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College of Engineering and Technology
Electrical Engineering Department
Industrial Automation Engineering

Graduation Project

Design of Multiple Scale Machine

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Abstract

Design Multiple Scales Machine

Due to the evolution of the industry dramatically, and its dependence on fully automated machines, the need for multi-scales machine in the process of weighting do not process traditional that time-consuming and effort as well as the ratio of the accuracy does not enough has become less urgent.

Strive through the project can offer machine automated to help technological development and automation of the entire process, starting from choosing weight to get more precision in the process of weighing down to the speed of the production process and the speed at which we want in addition to high-precision what distinguishes our project.

In the project this can be used in productivity and packing plants, as well as the weighing process can be used in the mixing process between the different materials, and do the weighing process in the end.

Design the machine multiple scales, weighted food of all kinds and the weight to be chosen from range 20 grams to 1 kilogram .

Design assists the operator who works on the machine to deal with it easily through automatic control system that depends on the data display screen.

الملخص

تصميم ماكينة متعددة الموازين

نظرا لتطور مجال الصناعة بشكل كبير , واعتماده على ماكينات مؤتمتة بشكل كامل , فإن الحاجة الى ماكينة متعددة الموازين لا تقوم بعملية التوزين التقليدي الذي يستهلك الوقت والجهد وكذلك تكون نسبة الدقة فيه اقل أصبح مُلحاً .

إننا نسعى من خلال مشروعنا ان نقدم ماكينة مؤتمتة للمساعدة على التطور التكنولوجي واتمتة العملية بالكامل , بدأ من اختيار الوزن الى الحصول على دقة اكثر في عملية التوزين وصولا الى السرعة في العملية الانتاجية وهذه السرعة التي نريدها بالاضافة الى الدقة العالية ما يميز مشروعنا .

إن مشروعنا هذا يمكن أن يُستخدم في الشركات الانتاجية ومعامل التعبئة , إذ وبالاضافة لعملية التوزين , يمكن استخدامه في عملية الخلط بين المواد المختلفة وتوزينها في النهاية.

وبناءًعلى ما سبق سنقوم بتصميم ماكينة متعددة الموازين , لتوزين المواد الغذائية بكافة انواعها والوزن المراد اختياره بدأ من 20 غرام الى 1 كيلو غرام.

كما سيمكن تصميمنا اليد العاملة على الماكينة من التعامل معها بكل سهولة من خلال نظام تحكم الي يعتمد على شاشة عرض وادخال البيانات بشكل اسهل .

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Chapter One

"Introduction"

1.1 Literature Review

The background research for this project occurred in some stages. You need to study previous designs to understand how to weight the required weight in a special bag.

In our research we found several ways to do this project, as the following, the first way depends on bringing a bag and opening it by complex mechanically method.

The second way depends on forming a bag of rolls of nylon, then filling the products, the Third way depend on bring a bag manual and filling by suitable weight, this way we will use in our project because we rely on the design of machine on the weight of the product accurately and not on the way to bring the bag.

Through our search for a project in libraries and websites and visit the industrial sector, especially in food factories and found that all machines must be designed in a way that was based on the weight required of the machine so that it is easy to control the machine to fit with the principle of its work in the industrial sector.

1.2 Importance of The Project

Through our field visit for some factories and we found there are more than design with respect to machine balance through the line of automated production we decided to work on machine because of the importance of accuracy in filling product in the bag carefully and work quickly and an increase in production in the factories it works continue engineers automation with market local line in the future.

Is a fast, accurate and reliable weighting machine, used in packing both food and non-food products.

This project can help in the following ways:

1.2.1 Filling bags

The range of bags which can be filled using multi-head weighters is immense ,at one end of the scale are large catering packs of many kilograms. At the other are small bags of crisps which can be handled at high speed and efficiency.

1.2.2 Mix-weighing

Products containing up to six components can be mixed on a machine, very accurately at high speeds. The weighter is divided into sections, each with its own in feed. This would ensure high weighing speed while ensuring that overfilling of the expensive ingredients was negligible.

1.3 Scales within an automated production line

Based on our field survey, we found that there is a possibility to do the same thing in order to improve this industrial sector; by designing automated scales within an automated production line that should eliminate mentioned weakness.

The design idea has a smart control system that realizes high accuracy at any level of the components of final product. Moreover, to realize on friendly used interface to facilitate dealing with the machine during the selection Weight of the desired product according to customer request.

1.4 Project Description

Design and Project implement:

Scope of the project is used in industrial applications in food production lines in factories rely on electronic scales reliable weighting of products such as confectionery, biscuits, nuts, snack foods, fresh and frozen foods, rice, pasta pieces, solid items, spices, dried fruits etc.

This range of project weighted is one of the most advanced computerized weighters.

1.5 Abbreviations

- PLC : Programmable Logic Controller.
- CPU : Central Processing Unit.
- I/O : Input-Output.
- HMI : Human-Machine Interface.
- MMI : Man-machine interface
- GUI : Graphical User Interface.
- O/P : Output.
- ELCB: Earth Leakage Circuit Breaker.

1.6 Time Table:

The proposed project is scheduled about 30 a week, as shown in Table (1.1).

Table (1.1): Time Line 1 of the Project:

Tasks \ Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Literature Review and Problem Statement	■	■	■	■											
Proposing Methodology				■	■	■									
Component's Survey and Cost Estimation, Selection							■	■	■						
Reporting First Chapters									■	■	■				
Design of Electromechanical Parts									■	■	■	■			
Typing the Report						■	■	■	■	■	■	■	■	■	
Report Submission														■	■

Table (1.2) shows the time required for several project components, the overlapping during implementation over these weeks.

Table (1.2): Time Line 2 of the Project:

Task \ Weeks	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Starting Implementation of the Mechanical Design	■	■	■	■	■	■									
Purchasing the Components			■	■	■	■									
Assembly the Electrical and Mechanical Parts							■	■	■	■					
Testing and Calibration										■	■	■			
Typing the Final Report												■	■	■	
Report Submission and Preparing the Project Presentation														■	■

1.7 Project Cost

The details of the project expenditures are showed in Table (1.3).

Table (1.3): Cost of the Project:

The Content	Number of Quantities	Price (NIS)
Stainless Steel	—	1500
Iron	—	700
Weight Sensor	6	2400
PLC	1	1500
Relay	6	100
Piston	13	1800
Solenoid	13	800
Switch	8	100
Air Pipelines	—	250
Wires	—	100
Vibrators	6	2400
Touch screen	1	700
	TOTAL COST	12350

Chapter Two

"Review"

2.1 Introduction

In this section we talk about the elements used in the project, and explain the principle of its work, and how to use them in our application.

This section contains the electrical and pneumatic parts expected to take advantage of them and explain them expanded, where the researcher can benefit from this information by making sure the documentation that came

The main objective of this section is an overview of all the parts used in the project and protection and stainless steel.

2.2 Programmable logic controllers (PLC)

A programmable logic controller (PLC) or programmable controller as shown in figure (2.1) is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many industries and machines. Unlike general-purpose computers, the PLC is designed for multiple 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.

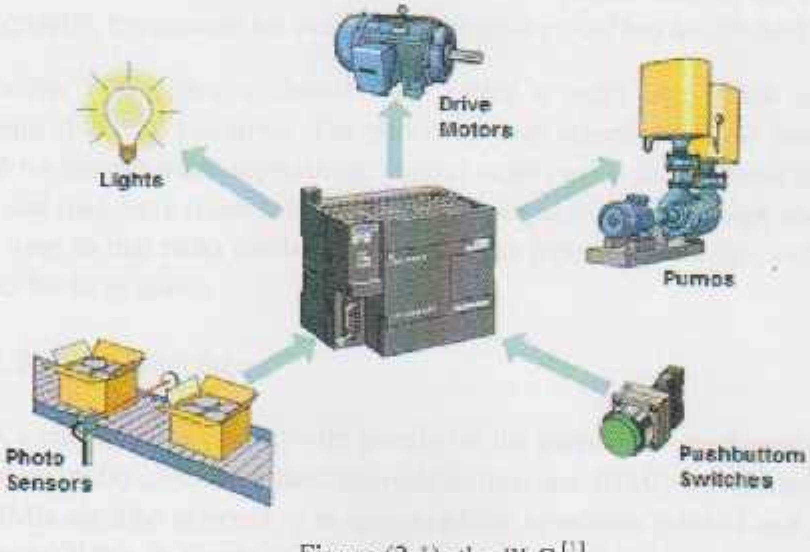

Figure (2.1): the PLC [1]

2.2.1 PLC Consists:

1. Power Supply Unit.
2. Memory Unit.
3. Central Processing Unit (CPU).
4. Programming Device.
5. Input/output Interface.

These components are shown in Figure (2.2).

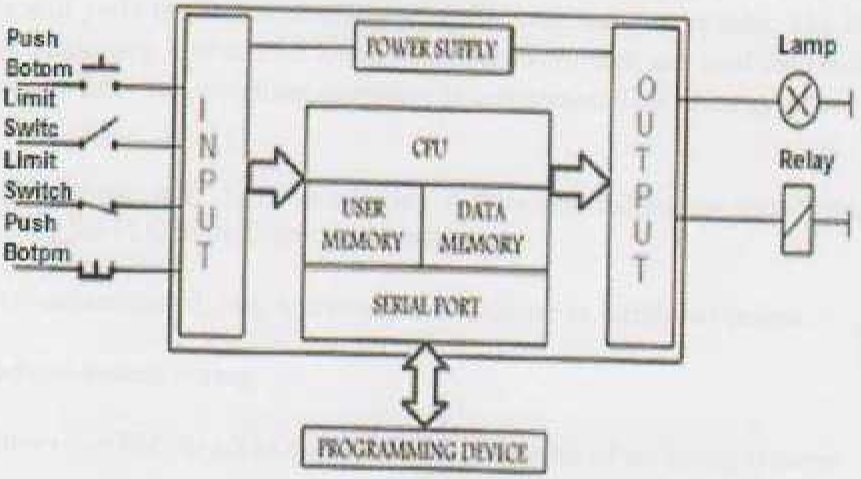

Figure (2.2): the components PLC [2]

A small PLC will have a fixed number of connections built in for inputs and outputs. Typically, expansions are available if the base model has insufficient I/O.

Modular PLCs have a chassis (also called a rack) into which are placed modules with different functions. The processor and selection of I/O modules are customized for the particular application. Several racks can be administered by a single processor, and may have thousands of inputs and outputs. A special high speed serial I/O link is used so that racks can be distributed away from the processor, reducing the wiring costs for large plants.

2.2.2 User Interface

PLCs may need to interact with people for the purpose of configuration, alarm reporting or everyday control. A human-machine interface (HMI) is employed for this purpose. HMIs are also referred to as man-machine interfaces (MMIs) and graphical user interface (GUIs). A simple system may use buttons and lights to interact with the user. Text displays are available as well as graphical touch screens. More complex systems use programming and monitoring software installed on a computer, with the PLC connected via a communication interface. [3]

2.2.3 Programming

The PLC can be programmed using different languages, such as:

- Ladder diagram.
- Functional block diagram.
- Instruction list.

2.2.4 Implementing the Control Strategy

Whatever the method of communication used, having the PLC act as a scheduler will yield the fastest response with the most accurate results. The PLC can download single-step instructions to the weighing instrument and read the results from the instrument after the weighing operation is completed. This strategy offers several benefits. It:

- Offloads the PLC from monitoring the weight values for cutoff decisions, freeing the PLC to perform other functions.
- Provides dedicated, fast, and consistent response to weight set points.
- Reduces system wiring.
- Allows one PLC to act as master to a large number of weighing systems.
- Reduces system costs.
- Reduces development and startup costs.
- Provides for easier post-development support.
- Gives the weighing system the capability to stand alone and run if communications are lost to the PLC.[4]

2.3 Touch Screen

The Touch screen as shown in Figure (2.3) is an electronic visual display that can detect the presence and location of a touch within the display area. The term generally refers to touching the display of the device with a finger or hand.

Due to rapid growth of PLC technology nowadays PLC touch screen is found wide speed applications that give the user friendly and simply communication with the system. This visual display gives the consumer the possibility of dealing with the system easily.

This technology,called human-machine interaction (HMI) with touch screen.

The main goal of this technology is to produce a user interface which makes it easy, efficient, and enjoyable to operate a machine in the way which produces the desired result.

This generally means that the operator needs to provide minimal input to achieve the desired output, and also that the machine minimizes undesired outputs to the human.

Some advantages of the touch screen:

- It is a mean to replace the operating signals.
- It is a mean to observe the operating process of the machine.
- It is a mean to dispense some external parts that is connected with the PLC, such as changing the time of the counter, and the time of the timer.
- It helps in detecting the error quickly.
- It detects the response time of fixing the error, whether it is slow or quick.[5]

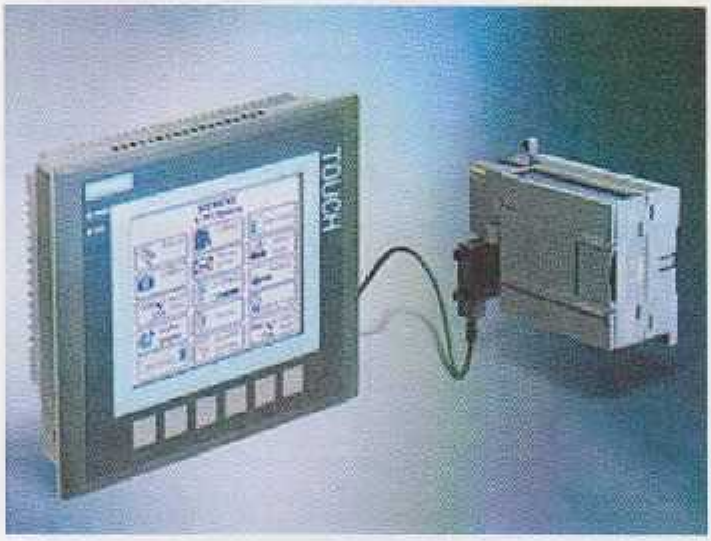

Figure (2.3): PLC Touch Screen [6]

2.4 Electro Pneumatic System

A pneumatic system is a system that uses compressed air to transmit and control energy, the most used pneumatic actuation systems are electrically controlled systems. These systems are called electro-pneumatic actuation systems. Electro-pneumatic control system is a combination of electrical unit and pneumatic control unit both in one unit. A number of electro-pneumatic elements are used in electro-pneumatic controls. In electro-pneumatic circuits solenoid operated directional control valves, limit switches and pressure switches.

On an automation system one can find three families of components, which are sensors, valves and actuators. A solenoid is used in pneumatic valves to act as the actuating element.

2.4.1 Compressor

A compressor can compress air to the required pressures. It can convert the mechanical energy from motors and engines into the potential energy in compressed air. A single central compressor can supply various pneumatic components with compressed air, which is transported through pipes from the cylinder to the pneumatic components. Compressors can be divided into two classes: reciprocator and rotary. [7]

2.4.2 Service unit

The individual function of compressed air preparation, filtering, regulating and lubricating, can fulfilled by individual components[8], as shown in figure (2.4) and figure (2.5).

These function have often been combined into one unit, serves units are connected upstream of all pneumatic system.

Figure (2.4): Practical Service Unit [9]

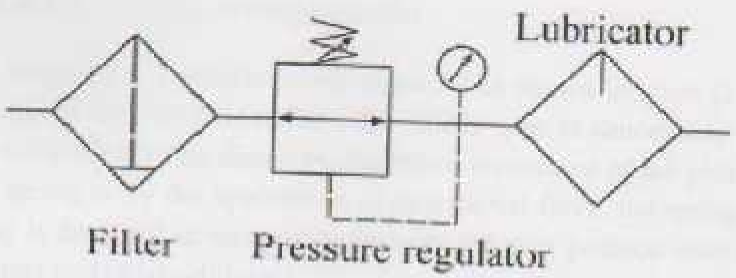

Figure (2.5): The Symbol of the Service Unit [10]

- The air service unit is a combination of the following:

2.4.2.1 Air filters

The compressed air filter has the job of removing all contaminants from the compressed air following through it as well as water which has already condensed. [11]

2.4.2.2 Pressure regulator

The purpose of the regulator is to keep the operating pressure of the system (secondary pressure)virtually constant regardless of fluctuations in the line pressure (primary pressure) and the air consumption.

2.4.2.3 Lubricator

The purpose of the lubricator is to deliver a metered quantity of oil mist into a leg of the air distribution system when necessary for the operation of the pneumatic system.

2.4.3 Pneumatic Air Lines

The components of a pneumatic circuit are connected plastic tubes, typically made of from nylon or polyurethane.

2.4.4 Cylinders

An actuator is an output device for the conversion of supply energy into useful work, the output signal is controlled by the control system, and the actuator responds to the control signals via the control element.

There are many kinds of cylinders, such as single acting cylinders and double acting cylinders.

2.4.4.1 Single acting cylinder

With single–acting cylinder compressed air as shown infigure (2.6) is applied on only one side of the piston face. The other side is open to atmosphere. The cylinder can produce work in only one direction, the return movement of the piston is effected by a built-in spring or by the application of an external force .the spring force of the built-in spring is designed to return the piston to the start position with a reasonably high speed under no load conditions.

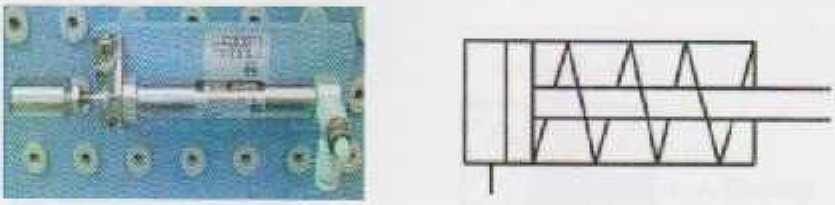

Figure (2.6): Single acting cylinder picture and symbol [9]

2.4.4.2 Double acting cylinder

The construction principle of a double-acting cylinder as shown in figure (2.7) is similar to that of the single-acting cylinder .however, there is no return spring, and the two parts are used alternatively as supply and exhaust ports. The double-acting cylinder has the advantage that the cylinder is able to carry out work in both directions of motion.

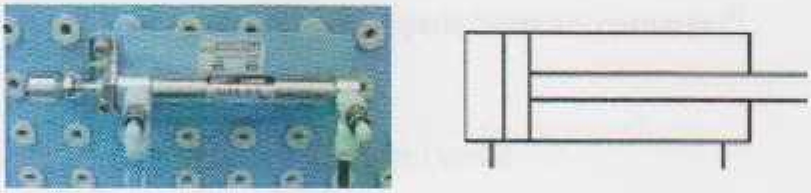

Figure (2.7): double acting cylinder picture and symbol [9]

2.4.5 Directional control valve

Directional control valves ensure the flow of air between air ports by opening, closing and switching their internal connections. Their classification is determined by the number of ports, the number of switching positions, the normal position of the valve and its method of operation. Common types of directional control valves include 2/2, 3/2, 5/2, etc. The first number represents the number of ports; the second number represents the number of positions.

2.4.5.1 3/2 Directional control valve

A 3/2 directional control valve can be used to control a single acting cylinder as shown in figure (2.8). The open valves in the middle will close until 'P' and 'A' are connected together. Then another valve will open the sealed base between 'A' and 'R' (exhaust). The valves can be driven manually, mechanically, electrically or pneumatically. 3/2 directional control valves can further be divided into two classes: Normally open type (N.O) and normally closed type (N.C). [12]As shown in figure (2.9).

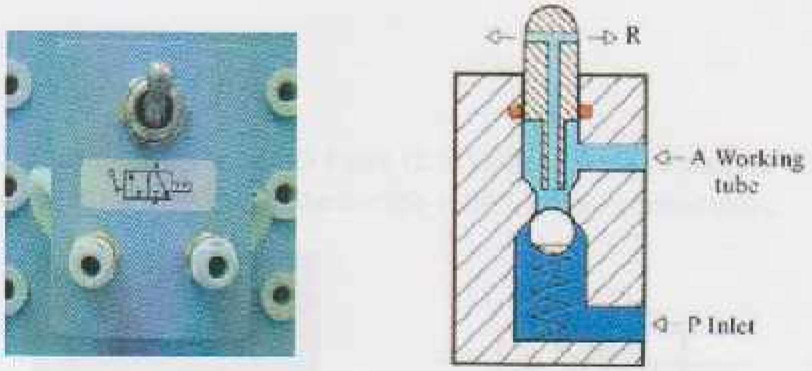

Figure (2.8): (a) 3/2 directional control valve (b) Cross section

Figure (2.9): (a) normally closed type(b) Normally open type [5]

2.4.5.2 5/2 Directional control valve

When a pressure pulse is input into the pressure control port 'P', as shownin figure (2.10) the spool will move to the left, connecting inlet 'P' and work passage 'B'. Work passage 'A' will then make a release of air through 'R1' and 'R2'. The directional valves will remain in this operational position until signals of the contrary are received. Therefore, this type of directional control valves is said to have the function of 'memory'. [12]

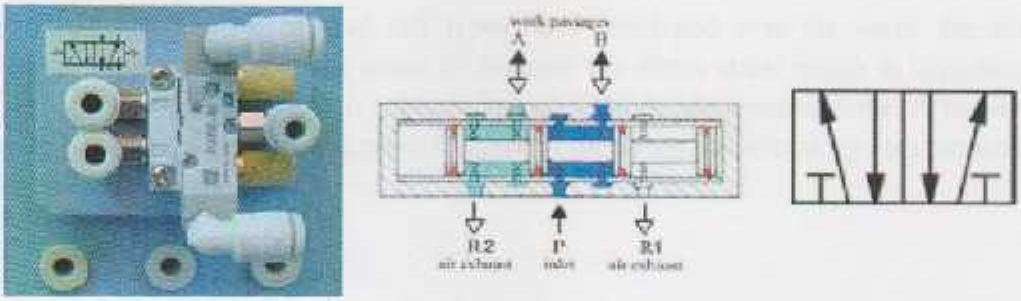

Figure (2.10): (a) 5/2 directional control valve(b) Cross section (c) Pneumatic symbol [9]

2.4.6 Flow control valve

Flow control valves as shown in figure (2.11) influence the volumetric flow of the compressed air in both directions .the throttle valve is a flow control valve.

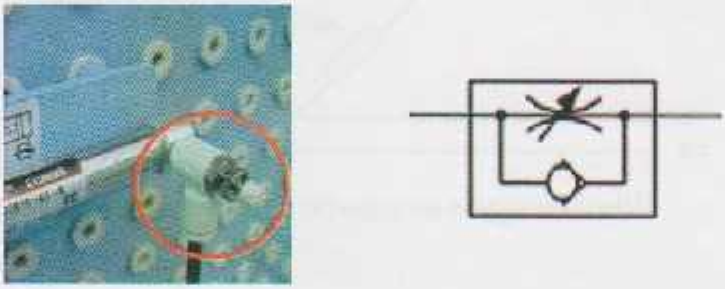

Figure (2.11):(a) Flow control valve(b) Pneumatic symbol [9]

2.5 Sensors

2.5.1 Load cell sensor

The load or force cell takes many forms to accommodate the variety of uses throughout research and industrial applications. The majority of todays designs use strain gauges as the sensing element, whether foil or semiconductor. Foil gauges offer the largest choice of different types and in consequence tend to be the most used in load cell designs. Strain gauge patterns offer measurement of tension, compression and shear forces.

Semiconductor strain gauges come in a smaller range of patterns but offer the advantages of being extremely small and have large gauge factors, resulting in much larger outputs for the same given stress. Due to these properties, they tend to be used for the miniature load cell designs.

Proving rings are used for load measurement, using a calibrated metal ring, the movement of which is measured with a precision displacement transducer.

A vast number of load cell types have developed over the years, the first designs simply using a strain gauge to measure the direct stress which is introduced into a metal element when it is subjected to a tensile or compressive force. A bending beam type design uses strain gauges to monitor the stress in the sensing element when subjected to a bending force.

2.5.2 The Wheatstone Bridge Circuit

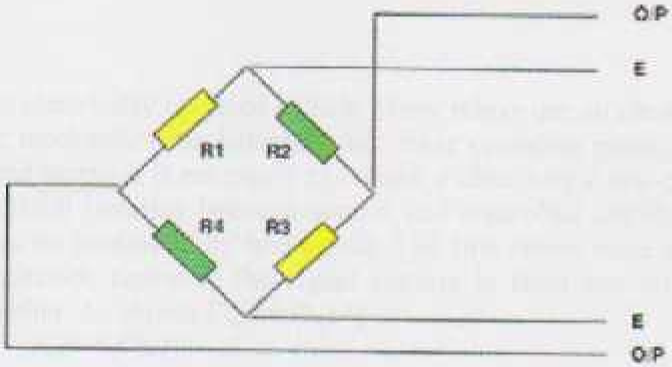

Figure (2.12): The Wheatstone bridge circuit [13]

- E: Excitation Voltage
- O/P : Output Signal

2.5.3 Miniature Load Cells

Miniature load cells because of their compact size usually use semiconductor strain gauges as the sensing element. They are available in many different configurations for both tension and compression force measurement. They offer good performance with high outputs and high overload capability for protection.

Specialty Automotive/Auto sport Load Cells

Many more Load Cell designs exist and we will bring you details of these at a later stage. [13]

2.5.4 Load Cell Spring Member Design Considerations

Bending elements as shown in figure (2.13) are low-force, generally less than 1,000 lbf range, high-deflection structures offering convenient and flat strain gauging surfaces where complete push/pull strain symmetry is maintained.

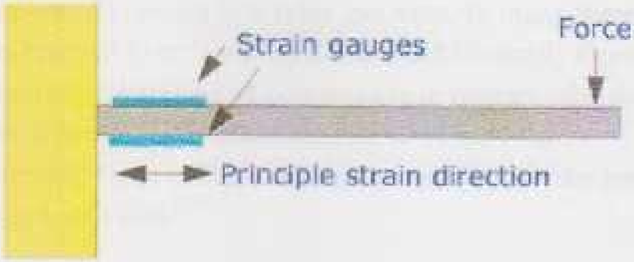

Figure (2.13): Bending: The simple cantilever [14]

2.6 The Relay

A relay is an electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits, repeating the signal coming in from one circuit and re-transmitting it to another. As shown Figure (2.14)

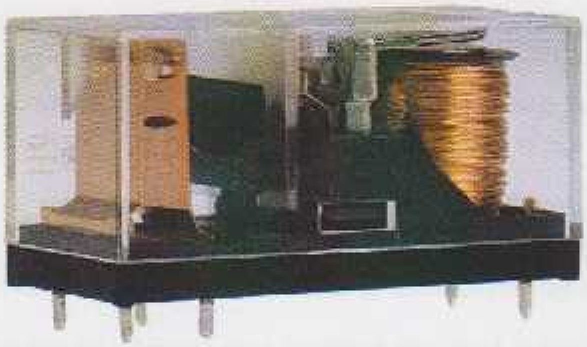

Figure (2.14): Bending: The simple cantilever [16]

Why are they used?

- Generally speaking a relay is used to control a circuit, typically low current.
- Other purposes:
  - ✓ Safety.
  - ✓ Remote control.
  - ✓ Size (Starter Motor, Head Lights, and Horn).
- Relay contacts.
  Normally Open vs. Normally Closed

- The number of contacts in a relay can vary. In many there are two sets of contacts referred to as Normally Closed and Normally Open.
- The Normally Closed set of contacts are in contact with the contact on the armature when the relay is not activated.
- The Normally Open contacts are not in contact with the armature when the relay is not activated.[15]

2.7 Vibrator

There are many factors involved in choosing the proper vibratory feeder .The material bring processed is the most important element in selecting equipment .Many standard of feeders and conveyors can be fine-tuned to improve the product flow selecting the proper equipment for the type.

2.7.1 Mechanical drives

Mechanical vibratory drive comes in wide range of designs. These drives create a back and forth motion of a tray caused by either a direct mechanical link are (push rod) or by stimulating motion with out of balance weights then amplifying that vibration into the tray through a set of spring ,the following are types of mechanical drives.

1.Brute force- mechanical drive uses two special motors with eccentric weight on each end of shaft that create an out of balance vibration and motion into tray.

2. Eccentric shaft mechanical drives use a standard the shelf motor driving an out of balance (eccentric) shaft the eccentric shaft creates a small vibration that is amplified through a spring system. These units are considered two mass systems that work in increase amplitude under the head load.

2.7.2 Electromagnetic drives

Electromagnetic drives systems operated by either AC or DC power .both drives use magnetic circuits to energize the vibratory motion a spring set up is mounted to a mass within or on the drive and attached to the units tray each of these drives has its advantages with AC units providing high precision with lower operating costs and the DC models typically being less expensive. [17].as shown in figure (2.15)

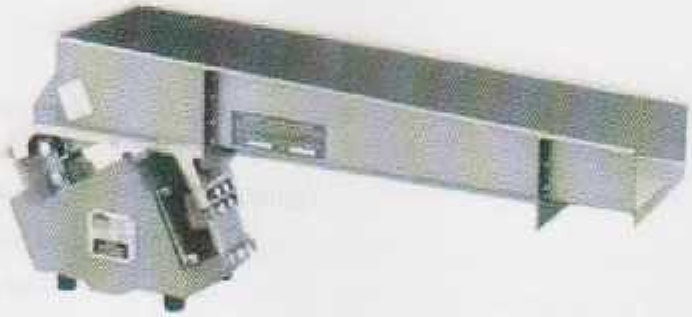

Figure (2.15):The vibration [17]

2.8 Protection system

2.8.1 Circuit Breaker

Is an electrical device used in an electrical panel that monitors and controls the amount of amperes (A) being sent through the electrical wiring. Circuit breakers come in a variety of sizes. For instance, 10, 15 and 20 amp breakers are used for most power and lighting needs in the typical home. Some appliances and specialty items (washers, dryers, freezers, whirlpools, etc.) will require a larger circuit breaker to handle the electrical load required to run that appliance.

If a power surge occurs in the electrical wiring, the breaker will trip. This means that a breaker that was in the "on" position will flip to the "off" position and shut down the electrical power leading from that breaker. Essentially, a circuit breaker is a safety device. When a circuit breaker is tripped, it may prevent a fire from starting on an overloaded circuit; it can also prevent the destruction of the device that is drawing the electricity.As shown in figure (2.16)

Figure(2.16): Parts of Circuit Breaker [20]

Where:

The components inside the circuit breaker:

1. Toggle switch (Manual tripping).
2. Actuator mechanism.
3. Contacts.
4. Terminals.
5. Bimetallic strip.
6. Calibration screw - allows the manufacturer to precisely adjust the trip current of the device after assembly.
7. Solenoid.
8. Arc divider/extinguisher.[19]

2.8.2 Earth Leakage Circuit Breaker (ELCB)

Is a safety device used in electrical installations with high earth impedance to prevent shock. It detects small stray voltages on the metal enclosures of electrical equipment, and interrupts the circuit if a dangerous voltage is detected. Once widely used, more recent installations instead use residual current circuit breakers which instead detect leakage current directly.

The main purpose of earth leakage protectors is to prevent injury to humans and animals due to electric shock. As Shown in figure (2.17)

Figure (2.17): Earth leakage [21]

- Types of Earth

There are two types of ELCB:

- Voltage operated.
- Current operated.[20]

2.8.3 Emergency-Stop button

Emergency-Stop as shown in figure (2.18) is now state-of-the-art, providing safety for Man and the machine. Eaton offers a wide range of Safety Components for the protection of Man, machines and production goods in emergency situations.

It is the purpose of an emergency-stop device to deflect or minimize the risk as quickly as possible and optimally in the event of an emergency arising. in accordance with the machine directive, an emergency-stop device must be fitted on all machines/systems, with the exception of machines on which an emergency-stop device would not reduce the risk. Machines carried and operated by hand.[19]

Figure (2.18): Emergency-Stop Button[21]

2.9 Stainless Steel

Is a combination of multiple elements such as iron, nickel and chromium used as feedstock for industries that require high purity such as the pharmaceutical industry, medical devices, biotechnology and called white steel.

2.9.1 Uses Stainless Steel is used in the food industry

1. Ease of maintenance and cleanliness.
2. High resistance to rust and corrosion.
3. Ease of use in large areas and large trading volumes.

2.9.2 The characteristics of the types of Stainless Steel

- 304, 304L used in the industry where there is no direct contact with the product (external surfaces).
- 316, 316L used in all surfaces in contact with the materials and components Products Wetlands (internal surfaces).[22]

Chapter Three

"Mechanical Design"

Chapter Three

"Mechanical Design"

3.1 Introduction

In this section we talk about the mechanical parts, the elements used, and the construction of the implementation method. Moreover, there are detailed dimensions of the whole elements used with directed positions.

The mechanical system in the project has major parts, these parts are combined together to form mechanical units, in addition these units are combined together for forming the machine.

The proposed design depends on the sequence of mechanical movement in the machine, starting from main hopper, passing through balance measurement and ending of packing in the bag and close tightly.

3.2 General Block Diagram

The following Figure (3.1) shows the general block diagram of the proposed design for multi weight machine.

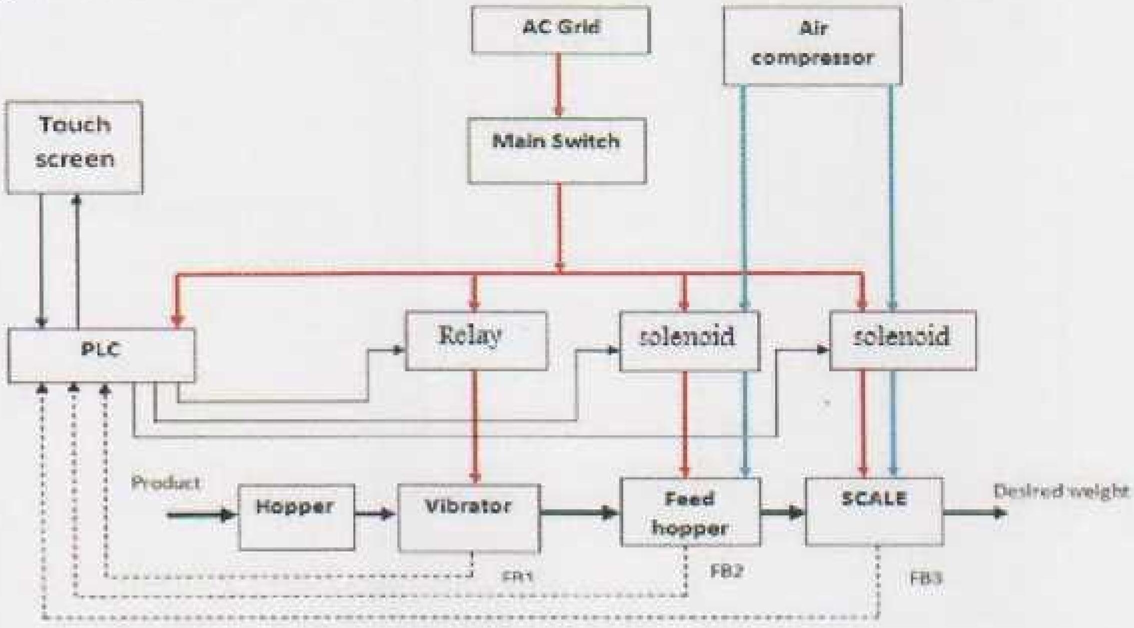

Figure (3.1): General Block Diagram

Where:

- —— : Present power supply line.
- —— : Present Air supply line.
- —— : Present product line.
- —— : Present is signal from PLC line.
- -------- : Present signal to PLC.
- FB1: the first feedback used to take a signal that if the contain material above to the vibration.
- FB2: the second feedback used to take a signal when the machine finishes filling the

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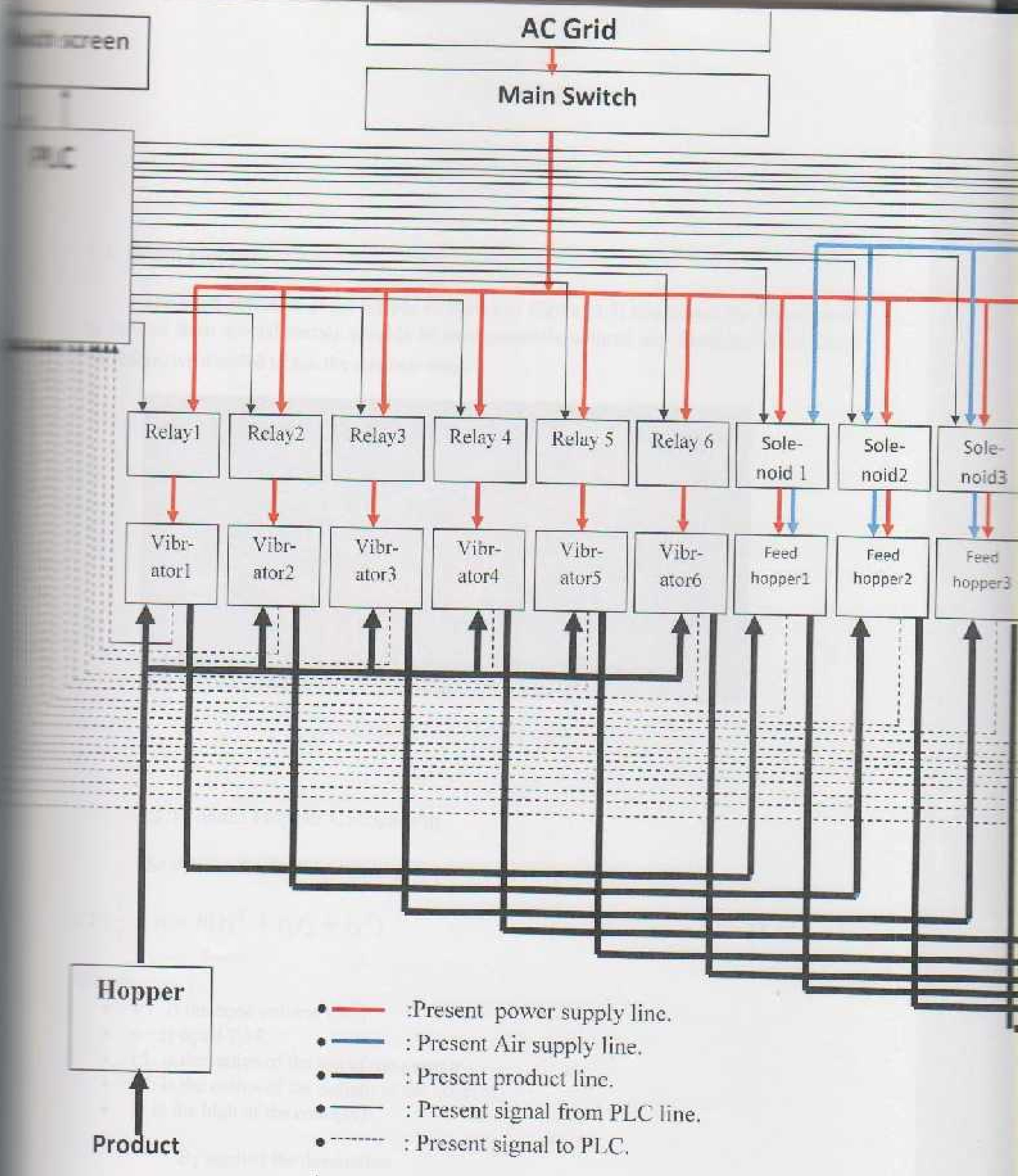
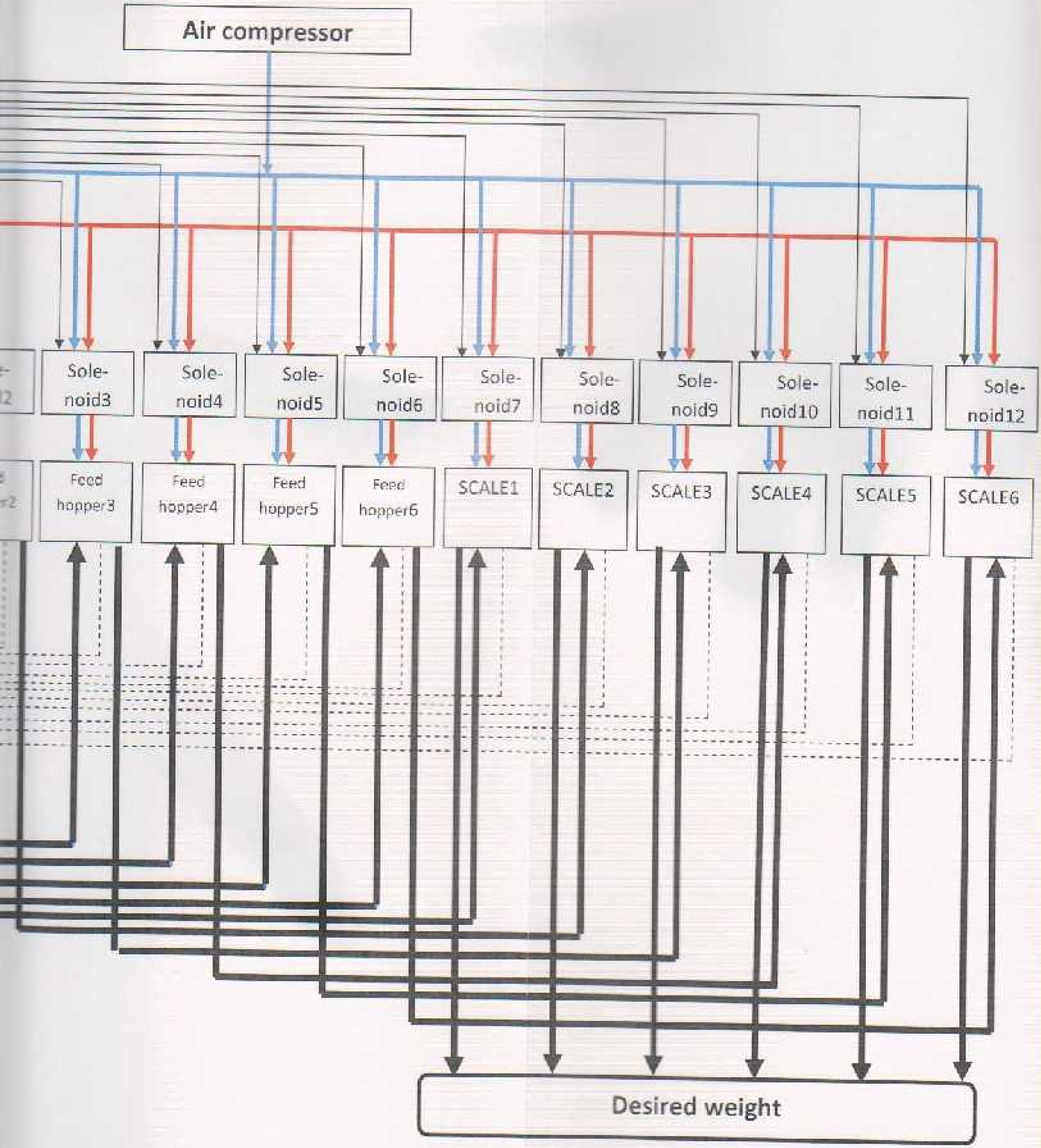
- ——— : Present Air supply line.
- ——— : Present product line.
- ——— : Present is signal from PLC line.
- -------- : Present signal to PLC.
- FB1: the first feedback used to take a signal that if the contain material above to the vibration.
- FB2: the second feedback used to take a signal when the machine finishes filling the bag.
- FB3: the third feedback used to take a signal that if in the weight reaches to the specific weight.
- .

3.2.1 Detailed Block Diagram

The following Figure (3.2) shows the detailed block diagram of the proposed design for multi weight machine.


screen
PLC
AC Grid
Main Switch
Relay1
Relay2
Relay3
Relay 4
Relay 5
Relay 6
Sole-noid 1
Sole-noid2
Sole-noid3
Vibr-ator1
Vibr-ator2
Vibr-ator3
Vibr-ator4
Vibr-ator5
Vibr-ator6
Feed hopper1
Feed hopper2
Feed hopper3
Hopper
Product
:Present power supply line.
: Present Air supply line.
: Present product line.
: Present signal from PLC line.
: Present signal to PLC.


Air compressor
Sole-noid3
Sole-noid4
Sole-noid5
Sole-noid6
Sole-noid7
Sole-noid8
Sole-noid9
Sole-noid10
Sole-noid11
Sole-noid12
Feed hopper3
Feed hopper4
Feed hopper5
Feed hopper6
SCALE1
SCALE2
SCALE3
SCALE4
SCALE5
SCALE6
Desired weight

3.3 Main Hopper

The main objective of the hopper as shown in Figure (3.3) that means the hopper must be formed from special metals suitable to save materials without any changing in the taste. Therefore, we decided to use the stainless steel.

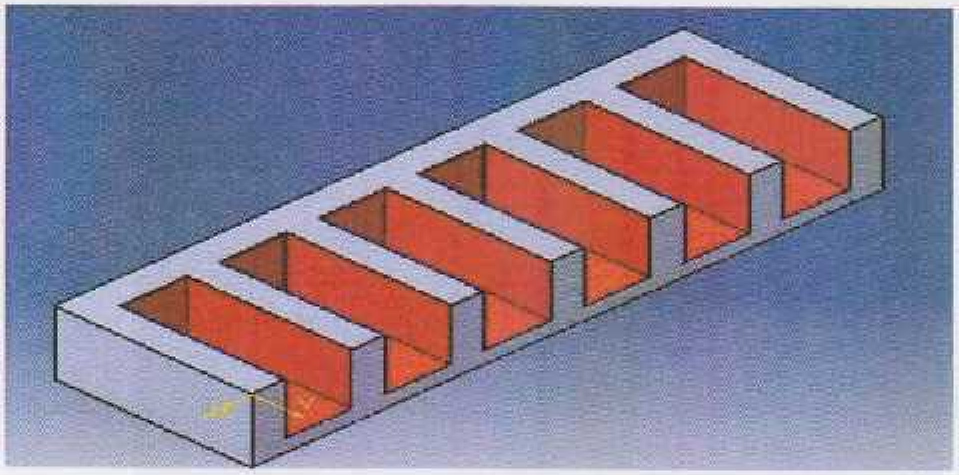


Figure (3.3): Main Hopper

3.3.1 Main Hopper Calculation

The volume can be calculated by:

$$V1= \frac{1}{3} \times \pi \times h({r_1}^2 + r_1 r_2 + {r_2}^2) \tag{3.1}$$

Where:

- V1: is the cone volume (m^3).
- π : is equal 3.14.
- r1: is the radius of the top of the cone(m).
- r2: is the radius of the bottom of the cone(m).
- h: is the high of the cone(m).

By applied the diminution

$$V1 = \frac{1}{3} \times \pi \times h \times \ (0.35^2 \ + \ 0.35 * 0.15 \ + \ 0.15^2)$$

3.4 Feed Hoppers

Range of feed hoppers designed to cope with a variety of capacity requirements. These units can be used for the materials; it uses hopper feeders to receive materials derived from vibrators initially before the unloaded in balances after these balances ready to receive materials based on a signal coming from the sensor for this, and this hopper feeders made of stainless steel to preserve the characteristics of food as they are. As shown in Figure (3.4).

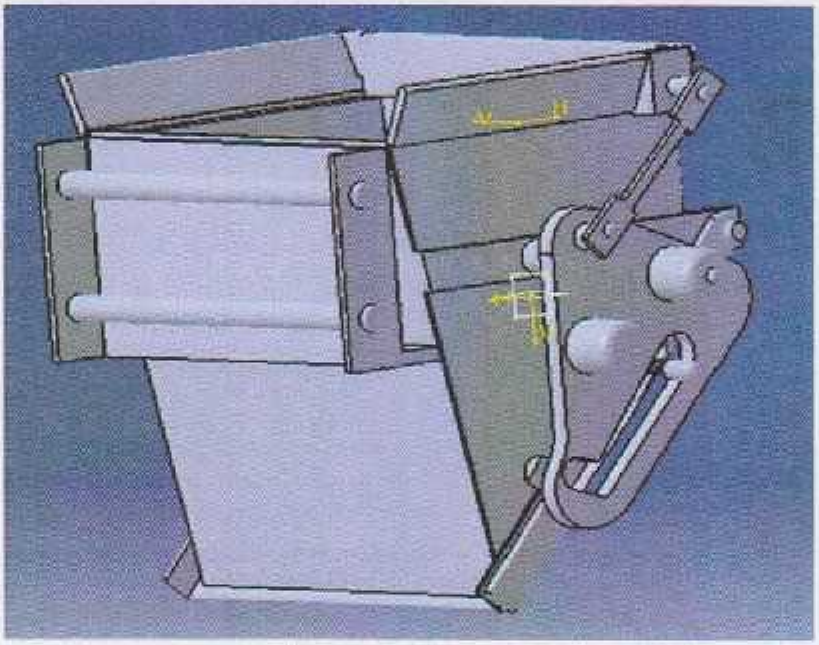


Figure (3.4): Feed Hopper

3.4.1 Feed Hopper Calculation

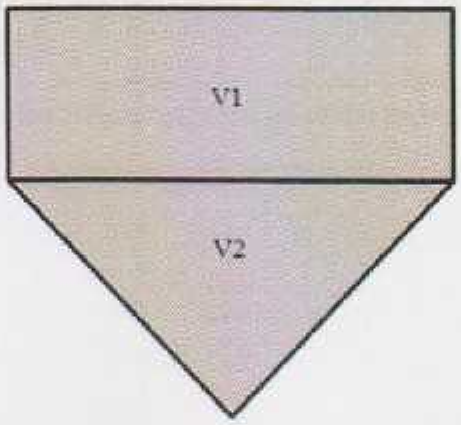


Figure (3.5): Feed Hopper Calculation

Total Volume $=$ Volume 1 $+$ Volume 2 (3.2)

Volume 1 $= L \times W \times H$ (3.3)

$$= 0.06 \times 0.11 \times 0.1$$
$$= 0.00066\ \mathrm{m}^3$$

Where:

- L : Length of Rectangle
- W: Width of Rectangle
- H: Height of Rectangle

Volume 2 $= \frac{1}{2} \times B \times H \times D$

$$= \frac{1}{2} \times 0.1 \times 0.08 \times 0.11$$
$$= 0.00044\mathrm{m}^3$$

Where:

- B:Base of Triangle
- H: Height of Triangle
- D: Dimension

Total volume $= 0.00066 + 0.00044 = 0.0011\mathrm{m}^3$

3.5 Balance Stages

The most important part of the user in the packaging machine is called balance stage which is a container used to collect material that comes from hopper to this part Tope Mobilized Using sensor is installed next to the container used for sensing weight accurately so that the weight sensor to give the lowest possible error. Using weight sensors is necessary to measure the material in a container.

As proof container cylinder that opens the gate at the arrival of the quantity needed .As Shown figure (3.6).

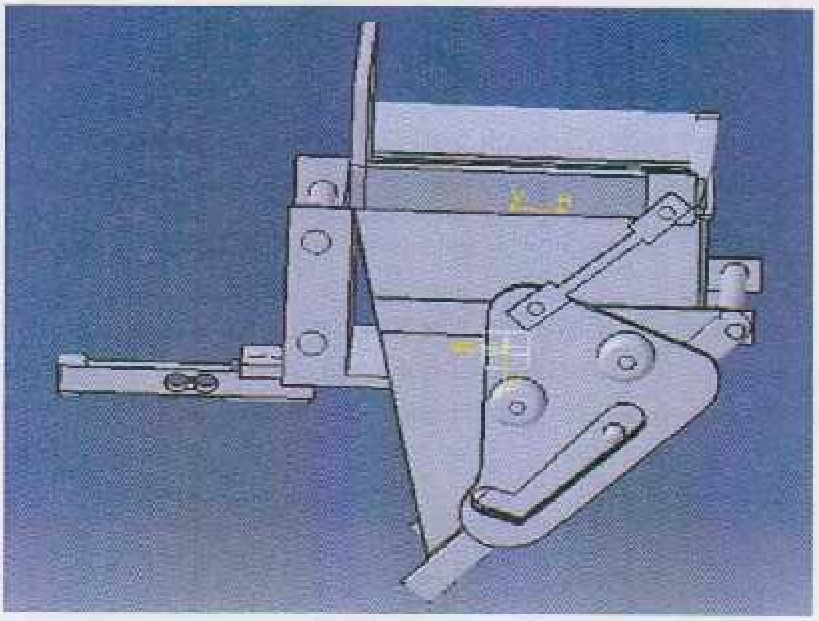


Figure (3.6): Balance Stage

3.5.1 Balance Stage Calculation

To calculate the amount safety on the container will use the equation to calculate the size of the container.

As equation (3.2)

$$\text{Total Volume} = \text{Volume 1} + \text{Volume 2}$$

As equation (3.3)

$$\begin{aligned}\text{Volume 1} &= L \times W \times H \\ &= 0.06 \times 0.11 \times 0.1 \\ &= 0.00066 \text{ m}^3\end{aligned}$$

As equation (3.4)

$$\begin{aligned}\text{Volume 2} &= \frac{1}{2} \times B \times H \times D \\ &= \frac{1}{2} \times 0.1 \times 0.08 \times 0.11 \\ &= 0.00044 \text{m}^3\end{aligned}$$

$$\text{Total volume} = 0.00066 + 0.00044 = 0.0011 \text{m}^3$$

3.6 Final Hopper

Hopper which collects the desired material (final material) after you send six scales, and thus it is a meeting place for the required material and sent to the timing hopper.

3.7 Timing Hopper

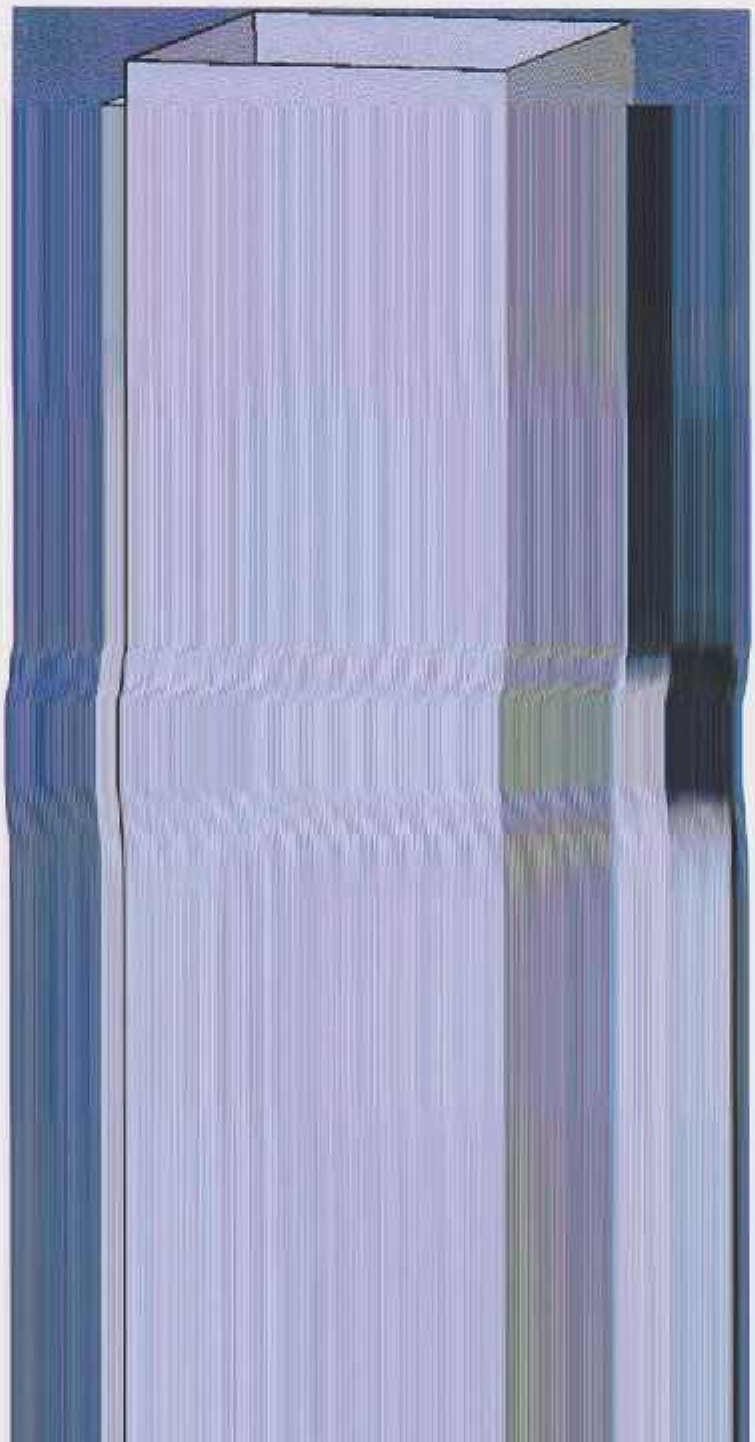
It is a container used to collect material that comes from balance stage, and is [illegible]

3.6 Final Hopper

Hopper which collects the desired material (final material) after you send six scales, and thus it is a meeting place for the required material and sent to the timing hopper.

3.7 Timing Hopper

which is a container used to collect material that comes from balance stage, and is placed in the space after the weight up to the desired weight, through an explosive, or its own baguettes and usually under this hopper production line to transport the materials to where they are stored . As shown in Figure (3.7).



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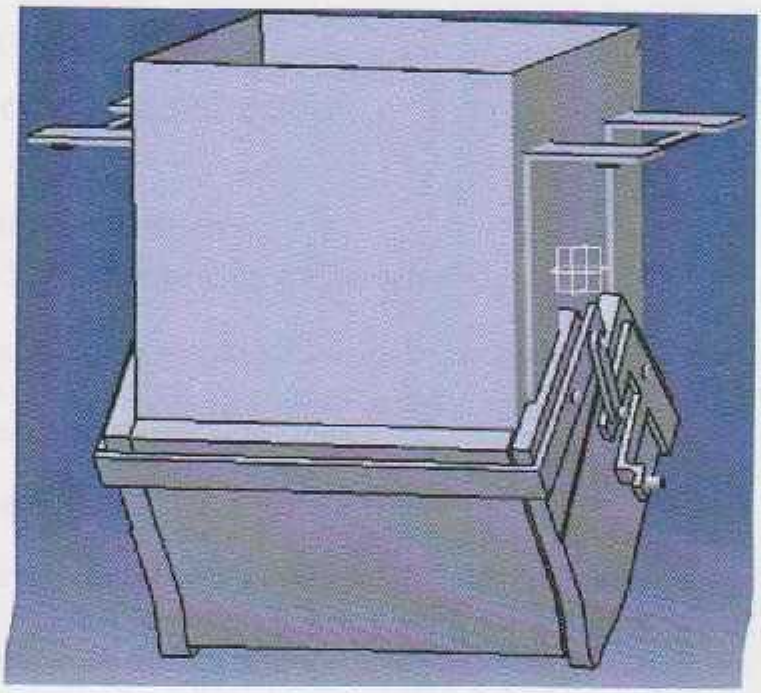


Figure (3.7): Timing Hopper

3.7.1 Timing Hopper Calculation

As equation (3.2)

Total

As equation (3.3)

$$\text{Volume } 1 = L \times W \times H$$

$$= 0.1 \times 0.14 \times 0.15$$

$$= 0.0021 \text{ m}^3$$

As equation (3.4)

$$\text{Volume } 2 = \frac{1}{2} \times B \times H \times D$$

$$= \frac{1}{2} \times 0.14 \times 0.07 \times 0.1$$

$$= 0.00049 \text{m}^3$$

Total volume =0.0021+0.00049=0.00259m^3

3.8 The Cylinder Calculation

3.8.1 Cylinder Performance Characteristics

Cylinder performance characteristics can be determine d theoretically or by the use of manufactures data .Both method are acceptable, but in general the manufactures data is more relevant to a particular design and application.

3.8.2 Piston Force

The piston force exerted by the cylinder is dependent upon the air pressure, the cylinder diameter and the frictional resistance of the sealing components. The theoretical piston force is calculated by the formula:

$$F_{th} = A \times P \tag{3.4}$$

Where:

- F_{th}:Theoretical piston force (N).
- A :Useful piston area (m^2).
- P :Operating pressure (Pa).

In practical, the effective piston force is significant. When calculating this, frictional resistance should be taken into consideration.

3.8.3 Single-acting cylinder

$$F_{eff} = (A \times P) - (F_R + F_F) \qquad (3.5)$$

3.8.4 Double-acting cylinders

$$\text{Forward stroke} F_{eff} = (A \times P) - F_R \qquad (3.6)$$

$$\text{Return stroke} F_{eff} = (A' \times P) - F_R \qquad (3.7)$$

Where:

- F_{th}:Effective piston force (N).
- A :Useful piston area (m^2).
- $A = \frac{D^2 \times \pi}{4}$ (3.8)
- A' : Useful annular surface (m^2).

$$A' = (D^2 - d^2)\frac{\pi}{4} \qquad (3.9)$$

Where:

- P : Working Pressure (Pa).
- F_R : Frictional spring force (N).
- F_F : Return spring force (N).
- D : Cylinder diameter (m).
- d : Piston rod diameter (m).

3.8.5 Stroke length

The stroke lengths of pneumatic cylinders should not be greater than 2 m .

With excessive stroke lengths the mechanical stress on the piston rod and on the guide bearings would be too great.

3.8.6 Piston speed

The piston speed of pneumatic cylinders is dependent on the load, the prevailing air pressure, the length of pipe, the cross-sectional area of the line between the control element and the working element and also the flow rate through the control element. In addition, the speed is influenced by the end position cushioning. [12]

Chapter Four

"Electrical and Pneumatic Design"

4.1 Introduction

In this section we talk about the electrical and pneumatic parts, the elements used, and the construction of the implementation method. Moreover, there are detailed calculations of the whole elements used with directed positions.

4.1 Introduction

In this section we talk about the electrical and pneumatic parts, the elements used, and the construction of the implementation method. Moreover, there are detailed calculations of the whole elements used with directed positions.

The electrical system in the project has major parts It has a system plc and the necessary protection elements and sensors on the weighing process as well as the accounts of the vibrator, and the principle of work Machine. And contains a Illustration for pneumatic parts and how Cylinder work.

Proposed design depends on the sequence of the data entry touch screen plc, and work full processed down to the desired weight.

4.2 Flow Chart

Figure (4.1): Flow Chart

4.3 Working Principle Hoppers

existing material inside the main hopper transmitted to the surrounding vibrators in the process of shake balanced materials to ensure non accumulation inside feed hoppers, and based on a signal from PLC, open feedhoppers to download material by weight to be scales, That collects weights converged desired weight with an error not exceeding 2 percent and are transported to the final hopper and then to the timing hopper for processing of packaging.as shown in figure (4.2)

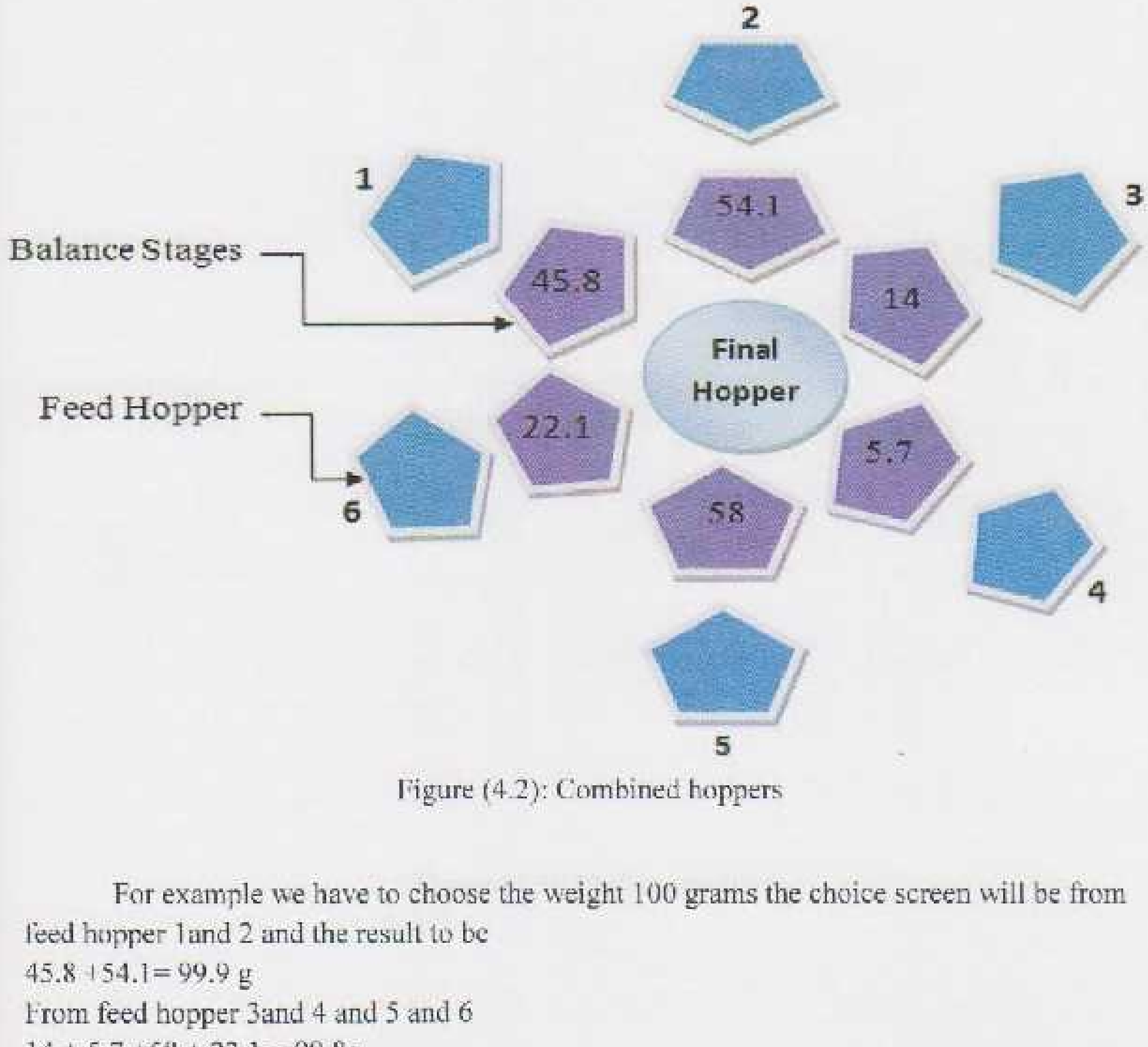


Figure (4.2): Combined hoppers

For example we have to choose the weight 100 grams the choice screen will be from feed hopper 1and 2 and the result to be

45.8 +54.1= 99.9 g

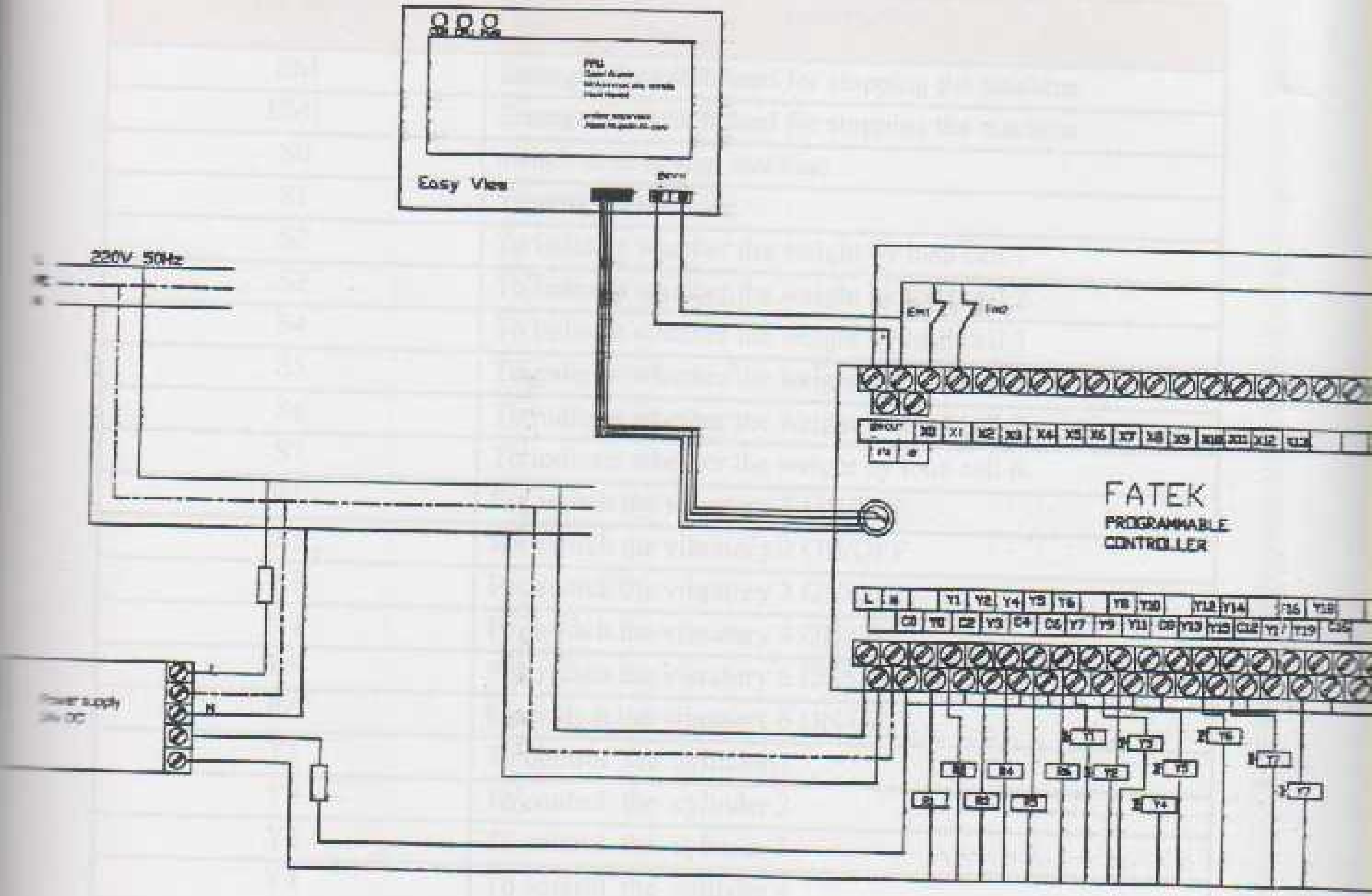
From feed hopper 3and 4 and 5 and 6

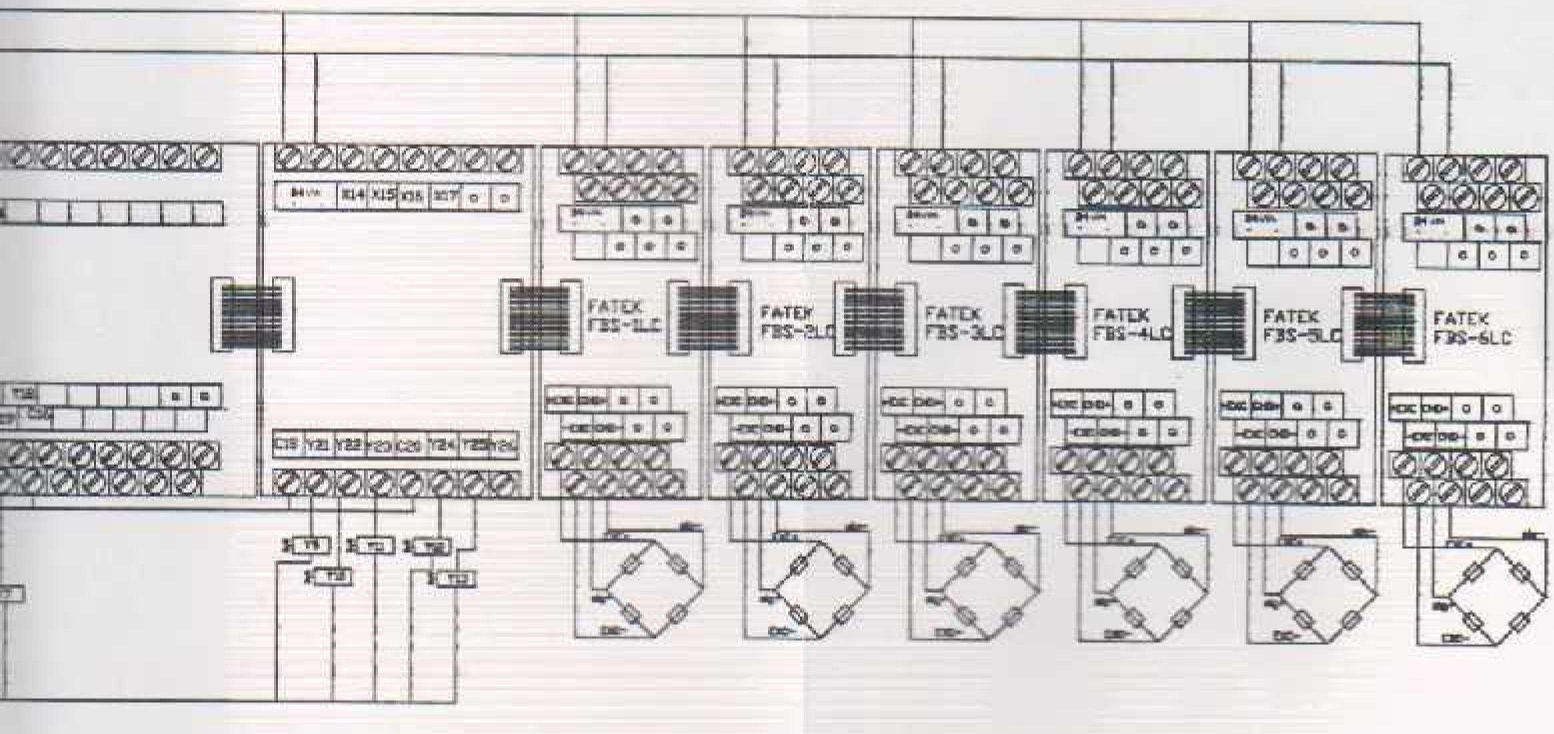
14 + 5.7 +58 + 22.1 = 99.8g,

4.4 Electrical design

4.4.1 PLC

Figure (4.3): PLC connection


Easy View
220V 50Hz
Power supply
24V DC
FATEK
PROGRAMMABLE
CONTROLLER

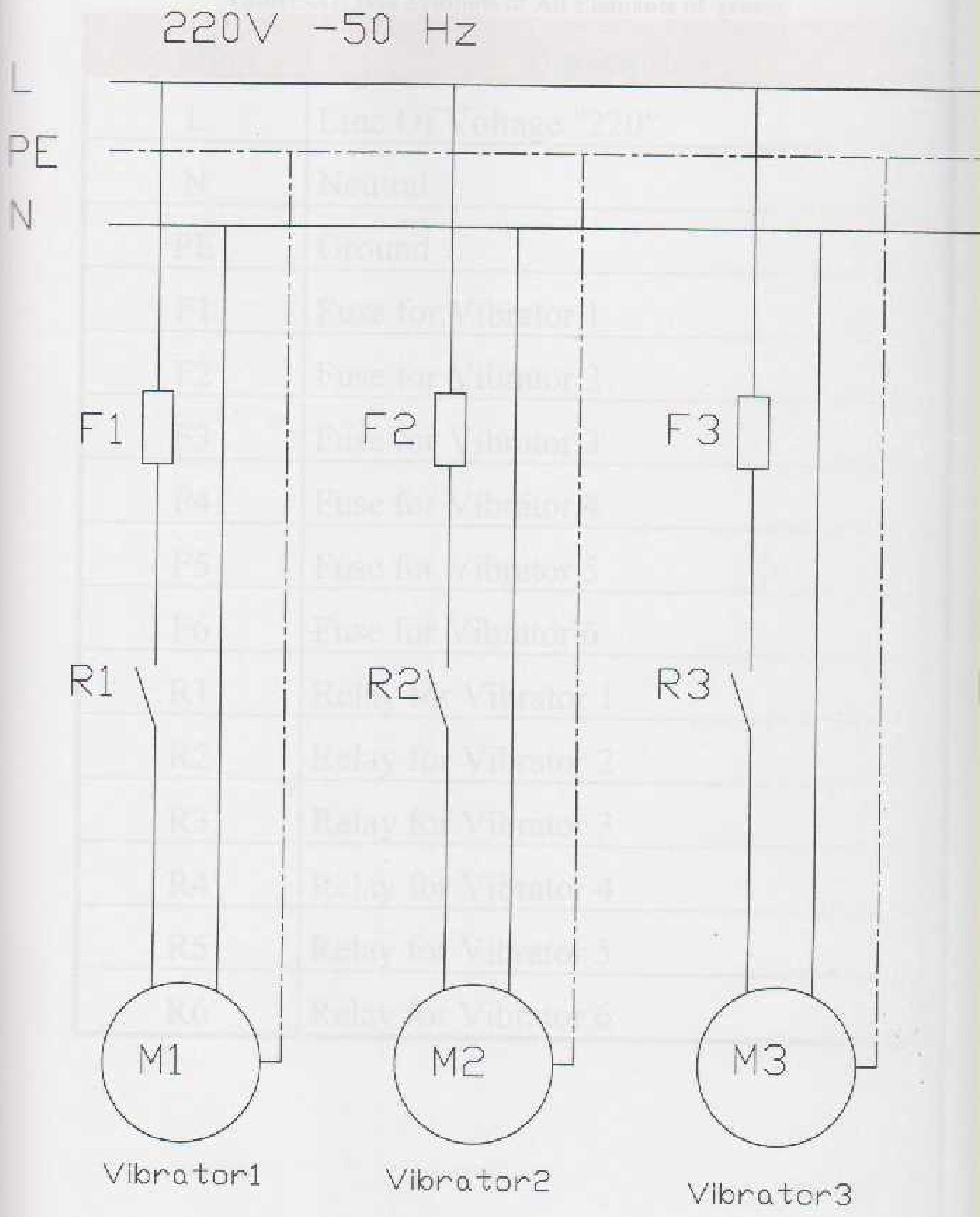


FATEK
FBS-1LC
FATEK
FBS-2LC
FATEK
FBS-3LC
FATEK
FBS-4LC
FATEK
FBS-5LC
FATEK
FBS-6LC
X14
X15

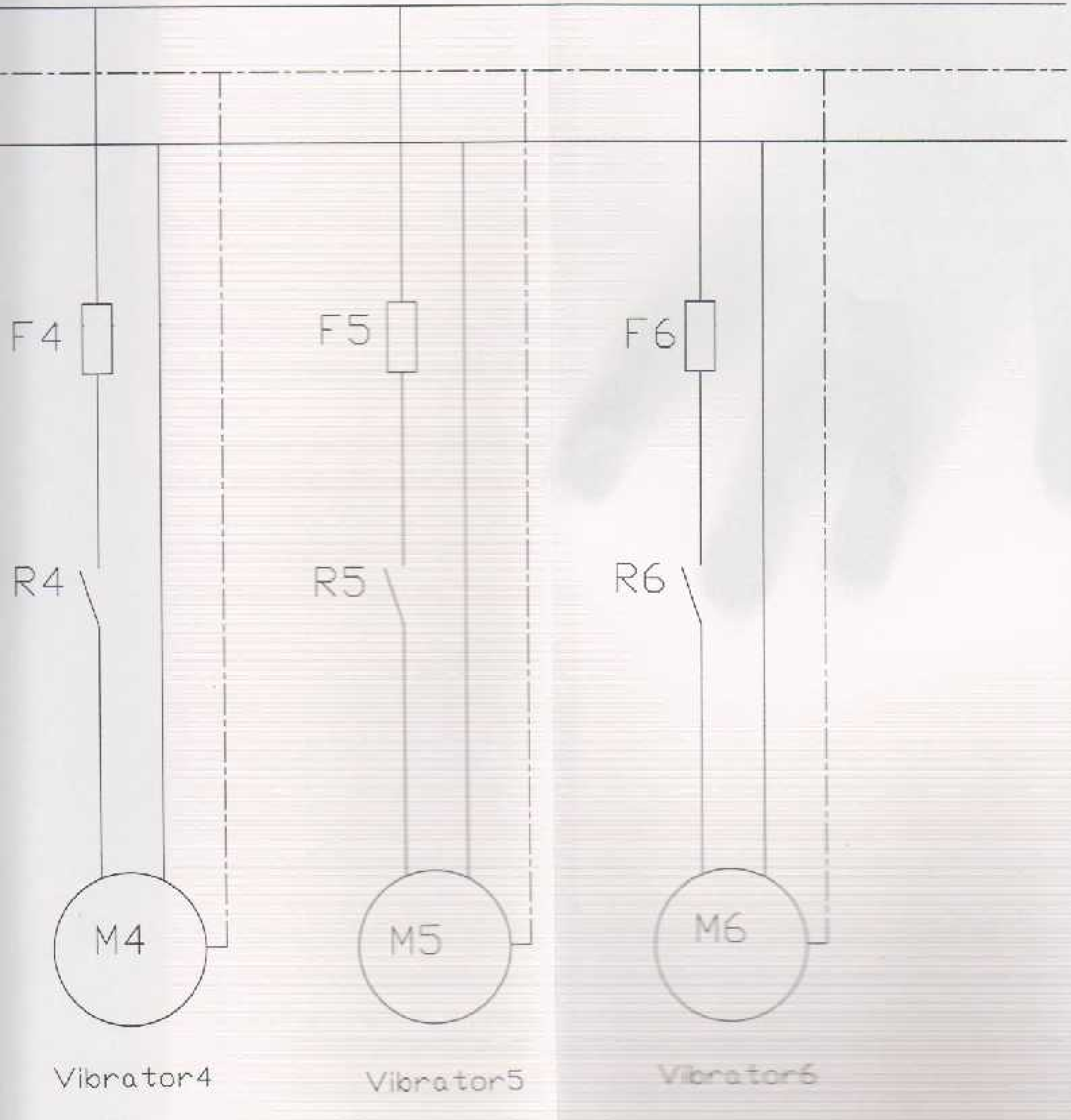
The following table (4.1) has symbols of all elements connected with the PLC, such as: digital and analog inputs, digital outputs, and its description.

Table (4.1) Has Symbols of All Elements Connected With the PLC

Symbols	Description
EM	Emergency switch used for stopping the machine
EM1	Emergency switch used for stopping the machine
S0	switch used to stop machine
S1	To start the machine
S2	To indicate whether the weight by load cell 1
S3	To indicate whether the weight by load cell 2
S4	To indicate whether the weight by load cell 3
S5	To indicate whether the weight by load cell 4
S6	To indicate whether the weight by load cell 5
S7	To indicate whether the weight by load cell 6
R1	For switch the vibratory 1 ON/OFF.
R2	For switch the vibratory 2 ON/OFF
R3	For switch the vibratory 3 ON/OFF
R4	For switch the vibratory 4 ON/OFF
R5	For switch the vibratory 5 ON/OFF
R6	For switch the vibratory 6 ON/OFF
Y1	To control the cylinder 1
Y2	To control the cylinder 2
Y3	To control the cylinder 3
Y4	To control the cylinder 4
Y5	To control the cylinder 5
Y6	To control the cylinder 6
Y7	To control the cylinder 7
Y8	To control the cylinder8
Y9	To control the cylinder 9
Y10	To control the cylinder 10
Y11	To control the cylinder 11
Y12	To control the cylinder 12
Y13	To control the cylinder 13

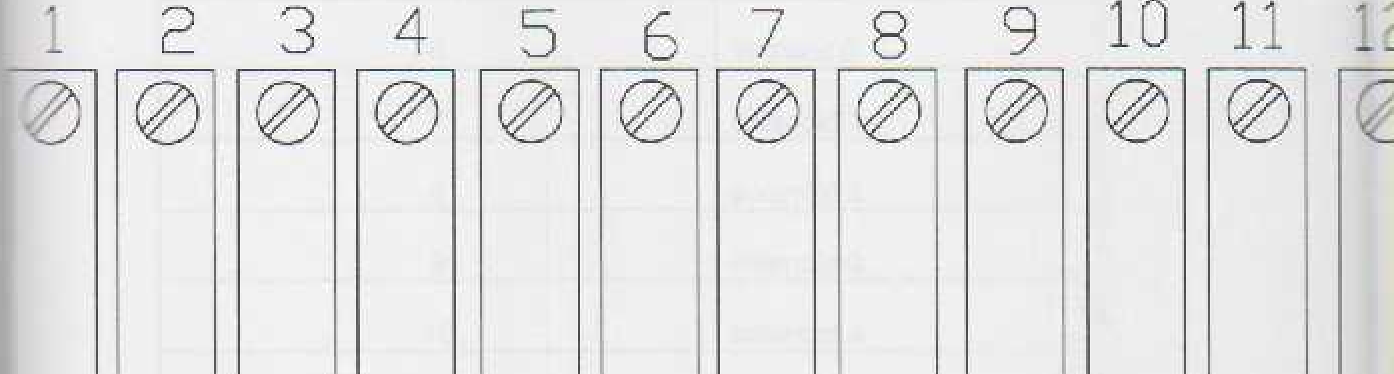


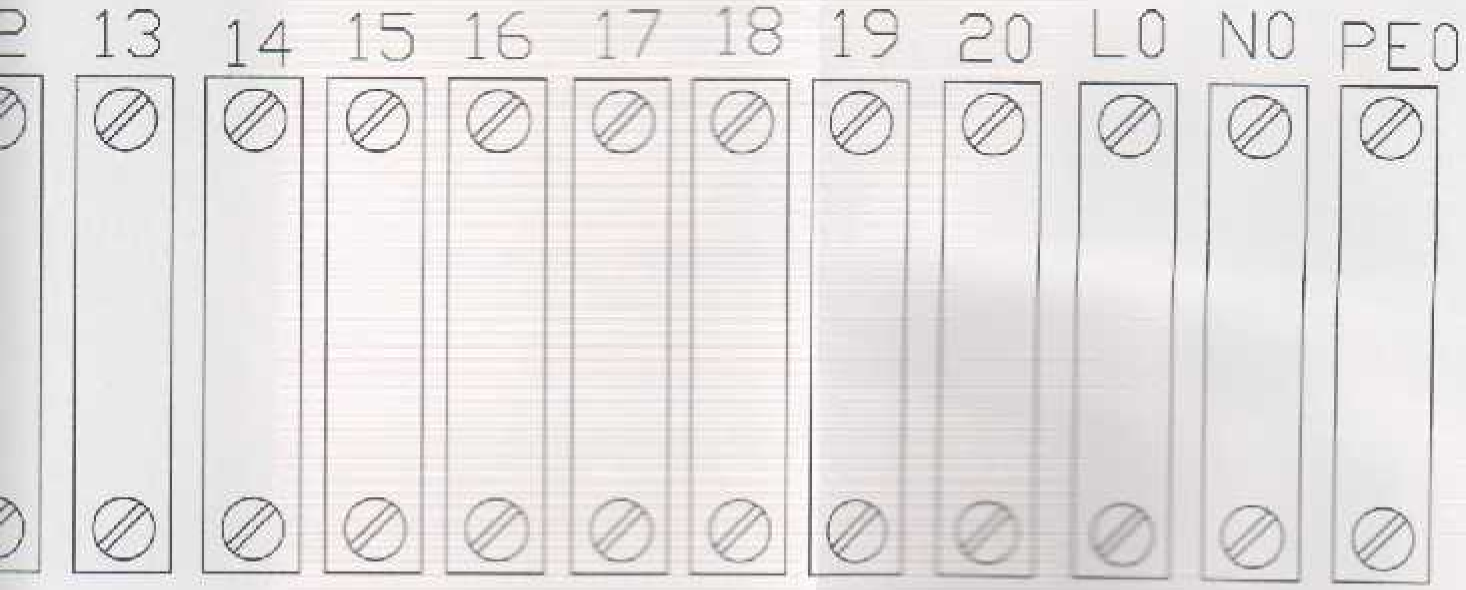
220V -50 Hz
L
PE
N
F1
F2
F3
R1
R2
R3
M1
M2
M3
Vibrator1
Vibrator2
Vibrator3


F4
F5
F6
R4
R5
R6
M4
M5
M6
Vibrator4
Vibrator5
Vibrator6

Table(5.1): Has Symbols of All Elements of power

Symbol	Description
L	Line Of Voltage "220"
N	Neutral
PE	Ground
F1	Fuse for Vibrator 1
F2	Fuse for Vibrator 2
F3	Fuse for Vibrator 3
F4	Fuse for Vibrator 4
F5	Fuse for Vibrator 5
F6	Fuse for Vibrator 6
R1	Relay for Vibrator 1
R2	Relay for Vibrator 2
R3	Relay for Vibrator 3
R4	Relay for Vibrator 4
R5	Relay for Vibrator 5
R6	Relay for Vibrator 6


1
2
3
4
5
6
7
8
9
10
11


13
14
15
16
17
18
19
20
L0
N0
PE0

Table(5.2) :Clement Sympole

Clement Number	Description
1	Vibrator 1
2	Vibrator 2
3	Vibrator 3
4	Vibrator 4
5	Vibrator 5
6	Vibrator 6
7	solenoid 1
8	solenoid 2
9	solenoid 3
10	solenoid 4
11	solenoid 5
12	solenoid 6
13	solenoid 7
14	solenoid 8
15	solenoid 9
16	solenoid 10
17	solenoid 11
18	solenoid 12
19	solenoid 13
20	PE
21	N
22	L(220V/50Hz

4.4.2 Vibrator

Table 4.2Parameter the Vibratory

Parameter	Value
Power supply	220V/50 Hz
Current	0.25A
Full load Power consumption	55 Watts
Net feeder Weight	60 Kg

The Vibrator Calculation:

$$\text{Total current} = N \times I \tag{4.1}$$

$$= 6 \times 0.25 = 1.5A$$

Where:

- N: Number of vibrators.
- I: Current.

$$\text{Total Power} = N * P \tag{4.2}$$

$$= 6 * 55 = 330 \text{ Watt}$$

4.4.3 Load Cell

A load cell usually consists of four strain gauges in a Wheatstone bridge configuration. Load cells of one strain gauge (Quarter Bridge) or two strain gauges (Half Bridge) are also available.[1] The electrical signal output is typically in the order of a few millivolts and requires amplification by an instrumentation amplifier

- A load cell is a force transducer that converts force or weight into an electrical signal
- The strain gage is the heart of a load cell

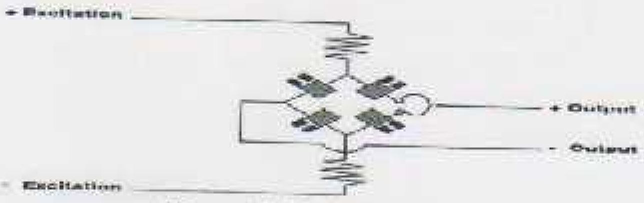


Figure (4.3):load cell

4.4.3.1 Wheatstone bridge

The type of resistive circuit used in load cell Wheatstone bridgehastwostates:

- Balanced Wheatstone bridge
- Unbalanced Wheatstone bridge

4.4.3.1.1 Balanced Wheatstone bridge

When power is applied to this bridge the current flowing in the branch R1/R3 is equal to the current flowing in the R2/R4 branch. this is true because all resistor are equal .since there is no voltage different between point 1 and 2 there is no current through the ammeter .this bridge is an a balanced condition figure(4.4)

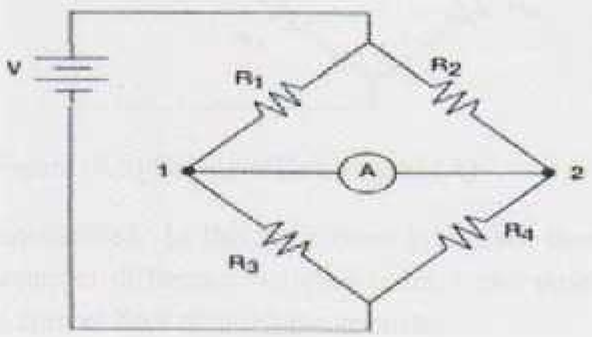


Figure (4.4):Bridge of balanced

When have replaced the ammeter with voltmeter which will represent display on our Wight indicator also lead connected to our indicator are designated these represent our positive and negative signal leads the 10volt in our indicator's power supply that provide the precise voltage to excite or power the load cell .the resistance value represent our four strain gauges which make up our load cell since there no load on our cell all strain gauge resistance are the same by using Ohms law:

$$I_{R1+R2} = \frac{E_{R1+R2}}{R1+R2} \quad (4.1)$$

$$I_{R3+R4} = \frac{E_{R3+R4}}{R3+R4} \quad (4.2)$$

The voltage drop at point 1 and point 2

$$E = IR \quad (4.3)$$

Since all resistance are equal the volyage at point 2 is equal point 1. there no voltage diffrence between point 1 and point 2 thus azero reading is displayed on our indicator.

4.4.3.1.2 Unbalanced Wheatstone bridge:

Now let's increase the resistance of R1 and R4 and decrease the resistance of R2 and R3.as shown Figure (4.5)

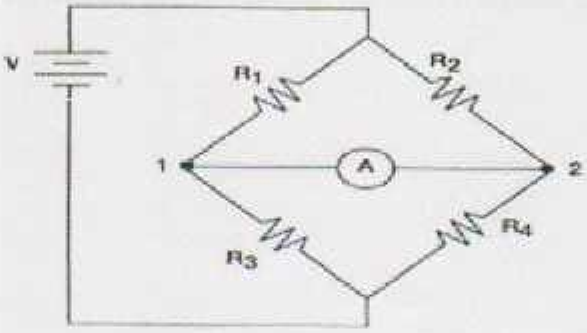


Figure (4.5):Bridge ofUnbalanced (A)

The bridge become unbalanced in this time there is current flow the ammeter this current flow is a result of potential difference between point 1 and point 2 .the larger the potential difference the larger current flow through the ammeter

Now let s place a force on our load cell .our force caused R1 and R4 to go into tension which increased their resistance R2 and R3 went into compression ,which decreased their resistance .these change are depicted as shown in figure(4.6)

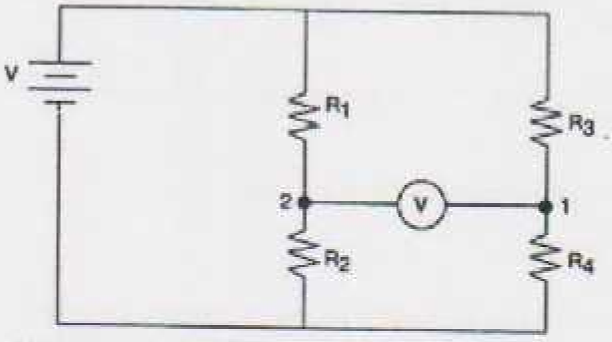


Figure (4.6): Bridge of Unbalanced (V)

We find the voltage at point 1 we will calculate the voltage drop across R3.

$$E_{R3} = I_{R3} * R_3 \quad (4.4)$$

We find the voltage at point 2 we will calculate the voltage drop across R1.

$$E_{R1} = I_{R1} * R_1 \tag{4.5}$$

To find the potential diffrence between point 1 and point 2 we subtract E_{R3} from E_{R1}.

We see that our bridge has become unbalanced.

The indicator is calibrated so certain millivolt reading would correspond to certain weight measurement.

4.5 Circuit of Pneumatic Design

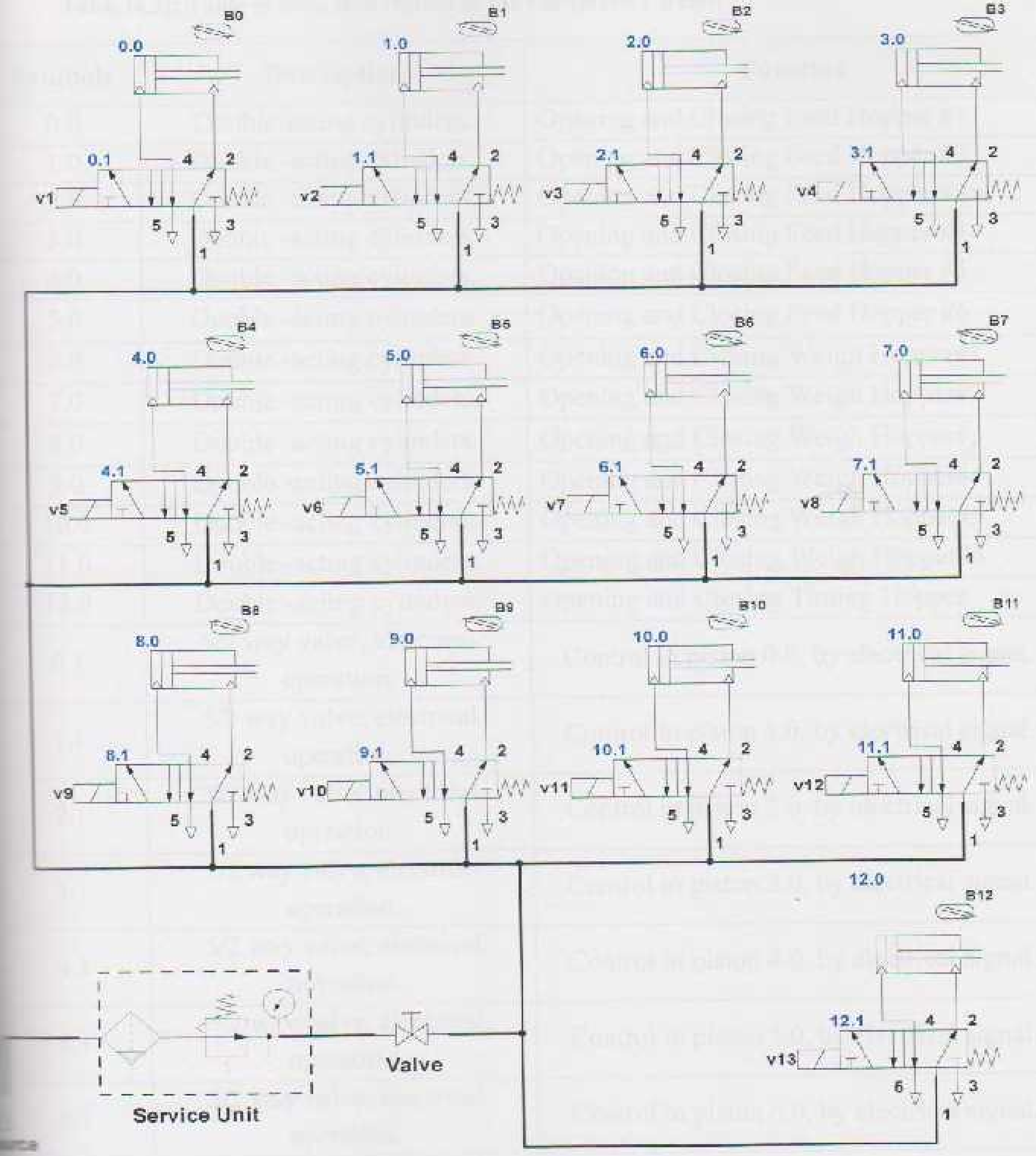


Figure (4.7): Circuit of Pneumatic Design

Table (4.3): Table of Data Description in the Pneumatic Circuit:

Symbols	Description	Function
0.0	Double-acting cylinders.	Opening and Closing Feed Hopper #1
1.0	Double -acting cylinders.	Opening and Closing Feed Hopper #2
2.0	Double -acting cylinders.	Opening and Closing Feed Hopper #3
3.0	Double -acting cylinders.	Opening and Closing Feed Hopper #4
4.0	Double -acting cylinders.	Opening and Closing Feed Hopper #5
5.0	Double -acting cylinders.	Opening and Closing Feed Hopper #6
6.0	Double -acting cylinders.	Opening and Closing Weigh Hopper#1
7.0	Double -acting cylinders.	Opening and Closing Weigh Hopper#2
8.0	Double -acting cylinders.	Opening and Closing Weigh Hopper#3
9.0	Double -acting cylinders.	Opening and Closing Weigh Hopper#4
10.0	Double -acting cylinders.	Opening and Closing Weigh Hopper#5
11.0	Double -acting cylinders.	Opening and Closing Weigh Hopper#6
12.0	Double -acting cylinders.	Opening and Closing Timing Hopper
0.1	5/2 way valve, electrical operation.	Control in piston 0.0, by electrical signal.
1.1	5/2 way valve, electrical operation.	Control in piston 1.0, by electrical signal.
2.1	5/2 way valve, electrical operation.	Control in piston 2.0, by electrical signal.
3.1	5/2 way valve, electrical operation.	Control in piston 3.0, by electrical signal.
4.1	5/2 way valve, electrical operation.	Control in piston 4.0, by electrical signal.
5.1	5/2 way valve, electrical operation.	Control in piston 5.0, by electrical signal.
6.1	5/2 way valve, electrical operation.	Control in piston 6.0, by electrical signal.
7.1	5/2 way valve, electrical operation.	Control in piston 7.0, by electrical signal.

8.1	5/2 way valve, electrical operation.	Control in piston 8.0, by electrical signal.
9.1	5/2 way valve, electrical operation.	Control in piston 9.0, by electrical signal.
10.1	5/2 way valve, electrical operation.	Control in piston 10.0, by electrical signal.
11.1	5/2 way valve, electrical operation.	Control in piston 11.0, by electrical signal.
12.1	5/2 way valve, electrical operation.	Control in piston 12.0, by electrical signal.
B0-B12	Magnetic sensors	Control of Signals Reverse

Chapter Five

" Implementation "

In chapter 4 we explained how to make the design and its' calculations for the project. From that result we started implementing the project practically not just theoretically. In this chapter we will explain the implementation process, providing photos of the project in different viewpoint, and the target from every part.

5.1 Implementation Process:-

5.1.1 The Body:

First part that we worked on is body of the machine as shown in figure (5.1), where this body will hold all parts of the machine. By using this body, we can easily assemble and disassemble the other parts of the machine. We gild the machine by using brown dotted black color, by paint oven.

Figure (5.1): The Body of the Machine

5.1.2 The Main Hopper:

The first assembly part in the machine is the hopper as shown in figure (5.2), where this hopper will hold the quantity material.

Figure (5.2): The Hopper

5.1.3 The Vibrator

Using Vibrator as shown in Figure (5.3) helps the transfer of materials from the main hopper to the Feed Hopper

Figure (5.3): The Vibrator

5.1.4 The Balance stage

Using the Balance stage as shown in the figure (5.4) is the process of weighing materials coming from Feed Hopper

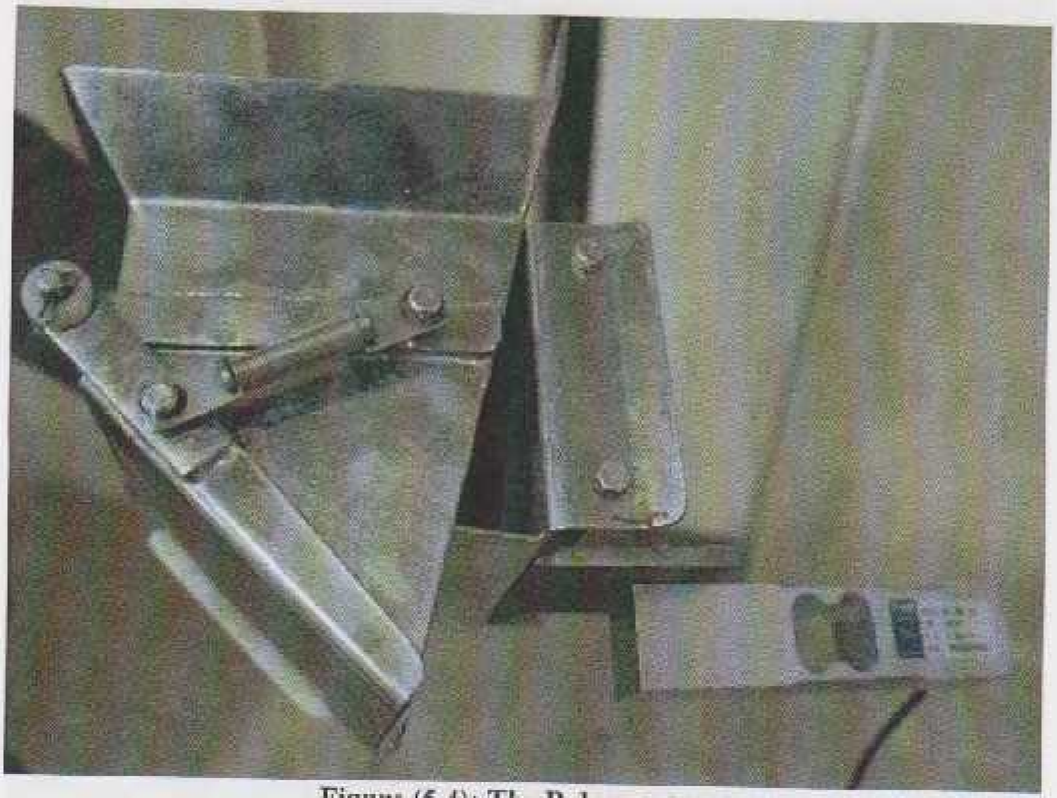


Figure (5.4): The Balance stage

5.1.5 The Feed Hopper

Using the Feed Hopper as shown in the figure (5.5) is receive materials from vibrators .

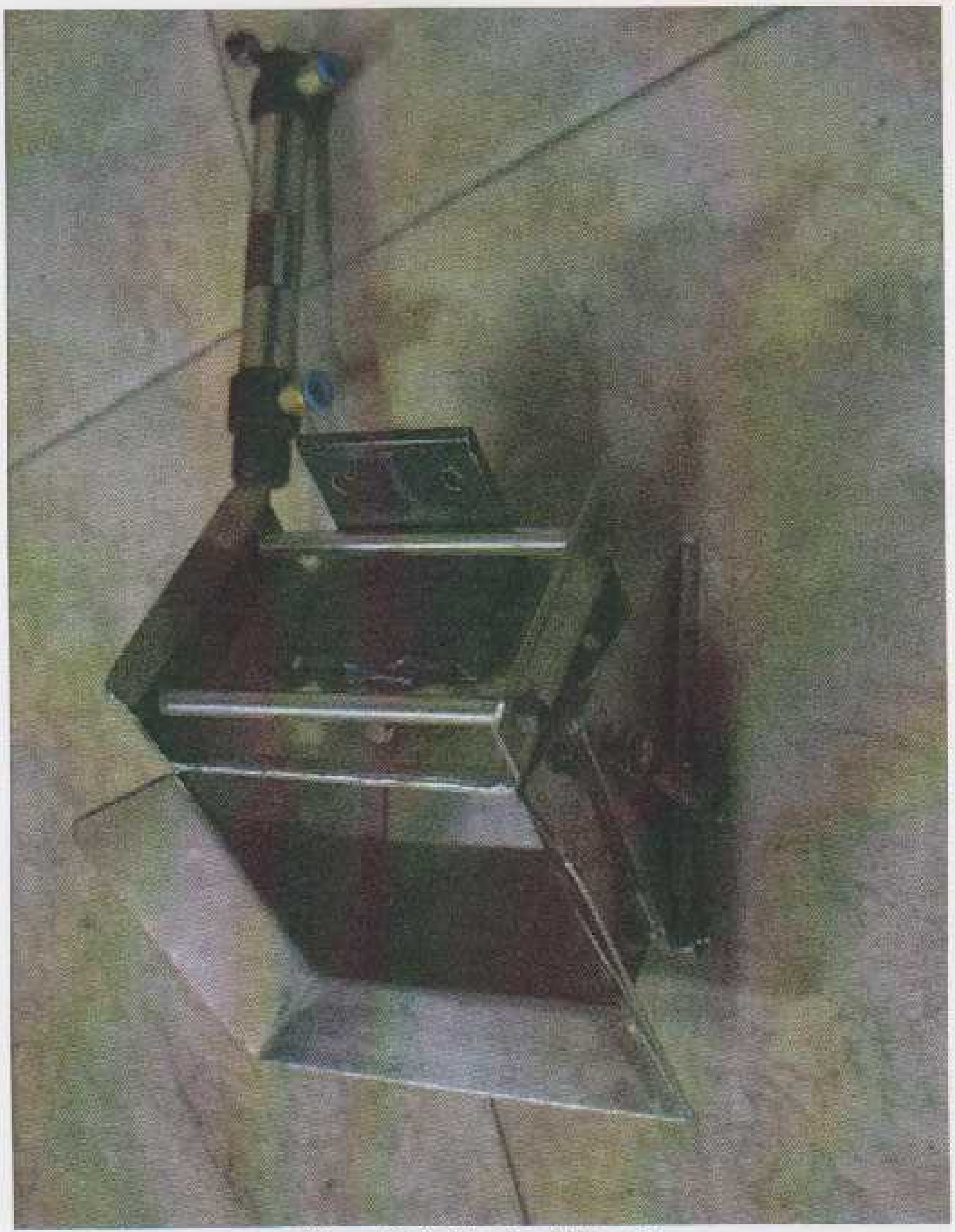


Figure (5.5): The Feed Hopper

5.1.6 The Final Hopper

Using the Final Hopper as shown in the figure (5.6) is receive materials from the Balance stage

Figure (5.6): The Final Hopper

5.1.7 The Timing Hopper

Using Timing Hopper as shown in Figure (5.7) opens the required weight to the packaging stage.

Figure (5.7): The Timing Hopper

5.1.8 The Panel Electricity

Electrical panel as shown in Figure (5.8) contain the parts of power and control electrical.

Figure (5.8): The Panel Electricity

5.1.9 The Pneumatic Panel

The pneumatic Panel as shown in Figure(5.9) contains the valves

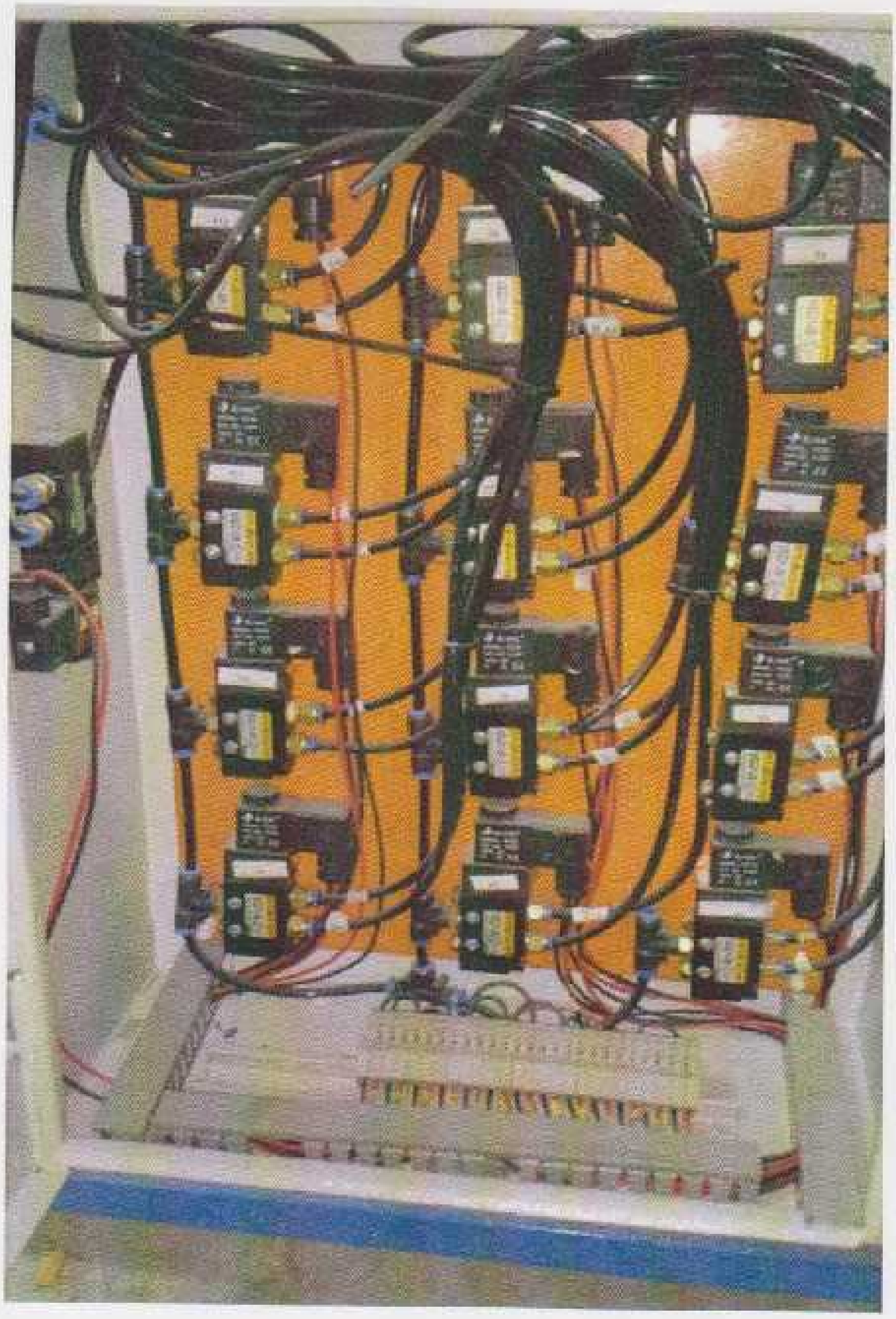


Figure (5.9): The Pneumatic Panel

5.1.10 The Final Shape of the Machine

The final shape of the machine is shown in figure (4.10).

Figure (5.10): The Final Shape of the Machine

Chapter Six

" Results "

6.1 Conclusions:

This section presents some conclusions that resulted from implementing and testing the project. Also it explains in details the goals that were achieved from the project. We can sum up the conclusions in the following points:

1. The team work of the project put the aims of the project and studied the theoretical part of the project (theories and laws). The team proved that the theoretical methods can be executed in real world and they can be applicable.

2. In the initial design of the mechanical parts, the vibrators body was separated from the full body of the machine to ensure that taking even greater accuracy and not the vibrators affect the weighing process.

3. Because of non-transmission of material from the main hopper which to choose weights to ensure move that material easily from one part to another in the machine .So we found it necessary to use vibrators that contribute to the transmission of material consistently

4. Used feed hopper to ensure do not the accumulation of material on load cell , we used also a number of load cell for speed in the weighting process, and get greater accuracy, and finally used the final hopper to the material is poured and the transition to the packaging process.

6.2 Recommendations

In the end, we have many recommendations that can contribute to the provision of improvements to the project, could have been done, but there was no plenty of time, and not have the financial support needed for them. These recommendations can be summarized in the following points:

1. This machine can be part of an integrated production line that contains: different materials, the completion of mixtures, then use the machine in the packaging to have the final product.

2. Increase the number load cells in the machine, allowing for greater speed and accuracy.

3. Add a packaging system for a machine, working on the introduction of belt conveyors for materials ended.

Appendix

Appendix 'A' {Load cell}

FBs-1LC

Load Cell Input Module

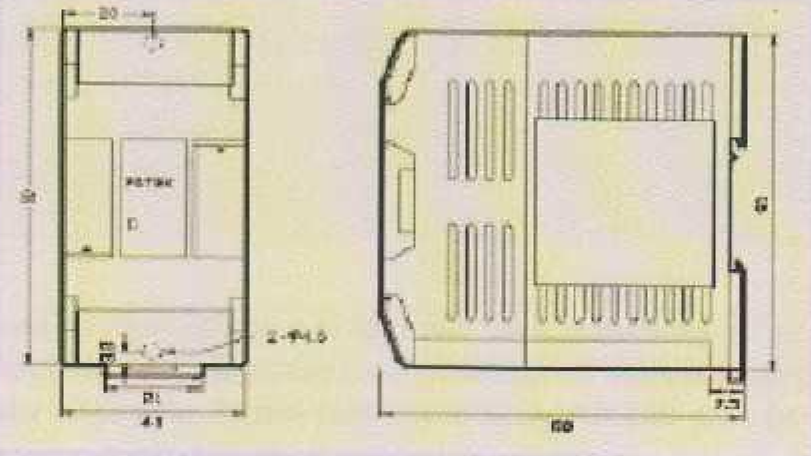
Introduction

FBs-1LC is one of the analog input modules of FATEK FBs series PLC. It can connect one 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.

Specifications

Total Channels - One channel
Resolution- 16 bit (include signed bit)
I/O Points Occupied - 1 RI(Input Register) and 8 DO
Conversion Rate- 5/10/20/25/60/120/240/480 Hz
Non-Linearity- 0.01% F.S. (@25℃)
Zero Drift- 0.2 μV/℃
Gain Drift- 10 ppm/℃
Excitation Voltage – 5V with 250Ω load
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

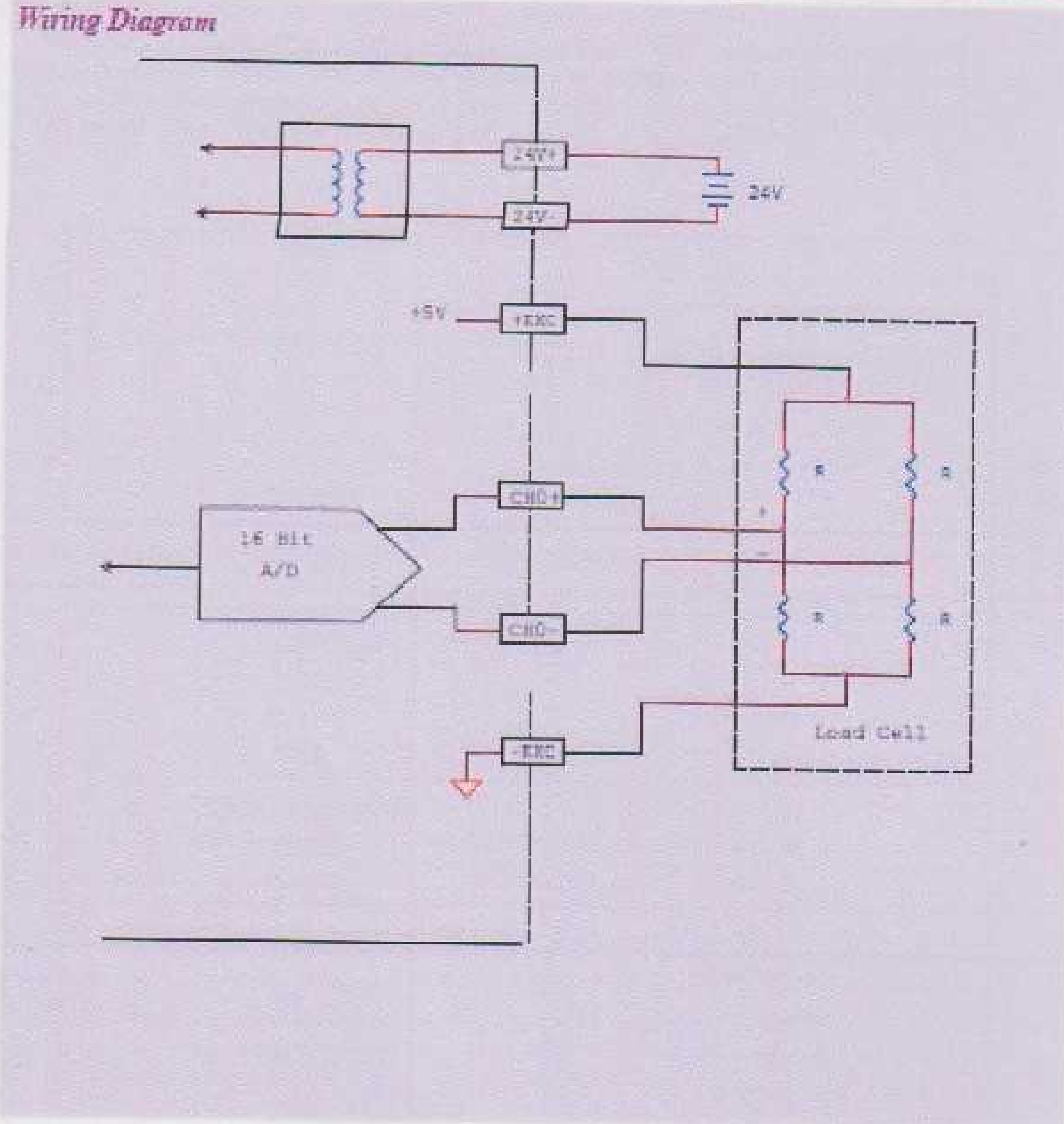
Dimensions



FBs-1LC

Load Cell Input Module

Wiring Diagram



The conversion result is represented by a 16 bit signed value, there should put an additional LCNV (FCN33)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 null drift.

FBs-1LC

Load Cell Input Module

PLC Control

The interface between PLC and 1LC module is thru 8 Pts. Of DO and one input register (RI). Thru the control of DO signal, the user can select the conversion rate, operating range and samples for average. Detail description of DO is listed at below. Y_n is the staring number of DO allocated for this module. The conversion result is carried in RI with 16 bit signed format.

Signal	Name	Function Description	
Y_{n+1},Y_{n+0}	SPAN	00	0~10mV(2mV/V)
		01	0~25mV(5mV/V)
		10	0~50mV(10mV/V)
		11	0~100mV(20mV/V)
Y_{n+2}	Speed Range-1	=0, Normal Speed =1, High Speed	
Y_{n+3}	RESERVED	Reserved	
Y_{n+5},Y_{n+4}	CONVSERSION RATE $Y_{n+2}=0$	00	5Hz
		01	10Hz
		10	20Hz
		11	25Hz
	CONVSERSION RATE $Y_{n+2}=1$	00	60 Hz
		01	120 Hz
		10	240 Hz
		11	480 Hz
Y_{n+7},Y_{n+6}	AVERAGE COUNT	00	No Average
		01	2 Samples
		10	4 Samples
		11	8 Samples

Note-1: This feature is supported after V1.2 (include) firmware

Appendix 'B'{PLC Controller}

General Specifications

Environmental specifications

Item			Specification	Note
Operating ambient temperature	Enclosure space	Minimum	5°C	Permanent installation
		Maximum	40°C	
	Open space	Minimum	5°C	
		Maximum	50°C	
Storage temperature			-25°C – +70°C	
Relative humidity(non-condensing, RH-2)			5% – 95%	
Pollution resistance			Degree II	
Corrosion resistance			Based on IEC-68 standard	
Altitude			≤2000m	
Vibration resistance	Fixed by DIN RAIL		0.5G, 2 hours for each direction of 3 axes	
	Fasten by screw		2G, 2 hours for each direction of 3 axes	
Shock resistance			10G, Three times for each direction of 3 axes	
Noise resistance			1500 Vp-p, pulse width 1μs	
Withstand voltage			1500VAC, 1 minute	L,N to any terminal

Power supply specifications — AC power supply

Item \ Specification		10/14 points main unit	20/24 points main unit	32/40 points main unit	60 points main unit
Input range	voltage	100 – 240VAC -15%/+10%			
	Frequency	50/60Hz ±5%			
Max. power consumption		21W (POW-14)	35W (POW-24)		
Inrush current		20A @ 264VAC			
Allowable power momentary interruption time		<20ms			
Fuse rating		2A, 250VAC			

Power supply specifications — DC power supply

Item \ Specification	10/14 points main unit	20/24 points main unit	32/40 points main unit	60 points main unit
Input range	12VDC/24VDC -15%/+20%			
Max. power consumption	15W (DPOW-10)	24W (DPOW-16)		
Inrush current	20A @ DC24V			
Allowable power momentary interruption time	<20ms			
Fuse rating	3.15A, 250VAC			

Main unit specifications

* : Default, changable by user

Item		Specification	Note
Execution speed		0.32us/Sequential instruction	
Program capacity		20K Words	
Program memory		FLASH ROM or SRAM + Lithium battery for back up	
Sequential instruction		36 instructions	
Function instruction		335 instructions (126 kinds)	Include derivative instructions
Flow chart command (SFC)		4 instructions	
Communication Interface	Port 0 (RS232 or USB)	Communication speed 4.8Kbps – 921.6Kbps (9.6Kbps)*	
	Port 1 – Port 4 (RS232, RS485, Ethernet or GSM)	Communication speed 4.8Kbps – 921.6Kbps (9.6Kbps)*	Port1 – 4 provides [illegible] or Modbus RTU/ASCII or user defined communication protocol
	Maximum link stations	254	

(Continue)

Item					Specification	Note
Digital (Bit status)	X	Input contact (DI)			X0 – X255 (256)	Corresponding to external digital input
	Y	Output relay (DO)			Y0 – Y255 (256)	Corresponding to external digital output
	TR	Temporary relay			TR0 – TR39 (40)	
	M	Internal relay	Non-retentive		M0 – M799 (800)*	Can be configured as retentive type
					M1400 – M1911 (512)	
			Retentive		M800 – M1399 (600)*	Can be configured as non-retentive type
		Special relay			M1912 – M2001 (90)	
	S	Step relay	Non-retentive		S0 – S499 (500)*	S20 – S499 can be configured as retentive type
			Retentive		S500 – S999 (500)*	Can be configured as non-retentive type
	T	Timer "Time-Up" status contact			T0 – T255 (256)	
	C	Counter "Count-Up" status contact			C0 – C255 (256)	
Register (Word data)	TMR	Timer current value register	0.01S Time base		T0 – T49 (50)*	T0 – T255 numbers for each time base can be adjusted
			0.1S Time base		T50 – T199 (150)*	
			1S Time base		T200 – T255 (56)*	
	CTR	Counter current value register	16-bit	Retentive	C0 – C139 (140)*	Can be configured as non-retentive type
				Non-retentive	C140 – C199 (60)*	Can be configured as retentive type
			32-bit	Retentive	C200 – C239 (40)*	Can be configured as non-retentive type
				Non-retentive	C240 – C255 (16)*	Can be configured as retentive type
	HR DR	Data register	Retentive		R0 – R2999 (3000)*	Can be configured as non-retentive type
					D0 – D3999 (4000)	
			Non-retentive		R3000 – R3839 (840)*	Can be configured as retentive type
	HR ROR		Retentive		R5000 – R8071 (3072)*	When not configured as ROR, it can serve normal register (for read/write)
			Read only register		R5000 – R8071 can be set as ROR, default setting is 0*	ROR is stored in special ROR area and not occupy program space
			File register		F0 – F8191 (8192)	Must save/retrieved via special commands
	IR	Input register			R3840 – R3903 (64)	Corresponding to external numeric input
	OR	Output register			R3904 – R3967 (64)	Corresponding to external numeric output
	SR	Special system register			R3968 – R4167 (200), D4000 – D4095 (96)	Except R4152 – R4154
		0.1mS high speed timer register			R4152 – R4154 (3)	
		High speed counter register	Hardware (4 sets)		DR4096 – DR4110 (4x4)	
			Software (4 sets)		DR4112 – DR4126 (4x4)	
	XR	Index register			V, Z (2), P0 – P9 (10)	
Interrupt control		External interrupt control			32 interrupts (16 points input positive/negative edge)	
		Internal interrupt control			8 interrupts (1, 2, 3, 4, 5, 10, 50, 100mS)	
0.1mS high speed timer (HST)					1 (16-bit), 4 (32-bit, share with HHSC)	
High-speed counter (HSC)		Hardware high-speed counter (HHSC) /32-bit	No. of channel		Up to 4	- Total number of HHSC and SHSC is 8 HHSC can be converted into 32-bit 0.1mS time base High-Speed Timer (HST) - Half of maximum frequency while A/B input
			Counting mode		8 modes (U/D, U/D×2, P/R, P/R×2, A/B, A/B×2, A/B×3, A/B×4)	
			Counting frequency		Maximum is 200KHz (Single-end input) or 920KHz (differential input)	
		Software high-speed counter (SHSC) /32-bit	No. of channel		Up to 4	
			Counting mode		3 modes (U/D, P/R, A/B)	
			Counting frequency		Maximum sum up to 5KHz	
NC positioning pulse out (HSPSO)		Number of axis			Up to 4	Half of the maximum while A/B output
		Output frequency			Maximum is 200KHz (Single-end output) or 920KHz (differential output)	
		Pulse output mode			3 modes (U/D, P/R, A/B)	
		Programming method			Dedicated position language	
		Interpolation			Maximum 4 axis linear interpolation	
HSPWM output		Number of points			Up to 4	
		Output frequency			72Hz – 18.432KHz (with 0.1% resolution) 720Hz – 184.32KHz (with 1% resolution)	
Captured input			Points		Maximum 36 points (All input with interrupt function)	
			Minimum capturable Pulse width		≥10 μS (for ultra high speed / high speed input)	
					≥47 μS (for Medium speed input)	
					≥470 μS (for Medium low speed input)	
Digital filter			X0 – X15		Adjustable frequency 14KHz – 1.8MHz	Chosen by frequency at high frequency
					Adjustable time constant 0 – 1.5mS/0 – 15mS (with 0.1mS/1mS)	Chosen by time constant at low frequency
			X16 – X35		Time constant 1mS – 15mS adjustable (with 1mS)	

(Continued)

Category	NO.	Instruction	Derivation	Function
Move operation	8	MOV	DP	Move S to D
	9	[illegible]	DP	Inverse S and move to D
	40	[illegible]	DP	Move the bits of S to D
	41	[illegible]	DP	Move N bit inputs to the Bit N of D
	42	BTMV	DP	Move the bits of S to the bits of D
	43	NBMV	DP	Move the Nibble N of S to the Nibble N of D
	44	BYMV	DP	Move the Byte N of S to the Byte N of D
	45	XCHG	DP	Exchange D1 and D2
	46	SWAP	P	Swap the High Byte of D with the Low Byte of D
	47	UNIT	P	Take the 4 bits of N words to form a Word
	48	DIST	P	Divide the 16 bits of S to the 4 bits of N Words
	49	BUNIT	P	Low bytes of words re-unit
	50	BDIST	P	Words split into multi-byte
	160	[illegible]	DP	Fill register zone
	161	WR-MP		Write memory pack
	162	RD-MP	P	Read memory pack
Shift/ Rotation	6	BSHF	DP	Shift D right 1 bit or left 1 bit
	51	SHL	DP	Shift D left N bits
	52	SHR	DP	Shift D right N bits
	53	ROL	DP	Rotate D left N bits
	54	ROR	DP	Rotate D right N bits
Code conversion	26	→BCD	DP	Convert S into BCD
	27	→BIN	DP	Convert S into Binary
	55	B→G	DP	Binary to Gray code conversion
	56	G→B	DP	Gray code to Binary conversion
	57	DECOD	P	Decode the No.~N of S
	58	ENCOD	P	Encode the No.~N of S
	59	→7SG	P	Convert the 4 bits of S into 7-segment code
	60	→ASC	P	Convert character/number into ASCII code
	61	→SEC	P	Convert hour, minute, second to seconds
	62	→HMS	P	Convert seconds to hour, minute and second
	63	→HEX	P	Convert ASCII code into hexadecimal
	64	→ASCII	P	Convert hexadecimal into ASCII code
Flow control	0	MC		Master control loop start
	1	MCE		Master control loop end
	2	SKP		The start of the skip loop
	3	SKPE		The end of the skip loop
		END		Terminate the execution of program (for debugging)
	20	BREAK	P	Exit from FOR-NEXT loop
	65	LBL		Define the string as label
	66	JMP	P	Jump instruction
	67	CALL	P	Call instruction
	68	RTS		Subroutine return instruction
	69	RTI		Interrupt return instruction
	70	FOR		The start of the FOR loop
	71	NEXT		Return point of FOR loop
I/O instruction	74	IMDIO	P	Refresh I/O immediately
	75	TKEY	D	10 keys input convenient instruction
	77	HKEY	D	16 keys input convenient instruction
	78	DSW	D	Thumbwheel switch input convenient instruction
	79	7SGDC	D	7-segment multiplexing display convenient instruction

Category	NO.	Instruction	Derivation	Function
I/O instruction	80	[illegible]		Multiplexing input convenient instruction
	81	[illegible]	D	Pulse output (PTO) instruction
	82	PWM		Pulse Width Modulation (PWM) output instruction
	83	SPD		Pulse speed detection instruction
	84	[illegible]		7/16 segment LED display control
	86	[illegible]		PID temperature control
	138	HPWM		Hardware PWM pulse output
Accumulative Timer	87	[illegible]		0.01 s time base accumulation timer
	88	[illegible]		0.1 s time base accumulation timer
	89	[illegible]		1 s time base accumulation timer
Monitor and control	90	WDT	P	Set watchdog timer
	91	RWDT	P	Reset watchdog timer
HSC/ HST	92	HSCRD		Read CV of hardware high speed counter/timer
	93	HSCWR		Write CV or PV of hardware high speed counter/timer
Text	94	ASCWR		Output ASCII message
Ascend/ Descend	95	RAMP		Ascending/Descending convenient instruction
Communication	100	[illegible]		Modbus protocol communication
	101	[illegible]		Read CPU link/Generic protocol communication
Table operation	100	R→T	DP	Move register Rs to the table Td
	101	T→R	DP	Move the Rs of table Ts to register Rd
	102	T→T	DP	Move the Rs of table Ts to the Rd of table Td
	103	BT_M	DP	Move table Ts to table Td
	104	T_SWP	DP	Swap Ts and Td
	105	R_T_S	DP	Search Rs from table Ts
	106	T_T_C	DP	Compare table Ts and table Td
	107	T_FIL	DP	Fill Rs into Td table
	108	T_SHF	DP	Shift table left or right
	109	T_ROT	DP	Rotate table left or right
	110	QUEUE	DP	First in first out (Queue) instruction
	111	STACK	DP	First in last out (Stack) instruction
	112	[illegible]	DP	Compare Rs with each datum of two tables
	113	SORT	DP	Sort the table
Matrix operation	120	MAND	P	AND two matrices
	121	MOR	P	OR two matrices
	122	MXOR	P	Exclusive OR (XOR) two matrices
	123	MXNR	P	Exclusive NOR (XNOR) two matrices
	124	MINV	P	Inverse matrix
	125	MCMP	P	Compare two matrices and find out the differences between two matrices
	126	MBRD	P	Read the bit of a matrix pointed by pointer
	127	MBWR	P	Write the bit of a matrix pointed by pointer
	128	MBSHF	P	Shift matrix left 1 bit or right 1 bit
	129	MBROT	P	Rotate matrix left 1 bit or right 1 bit
	130	MBCNT	P	Count the number of bits whose value is 1 or 0 in the matrix
NC position control	140	HSPO		Hardware NC high speed pulse output
	141	[illegible]		Set NC position parameters
	142	[illegible]	P	[illegible]
	143	PCNV	P	Convert pulse count into mechanical value for display
	147	MHSPO		Multi-Axis high speed pulse output
Interrupt control	145	EI	P	Enable external input or peripheral interrupt
	146	DI	P	Disable external input or peripheral interrupt

Appendix 'C' {Touch Screen }

MT500

Touch Screen for Industrial Applications
The EasyView 500 series touch screen is the result of our continuous efforts to prefect our PLC touch screen products.

Our accumulated knowledge in touch screen design has enabled us to produce these state-of-art touch screen, bringing out the PLC's full potential, and improving production line efficiency.

Power by 32-bit RISC Proccessor
Touch the screen and feel the power of the fastest RISC proccessor used in any touch screen on market. The EasyView 500 offers high performance features for the industrial environment. Even the most complicated graphics can be called up in a snap.

Connect Directly to Most of the PLC on Market
The EasyView 500 supports direct communication with most PLCs. It is not necessary for the PLC to run any special programs for data communication. The available PLC drivers include: AB, SIEMENS, OMRON, MITSUBISHI, KOYO, MODICON, GE FANUC, IDEC, TELEMECANIQUE etc...

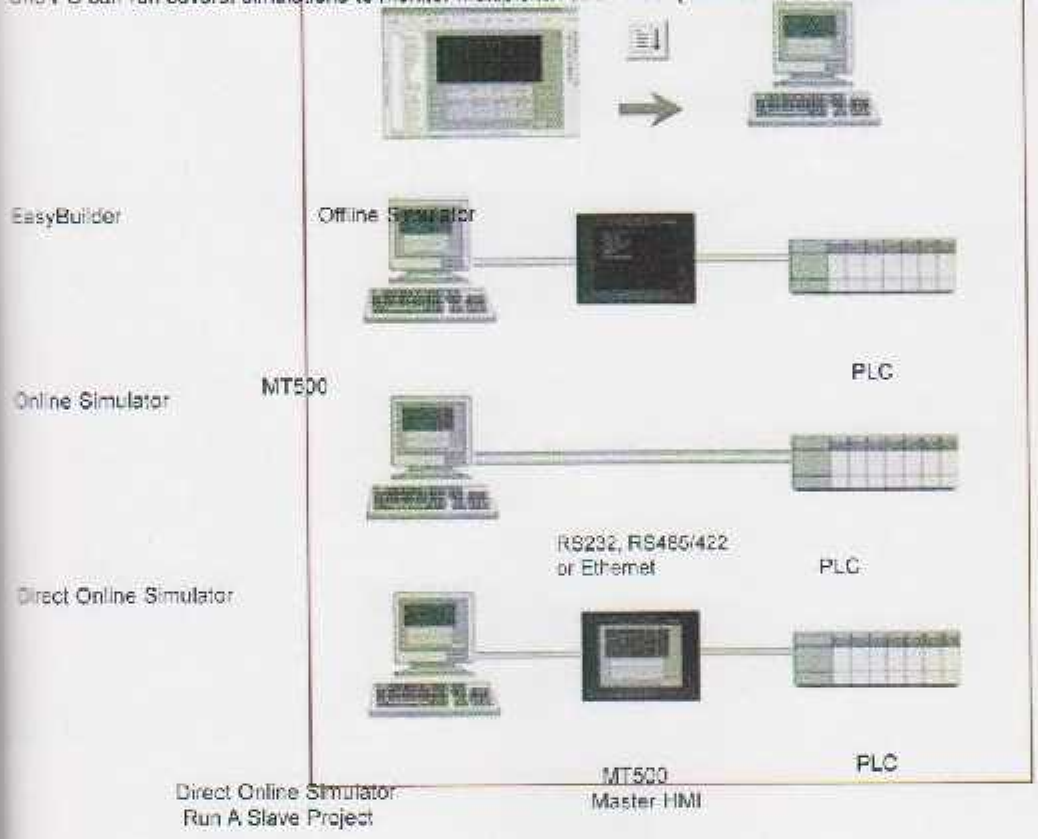
Power Simulator

Offline Simulator
Simulate the MT500 HMI operation on PC without MT500 HMI and PLC.

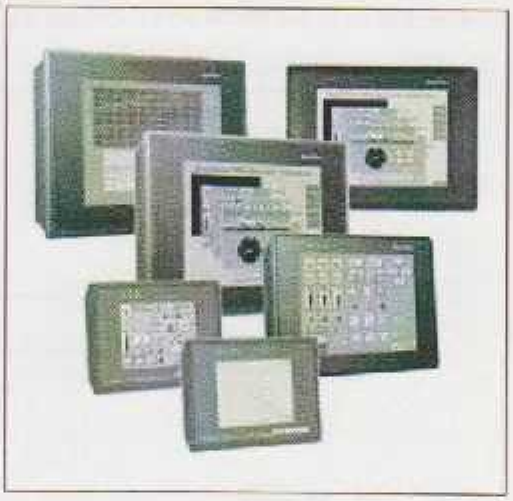
Online Simulator
Simulate the MT500 operation on PC with both MT500 HMI and PLC.
The Simulation will retrieve the data from PLC through MT500 HMI and simulate MT500 operation.

Direct Online Simulator
Simulate the MT500 operation on PC only with PLC. The Simulation will directly retrieve the data from PLC. (There is a time limit of 10 minutes limit for the simulation.)

Direct Online Simulation Of Running A Slave Project
The Slave Simulation will retrieve the data from Master MT500 HMI.
One PC can run several simulations to monitor multiple MT500 HMI's. (There is no time limit for the simulation.)



TOUCH SCREEN [illegible] INDUSTRIAL APPLICATION [illegible]



TOUCH SCREEN FOR INDUSTRIAL APPLICATION MT500

ultiple Touch Screen

?e MT 500 now is able to support master - slave communication feature for every PLC it supports. All the MT500 are connected one by ?e and the first one connects with the PLC.

ist of Parts

upport Portrait Display Mode

?ange the screen direction to vertical display and fit the control panel space

?gh Reliable Touch Panel
?e EasyView 500 is equipped with touch panel of industrial grade. The highly ?able and rugged touch panel is critical for long term reliable operation.

?gh contrast and high brightness LCD display offers 256 colors
?e high-quality color displays offer superior clarity and wide viewing angles. Both ?N and TFT are available. The EasyView 500 ?ers high reliability as all the components have been carefully selected to fulfill the ?quirements of the modem industrial environment.

?acro
?acro function provides a special feature that enables you to create a program to ?ecute function.
?acro Function is a Basic-like language.

?ulti-Language
?ery project can select one single-byte font (English and European languages) and ?e double-bytes font (Simplified Chinese, Traditional Chinese, Korean and Japanese ? use Windows fonts). You can develop an application in 4 different languages.

?g
?e Tag defines the device address where the HMI reads or writes data for the ?ject. The Tag Library is to provide easy reference tags name and device address.

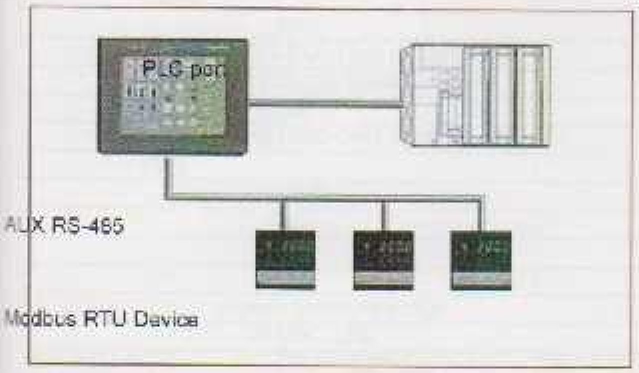
E4 Series Features

Modbus TCP / IP

Support Modbus TCP / IP Device Connect

Dual Port Driver Support

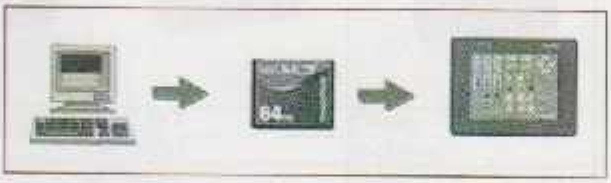
The AUX port (RS232 / RS485 2 wires) can select second device driver.
Communicate to Temperature Controller, Inverter and Distributed I/O.



Master / Slave TCP / IP Link

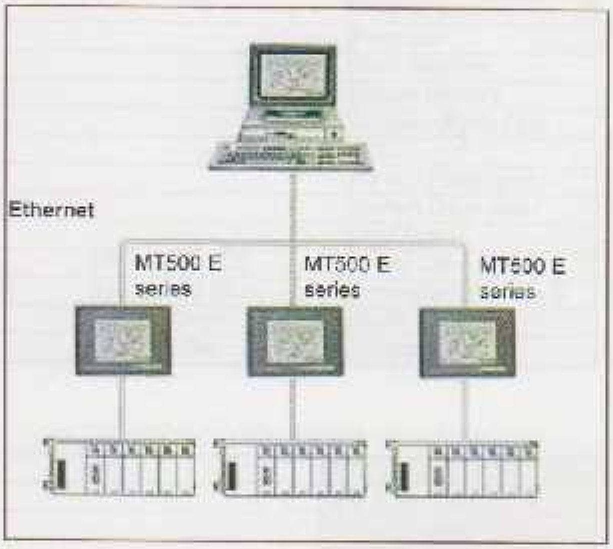
Project Down Through Compact Flash Card

About CF Card download, MT5xxE4 Series provide a CF Card socket. You can download your project onto multiple HMI's just through CF Card and do not need PC. The process is very easy and fast, and it is efficient for you to upgrade the project of a remote HMI just by the transfer of a CF Card.



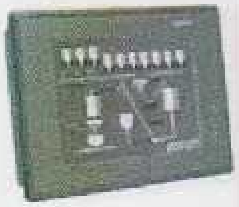
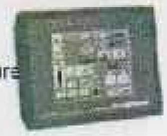
MT500 Master / Slave OPC Server (Option)

MT500 Master / Slave OPC Server software provides PLC data to supervisory control and data acquisition (SCADA) systems via Ethernet. MT500 Master / Slave OPC server supports all of the PLC drivers that are available for the MT500 Series HMIs.



TOUCH SCREEN FOR INDUSTRIAL APPLICATION MT500

Model

MT506SE	MT506TE	MT508SE	MT510TE	Model
				Picture 
5.7" STN	5.7" TFT	7.7" DSTN	10.4" TFT	Display
150 cd/m²	300 cd/m²	150 cd/m²	400 cd/m²	Brightness
256 color	256 color	256 color	256 color	Color
30:1	60:1	30:1	300:1	Contrast Ratio
320 x 240	320 x 240	640 x 480	640 x 480	Resolution (W x H)
CCFL x 1	CCFL x 1	CCFL x 2	CCFL x 2	Back Light
40,000 hr.	50,000 hr.	40,000 hr.	50,000 hr.	CCFL life time (avg.)
4 wire resistive type				Touch Panel
1.5mm		2mm		Touch Accuracy
4H				Surface Hardness
PC (RS-232), PLC (RS232/485)				Serial Interface
AUX (RS-232/RS485 2 wires)				AUX port
Yes				Ethernet port
32 bit RISC CPU 200MHz				Processor
2MB		4MB		Flash Memory
128KB				Recipe Memory
Yes				Compact Flash Card
Yes				RTC
N/A		Yes		Parallel Printer port
Power failure detection				System Diagnostic
24 VDC ±5%				Input Power
220mA@24VDC	370mA@24VDC	380mA@24VDC	430mA@24VDC	Power Consumption
204 x 150 x 48mm	204 x 150 x 48mm	231 x 176 x 55mm	315 x 238 x 62mm	Dimensions W x H x D
192 x 138mm	192 x 138mm	222 x 167mm	302 x 225mm	Panel Cutout
Approx 0.84kg	Approx 0.84kg	Approx 1.2kg	Approx 2.0kg	Weight

General Specification

Complies with EN50081-2 and EN50082-2 standards	CE
Complies with FCC Class A	FCC
500 VAC (1min.)	Voltage resistance
Exceed 50MW at 500 VDC	Isolation resistance
10 to 25Hz (X, Y, Z direction 2G 30 minutes)	Vibration endurance
IP65 front panel (O ring seal)	Protection structure
-20~60°C	Storage Temperature
0~45°C	Operating Temperature
10~90%RH (non-condense)	Operation Humidity
Plastic	Enclosure

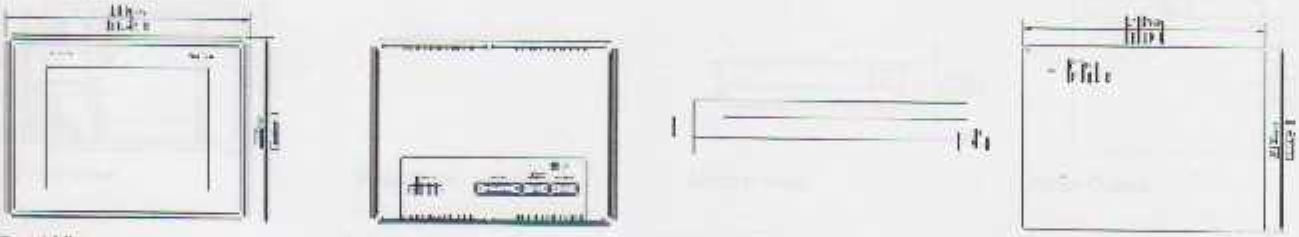
Touch Screen

TOUCH SCREEN FOR INDUSTRIAL APPLICATION MT500

Model

MT509M	MT510L	MT510T	Model
			 Picture
9.4" Gray	10.4" Gray	10.4" TFT	Display
110 cd/m²	100 cd/m²	400 cd/m²	Brightness
4 gray scale	4 gray scale	256 color	Color
20:1	18:1	300:1	Contrast Ratio
640 x 480	640 x 480	640 x 480	Resolution (W x H)
CCFL x 1	CCFL x 1	CCFL x 2	Back Light
50,000 hr.	50,000 hr.	50,000 hr.	CCFL life time (avg.)
4 wire resistive type			Touch Panel
2mm			Touch Accuracy
4H			Surface Hardness
PC (RS-232), PLC (RS232/485)			Serial Interface
N/A			AUX port
N/A			Ethernet port
32 bit RISC CPU 200MHz			Proccesor
2MB			Flash Memory
128KB			Recipe Memory
N/A			Compact Flash Card
Yes			RTC
Yes			Parallel Printer port
Power failure detection			System Diagnostic
24 VDC ±5%			Input Power
240mA@24VDC	250mA@24VDC	430mA@24VDC	Power Consumption
290 x 220 x 43mm	315 x 238 x 62mm	315 x 238 x 62mm	Dimensions W x H x D
282 x 213mm	302 x 225mm	302 x 225mm	Panel Cutout
Approx 1.4kg	Approx 2.0kg	Approx 2.0kg	Weight

MT-509



Front View Rear View Bottom View Panel Cutout

MT-510

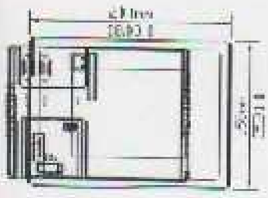
Front View Rear View Bottom View Panel Cutout

TOUCH SCREEN FOR INDUSTRIAL APPLICATION MT500

Models

MT506L	MT506S	MT506T	MT508S	Model
				Picture 
5.7" BLUE	5.7" STN	5.7" TFT	7.7" DSTN	Display
60 cd/m²	150 cd/m²	300 cd/m²	150 cd/m²	Brightness
4 gray scale	256 color	256 color	256 color	Color
15:1	30:1	60:1	30:1	Contrast Ratio
320 x 240	320 x 240	320 x 240	640 x 480	Resolution (W x H)
CCFL x 1	CCFL x 1	CCFL x 1	CCFL x 2	Back Light
50,000 hr.	40,000 hr.	50,000 hr.	40,000 hr.	CCFL life time (avg.)
4 wire resistive type				Touch Panel
1.5mm			2mm	Touch Accuracy
4H				Surface Hardness
PC (RS-232), PLC (RS232/485)				Serial Interface
N/A				AUX port
N/A				Ethernet port
32 bit RISC CPU 200MHz				Processor
2MB				Flash Memory
128KB				Recipe Memory
N/A				Compact Flash Card
Yes				RTC
N/A			Yes	Parallel Printer port
Power failure detection				System Diagnostic
24 VDC ±5%				Input Power
370mA@24VDC	370mA@24VDC	370mA@24VDC	380mA@24VDC	Power Consumption
204 x 150 x 48mm	204 x 150 x 48mm	204 x 150 x 48mm	231 x 176 x 55mm	Dimensions W x H x D
192 x 138mm	192 x 138mm	192 x 138mm	222 x 167mm	Panel Cutout
Approx 0.84kg	Approx 0.84kg	Approx 0.84kg	Approx 1.2kg	Weight

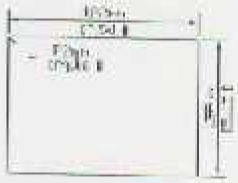
MT-506



Front View

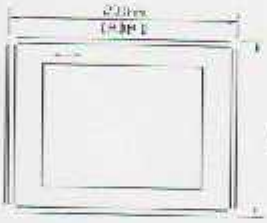
Rear View

Bottom View

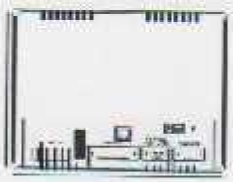


Panel Cutout

MT-508

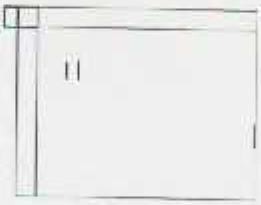


Front View



Rear View

Bottom View



Panel Cutout

References

[1] http://www.[illegible]

[2] http://[illegible]

[3] Daniel Kandray, Programmable Automation Technologies, Industrial Press 2010 ISBN [illegible], Chapter 8 Introduction to Programmable Logic Controllers

[4] M.A. Laughton, D. J. Warne (ed), Electrical Engineer's Reference book, 16th edition, Newnes, 2003 Chapter 16 Programmable Controller

[5] Behringer, R. "[illegible] Touch Screens as a means of [illegible] Different Screens" (2005).

[6] http://[illegible] Advantages of [illegible]

[7] [illegible], M., [illegible], [illegible], "[illegible] with [illegible]", Romanian Review Precision Mechanics and Mechatronics, 2011.

[8] [illegible] "[illegible] Manual", Polytechnic School [illegible] 2002.

[9] http://www.[illegible]

[10] http://www.[illegible]

[11] http://www.[illegible]

[12] [illegible] Touch [illegible] 2011.

[13] Fraden Jacob, Handbook of modern sensors: Physics, Designs, and Applications Third Edition, 2004 chapter 3.

[14] Fraden Jacob, Handbook of modern sensors: Physics, Designs, and Applications Third Edition, 2004 chapter 7.

[15] Mason, C. R. "Art of Science of Protective Relaying" Third Edition [illegible], Chapter [illegible]

[16] http://www.[illegible]

[17] http://www.[illegible]

[1] http://amr-poma.blogspot.com/2012_05_01_archive.html.

[2] http://s932.beta.photobucket.com/user/selectautomation1/media/PLC/

[3] Daniel Kandray, Programmable Automation Technologies, Industrial Press, 2010 ISBN 978-0-8311-3346-7, Chapter 8 Introduction to Programmable Logic Controllers

[4] M. A. Laughton, D. J. Warne (ed), Electrical Engineer's Reference book, 16th edition, Newnes, 2003 Chapter 16 Programmable Controller

[5]Holzinger, A. "Finger Instead of Mouse: Touch Screens as a means of enhancing Universal Access" (2003).

[6] http://www.concretemachinery.net/Big Six Advantages of QT Block Machine

[7] Avram, M., Panaitopol, H., Grămescu, B.,"Pneumatic circuit with programmer", Romanian Review for Precision Mechanics and Mechatronics, 2001.

[8] E.Nelli Silva," Fluid-mechanics systems Manual", Polytechnic School USP 2002.

[9] http://www.resources.hkedcity.net/res_files/2011/ Pneumatic Systems.

[10]. http://www.festo-didactic.com/_media/gallery_p_fa_009_280.jpg.

[11]http://www.resources.hkedcity.net/res_files/201101/20110128101153_25903 7, Pneumatic Systems.

[12] Peter Croser ,Frank Eble, Pneumatics Basic Level,Festo Didactic GmbH & Co,73770 Denkendorf 2002.

[13] Fraden ,Jacob, Handbook of modern sensor, physics, Design ,and Pllication ,Third Edition,2004 chapter 5.

[14] Fraden ,Jacob, Handbook of modern sensor, physics, Design ,and Pllication ,Third Edition,2004 chapter 7.

[15] Mason, C. R. "Art & Science of Protective Relaying" Third Edition 2003, Chapter 2

[16] http://www.mcuexamples.com/PIC-Relay.php

[17] http://www.eriez.com/Products/Index/Vibratory feeders and conveyors

[18] Christopher Shelton, *Electrical installations third edition*, Nelson Thornes,2004 ISBN 0-7487-7979-5

[19] http:// www.cndixsen.com // Products / EARTH LEAKAGE CIRCUIT BREAKER / earth leakage circuit breaker (CDSL6 Series)

[20] http://www.arab-eng.org/vb/t225632.html

[21] http://www.oilybits.com/images/uploads/ ELECTRICL _STOP_SWITCH.jpg

[22] Peter Croser ,Frank Eble, Pneumatics Basic Level,Festo Didactic GmbH & Co,73770 Denkendorf 2002.