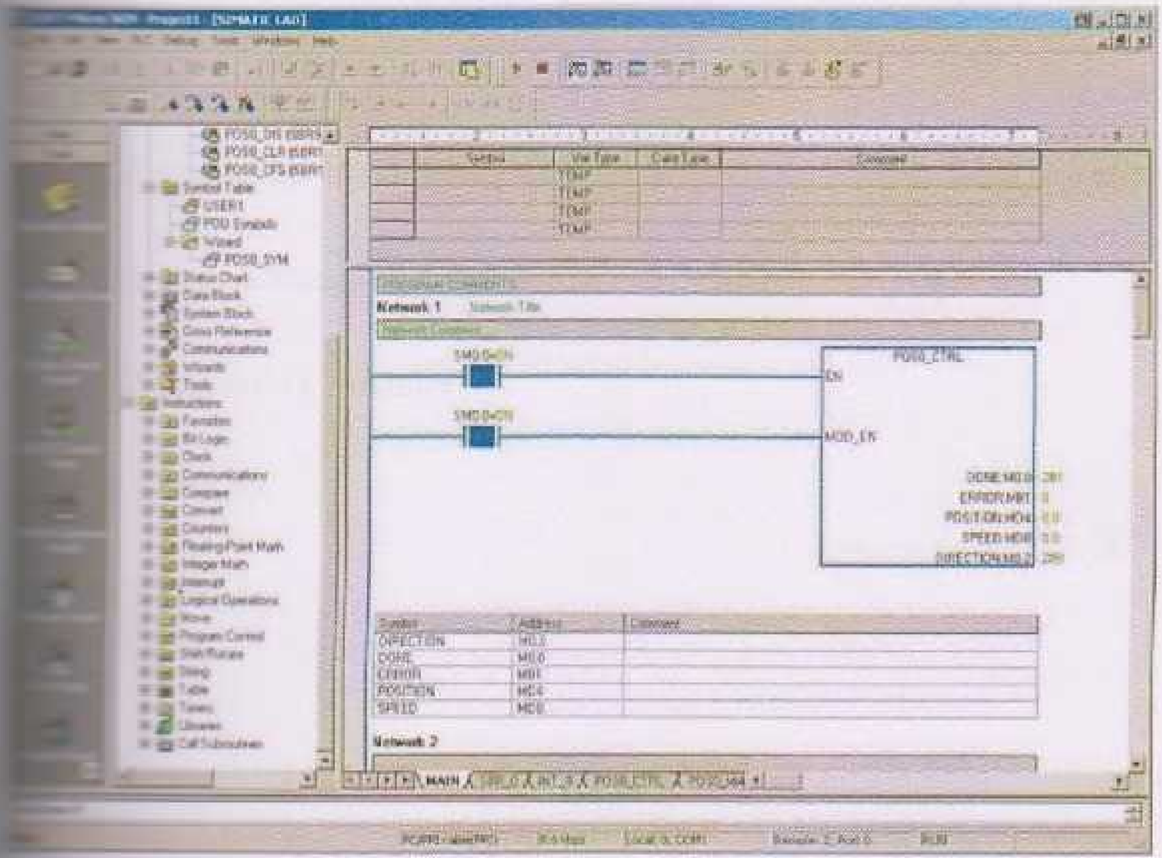



Fig. 2.8 STEP7-Micro/WIN 4.0

# CHAPTER THREE

## The main component details in the project

3.1 Fatek FBs-40MA PLC

3.2 Communication of FBs-40MA

3.3 FBs-40MA Modules

3.4 SCADA

3.5 Sensors

## 3. The main component's details in the project:

Unfortunately the project didn't complete by using the S7-200 because of many reasons; firstly, one of the most important modules was expired and it will take a lot of time in order to request from outside, as well as the high cost associated with it.

There's another technology to complete this project, from these technologies two were chosen which are FATEK and Siemens s7-1200 to take one of them according to price, technology, availability, easy to handle and availability of program.
According to the table 3.1 below FATEK is better than Siemens because it's cheaper than the second one and its program is open source so FATEK FBs-40MA PLC will used in the project instead of the previous type.

| components | FBs-40MA | S7-1200 |
|---|---|---|
| CPU | 1500 | 2300 |
| Load Cell Module | 1100 | 1500 |
| Temperature Module | 600 | 1000 |
| Analog Module | 600 | 900 |
| Total cost | 3800 NIS | 5700 NIS |

Table 3.1 Comparison between S7-1200 and FATEK

## 3.1 FATEK FBs-40MA PLC :

The FATEK FBS Series PLC is a new generation of micro PLC equipped with excellent functions comparable to medium or large PLC, with up to five communication ports. The maximum I/O numbers are 256 points for Digital Input (DI) and Digital Output (DO), 64 words for Numeric Input (NI) and Numeric Output (NO). The Main Units of FBS are available in three types: MA (Economy Type), MC (High-Performance Type), and MN (High-Speed NC Type). With the combination of I/O point ranges from 10 to 60, a total of 17 models are available. Fifteen DI/DO and 19 NI/NO models are available for Expansion Units/Modules. With interface options in RS232, RS485, USB, Ethernet, CANopen, Zigbee and GSM, the communication peripherals are available with 10 boards and modules.[4]

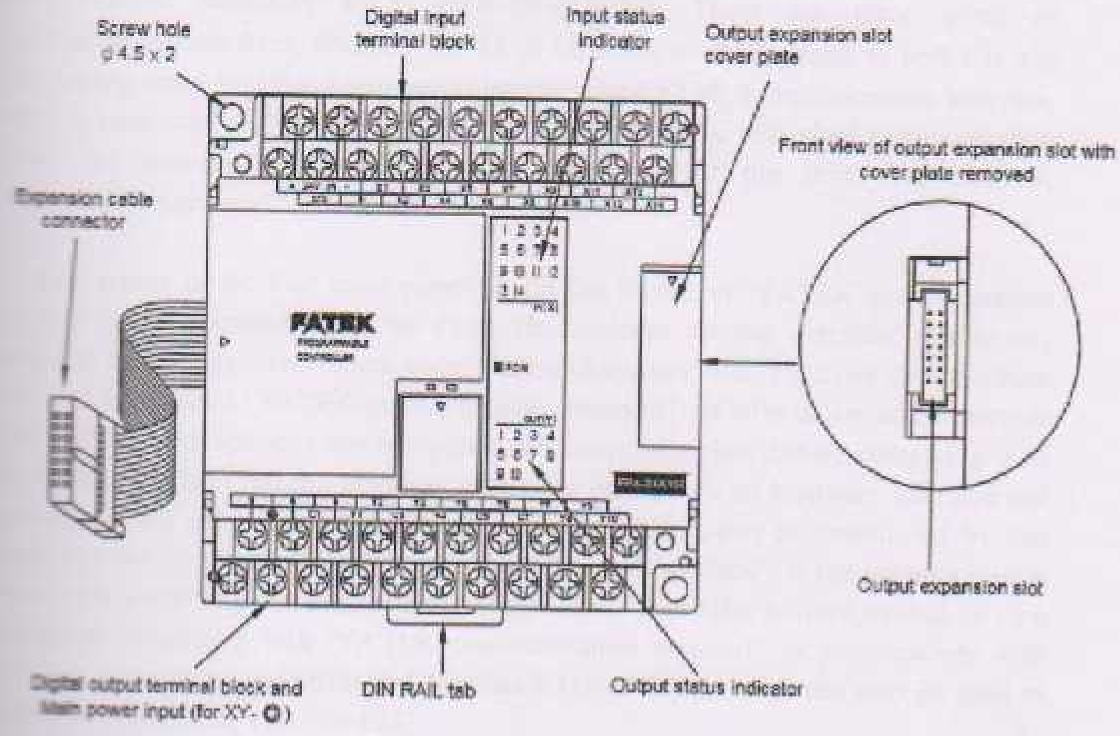



Fig.3.1 FATEK Series

FBs-40MA PLC shown in figure 3.2 used in the project since it's include all of inputs and outputs of the project. Which it contain 40 point I/O expansion unit (24 points IN, 16 points OUT). The using program in the PLC is WinPro Ladder

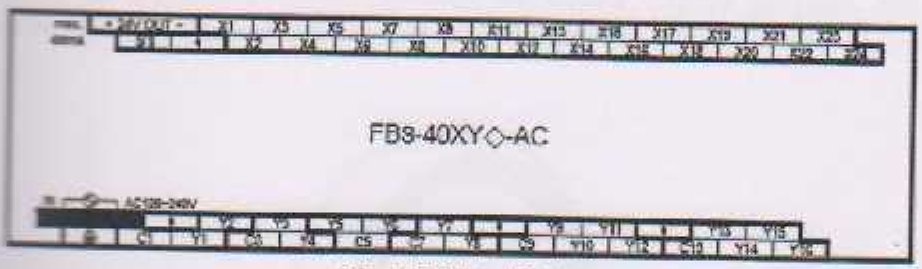



Fig. 3.2 FBs-40MA

## 3.2. Communication of FBs-40MA.

The FBs-PLC main unit has been built in the communication port0 with optional USB or RS232 interface. If additional communication boards (CB) have been purchased, then it can increase to 2~3 communication interfaces (depending on the model of CB). If it is still not enough, communication modules can be added to expand the number of communication interfaces to 5 (PORT0~PORT4). There are three types of communication interfaces, RS232、RS485 or Ethernet, to choose from in both CB and CM. Among them, Port 0 is a permanent interface for FATEK communications interface, which is controlled by the CPU of the PLC, using FATEK "Standard communication driver" to manage the communication transactions of the Port, i.e. "FATEK communication protocol".

Any access to the Port must comply with the format of "FATEK communication protocol" to get responses from the PLC. This includes starting character, station no., command code, body, error check code, ending characters, etc.; for more details please refer to "Appendix 1: FATEK communication protocol". WinProladder and numerous HMI and SCADA software are equipped with communication drivers complying with this communication protocol, therefore where the parameters on hardware interface and communications are consistent, communication connection can be established by just connecting the communication Port with the "Standard Interface". If the communication driver with complying communication protocol is not available, besides writing its own commands complying with "FATEK communication protocol" to communicate with PLC, the commonly used industrial Modbus RTU/ASCII protocol can also be used to establish a connection with FBs-PLC.

The factory setting and the PLC system initialization on Port 1 ~ Port 4 default to FATEK standard communication interface; though in order to meet the extensive application and requirements of communication connection, Port 1 ~ Port 4 provides FATEK standard communication interface, as well as providing easy communication commands that support powerful functions to allow users to compile their required communication application software through the Ladder diagram program, and easily achieve the aim of system integration and distributed monitoring.[6]

Fig. 3.3 RS-232 Cable

## 3.3. FBs-40MA modules.

To deal with any analog input; additional modules must be needed as a temperature module, load cell module and current module.

### 3.3.1 Load Cell Module (FBs-1LC).

FBs-1LC / FBs-2LC is one of the analog input modules of FATEK FBs series PLC. It supports one / two channel of load cell input for weight measurement. The conversion result is represented by a signed 16 bit integer value. In order to filter out the field noise imposed on the signal, it also provides the average of sample input function.

The supporting of I/O configuration for FBs-1LC/2LC module is available only for PLC OS V4.71 and Winproladder V3.22 or later version. For those early applications which do not use I/O configuration to work with 1LC module can still work properly provided that no additional FBs-2LC module control is required.

**The Procedures of Using FBs-PLC Load Cell Module:**

- Start.
- Connects Load Cell Modules to the expansion interface on PLC in series and connects an external 24VDC source and load cell measure input wires.
- Execute the WinProladder and configure the load cell configuration table address, the register address, and working register in load cell configuration windows, then you can read the weight measurement value form register directly.
- End.

**Wiring of Load Cell Modules (FBs-1LC):**

Connecting the Load cell sensor with Load cell module as shown in figure 3.4 . The conversion result is represented by a 16 bit signed value, there should put an additional LCNV (FCN33) shown in figure 3.5 or MLC (FCN34) function instruction in the ladder diagram, which will convert the raw reading value into the desire weight value. Because the measurement signal is quite small, for common practice, manual zero adjustment is required in order to overcome the cell drift.

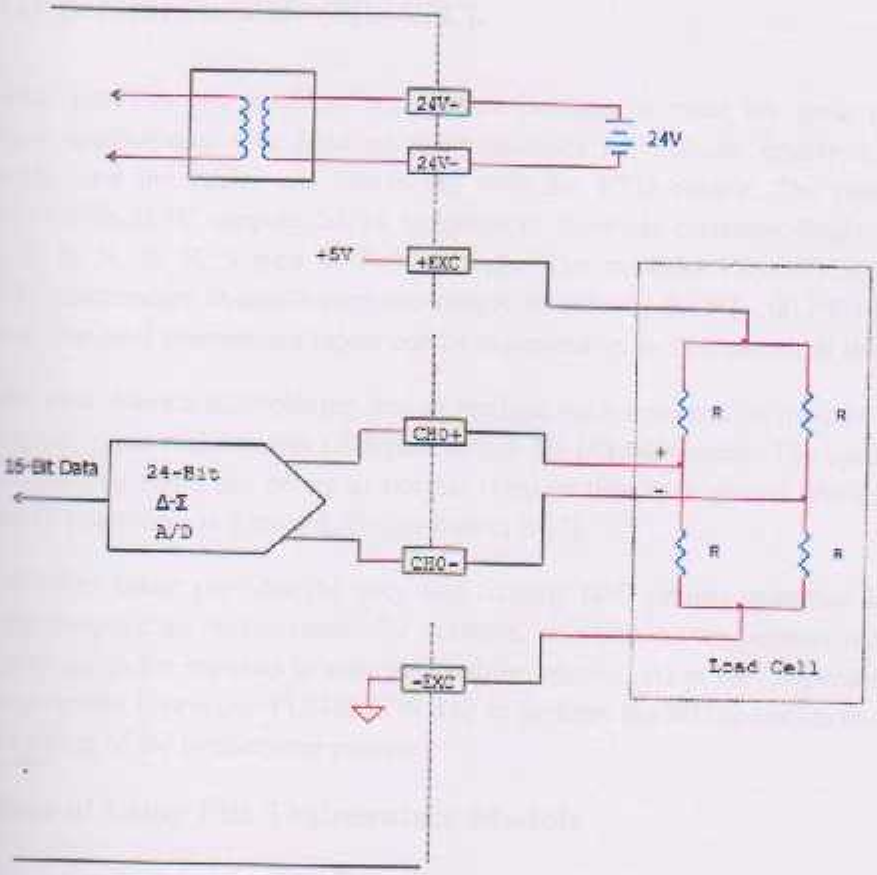



Fig. 3.4 FBs-ILC wiring

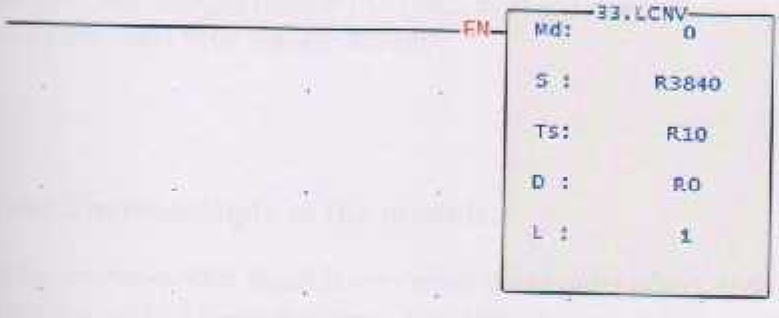



Fig. 3.5 LCNV Conversion

### 3.3.2 Temperature module (FBs-6TC).

FBs-PLC provides two kinds of temperature modules to meet the great temperature measurement applications. One kind of these modules are directly interfacing with the thermocouple, and the others are interfacing with the RTD sensor. The modules FBs-2TC/FBs-6TC/FBs-16TC support 2/6/16 temperature channels correspondingly to connect the J, K, T, E, N, B, R, S type of thermocouple. The modules FBs-6RTD/FBs-16RTD support 6/16 temperature channels correspondingly to connect the PT-100,PT-1000 type of RTD sensor. The total temperature inputs can be expanded up to 32 channels at the most.

By the time domain multiplexing design method, each temperature module occupies 1 point of register input and 8 points of digital output for I/O addressing. The update rate for temperature reading value can be set as normal (Update time is 4 second, the resolution is 0.1°) or fast (Update time is 2 second, the resolution is 1°).

The WinPro ladder provides the very user friendly table editing operation interface to configure the temperature measurement, for example, selecting the temperature module, type of sensor, and assign the registers to store the reading values… As to the temperature control, it has the convenient instruction FUN86 (TPCTL) to perform the PID operation to control the heating or cooling of the temperature process.

### The Procedure of Using FBs Temperature Module

- Start.
- Connect Modules to the expansion interface on PLC in series and connect an external 24VDC source and temperature measure input wires.
- Executing the WinProladder and configure the configuration table address Temperature register address and working register in "Temp. configuration" windows then you can read temperature value from register directly.
- End.

### Wiring of the Thermocouple to the module.

Because the thermo-couple signal is very small (in an order of uv), if possible please use the shielded twisted cable for signal wiring. Also if the length of thermo-couple wire is not long enough, please make sure to use the proper compensation wire otherwise will cause excessive error on cold junction compensation.

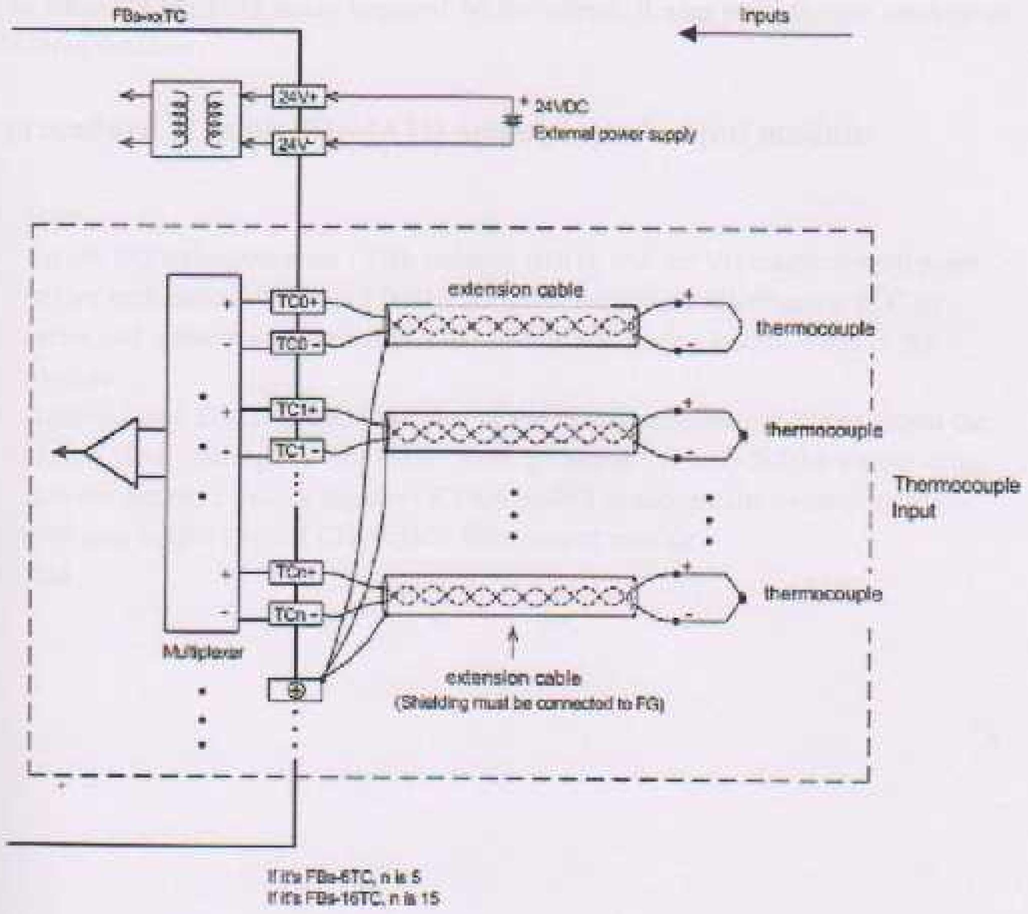



Fig. 3.6 wiring of the thermocouple

### 3.3.3 FBs-4A2D Analog Input/output Module.

FBs-4A2D is one of the analog I/O modules of FATEK FBs series PLC. For analog output it provides 2 channels of 14 bit D/A output. Base on the different jumper settings it can provide varieties of current or voltage output signal. The output code can be configured as unipolar or bipolar which makes the relation of output code and real output signal more intuitive. For safety, the output signal will be automatically forced to zero(0V or 0mA) when the module is not serviced by CPU for 0.5 second. For analog input it provides 4 channels A/D input with 12 or 14 bits effective resolution.

Base on the different jumper settings it can measure the varieties of current or voltage signal. The reading value is represented by a 14 bit value no matter the effective resolution is set to 12 or 14 bits The output code also can be configured as unipolar or bipolar which makes the relation of input code and real input signal more intuitive.. In order to filter out the field noise imposed on the signal, it also provides the average of sample input function.

## The procedure of using FBs-4A2D analog input/output module:

- Start.
- Set the I/O voltage/current (V/I), polarity (B/U), and the V/I range of each point before installation. Connect FBs-4A2D to the expansion interface on PLC in series and connect an external 24VDC source and analog output wires to the module.
- Analog Input: Directly read the value of the four corresponding IRs to obtain the analog input reading of CH0~CH3. Analog Output: Directly fill the output value into the analogue output registers R3904 R3967 to acquire the corresponding analogue output span of CH0 CH63 from output module.
- End

## Wiring diagram:

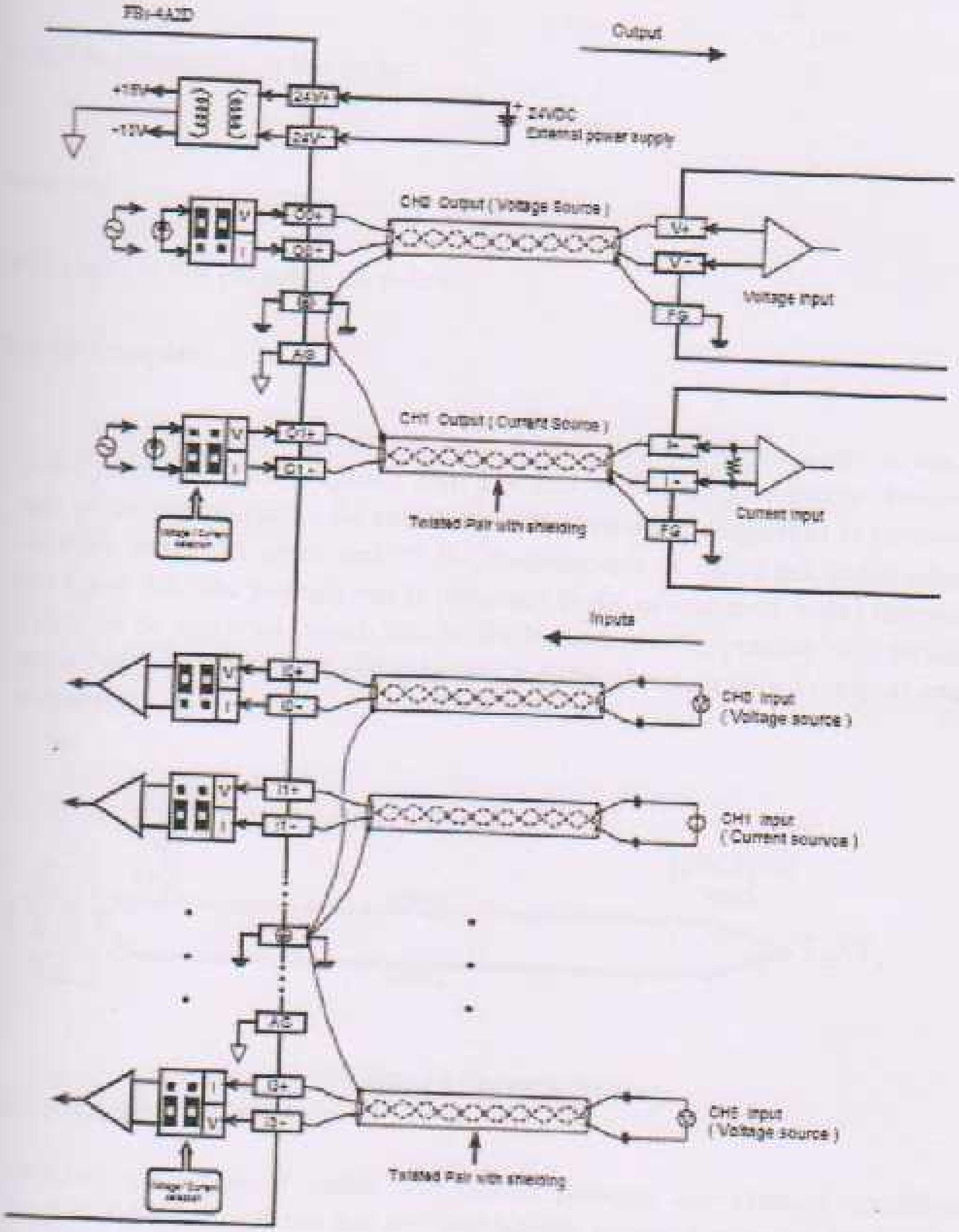



Fig. 3.7 wiring diagram of the FBs-4A2D

## 3.4. SCADA System:

It may be dispensable In this project

## 3.5. Sensors:

The sensor that used in this project as the follow:

### 3.5.1 Thermocouples

A thermocouple is a device made by two different wires joined at one end, called junction end or measuring end. The two wires are called thermo elements or legs of the thermocouple: the two thermo elements are distinguished as positive and negative ones. The other end of the thermocouple is called tail end or reference end figure 3.8 .The junction end is immersed in the environment whose temperature $T_2$ has to be measured, which can be for instance the temperature of a furnace at about 500°C, while the tail end is held at a different temperature $T_1$, e.g. at ambient temperature.

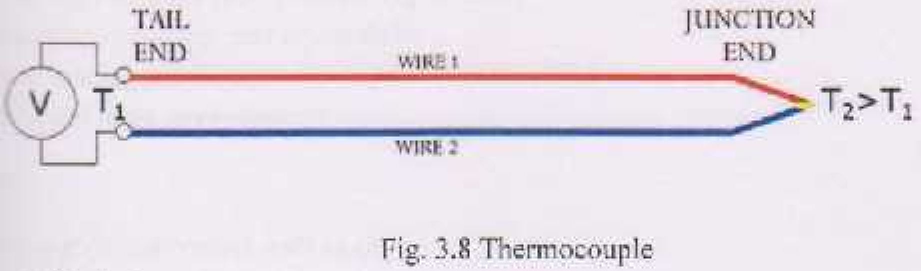



Fig. 3.8 Thermocouple

### 3.5.2 Limit Switch:

Limit switches are a type of sensor that detects presence and absence. Specifically, mechanical limit switches are switches that are mechanically activated, meaning that they have some sort of arm, lever, knob, plunger, etc., which is physically—or mechanically—activated by making contact with another object. As the object makes contact with the actuator of the switch, it eventually moves the actuator to its "limit" where the contacts change state. Other varieties of sensors/switches exist, including proximity sensors, light sensors, electric switches, among others.

In its simplest form, a limit switch is a "switch" that can be mounted into remote locations so that it is actuated by an object other than a human operator. Some basic functions of limit switches are:

- Detecting presence/absence
- Counting • Detecting range of movement
- Detecting positioning & travel limit
- Breaking a live circuit when unsafe conditions arise
- Detecting speed
- ...and hundreds of other applications

Limit switches are a problem-solving product. There is often "no right answer" as to which switch can be used in any given situation. Usually product choice is left to the user to determine how he can best utilize the switch. Because of this characteristic, limit switches can be fun to sell as a "fun" product—they are the solution to a brainteaser game.

Mechanical limit switches can be found in any industrial or commercial application where detection or safety is needed.

Strengths and weaknesses:

Strengths:

- Switching high currents is no problem (up to 10A)
- High precision, accuracy, and repeatability
- Economic sensing solution
- Can withstand most environments

Weaknesses:

- Must make physical contact with an object to actuate
- Mechanical component can wear out

## 3.5.3 current transformer:

Fig 3.9 CT's

A current transformer (CT) as shown in figure 3.9 is used for measurement of alternating electric currents. Current transformers, together with voltage (or potential) transformers (VT or PT), are known as instrument transformers. When current in a circuit is too high to apply directly to measuring instruments, a current transformer produces a reduced current accurately proportional to the current in the circuit, which can be conveniently connected to measuring and recording instruments. A current transformer isolates the measuring instruments from what may be very high voltage in the monitored circuit. Current transformers are commonly used in metering and protective relays in the electrical power industry.

Like any other transformer, a current transformer has a primary winding, a magnetic core and a secondary winding. The alternating current in the primary produces an alternating magnetic field in the core, which then induces an alternating current in the secondary winding circuit. An essential objective of current transformer design is to ensure the primary and secondary circuits are efficiently coupled, so the secondary current is linearly proportional to the primary current. Lock at figure 3.10.

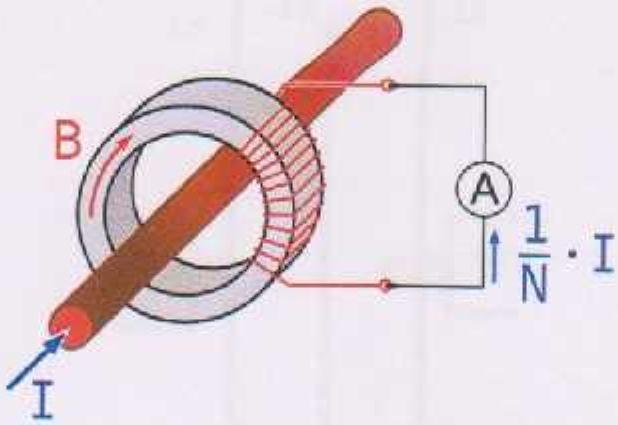



Fig 3.10 Basic operation of current transformer

Current transformers are used extensively for measuring current and monitoring the operation of the power grid. Along with voltage leads, revenue-grade CTs drive the electrical utility's watt-hour meter on virtually every building with three-phase service and single-phase services greater than 200 amperes.

**Features:**

1- Low cost.
2- Water proof.
3- More than 30 outline size.
4- (5.0, 1.0) A ac secondary ratios available

**Applications:**

1- Current, Power, Energy monitoring devices.
2- Relay protection device.

After all of this description the most perfect sensor and suitable for our project is the CT, and we will use two CT's (CT1 and CT2); CT1 used for detect the level of material, and the comparison between CT1 and CT2 detect the fault in motor of the mixer.

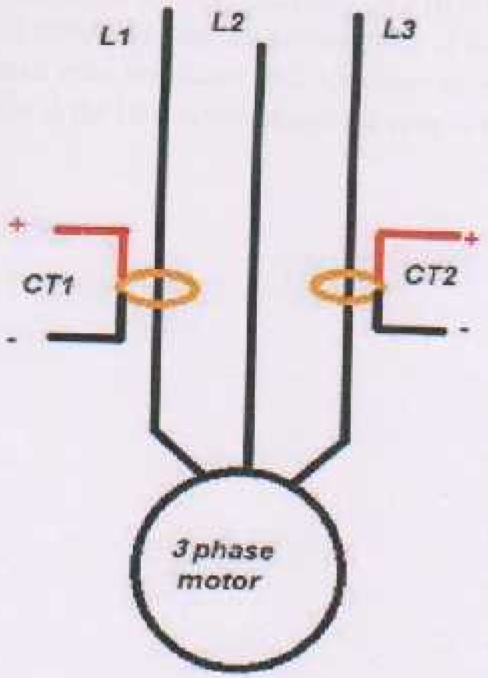



Fig. 3.11 Double CT's

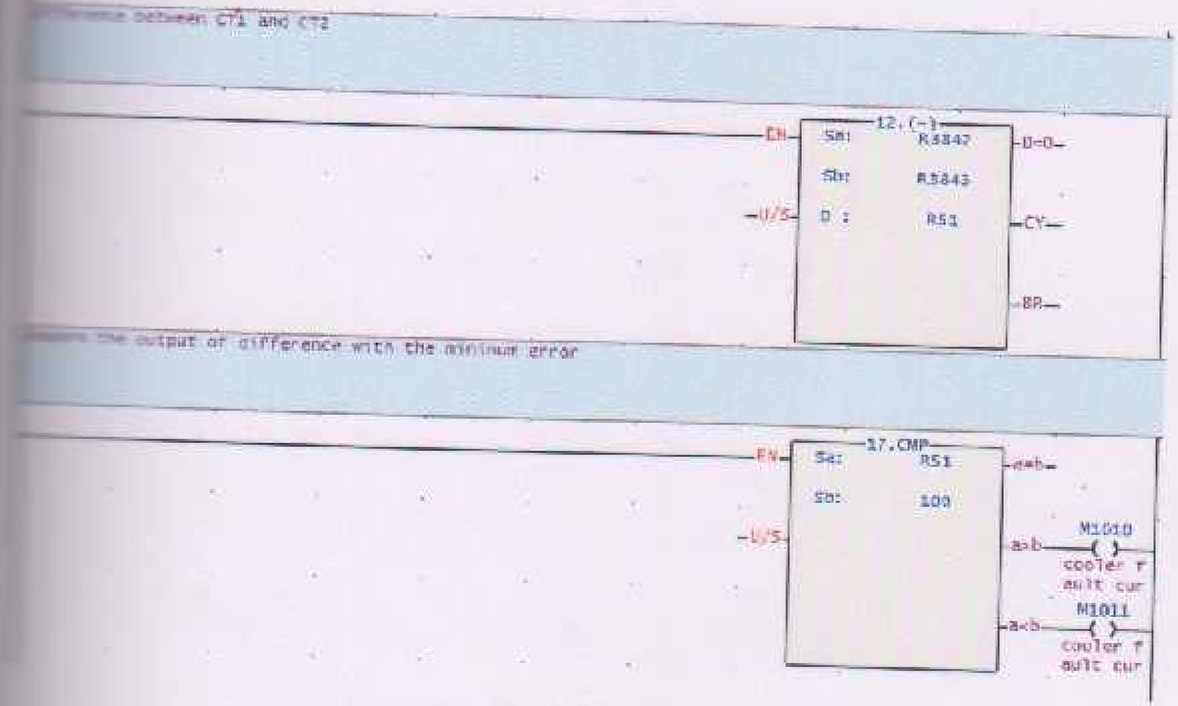



Fig. 3.12 reading CT1 and CT2

Figure 3.12 shows the reading of CT1 (R3842) and CT2 (R3843) from PLC, to detect the fault in the motor, if there's a difference between two readings of the phase current in the motor (look at figure 3.11) with small error that mean fault happened in the motor, according that the program will print the message in the HMI which shows the state of the fault.

# CHAPTER FOUR

## BLOCK DIAGRAM AND DESIGNE

This chapter describes the block diagram and the design of project and all connections to PLC

## 4.1 Block Diagram:

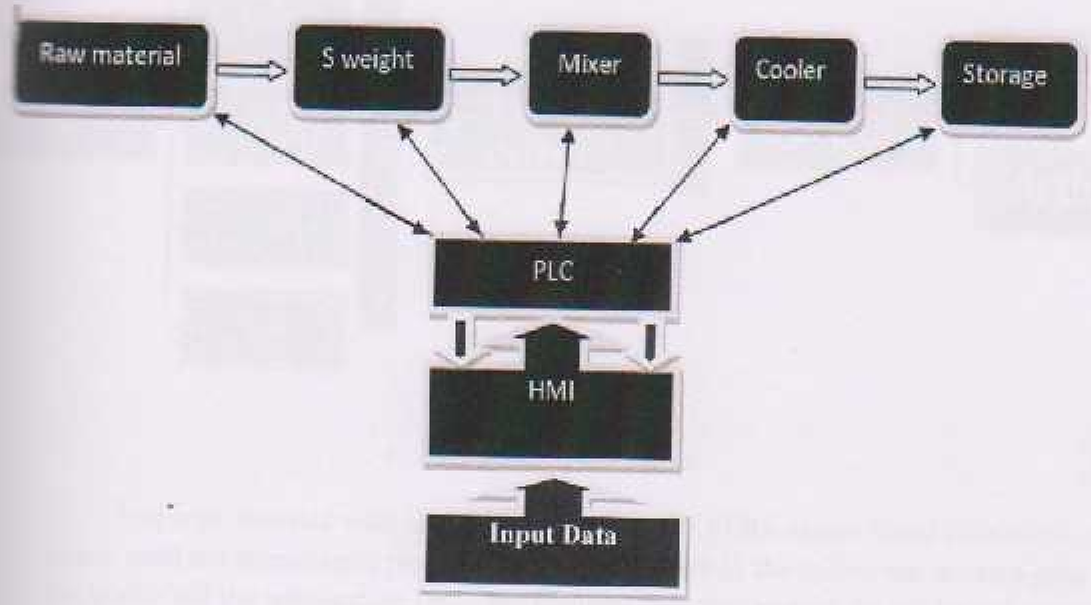



Fig. 4.1 Block Diagram

Figure 4.1 explain the process of the production line started with raw material to storage, all these process connected to PLC with suitable control, and we will use HMI to control in PLC and monitor the work.

## 4.2 Inputs and outputs parameters:

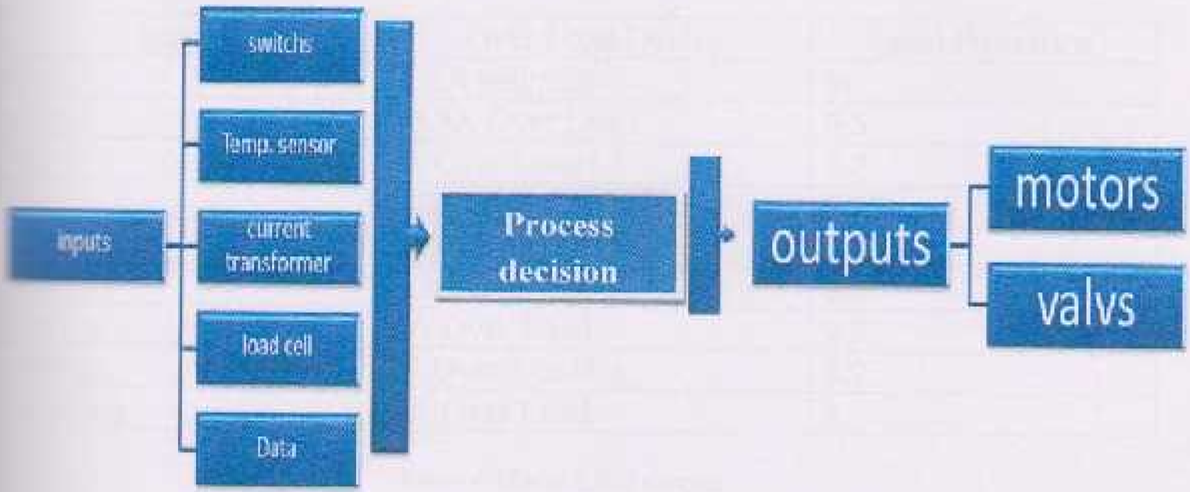



Fig.4.2 inputs and outputs

Prepared material with required weight transfer to the mixer based on the desired value, until the temperature reach to the required value in the mixer, the mixture goes to the cooler tell the temperature reach the required temperature into the cooler and then the mixture goes to the saving by unloading motor.

## 4.3 Connections

### 4.3.1 Over Loads and contactors:

**Over Loads:**

| Load | Over Load Device | Rated Power(kw) |
|---|---|---|
| Mixer | 165A soft start | 90 |
| cooler | 13.5A Over Load | 6.5 |
| PVC | A Over Load4.5 | 2.2 |
| color | 1.2A Over Load | 0.27 |
| Mulien | 1.2A Over Load | 0.27 |
| Axiom | 1.2A Over Load | 0.27 |
| Filler | 4A Over Load | 2.2 |
| Loading | A Over Load5.4 | 2.2 |
| Unloading | 6A Over Load | 3 |

Table 4.1Over Load device

Table1 shows the project's motors with it's over load protection since it adjust at the rated current According to the name plate of the motors , depending on this table the contactors were chosen refer to the current .

Each motor has small rated current except Mixer motor which has a large rated current, so starting method of the motor must be required as star delta method, frequency converter and soft start but because of the price and simplicity the soft start is the perfect method.

**Contactors:**

| | |
|---|---|
| cooler | 20 A |
| PVC | Soft start |
| color | 4 A |
| Mulien | 4 A |
| Axiom | 4A |
| Filler | 10 A |
| Loading | 10 A |
| Unloading | 10 A |

Table 4.2 Contactors

The contactors selected as 30% grater then rated current, if the value does not exist in catalogs, the next value will be chosen.

## 4.3.2 Power Circuit:

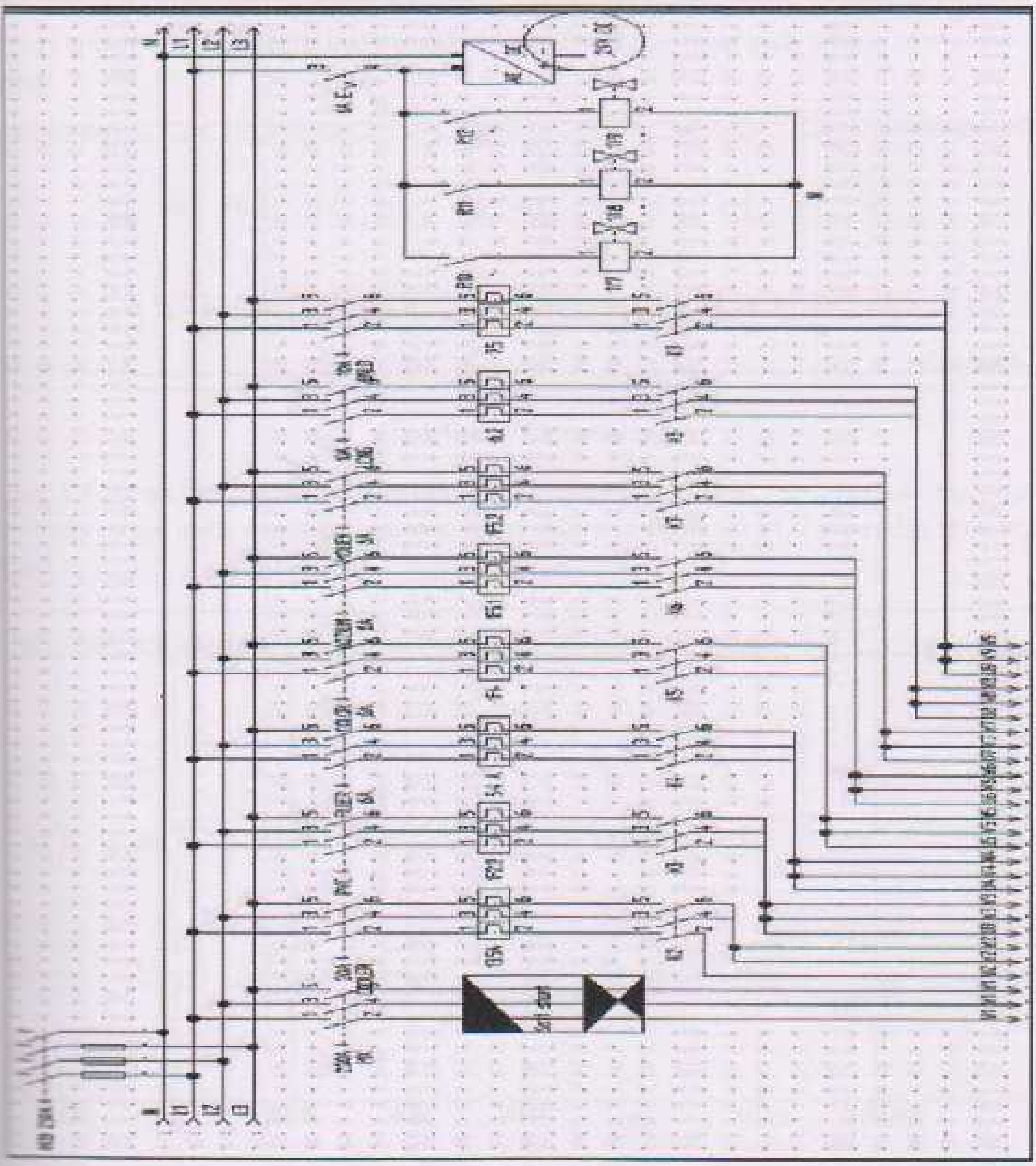


Fig.4.3 power circuit

Figure 4.3 shows the connection of the power circuit of motors with their protections, valves, DC power supply and Clements of outputs.

PLC will activate relays, these relays used to activate contactors. The function of relays is to isolate the high voltage from low voltage.

## 4.4 Control Circuit

Control circuit consist the parts that transfer signal from PLC to other parts used to control the output.

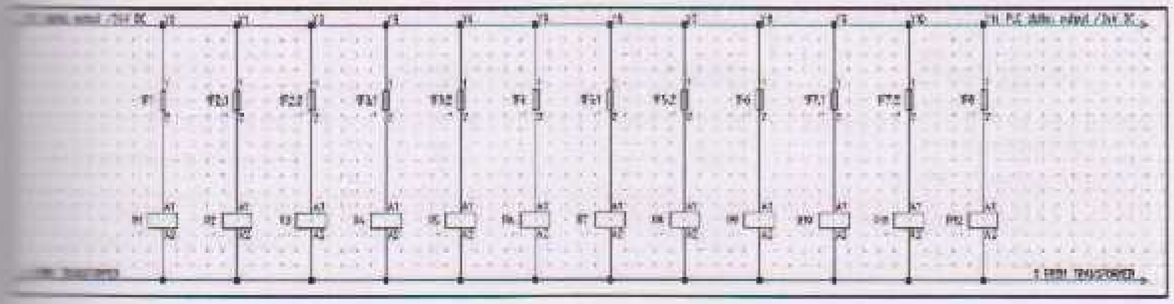


Fig 4.4Relay Connection

Figure 4.4 shows the connection between relays_ operate at 24VDC _and PLC, as mentioned previously relays is the contactor operator. Fuses shown in figure for PLC protection from high current.

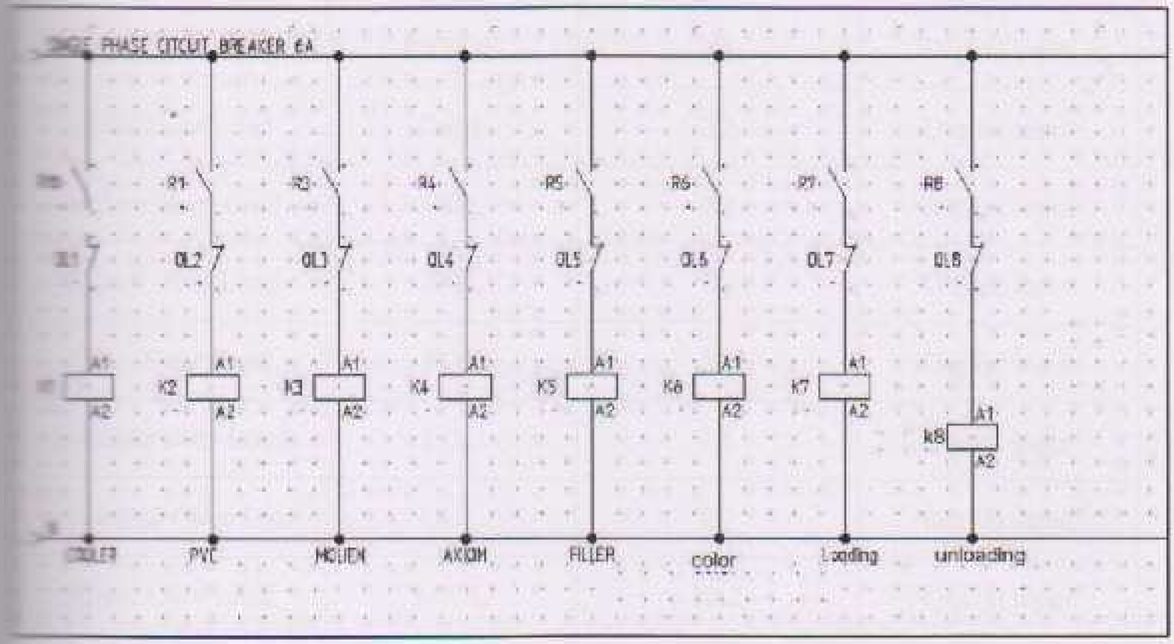



Fig 4.5 Contactors Connection

Figure 4.5 shows connection of the contactors _220v AC_, using the normally closed contact of over load to sure the operation in save mode; that mean when the over load of any motor activate the control of this motor does not operate.

## 4.5 PLC Variables

**Inputs:**

| Name | Symbol | Address | Description |
|---|---|---|---|
| Temperature sensor 1 | Ts1 | I0+ | Temp sensor for mixer, Analog input |
| Temperature sensor 2 | Ts2 | I1+ | Temp sensor for cooler, analog input |
| Emergency | Em | X14 | Digital input |
| S-Weight | S | Ch0 | Analog input |
| Cooler Over Load | COL | X0 | Digital input |
| PVC Over Load | PVCOL | X1 | Digital input |
| Color Over Load | CoOL | X2 | Digital input |
| Mulien Over Load | MOL | X3 | Digital input |
| Axuim Over Load | AOL | X4 | Digital input |
| Filler Over Load | FOL | X5 | Digital input |
| Loading Over Load | LOL | X6 | Digital input |
| Unloading Over Load | UOL | X7 | Digital input |
| Mixer Over Load | MiOL | X12 | Digital input |

Table 4.3 Input parameters to PLC

**Outputs:**

| Name | Symbol | Address | Description |
|---|---|---|---|
| Motor 1 | M1 | Y0 | PVC motor |
| Motor 2 | M2 | Y4 | Filler motor |
| Motor 3 | M3 | Y1 | Color motor |
| Motor 4 | M4 | Y2 | mulien motor |
| Motor 5 | M5 | Y3 | Axiom motor |
| Motor 6 | M6 | Y11 | Start Mixer motor |
| Motor 6 | M6 | Y12 | Stop Mixer Motor |
| Motor 6 | M6 | Y13 | Reset Mixer Motor |
| Motor 7 | M7 | Q0.6 | Cooler motor |
| Motor 8 | M8 | Q0.7 | Motor to transfer material from weight to mixer |
| Motor 9 | M9 | Q1.0 | Motor to transfer material from cooler to store |
| Valve 11 | V11 | Q1.1 | Between weight and spare |
| Valve21 | V21 | Q1.3 | Cylinder of mixer to cooler |

Table 4.4 Output parameters from PLC

## 4.6 Human Machine Interface(HMI):

It's necessary of using HMI in the large projects to make the process more easily, monitoring, less connections and fast fault diagnostic, since there's a lot of push button so using the HMI avoids this problem.

Easy builder screen (HMI) was used in this project which is working suitably with the FBs-40MA (PLC). The HMI parted into many screens, each of them for one process as main process, load cell setting, automatic operation, manual operation and main setting.

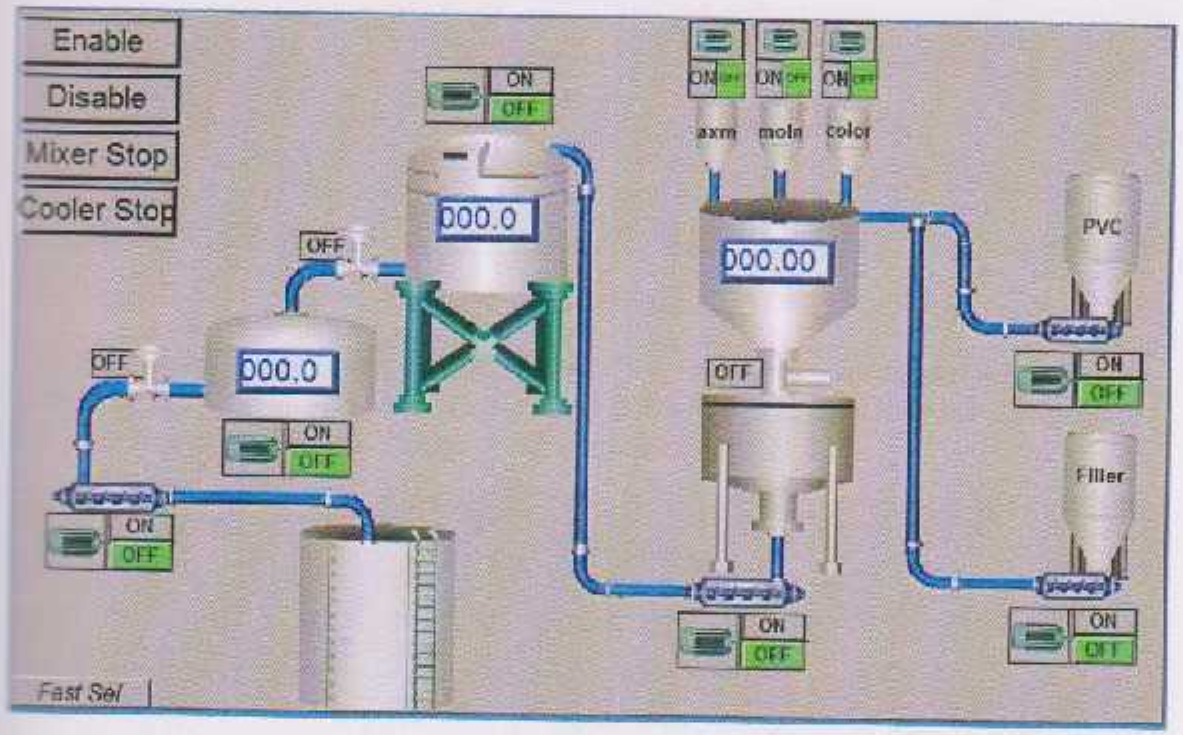



Fig. 4.6 Automatic process

The main process of the project as shown in figure 4.6 , in the automatic mode which is show the input materials, loading part, mixing part, cooling part and unloading part respectively from the right side of the figure.

The worker can use the setting window to control of all the process by interring the data like amount of required materials and the suitable temperature for the mixer and cooler. Lock at figure 4.7.

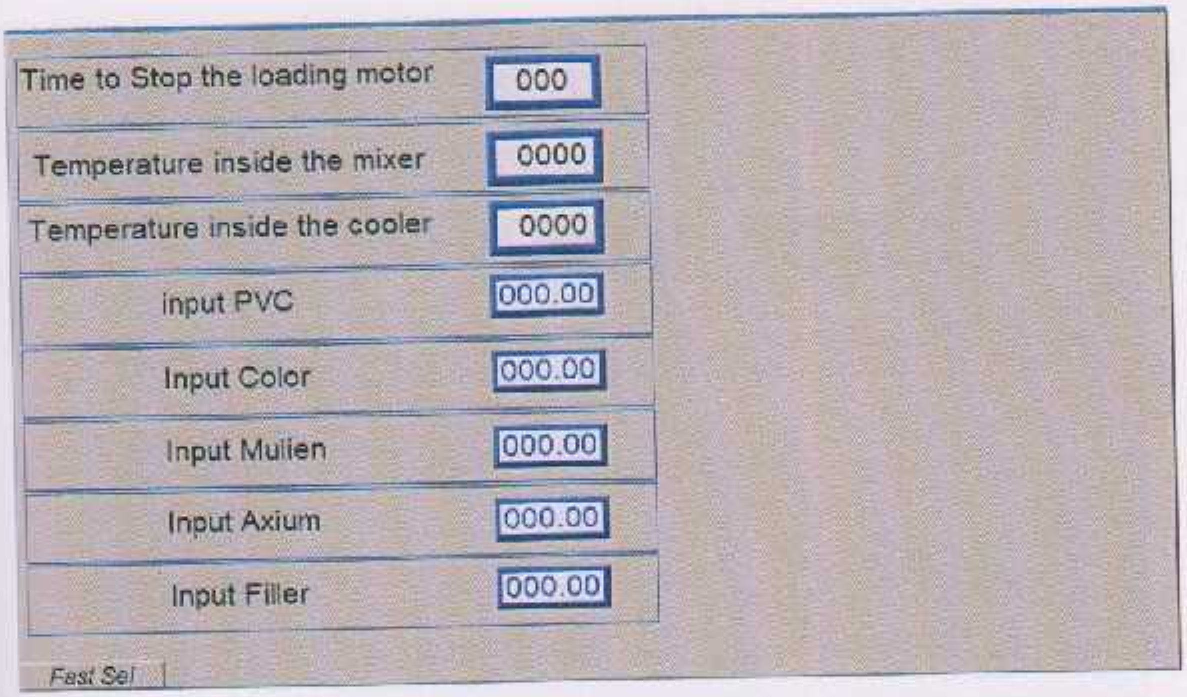



Fig. 4.7 Setting Window

The Manual screen can be used for maintenance, testing and manual operation which is containing push button for every motor without self-holding. In control of the mixer motor tow push buttons were used to control of soft start. Lock at figure 4.8.

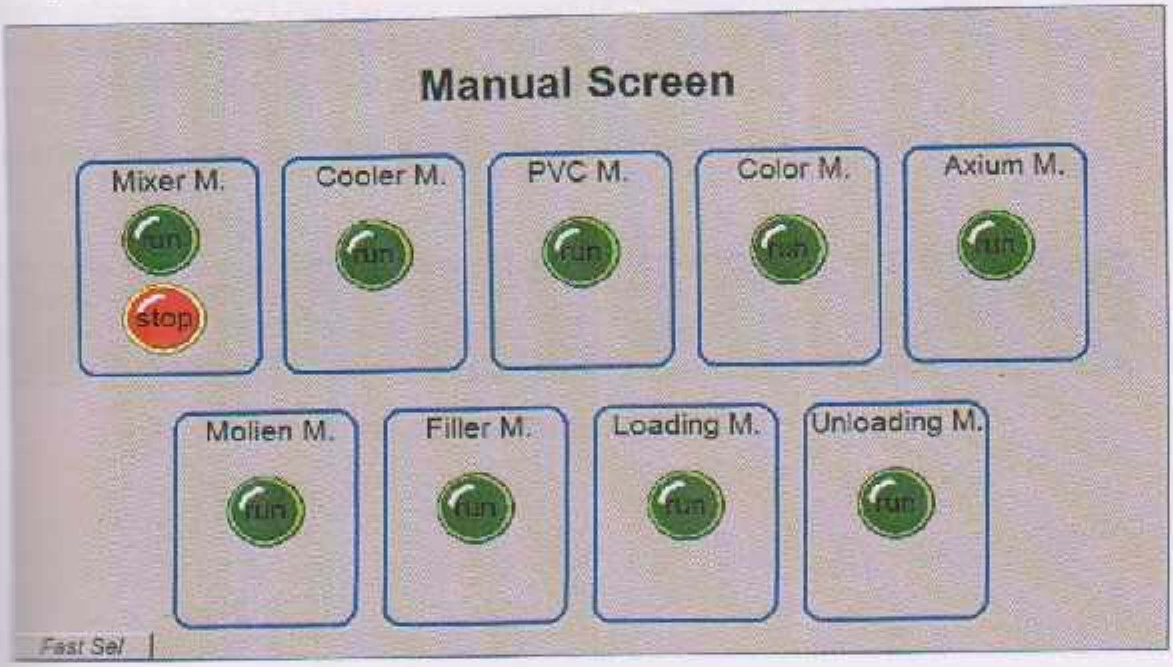



Fig. 4.8 Manual Window

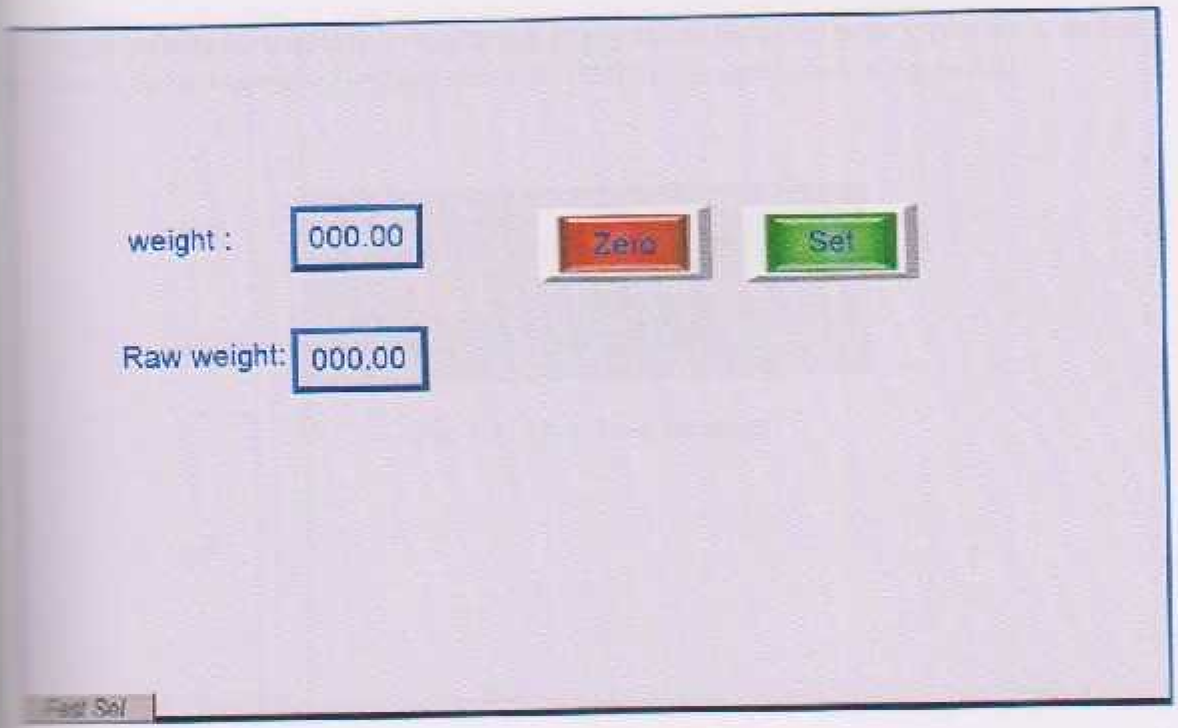



Fig. 4.9 Load Cell Setting Window

Before using the load cell, calibration must be occurred to make the reading more actually and to avoid any error in the weights. This calibration can done using the load cell setting window (figure 4.9) with mass known its weight (Raw weight) putting at the load cell sensor and interring its weight in its place, then by pressing set button the weight will stored into the memory of the PLC then the load cell became calibrated.

All of these windows can be selected by the fast election window shown in figure 4.10.

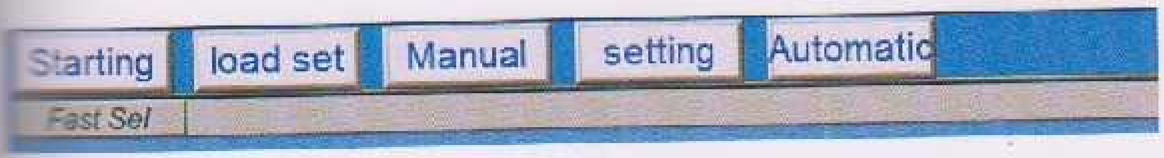



Fig. 4.10 Fast Selection Window

The main purpose for the HMI is monitoring, so any action happened must appear on it, such as any over Load in the motors will appear on the HMI as message shown in figure 4.11 .

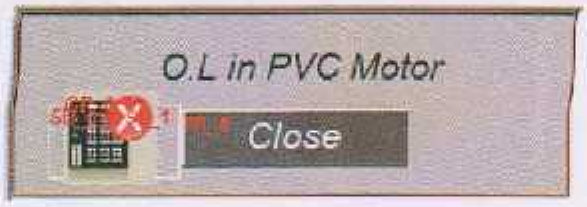



Fig. 4.11 Over Load message

## 4.7 Flow Chart and Programming:

### 4.7.1 Flow Chart:

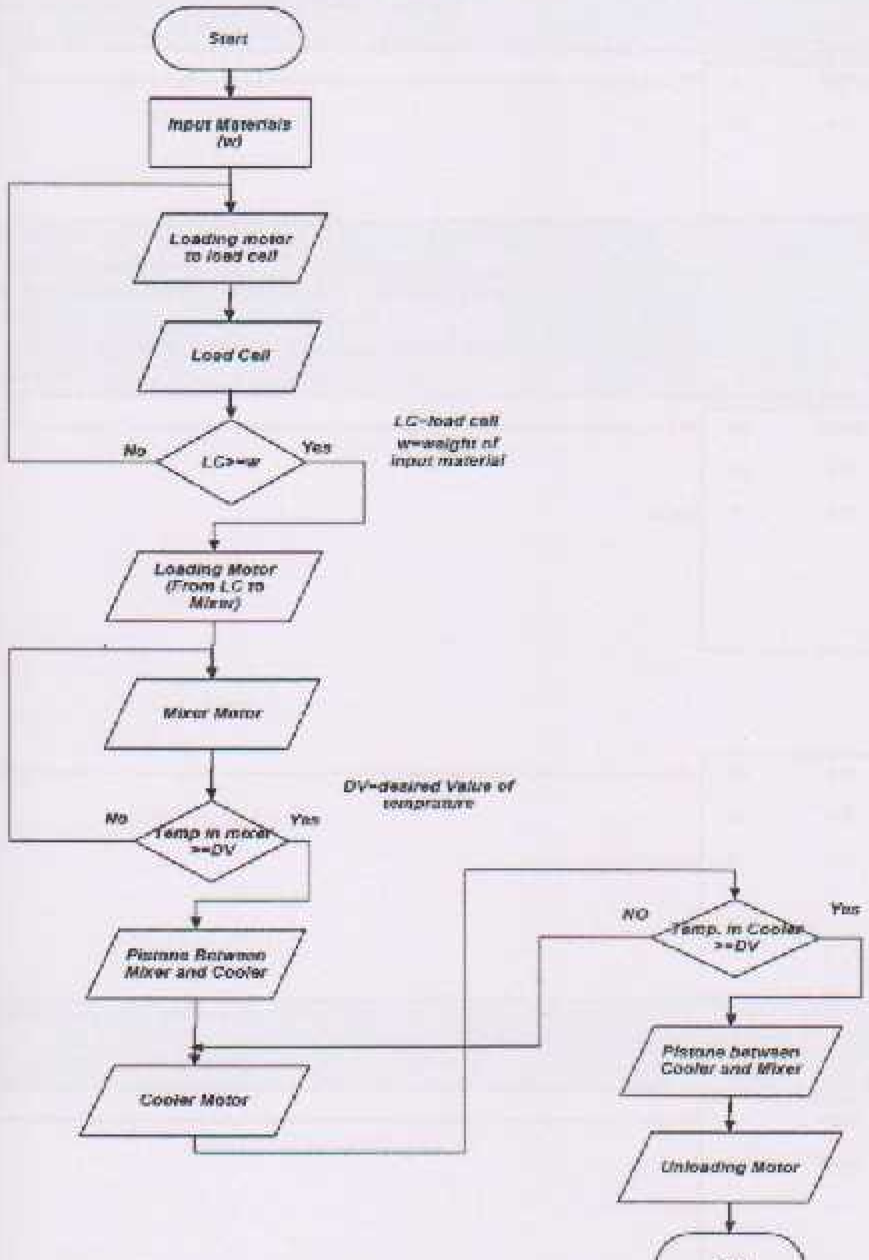
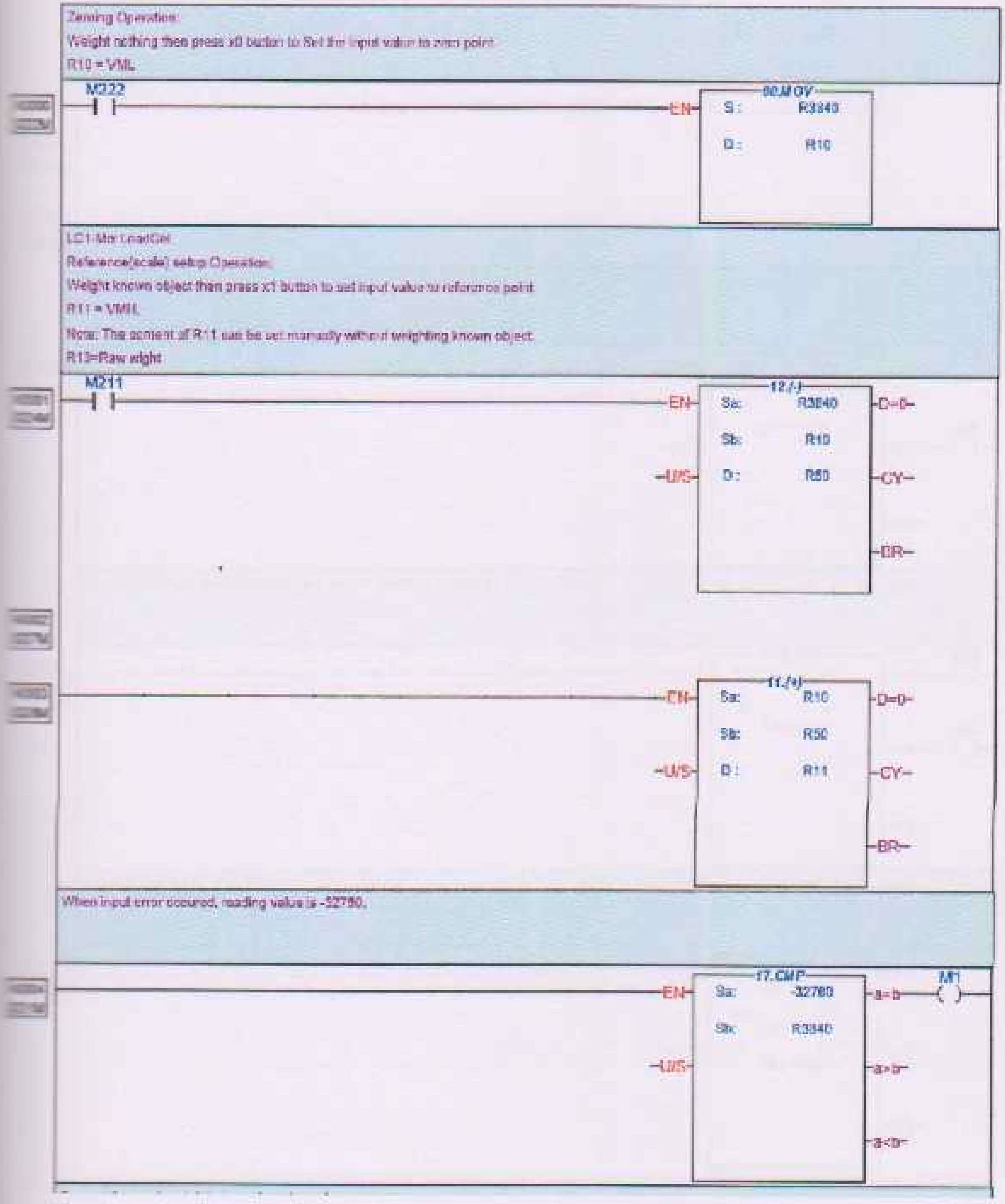
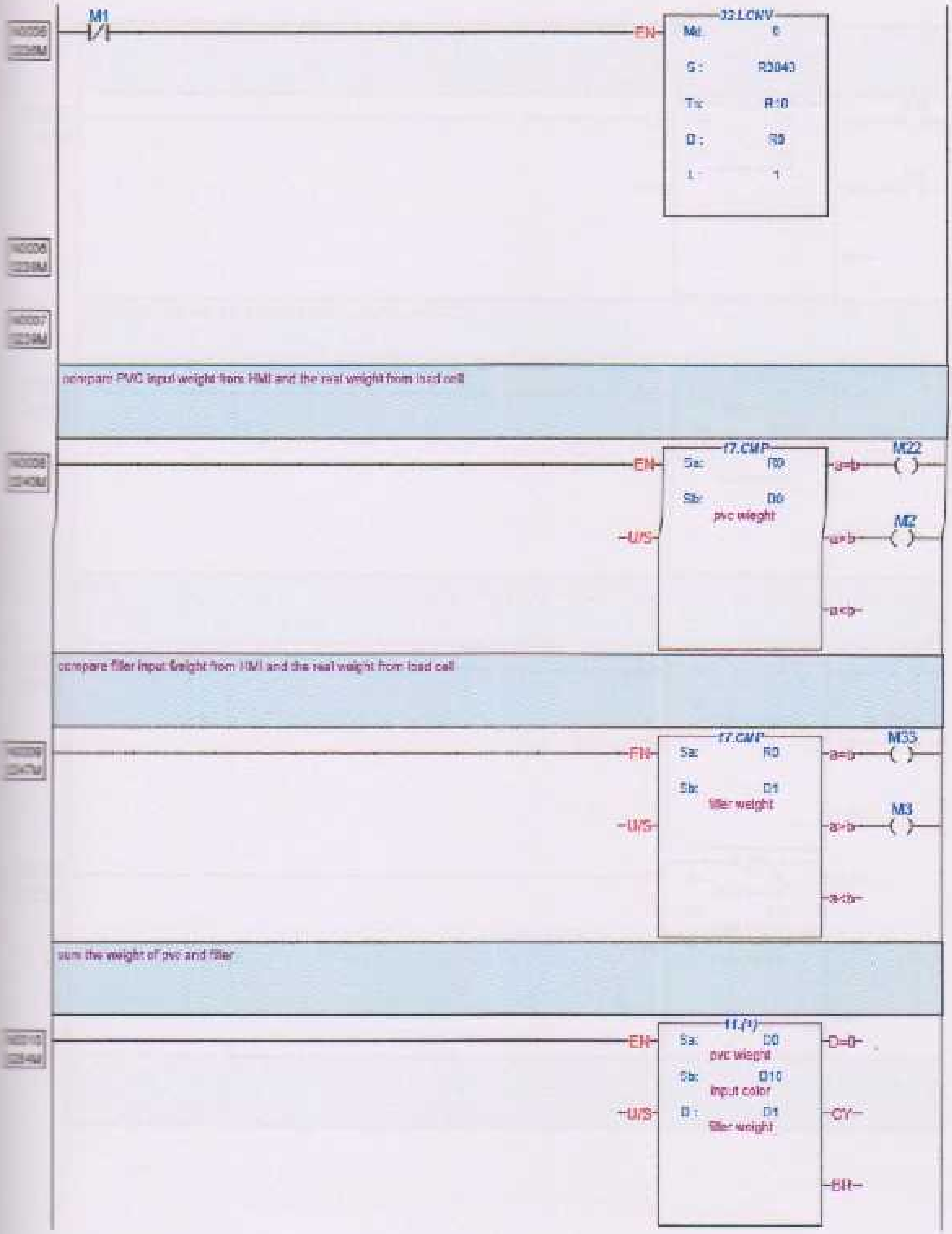


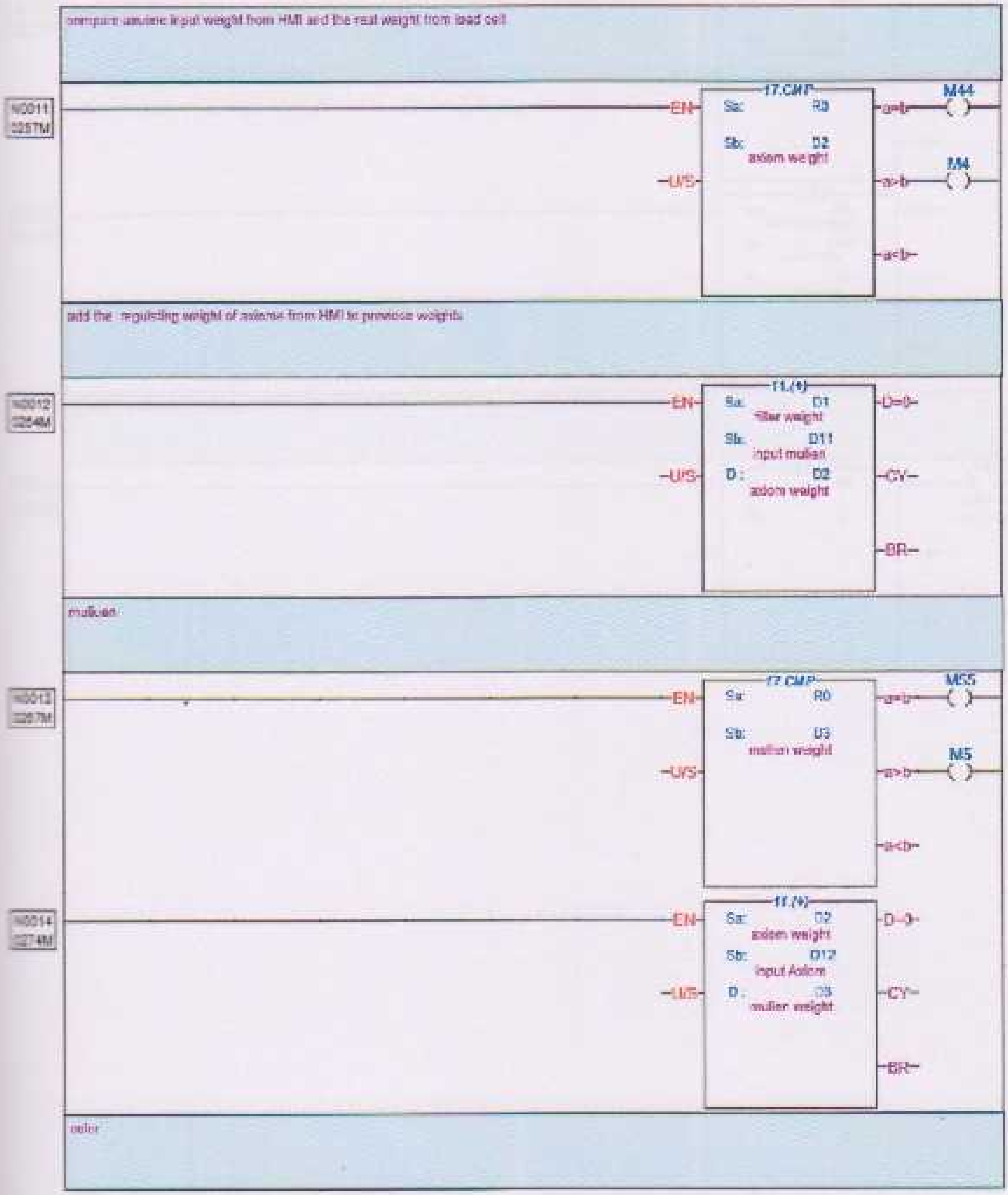

Fig. 4.12 Project Flow chart

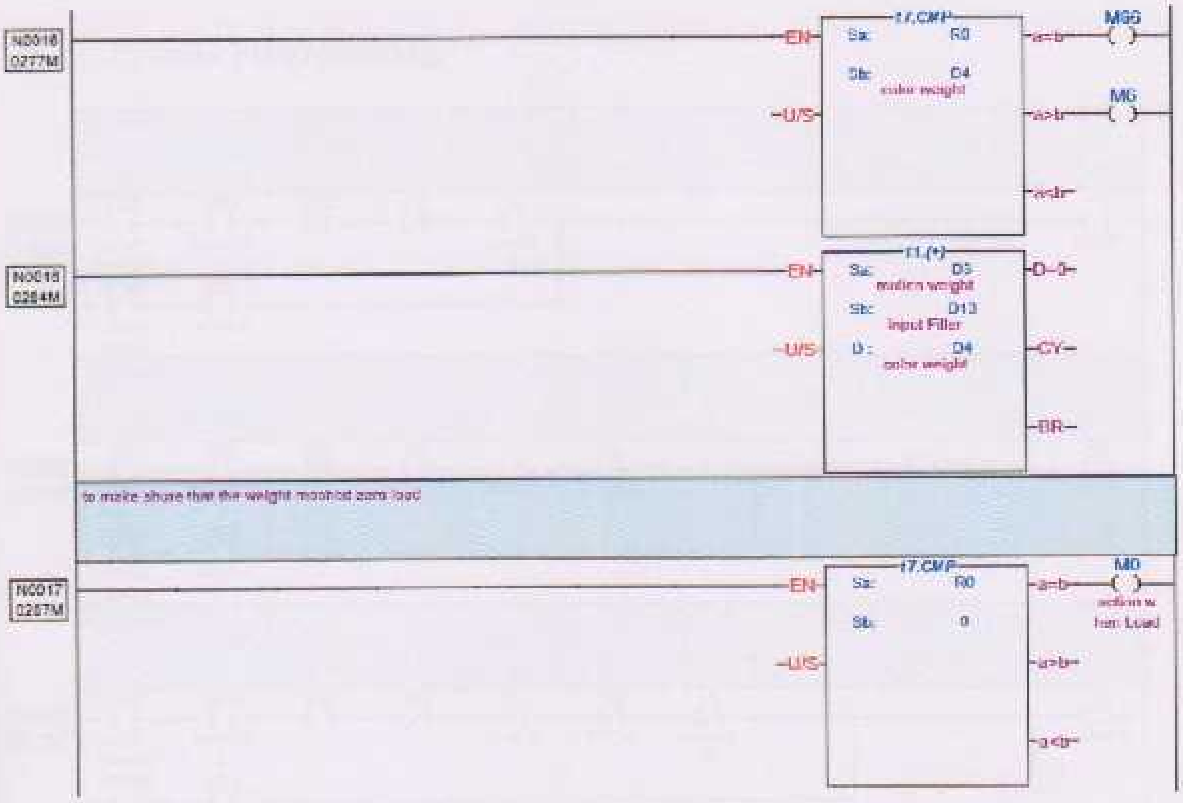
## 4.7.2 Programming:

## Load Cell Programming:

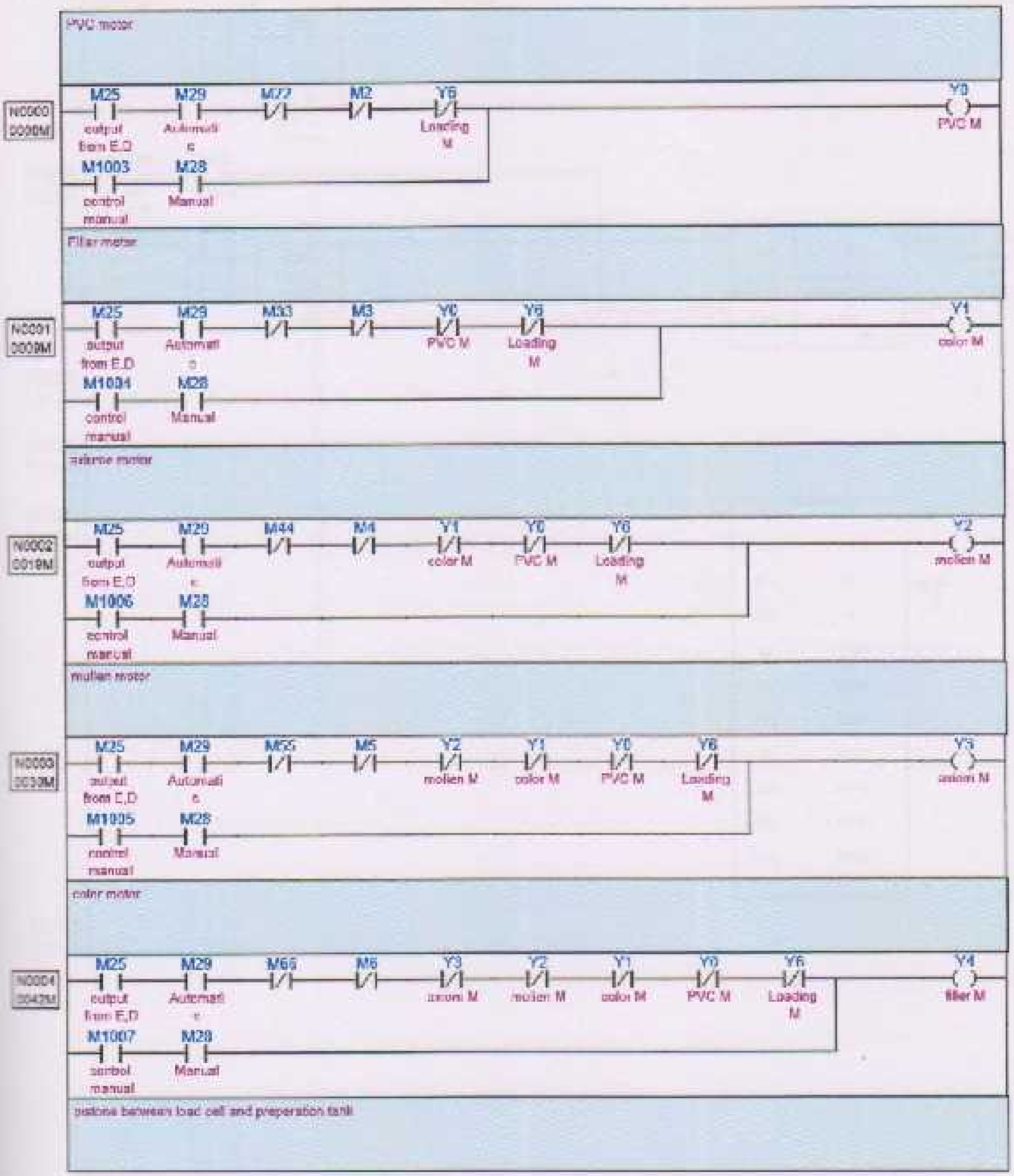


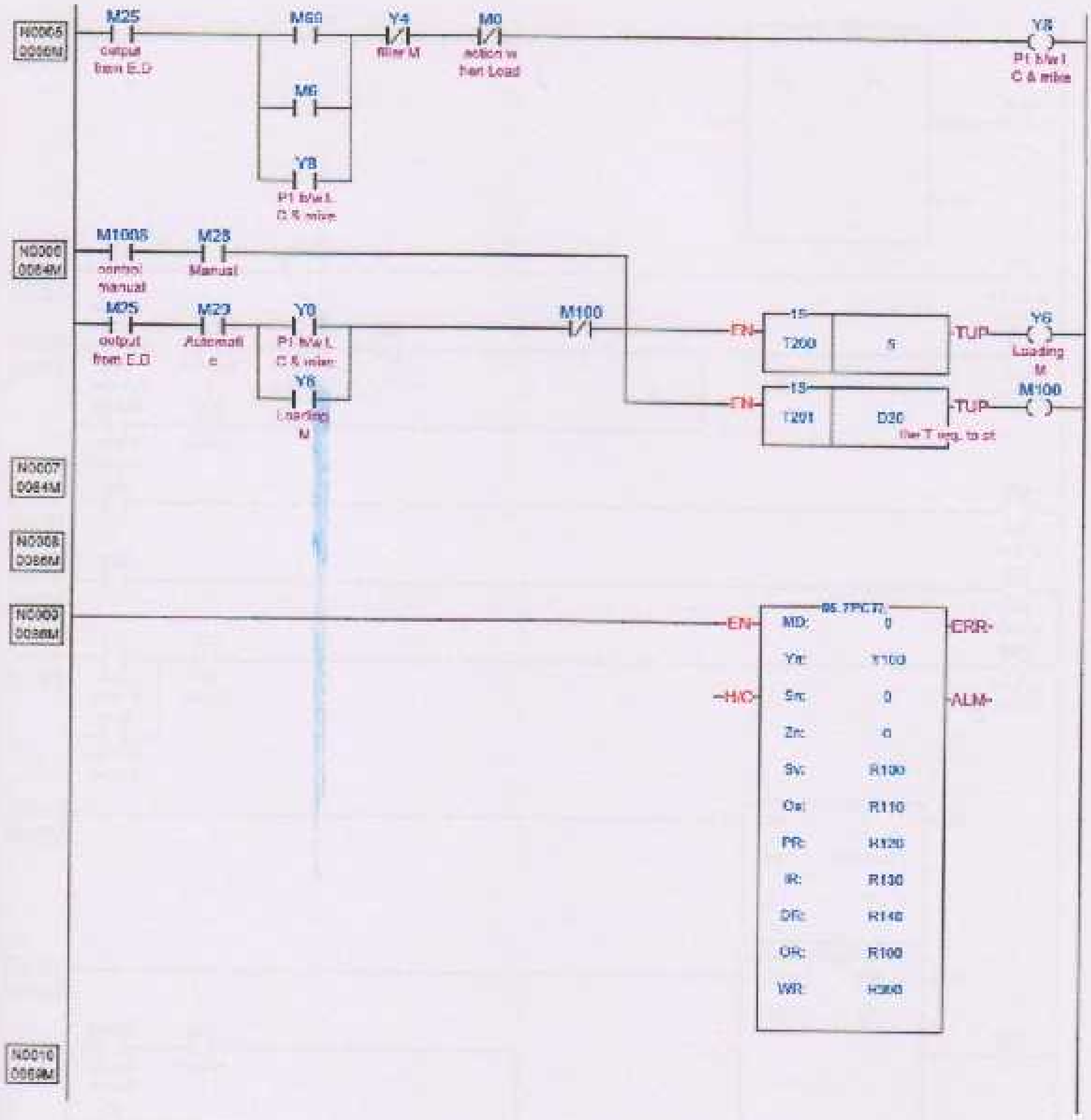

M1
EN
Md:
S:
R3043
T:
R10
D:
R0
L:
1
compare PVC input weight from HMI and the real weight from load cell
EN
Sa:
R0
Sb:
D0
pvc wieght
U/S
M22
M2
compare filler input weight from HMI and the real weight from load cell
Sa:
R0
Sb:
D1
filler weight
U/S
M33
M3
sum the weight of pvc and filler
EN
Sa:
D0
pvc wieght
Sb:
D10
input color
U/S
D:
D1
filler weight
CY
ER

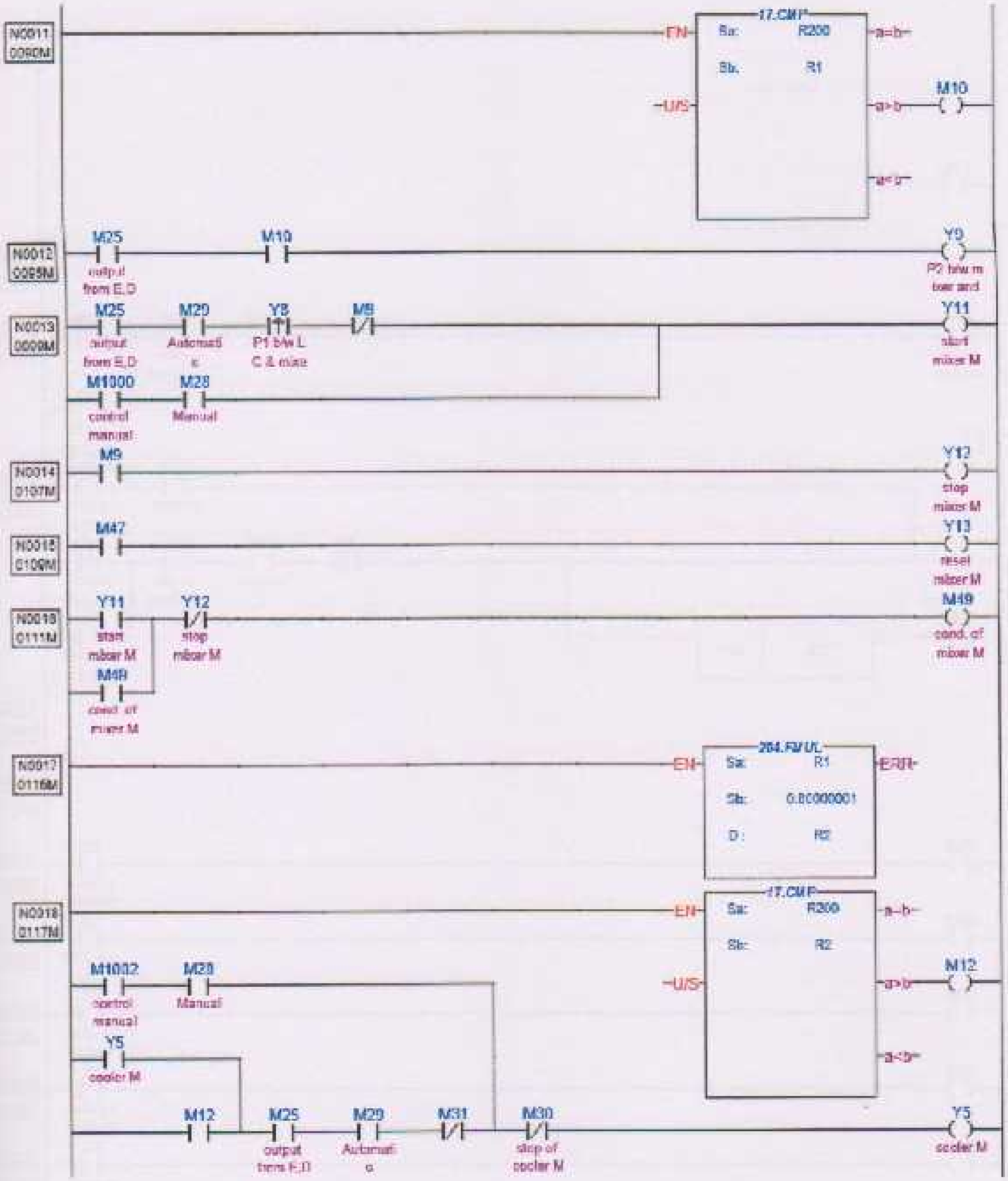

17.CMP
EN
U/S
Sa:
Sb:
D2
axiom weight
M44
M4
a=b
a>b
a<b
11.(+)
D1
filler weight
D11
input mullen
D :
D2
axiom weight
D=0
CY
BR
mullen
17.CMP
R0
D3
mullen weight
M55
M5
11.(+)
D2
axiom weight
D12
input Axiom
D3
mullen weight


EN
U/S
Sa:
Sb:
R0
D4
MG
Sa:
Sb:
D:
D5
D13
input Filler
D4
CY
BR
EN
U/S
Sa:
Sb:
R0
0
M0

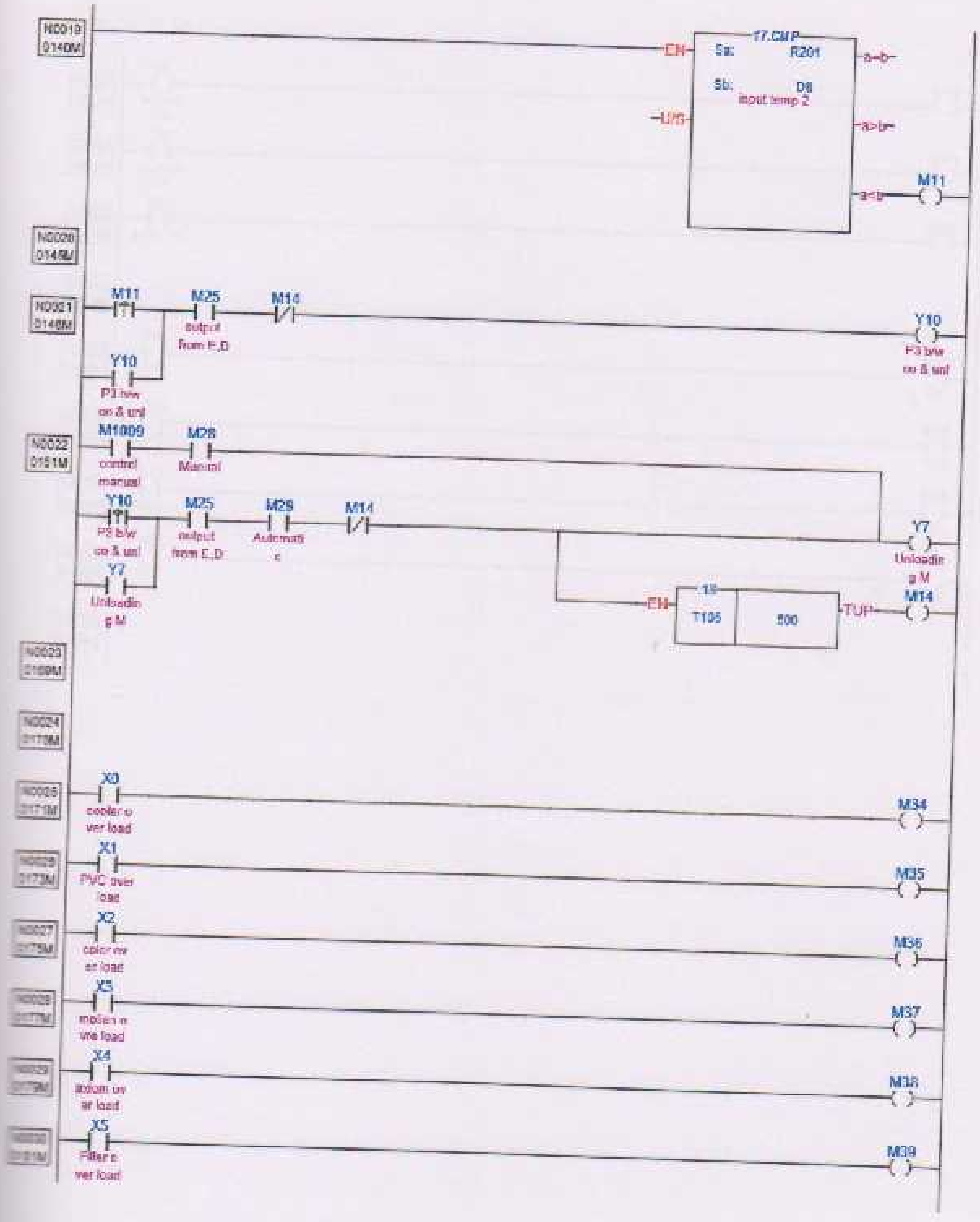
## Process programming:







17.CMP
EN
Sa: R200
Sb: R1
U/S
a=b
a>b
a<b
M10
M25
output from E.D
M19
Y0
M20
Automati c
Y8
P1 b/w L C & mixe
M9
Y11
start mixer M
M1000
control manual
M28
Manual
Y12
stop mixer M
M47
Y13
reset mixer M
M49
cond. of mixer M
204.FMUL
ERR
Sa: R1
Sb: 0.00000001
D: R2
17.CMP
Sa: R200
Sb: R2
M12
M1002
Y5
cooler M
M31
M30
stop of cooler M



17.CMP
Sa: R201
Sb: D8
input temp 2
EN
U/S
a=b
a>b
a<b
M11
M25
output from E,D
M14
Y10
P3 b/w on & unl
M1009
control manual
M28
Manual
M29
Automatic
Y7
Unloading M
T105
500
TUP
X0
cooler over load
M34
X1
PVC over load
M35
X2
color over load
M36
X3
M37
X4
M38
X5
Filler over load
M39


X6
loading OL
M40
X7
unloading OL
M41
X12
mber OL
M42
X13
LS1
M43
LS1
X14
LS2
M45
X15
LS3
M46
LS3
X16
EM
M48
EM

## 4.8 Panel Design

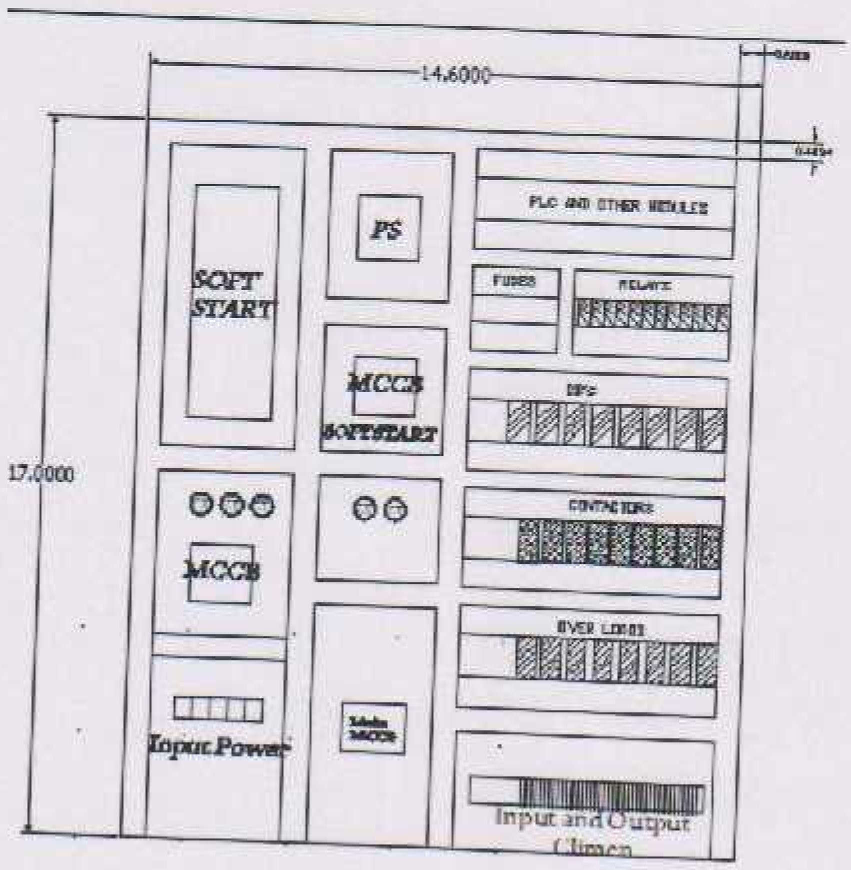



Fig. 4.13 panel design

Figure 4.13 show the firs design of panel, showing the component of panel contactors, fuses, soft start, MCCB, DC power supply and current transformer with their real position and nodes of inputs and outputs. At the and dimension of panel is obtained.

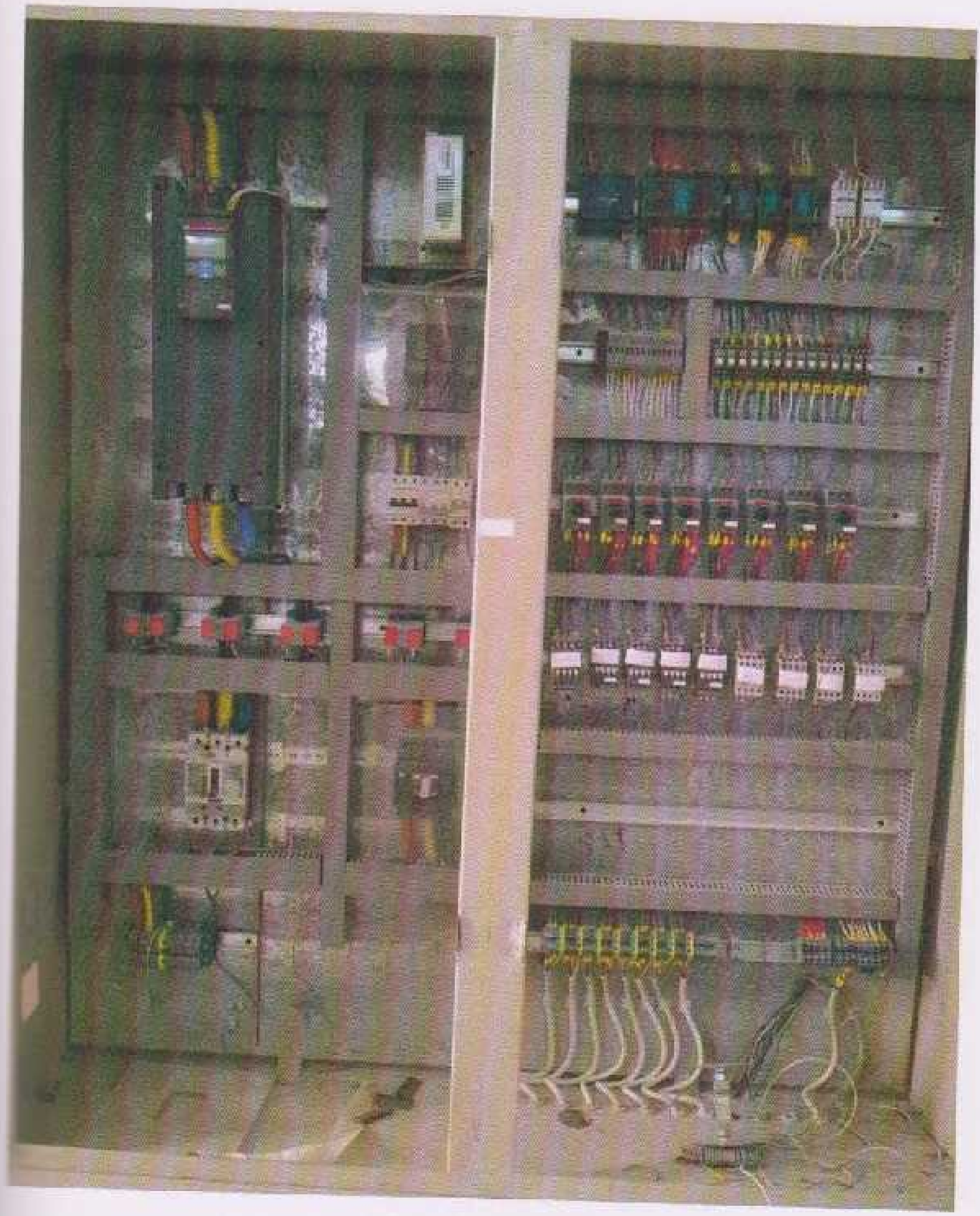


Fig. 4.14 Real Panel

## 4.9 Project cost

| Item | Description | Quantity | Price | Amount |
|---|---|---|---|---|
| Load cell | | 3 | 800 | **2400** |
| PLC | FATEK ,40MAR2,AC | 1 | 1500 | **1500** |
| PLC Module | FBS-1LC ,Load Cell Module | 1 | 1100 | **1100** |
| PLC Module | FBS-4A2D ,Current Module | 1 | 600 | **600** |
| PLC Module | FBS-6TC,Tempreture module | 1 | 600 | **600** |
| ACT-2 | Current module | 2 | 700 | **1400** |
| Relay | 24VDC,8PINS | 14 | 30 | **420** |
| Contactor | ABB,5.5KW,220V | 4 | 60 | **240** |
| Contactor | ABB,11KW,220V | 1 | 80 | **80** |
| Contactor | ghisalba,4KW,220V | 4 | 50 | **200** |
| Power supply | 220-24vdc,4.2A | 1 | 200 | **200** |
| Power supply | 220-24vdc,2A | 1 | 150 | **150** |
| Circuit Breaker | Hager, single phase,c10A | 2 | 12 | **24** |
| Circuit Breaker | 3phase , C2A | 1 | 20 | **20** |
| Circuit Breaker | ABB,3phase ,C53A | 1 | 50 | **50** |
| Circuit Breaker | ABB,3phase ,C200A | 1 | 300 | **300** |
| Circuit Breaker | 3phase ,C250A | 1 | 350 | **350** |
| Overload | 10-16A | 1 | 80 | **80** |
| Overload | 1.6-2.5 A | 3 | 50 | **150** |
| Overload | 2.5-4 A | 4 | 60 | **240** |
| Power analyzer | | 1 | 500 | **500** |
| Emergency | Emergency Switch | 1 | 25 | **25** |
| CT | (60—5)A | 2 | 30 | **60** |
| CT | (200—5)A | 3 | 50 | **150** |
| Soft start | ABB,90KW | 1 | 8000 | **8000** |
| Board | Panel Electricity | 1 | 2000 | **2000** |
| Fatek Screen | Touch Screen | 1 | 2000 | **2000** |
| Wiring | | - | 10000 | **10000** |
| Accessories | | - | 3000 | **3000** |
| ---------------- | -------------- | -------- | --------- | ---------- |
| Total price | | | | **35,839** |

Table 4.5 Project Cost

# CHAPTER FIVE

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## FUTER WORK AND CONCLUSION

**5.1 Recommendations.**

**5.2 Challenges.**

**5.3Conclusions.**

## 5.1 Recommendations

In this project, control room has been design and built, it can be improved in many ways such as implementing a SCADA system for dispensing data cable between PLC and HMI, so control would be remote.

## 5.2 Challenges

While designing the system, there are many challenge were faced, such as:

- ✓ Some of required components for the project are not available in the local market; such as load cell module.
- ✓ Some of the project components are expensive.
- ✓ Lack of knowledge about PLC and HMI programs.
- ✓ Climate cost us a lot of time.

## 5.3 Conclusions.

- ✓ In this project many information about types of PLC and HMI have been learned and gained.
- ✓ FATEK and Easy builder programming has been learned.
- ✓ Dealing with panels and wiring has been obtained.
- ✓ Over loads, contactors and circuit breaker selecting has been obtained.

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# Appendix

# Appendix A

# FBs-4A2D

## Analog A/D&D/A Combo Module

### ntroduction

Bs-4A2D is one of the analog I/O modules f FATEK FBs series PLC. For analog output t provides 2 channels of 14 bit D/A output. ase on the different jumper settings it can rovide varieties of current or voltage output gnal. The output code can be configured as npolar or bipolar which makes the relation f output code and real output signal more tuitive. For safety, the output signal will be tomatically forced to zero(0V or 0mA) hen the module is not serviced by CPU for 5 second.

r analog input it provides 4 channels A/D put with 12 or 14 bit effective resolution. se on the different jumper settings it can easure the varieties of current or voltage gnal. The reading value is represented by a 4 bit value no matter the effective resolution set to 12 or 14 bit The output code also can configured as unipolar or bipolar which kes the relation of input code and real put signal more intuitive.. In order to filter t the field noise imposed on the signal, it so provides the average of sample input nction.

### *Specification*

#### *Analog Input*

**Total Channels** - 6 CH
**Resolution**- 14 or 12 bit
**Signal Resolution** - 0.3mV(Voltage), 0.61uA(Current)
**I/O Points Occupied** - 6 RI(Input Register)
**Conversion Time**- Updated each scan
**Accuracy**- ±1 %
**Max. Absolute Input Rating**-
±15V(Voltage), 30mA(Current)
**Software Filter**- Moving average
**Average Samples**- 1~16 configurable
**Input Impedance**- 63.2KΩ(Voltage), 250Ω(Current)
**Measurement Range**-
-10~+10V, -5~+5V, 0~10V, 0~5V
-20~+20mA, -10~+10mA, 0~20mA, 0~10mA

#### *Analog Output*

**Total Channels** –2 Channels
**Resolution**- 14 bit
**Signal Resolution** - 0.3mV(Voltage), 0.61uA(Current)
**I/O Points Occupied** –
2 RO(Output Register)
**Conversion Time**- Updated each scan
**Accuracy**- ±1 %
**Max. and Min. output loading**-
Voltage Output- 500~1MΩ
Current Output- 0~500Ω
**Output Range**-
-10~+10V, -5~+5V, 0~10V, 0~5V
-20~+20mA, -10~+10mA, 0~20mA, 0~10mA

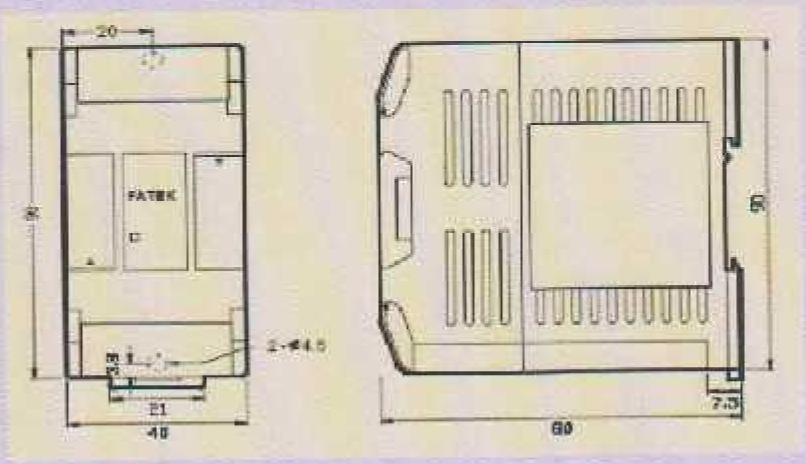
#### *Common Specification*

**Isolation**- Transformer(Power) and photo-coupler(Signal)
**Indicator(s)** - 5V PWR LED
**External Power and Consumption**-
24V-15%/+20%,
100mA max.
**Internal Power Consumption**- 5V, 20mA
**Operating Temperature**- 0 ~ 60 ℃
**Storage Temperature**- -20 ~ 80 ℃
**Dimensions**- 40(W)x90(H)x80(D) mm

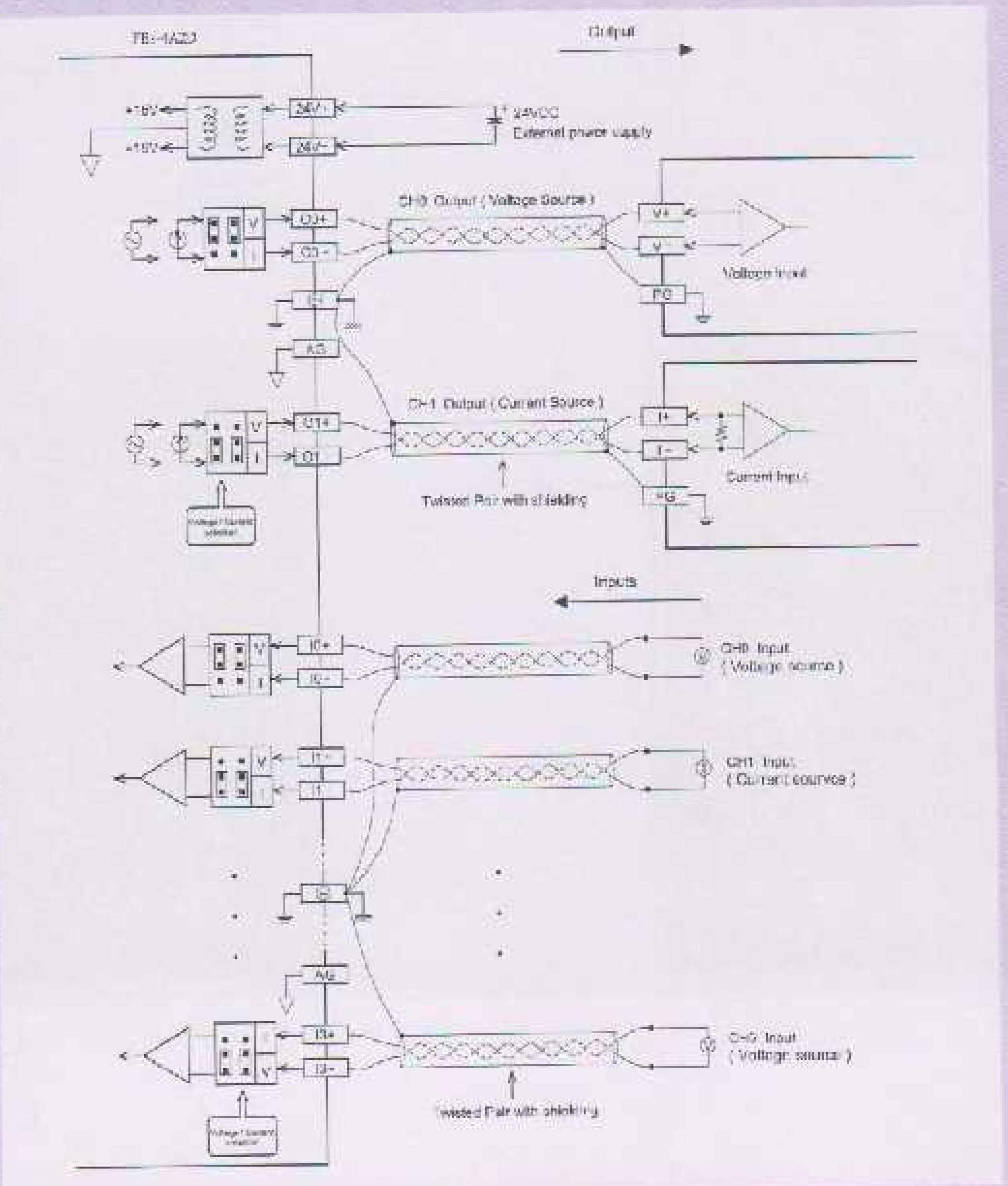
# FBs-4A2D

Analog A/D&D/A Combo Module

## Dimensions



## Wiring Diagram



# FBs-4A2D

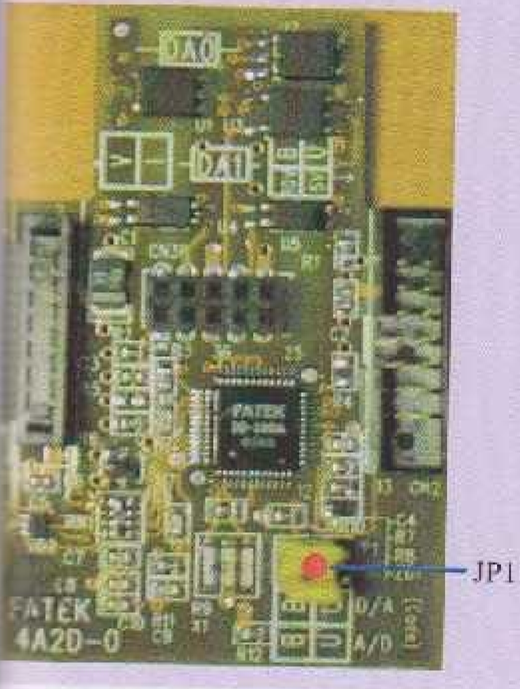
**Analog A/D&D/A Combo Module**

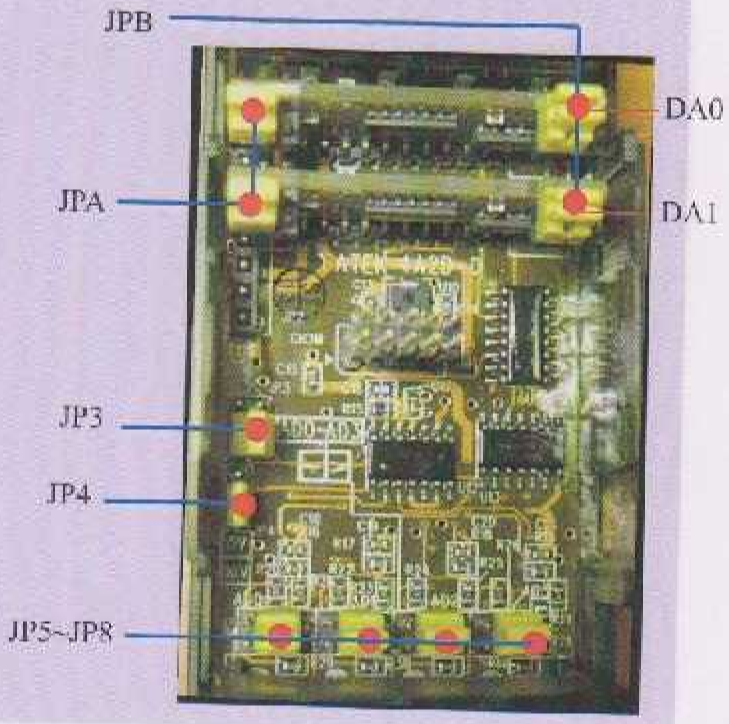
### */A Jumper Setup*

#### *utput Code Format Selection*

here are two formats of output code can be selected, one is Unipolar and the other is Bipolar. The range f the Unipolar code value is 0~16383 while the Bipolar is -8192~8191. The extreme two ends of the ode value corresponding to the minimal and maximal analog output level respectively. For example, if e analog signal is set to -10V~+10V range, for the same code value 0, the Bipolar code will result 0V utput, while the Unipolar code will result -10V output, for the code value 8191, the Bipolar code will sult 10V output, while the Unipolar code will result 0V output. The JP1 are shared for CH0, CH1 which eans both channels can not configure to different output code format.

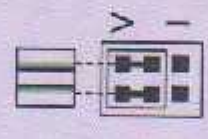
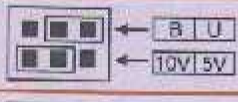
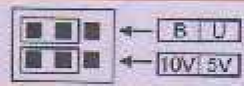
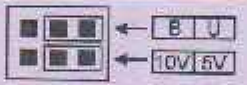
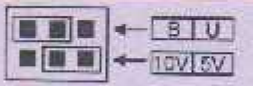
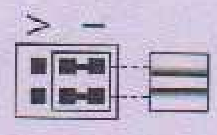
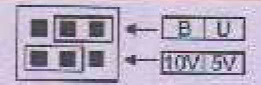
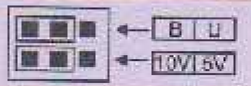
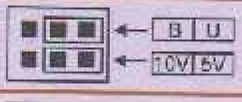
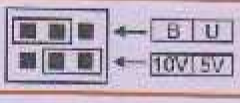
| Format | JP1 | Code Range | Corresponding Output |
|---|---|---|---|
| Bipolar | JP1 (B U) (D/A) | -8192 ~ 8191 | -10V ~ 10V(-20mA ~ 20mA)<br>-5V ~ 5V(-20mA ~ 20mA)<br>0V ~ 10V(0mA ~ 20mA)<br>0V ~ 5V(0mA ~ 10mA) |
| Unipolar | JP1 (B U) (D/A) | 0 ~ 16383 | |



*Output Signal Type Selection*

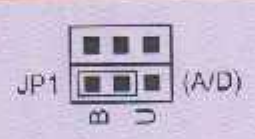
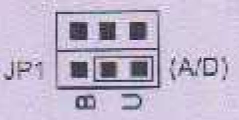
Please refer the above picture for the location of JPA & JPB. The upper row of JPA & JPB is for CH0 D/A, while the second row of JPA & JPB is for CH1 D/A.

| Signal Type | JPA (Voltage/Current) Setup | JPB (Range&Polarity) Setup |
|---|---|---|
| 0V ~ 10V |  |  |
| -10V ~ 10V | |  |
| 0V ~ 5V | |  |
| -5V ~ 5V | |  |
| 0mA ~ 20mA |  |  |
| -20mA ~ 20mA | |  |
| 0mA ~ 10mA | |  |
| -10mA ~ 10VmA | |  |

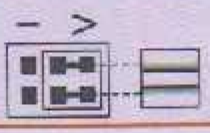
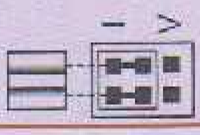
## /D Jumper Setup

### *put Code Format Selection*

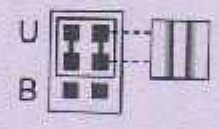
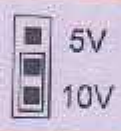
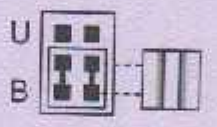
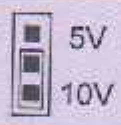
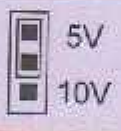
here are two input data formats can be selected which are bipolar and unipolar. The range of input value 0~16383 for unipolar format while bipolar is -8192~8191. The two extreme values of each range orresponding to the minimal and maximal input signal. For example, if chose the -10V~+10V type gnal, for 10V input signal the input value is 16383 for unipolar format while the bipolar format is 8191. ormally the input code format setting is consistent with input signal type (bipolar coded for bipolar put signal, unipolar coded for unipolar input signal). Only when use the FUN32 for offset conversion hould set the bipolar code for unipolar input signal (Please refer the FUN32 description). The code rmat of all input channels are set by the same JP1 jumper. The location and the setting of jumper of JP1 e shown at below

| Code Format | JP1 Setup | Code Range | Corresponding Input |
|---|---|---|---|
| Bipolar |  | -8192 ~ 8191 | -10V ~ 10V(-20mA ~ 20mA)<br>-5V ~ 5V(-20mA ~ 20mA)<br>0V ~ 10V(0mA ~ 20mA)<br>0V ~ 5V(0mA ~ 10mA) |
| Unipolar |  | 0 ~ 16383 | |

### *ltage/Current input signal type setting*

| Signal Type | JP5 ~ JP8 |
|---|---|
| Voltage |  |
| Current |  |

*Signal Type selection*

| Signal Type | Polarity Setting (JP3) | Range Setting (JP4) |
|---|---|---|
| 0~10V<br>or<br>0~20mA |  |  |
| 0~5V<br>or<br>0~10mA | |  |
| -10~+10V<br>or<br>-20~+20mA |  |  |
| -5~+5V<br>or<br>-10mA~+10mA | |  |

default factory settings of 4A2D analogue input/output module are
ut code format – Bipolar(-8192~+8191)
ut signal type and range – Bipolar(-10V ~ +10V)
put code format – Bipolar(-8192~+8191)
put signal type and range – Bipolar(-10V ~ +10V)

hose applications that require the setting differ than the above default setting should make some ifications of jumper position according to above tables.

e application, besides the setting of jumper should be conducted, the AI module configuration of roladder also need to be performed.

# Appendix B

# Load Cell Input Module

FBs-1LC / FBs-2LC is one of the analog input modules of FATEK FBs series PLC. It supports one / two channel of load cell input for weight measurement.

The conversion result is represented by a signed 16 bit integer value. In order to filter out the field noise imposed on the signal, it also provides the average of sample input function.

Note: 1. The supporting of I/O configuration for FBs-1LC/2LC module is available only for PLC OS V4.71 and Winproladder V3.22 or later version.

2. For those early applications which do not use I/O configuration to work with 1LC module can still work properly provided that no additional FBs-2LC module control is required.

## 1 Specifications of FBs-PLC Load Cell Measurement Modules

### FBs-1LC/ FBs-2LC Load Cell Measurement Modules

| Specifications | FBs-1LC | FBs-2LC |
|---|---|---|
| Total Channels | one channel | two channels |
| A/D Converter Utilized | 24-bit Δ-Σ A/D | |
| Resolution | 16 bits (include signed bit) | |
| I/O Points Occupied | 1 RI(Input Register) and 8 DO | |
| Conversion Rate | 5/ 10/ 25/ 30/ 60/ 80 Hz | 1/ 3/ 5/ 8 Hz |
| Non-Linearity | 0.01% F.S. (@25℃) | |
| Zero Drift | 0.2 µV/℃ | |
| Gain Drift | 10 ppm/℃ | |
| Excitation Voltage | 5V with 100Ω driving capability | |
| Sensitivity | 2mV/V, 5mV/V, 10mV/V,20mV/V | |
| Software Filter | Moving average | |
| Average Samples | 1~8 configurable | |
| Isolation | Transformer(Power) and photo-coupler(Signal) | |
| Indicator(s) | 5V PWR LED | |
| Supply Power | 24V-15%/+20%, 2VA | |
| Internal Power Consumption | 5V, 100mA | |
| Operating Temperature | 0 ~ 60 ℃ | |
| Storage Temperature | -20 ~ 80 ℃ | |
| Dimensions | 40(W)x90(H)x80(D) mm | |

## 2 The Procedures of Using FBs-PLC Load Cell Module

Start

↓

Connects Load Cell Modules to the expansion interface on PLC in series and connects an external 24VDC source and load cell measure input wires.

↓

Execute the WinProladder and configure the load cell configuration table address, the register address, and working register in load cell configuration windows, then you can read the weight measurement value form register directly.

## 3 The Procedures of Configure the Load Cell Measurement

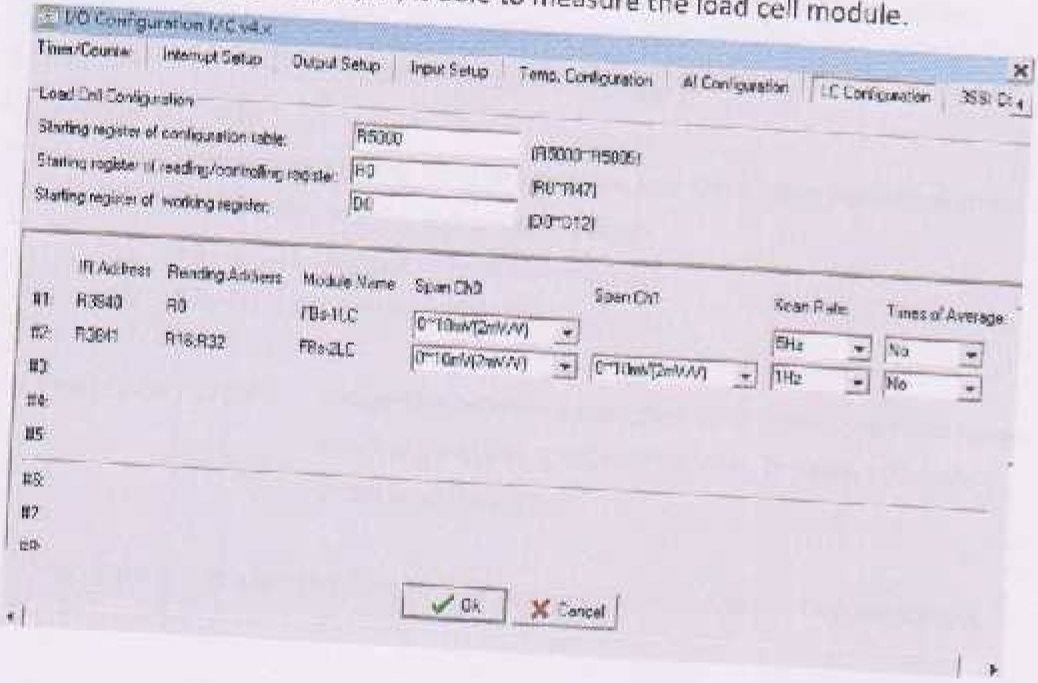
Click the item "I/O Configuration" which in Project Windows:

Project

└ I/O Configuration

➔ Select "LC Configuration":

Once the setting page displayed, is able to measure the load cell module.



1. 【Starting register of configuration table】:

Assign a starting register value to store the load cell configuration table, there will allow the following inputs:

RXXXX or DXXXX

The configuration table only occupies 4+N of registers, where N is the number of load cell modules.

As shown in the above example, R5000~ R5005 stores the load cell configuration table.

2. 【Starting register of reading/control register】:

Please input the starting register number of a block register that were allocated for receiving the measurement value and control parameters for load cell

There will allow the following inputs, RXXXX or DXXXX

one channel occupies 16 register.

As shown in the above example, channel 1 used R0 ~ R15.

3. 【Starting register of working register】:

Assign a starting registers to reserve the working registers, there will allow the following inputs RXXXX or DXXXX.

The load cell measurement register occupies (Nx4)+5 registers, where N is the number of load cell modules.

As shown in the above example, D0~D12 are the working registers.

Notes: The above three settings can be used in all Load Cell modules.

【Load cell module installation information and setup】

4. 【Module #1 ~ #16】:

Display the name of the installed module and the analog starting address of its own, there are the following modules.

① FBs-1LC (1 channel of load cell module)

② FBs-2LC (2 channels of load cell module)

5. 【Span Ch0# / Ch1#】: Assign the following selection of the measurement range: 0~10mV(2mV/V), 0~25mV(5mV/V), 0~50mV(10mV/V), 0~100mV(20mV/V)

6. 【Scan Rate】: Assign the scan rate of reading value, there are two selections:

① FBs-1LC has 5 / 10 / 25 / 30 / 60 / 80 Hz can be assigned
② FBs-2LC has 1 / 3 / 5 / 8 Hz can be assigned

7. 【Times of Average】: Assign the times of average for load cell measure, unbalanced average, 2 times the average, 4 times the average, and 8 times of the average can be assigned.

## 4 Load cell reading / control register

In following table, let's assume the starting register of reading/control register is R

| Register Offset | Description | R/W |
|---|---|---|
| R+0 | Engineering weight value | R |
| R+1 | Raw weight value | R |
| R+2 | High reference engineering value. Max. 32767 | W |
| R+3 | Command register-<br>Bit 0 – set zero/tare reference<br>Bit 1 – set high(full scale) reference | W |
| R+4 | Auto zero threshold 0~255 | W |
| R+5 | Status register<br>Bit 0 – Error indication<br>Bit 1 – Over range or sensor broke Indication | R |
| R+6 | SPAN value( high reference –zero reference ) | R |
| R+7 | Zero value set by performing set zero reference | R |
| R+8 | Current compensated zero value | R |
| R+9 | Register for internal process usage | R |
| R+10~R+15 | Reserved | |

Each channel occupies 16 registers.

Note:

1. Only the R+2、R+3、R+4 register are set by user, the other register are set by system
2. R+3:

   Bit 0 = 1, set current measurement value as zero reference

   Bit 1 = 1, for SPAN. set current measurement value minus zero reference value as high reference value which corresponding to the weight value set in R+2
3. User can convert the engineering value on their own with reference the value in R+2,R+6 register if necessary.

4. Error indication includes

high reference engineering value(R+2) or SPAN(R+6) is zero or negative

5. Auto zeroing threshold -

This value confines the zero value drift tolerance region. If the zero drift value falls in this region, the zero drift will be compensated.

Set this value to zero will disable the auto zeroing function.

6. D4052 – delay time for auto zeroing activation , range from 1000 ~ 5000 (mS), default is 3000 (mS).

## 5 Description of Related Registers for Load Cell Measurement

### Installation Status of Load Cell

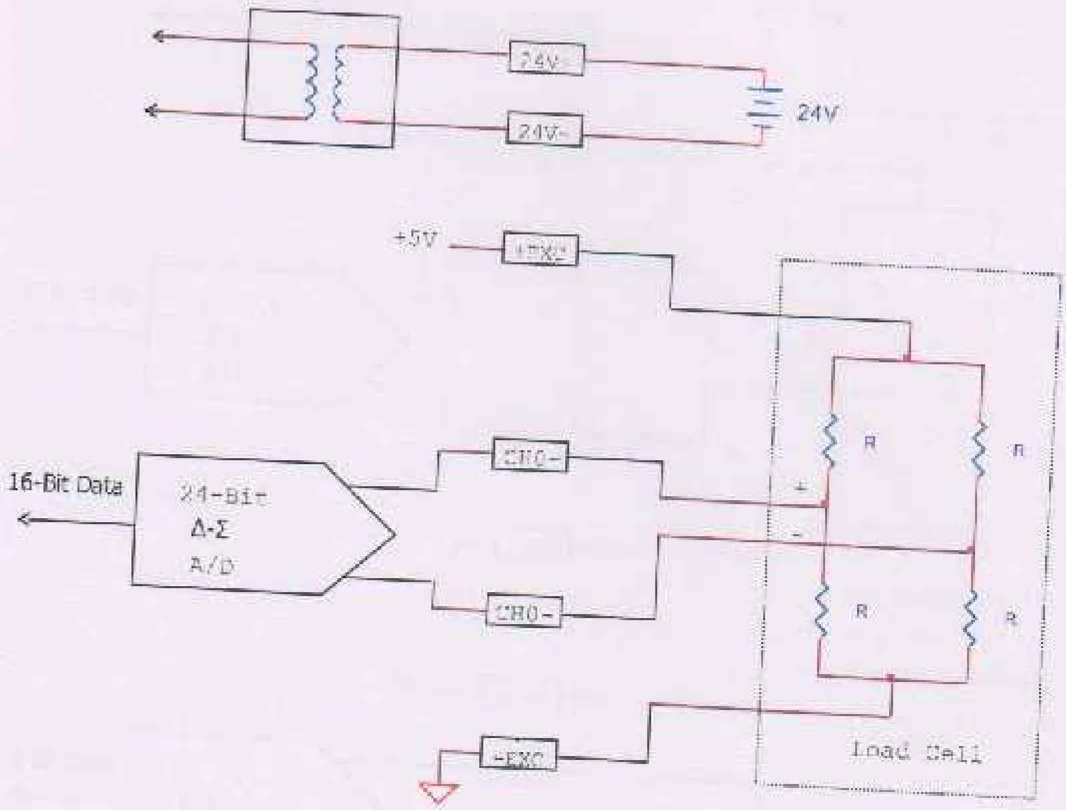
- R4016 : B0=1 means that the 1st channel is installed
  .
  .
  B15=1 means that the 15th channel is installed
  (the default of R4016 is FFFFH)
- R4017 : B0=1 means that the 16th channel is installed
  .
  .
  B15=1 means that the 31th channel is installed
  (the default of R4017 is FFFFH)
- When the load cell is installed (the corresponding bit must be 1), the system will perform the line broken detection. If there is line broken happened, the broken value -32760 will be displayed.
- When the load cell is not installed (the corresponding bit must be 0), the system will not perform the line broken detection. The broken value will be 0.
- Depends on the user's installation, the ladder program may control the corresponding bit of R4016 and R4017 to perform or not perform the line broken detection.

## 6 I/O Addressing of Load Cell Module

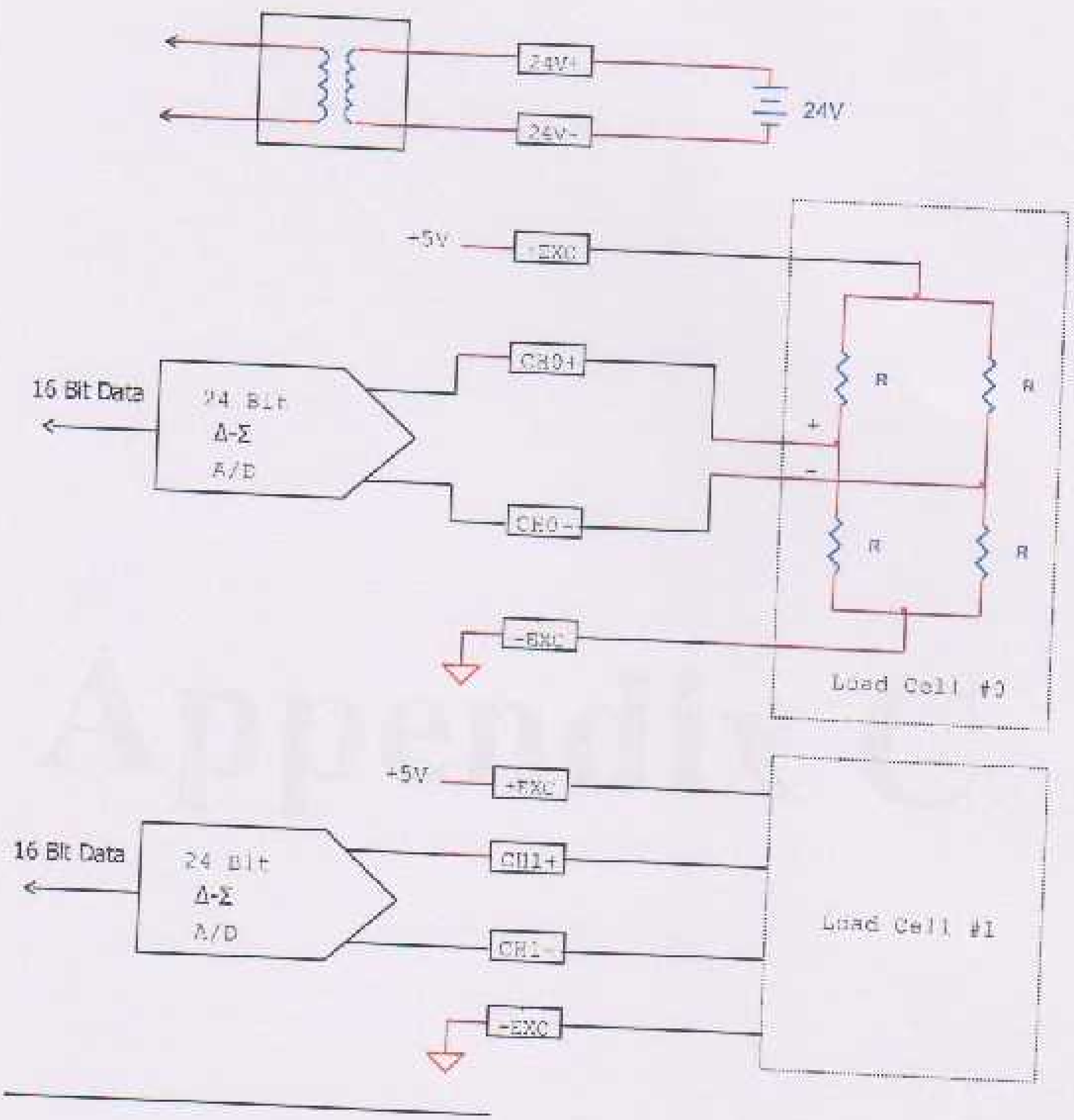
By the time domain multiplexing design method, each load cell module occupies 1 point of input register and 8 points of digital output for I/O addressing. For correct I/O access, the I/O addressing of extension modules following the load cell module must be added the I/O quantity which the corresponding module should have. The WinProladder provides an easy and convenient way to calculate the I/O address for the extension modules through the on-line "I/O Numbering" operation.

# 7 Wiring of Load Cell Modules

## Wiring of FBs-1LC



Wiring of FBs-2LC



# Appendix C

# FBs-TC6

**6 Channel Thermo-Couple Temperature Input Module**

### *Introduction*

FBs-TC6 is one of the temperature input modules of FATEK FBs series PLC. It provides 6 channels of thermo-couple temperature measurement input with 0.1 ℃ or 1 ℃ resolution. The scan rate for 0.1 ℃ resolution is 4 seconds, while the scan rate for 1 ℃ resolution is 2 seconds. The cold junction compensation is carried out inside the module, also it provides wire broken detection feature. To give the user more choices for the selection of thermo-couple type and in order to enhance the noise immunity, the isolation scheme is per channel basis. All the optional features of this module are software configurable, there are no hardware jumpers or switches for user to setup.

### *Specifications*

**Total Channels** - 6 CH

**Resolution**- 0.1 ℃ or 1 ℃

**I/O Points Occupied –**

1 RI(Input Register)

8 Discrete Output(DO)

**Conversion Time**- 2 or 4 Seconds

**Accuracy**- ±(1 %+1℃)

**Sensor Type**- J,K,R,S,E,T,B,N

**Software Filter**- Moving average

**Average Samples**- 1,2,4,8,16 configurable

**Compensation**- Built in cold junction compensation

**Measurement Range-**

J: -200~1200℃ K: -200~1200℃

R: 0~1800℃ S: 0~1700℃

E: -190~1000℃ T: -190~380℃

B: 350~1800℃ N: -200~1000℃

**Isolation**- Transformer(Power) and photo-coupler(Signal)

**Indicator(s)** – 5V PWR LED

**Supply Power**- 24V-15%/+20%, 2VA

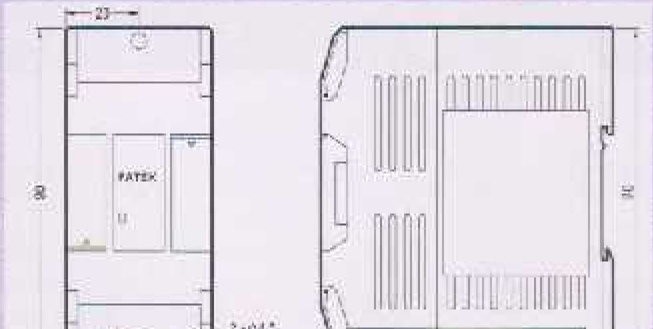
**Internal Power Consumption**- 5V, 35mA

**Operating Temperature**- 0 ~ 60 ℃

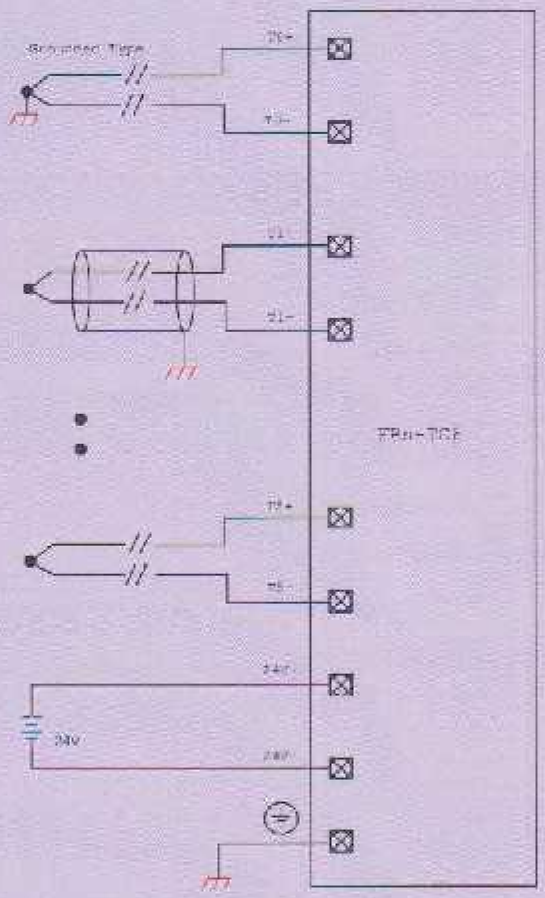
**Storage Temperature**- -20 ~ 80 ℃

**Dimensions**- 40(W)x90(H)x80(D) mm

### *Dimensions*



## *Wiring Diagram*

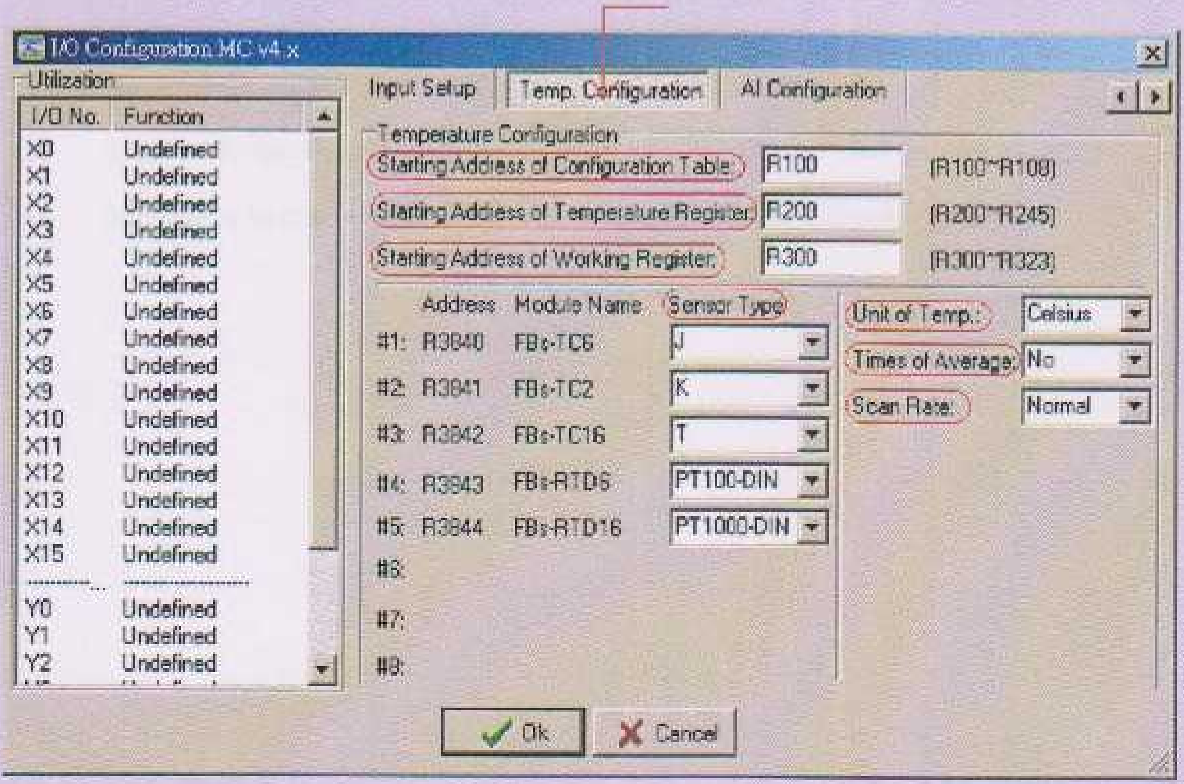



Note:

Because the thermo-couple signal is very small (in an order of uv), if possible please use the shielded twisted cable for signal wiring. Also if the length of thermo-couple wire is not long enough, please make sure to use the proper compensation wire otherwise will cause excessive error on cold junction compensation.

## *I/O Configuration*

Before the temperature value can be retrieved, the user should perform the I/O configuration of temperature module with the help of Winproladder software. The following screen will be shown when perform the I/O configuration




The user need to assign a starting register of a contiguous register area for holding temperature reading value and areas for storing the configuration table and working scratchpad and define the sensor type, unit of temperature, scan speed and samples for average. Please refer the advanced manual II for detail explanation.