Palestine Polytechnic University

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Electrical Engineering Department

Title

Coins Operated Pizza Vending Machine

Project Team

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Abstract:

Pizza is the fastest food ordered and Due to the small number of pizza restaurants and Most people don't know how make it and the high demand on it by people. So, we decided to design and implement an automatic machine with dimensions (3m long,1.5m width) , make to produce pizza with high quality without waiting in markets.

The prototype contains a six main parts: Coins Detector, Refrigerator ,sauce distribution, Cheese distribution ,Vegetable distribution and Baking stage, with experiments as follows. is Activated the Coins Detector by pay 5 (₪), then the dough piece from the conveyor belt inside the refrigerator is download to the main conveyor belt , and adding the materials (sauce, vegetables and cheese) to the dough piece, , and finally the entry the piece pizza into the oven For 10 minutes . Already A Pizza has been produced.

The advantages of using this machine are for save the man power, money and time, this machine is located in public places.

الملخص

البيتزا هي من أسرع الأطعمة التي يتم طلبها في الأسواق وبسبب قلة عدد مطاعم البيتزا و معظم الناس لا يعرفون كيف يصنعها والطلب الكبير عليها من قبل الناس . لذلك ، قررنا تصميم وتنفيذ ماكينة أوتوماتيكية بأبعاد (3 م طولاً ، 1.5 م عرض) لإنتاج البيتزا بجودة عالية دون الانتظار في الأسواق .

يحتوي النموذج الأولي الذي تم تصنيعه على ستة أجزاء رئيسية: كاشف العملات ، ثلاجة , توزيع الصلصة , توزيع خضروات ، توزيع جبنة وفرن. تم إجراء التجارب على النحو التالي ، يتم تفعيل كاشف العملات بواسطة قطعة معدنية من صنف 5 شيكل ، ثم يتم أنزال قطعة العجينة من السير الناقل الذي بداخل الثلاجة الى السير الناقل الرئيسي ، وبعدها يتم أضافة الصلصة ، الخضروات و الجبنة ، واخيرا يتم دخول قطعة البيتزا الى الفرن لمدة 10 دقائق وبعدها ينتج لنا قطعة بيتزا جاهزة للأكل ، بالفعل تم إنتاج بيتزا .

مزايا أستخدام هذه الماكينة هي لتوفير الطاقة البشرية (الأيدي العاملة) والمال والوقت ، ويقع هذا الجهاز في الأماكن العامة .

إهداء

إلى المعلم الاول ... الحبيب المصطفى صلى الله عليه وسلم ... إلى القلب الحنون التي كانت بجانبي بكل المراحل التي مضت ... من تلذذت بالمعاناة وكانت شمعة تحترق لتنير دربي ... إلى أمهاتنا الحبيبات.. إلى من علمني أن اقف وكيف ابدأ الالف ميل بخطوة .. إلى يدي اليمنى .. إلى من علمني الصعود وعيناه ترقباني ... إلى آبائنا الأجلاء .. إلى من رووني من ينابيع الفضيلة .. إلى الذين أخذو بيدي إلى منهل المعرفة وأظلوني بشجرة الإيمان ... إلى أهلنا الأعزاء.. إلى من أمسك بيدي وعلمني حرفا .. إلى من كانوا سندا لي ..

الى من لهم الفضل بإرشادي إلى طريق العلم والمعرفة ..

إلى الدكتور الفاضل رائد عمرو.

إلى كل محبي المعرفة.

إلى من ضاقت السطور عن ذكرهم فوسعهم قلبي ... إلى أصدقائنا الأوفياء .

إلى من ضحوا بحرياتهم من أجل حرية غيرهم ... إلى أسرانا البواسل.

إلى من هم أكرم منا ... إلى شهدائنا الأبرار.

ولن أنسى هذا المكان الذي جمعني بمقاعده وأبوابه حتى فنائه .. إلى كل جزء .. إلى جامعة بوليتكنك فلسطين إلى من احتضنتني طوال هذه الأعوام ... إلى فلسطين الحبيبة ..

نهدي علمنا هذا ..

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1.1 Introduction

The main aim of the project is to design, develop and implement automatic Pizza Machine which helps to have Pizza easier and without waiting in markets. The advantages of using this machine are for save the man power, money and time.

The Pizza machine will help to save money up to 30%, increases productivity approximate 3 times.

- **Types of Pizza**

1. **Vegetable Pizza**: It is the most Pizza demand, its component from a sauce under a layer of Vegetables mix and special type of chees.
2. **Meat Pizza**: this type of pizza can made by add a chopped meat and some sauce under the chees layer.
3. **Sausage Pizza:** Many people prefer this type of pizza, its component from a sauce, pieces of sausage and special type of cheese.
4. **Cheese Pizza**: This type of pizza is characterized by the amount of large of cheese used in the preparation, its component from a sauce and special type of cheese.

Notes: We will work to produce the first type of types of pizza **(Vegetable Pizza)** and the size of the pizza produced is 15 cm, because of the lack of possibilities, money and time.

1.2 Problem Statement

Due to the small number of pizza restaurants and the lot demand on it by people, and the pizza needs a great time in processing in restaurants compared to this machine.

1.3 Recognition of Need

Notice that, the local market needs the machines product fast food such as pizza for save money and time.

- High specifications for local product.
- A good price for local market.
- A Mechanical electrical system without using a human hand.
- Support the national economy.

1.4 Objectives

The actual targets of this research were set as follows:

- Design and implementation of a control system for the automatic pizza machine.
- Make machine structure simple.
- Produce more than a piece of dough at the same time.
- Produce a multi types of pizza on the same line.
- Design a prototype for machine.

1.5 Methodology

- Study the machine in the global market and compare it to the cost of producing a machine here in Palestine.
- Create a model using computer.
- Simulate the project and get the outcomes.
- Create a real model and producing pizza.

1.6 Time Schedule

The following time table shows the project work divided in fifteen weeks of the as following.

Table 1.6.1: Time Schedule

Tasks/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Selecting project title															
Collection data and information on the subject of the project															
Identify function and task															
Design and analysis															
Documentation															

1.7 Budget

Table (1.2) shows the total work of the machine for 5 hours

Table 1.7.2: The total profit

Tools and devices	Items	Item price (₪)	Total price (₪)
Pizza materials	-	-	-60
Pizza Box	60	0.5/1	-30
Power consumption	3.743KW/h	0.59	-0.4
Refrigerator	24KW/day	0.59	-14.16
Additional costs (machines, workers, Electricity…)	-	-	-20
Product sale	60	5	+300
Total profit			**151 ₪**

Table (1.7.3) shows the total cost of project:

Table 1.7.3: The total cost

Tools and devices	**Items**	**Item price (₪)**	**Total price (₪)**
Stainless steel	**-**	**-**	**1000**
PLC	**-**	**-**	**500**
Motor	**2**	**250**	**500**
Power Supply	**1**	**220**	**220**
Cooling system	**-**	**-**	**800**
Pneumatic piston	**3**	**50**	**150**
Sensors	**9**	**-**	**200**
HMI Screen	**1**	**1500**	**1500**
converse	**2**	**-**	**3000**
Heater	**5**	**15**	**75**
Electrical wires	**70m**	**2/meter**	**140**
Coins Detector	**-**	**-**	**150**
Industrial cost	**-**	**-**	**2500**
Protection Devise	**-**	**-**	**700**
Total cost			**11500**

1.9 Conclusions

This project will solve many problems such as save the man power, money and time … etc. After studying the budget, this project will generate good profits and Support the national economy.

2

Chapter 2: Mechanical Components

1. **Introduction.**
2. **Machine Parts.**

2.1 Introduction

This chapter, will shows the general view of Pizza machine in a fully automated system programmed with PLC, which allow to control the system operation.

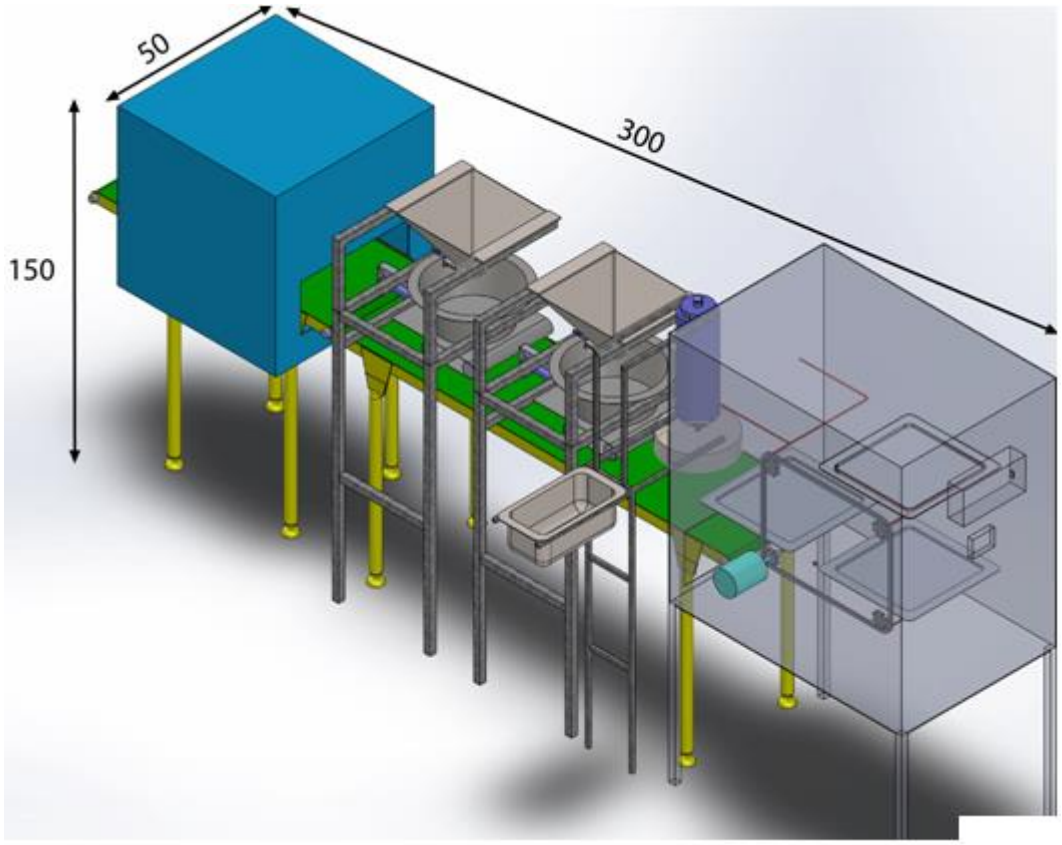


Figure (2.1): Coins operated pizza vending machine

Notes: Determine the true dimensions of the machine L=300 cm, W=50 cm and H=150 cm.

2.2 Machine parts

The proposed machine consists the following Modules:

2.2.1 Order

The machine produces two different types of Pizza, but we decide to limited it for a one type (Vegetable Pizza) , and to select the order we use the **HMI PLC**. The price for one piece of Vegetable Pizza is 5₪ , We are forced to use one type of coins which is

5₪, the consumer has a free choice to use single conins of type 5₪ or to use a conis of type 5₪ twiced.

Key word: ₪ the shekel symbol.

Notes: We will work to produce the first type of types of pizza **(Vegetable Pizza)** because of the lack of possibilities, money and time.

2.2.2 Refrigerator

The rate of keeping pizza paste at a temperature of 5 Celsius is about 8 hours, the pizza pastes wil be holding on a Conveyor belt and another conveyor holding this pizza paste inside the cooler.

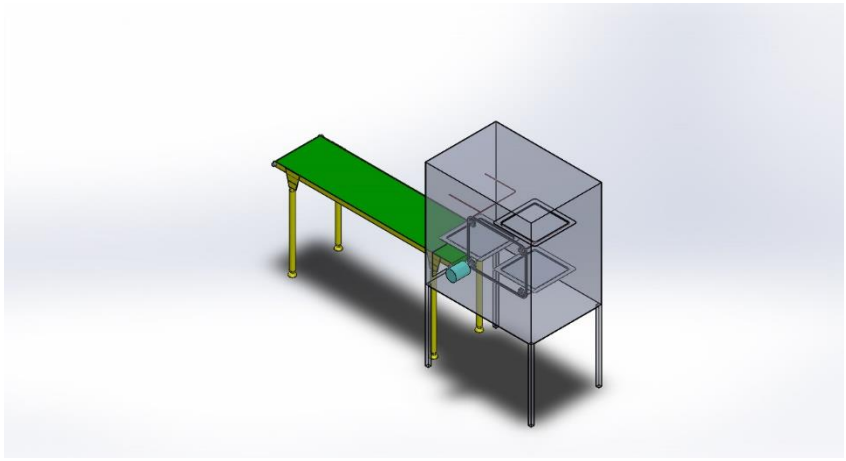


Figure (2.2): Refrigerator.

2.2.3 The sauce distribution

An electrical switch controlled the status of a valve to distribute the sauce on pizza paste, when the inductive sensor is ON.

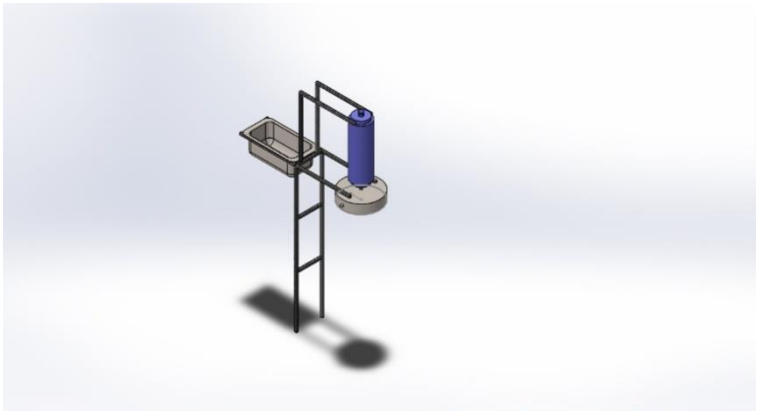


Figure (2.3) sauce distribution.

2.2.4 Cheese distribution

Operation process to distribute cheese on pizza paste:

- A motor mixed the cheese continuously to maintain its smoothness.
- When the pizza paste reached to the inductive sensor a valve open to put a quantity of cheese on a slider bar.
- This slider bar will be fit with pizza paste on Conveyor belt to distribute the cheese.

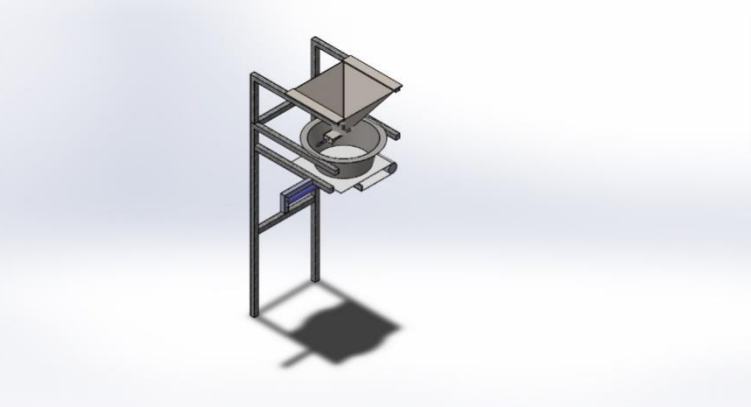


Figure (2.4): cheese distribution.

2.2.5 Vegetable distribution

- When the pizza paste reaches the inductive sensor a valve open to put a quantity of Vegetable on the slider bar.
- This slider bar also fit with the pizza paste on Conveyor belt, to distribute the Vegetable.

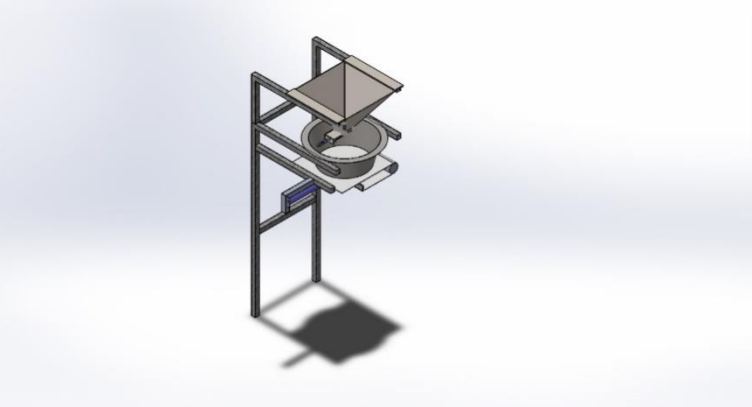


Figure (2.5): Vegetable distribution.

2.2.6 Baking stage

When the first confirmation signal arrives from the coin's detectors here, we start the baking stage, where the oven fired Until we get a suitable temperature for the body and the surface of this oven and we must prepare this condition before we start baking.

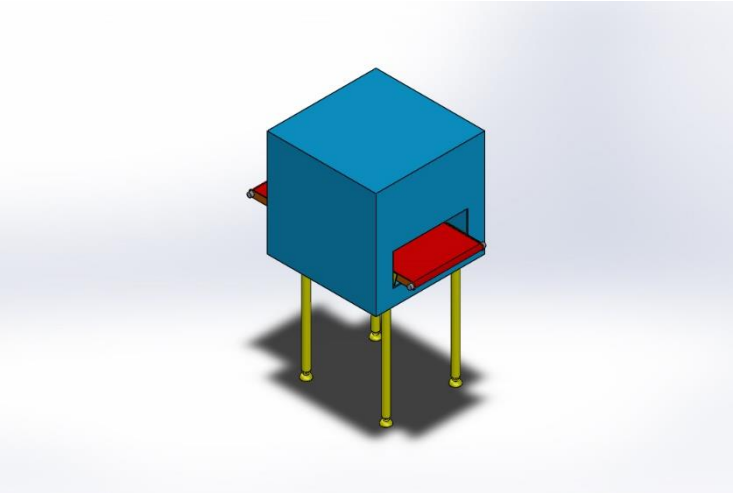


Figure (2.6): Oven.

2.2.7 Sterilization

At this stage the machine stops completely after midnight for 15 minutes, to sterilize.

The sterilization mechanism has three stages:

1. In the first stage, the conveyor belt is sprayed with sterile material for 5 minutes by a pneumatic spray.
2. After 5 minutes of sterilization, the conveyor belt is washed with fresh water for another 5 minutes.
3. After washing is dried by pumping air.

2.2.8 Conveyors

We have two conveyor belts are made of the same type.

Roller chain is the type of chain drive most commonly used for transmission of mechanical power on many kinds of domestic, industrial and agricultural machinery, including conveyors, wire- and tube-drawing machines, printing presses, cars, motorcycles, and bicycles. It consists of a series of short cylindrical rollers held together by side links. It is driven by a toothed wheel called a sprocket. It is a simple, reliable, and efficient means of power transmission. As shown Figures

Figure (2.7): Roller chain.

Figure (2.8): sprocket

3

Chapter 3: Mechanical Design

3.1 Pneumatic system.

3.2 Refrigerator conveyor motor.

3.1 Pneumatic system.

A pneumatic system is a system that uses compressed air to transmit and control energy.

The advantages of pneumatic systems:

Pneumatic control systems are widely used in our society, especially in the industrial sectors for the driving of automatic machines. Pneumatic systems have a lot of advantages:

- High efficiency
- Simple design
- Safety
- Easy selection of speed and pressure

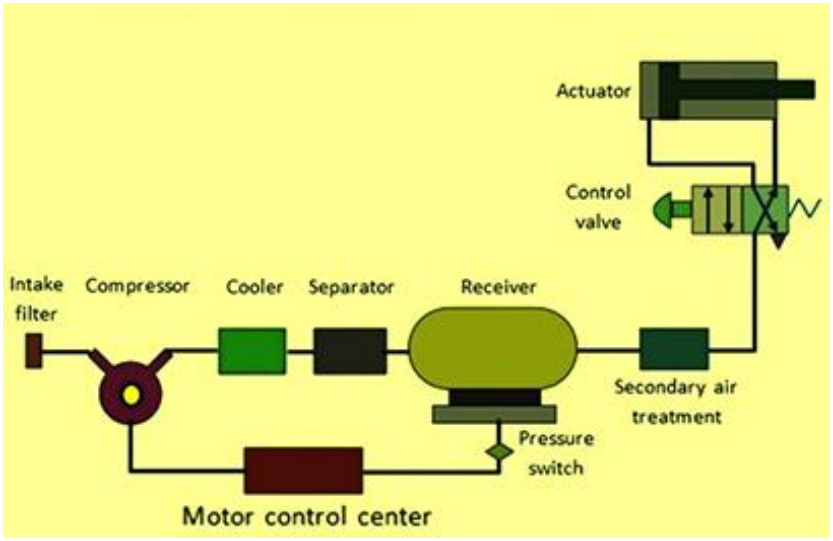


Figure (3.1): pneumatic system.

All main pneumatic components can be represented by simple pneumatic symbols. Each symbol shows only the function of the component it represents, but not its structure. Pneumatic symbols can be combined to form pneumatic diagrams. A pneumatic diagram describes the relations between each pneumatic component.

Cylinder calculation

The diminution of flexing piston is calculated by the following equations:

$$F=P*A \quad \text{Equation 1}$$

Where

- F: force(N).
- P: pressure(bar)=0.5N/ mm^2.
- A: cross section area of the piston rod.

According to newton second low, the force can be calculated by the following equations:

$$F=M*G \quad \text{Equation 2}$$

Where

- M: mass of prism (kg).
- G: Acceleration of gravity (m/ s^2).

Mass of object can be calculated by the following equation:

$$M=P*V \quad \text{Equation 3}$$

Where

- p: Aluminum density =2700 Kg\m^2
- V: volume of pec

The volume of pec can be calculated by the following equation:

$$V=x*y*z \quad \text{Equation 4}$$

$$=0.00004\ m^2$$

$$M=p*v \quad \text{Equation 5}$$

$$=2700*00004$$

$$=0.108kg$$

$$F=m*g \quad \text{Equation 6}$$

$$=0.108*9.8$$

$$=1.058\ N$$

$$A=\frac{f}{p}=\frac{1.058N}{0.5}=2.1mm^2 \quad \text{Equation 7}$$

The piston diameter can be calculated by the following equation:

$$A=\frac{\pi}{4}*d^2 \quad \text{Equation 8}$$

$$d=\frac{A*U}{\pi}=2.69mm$$

The volume of pec can be calculated by the following equation:

$$V=\frac{\pi}{4}*d^2*h \quad \text{Equation 9}$$

$$=568.03\ mm^3$$

Where

- h: length of pec =10 cm.
- d: diameter.

3.2 Refrigerator conveyor motor

calculating the torque of refrigerator motor:

$$T_L = \frac{(\mu F_A + mg)D}{2i} \qquad \text{Equation 10}$$

$$= \frac{(0 + 9 * 9.8) * 0.05}{2 * 1} = 2.205\ N/m$$

Where

- μ : Fraction coefficient.
- Fa : External Force.
- M : total mass of the table and load.
- G : Gravitational acceleration.
- I : gear ration.

Appendix, Table A.2: Data sheet for motor refrigerator.

Appendix, Figure 1: Motor torque sheet calculation.

Appendix, Figure 2: Refrigerator motor diminution

We select a motor that have torque range between 20 – 30 (Kg.cm)

Figure (3.2): Refrigerator conveyor motor.

4

Chapter 4: Electrical Design

4.1 Introduction.
4.2 Calculation Of Protection.
4.3 Protection.
4.4 Control element.
4.5 Accessories.
4.6 State graph.
4.7 Pneumatic circuit.

4.1 Introduction

This chapter contains the electrical component specifications (motor, sensor, overload, etc.), power and control circuit which will be used in our project.

4.2 Calculation Of Protection.

Table (4.2.1) shows the Calculation Of Protection.

	Power (W)	Power Factor (PF)	Current (A)	Rated Current (A)	We Choose C.B of C Type and Fuse
DC Motor Of Refrigerator conveyor	8.6	-	0.7	-	-
DC Pump Of Sauce	8.6	-	0.7	-	-
AC Motor of Main conveyor	180	0.66	1.2	1.5	2 A F
Heater	4*700	-	12.72	15.9	16A C.B
Compressor	746	-	3.39	4.2	6A C.B

- Current (A) = $\frac{Power}{Voltage \times PF}$ Equation 11

- Rated Current (A) = Current × Safety Current Equation 12

Safety Current=1.25 .

Main Circuit Breaker = 25 A Type of C

Residual Current Device = 25 A 30 m.

4.3 Protection

Circuit breaker

A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by excess current.

There are type of circuit breakers, circuit breaker one phase for control circuit as shown in figure (4.1).

Figure (4.3.1): circuit breaker.

Fuses

A fuse is the simplest Over Current Protection device (OCPD) in electrical circuits, yet it is very important. A fuse is a two-terminal device which is placed in series with the circuit it is supposed to protect. It performs its function by melting itself out when the current tries to exceed the specified level, thus breaking the circuit open. Once operated (fused) it must be replaced. Replacing is not a problem because fuses are relatively inexpensive.

Figure (4.3.2): The Fuses.

Earthing system

Earthing can be defined as an electrical connection, intentionally made between an electrical device or a network of devices on the one hand, and the Earth's mass. So grounding is required to provide safety for the electrical system and for customers.

Note: The grounding is done by a number of grounding electrode**.**

Figure (4.3.3) grounding electrode.

4.4 Control element

Switches

The start pushbutton switch is used to turn on the process.

The emergence switch is used to stop the machine immediately when something wrong happened with the machine.

Figure (4.4.1): start pushbutton.

Figure (4.4.2): Emergence switch.

Sensor

1. ***An inductive sensor***

Is a device that uses the principle of electromagnetic induction to detect objects. An inductor develops a magnetic field when a current flow through it alternatively, a current will flow through a circuit containing an inductor when the magnetic field through it changes. This effect can be used to detect metallic objects that interact with a magnetic field. Non-metallic substances such as liquids or some kinds of dirt do not interact with the magnetic field.

Note: In this project there are sex ultrasonic sensors used

Figure (4.4.3): Inductive sensor.

2. ***Reed switch***

It is an electric switch affected by the applied magnetic field. It consists of a pair of electrical conductors inside a sealed glass cane. The conductor is open in the normal position, and when there is a magnetic field the two ends connect, or vice versa so that it is closed in the normal position and when the magnetic field exists the two ends are separated

Note: In this project there are 4 Reed sensors used

Figure (4.4.4): Reed sensor.

Appendix, Figure 4: Reed sensor datasheet.

Relay

A relay is an eclectically controlled switch used for switching a power circuit with lower current ratings .

Figure (4.4.5): Relay.

Residual Current Device (RCD)

is a life-saving device which is designed to prevent you from getting a fatal electric shock if you touch something live, such as a bare wire. It can also provide some protection against electrical fires. RCDs offer a level of personal protection that ordinary fuses and circuit-breakers cannot provide.

Figure (4.4.6): Residual Current Device.

Heater

A heater we use that at oven for Cooking pizza
Note: we use 4 the heater type of cerix T/C k.

Figure (4.4.7): Heater.

Cylinders

In this project we used two cylinders, are used to control the cheese and Vegetable distribution.

Figure (4.4.8): cylinders.

Variable Frequency Drive:

Is a device whose to control motor speed, direction, etc. As show in figure (4.4.9).

Note: The type of inverter 200v 1phase 0.7/0.55 kw .

Figure (4.4.9): Variable Frequency Drive.

4.5 Accessories.

Extra designed accessories are as follow

- ***HMI Screen***

The used human machine inter face module aims at realize friendly communication between the machine and operation pre out such as calibration the mechanism speed, size, counter and monitoring the product progress.

Figure (4.5.1): HMI

Coins Detector

A Coins detector is a device that determines whether notes or coins are genuine or counterfeit. These devices are used in many automated machines found in retail kiosks, self-checkout machines.

In normal operation, if any item such as a coin, it is retained within the machine and it falls into a storage container to allow a member of staff to collect it later when the machine is being emptied. If the item is rejected, the machine returns the item to the customer.

Figure (4.5.2): coins detector.

Appendix, Figure 5: Coins detector datasheet .

4.6 State graph.

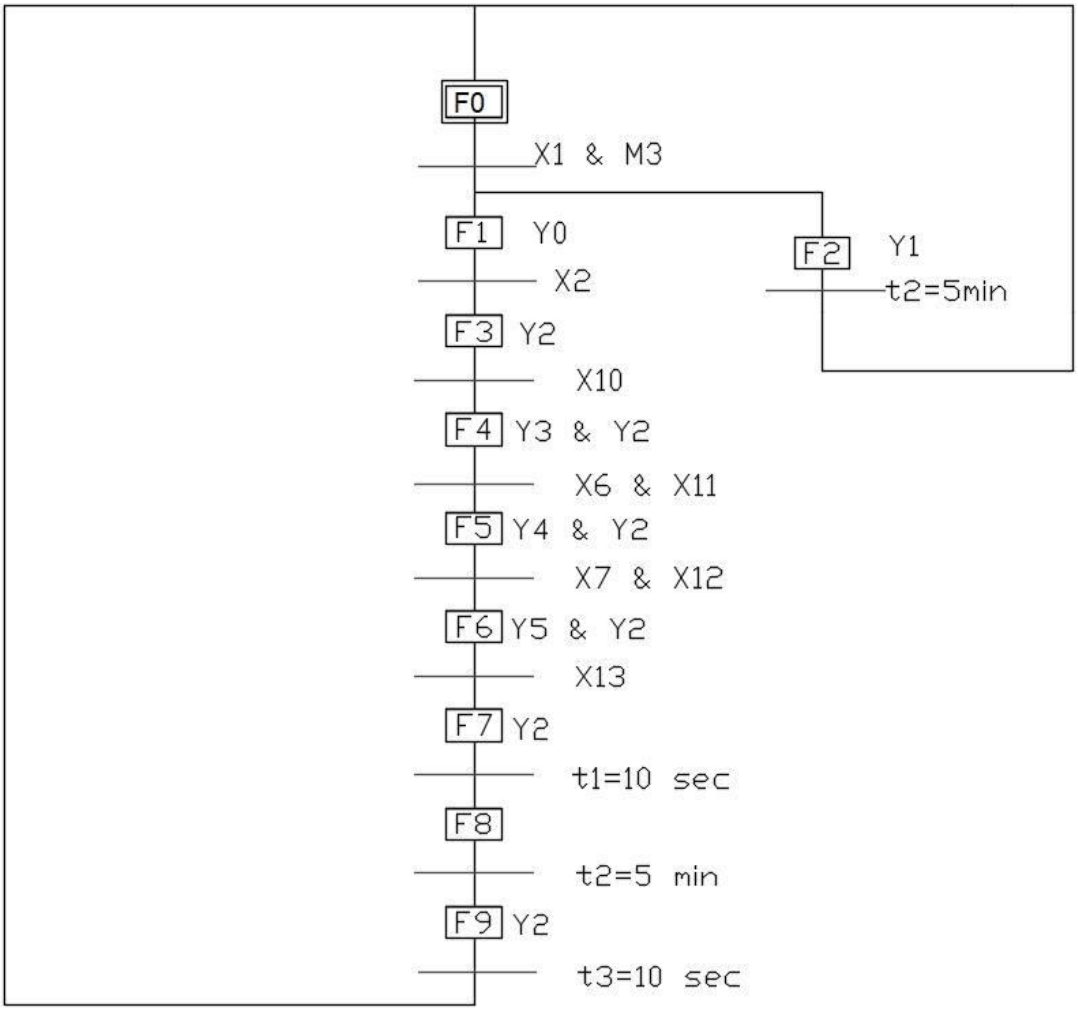


Figure (4.6.1): State graph.

4.7 Pneumatic circuit.

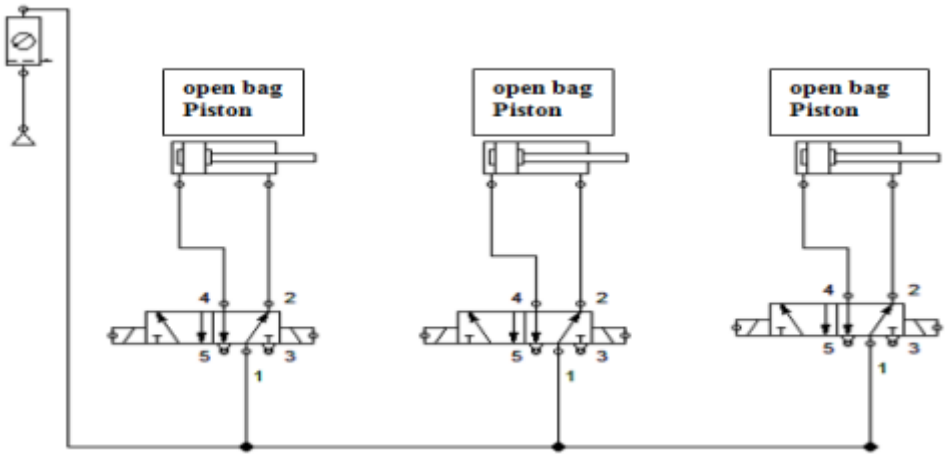


Figure (4.7.1): Pneumatic circuit.

5

Chapter 5: Control and Prototyping

5.1 Introduction
5.2 PLC Characteristic
5.3 System Programming
5.4 Project Prototype
5.5 Prototype Running On
5.6 Recommendations

5.1 Introduction

As mentioned, the operation of Pizza Machine will be full automated in serial orders by using PLC (programming logic controller). This program added some specifications like automated running and occupational safety. This chapter provides experimental result and, some recommendations from the work team for this project.

5.2 PLC Characteristic

Programmable Logic Controller (PLC) is a digital computer used for automation of electromechanical process, such as control of machinery on factory assembly lines, PLCs are used in many industries and machine. 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. In our controlling design it is desirable to use a PLC with 13 input and 11 outputs mention, it can be operated on 24 volts. The used PLC is **Fatek** base controller 24VDC with 13 inputs and 9 outputs.

Appendix, Figure 6: PLC Fatek datasheet.

5.3 System Programming

The program of the system has been done of three stages: define outputs and inputs of the system with symbols, programmatic expression for system parts and movements by SFC, transfer SFC to Ladder program

1. Inputs and outputs definition
   (sensors) (Appendix, table A.3.2). And outputs (motors, cylinders) (Appendix, table A.3.1).
2. Building SFC
   Coordinate movement of system parts sequentially by SFC
3. Ladder program
   After making SFC, transfers it to ladder program then upload the code to PLC

5.4 Project Prototype

The figure (5.1) shows the prototype that was made and it consists of three main parts: **Refrigerator, sauce distribution, cheese distribution, Vegetable distribution**, and oven.

Figure (5.4.1): Final Project Prototype

5.5 Prototype Running On

The process begins when the Coins Detector is activated by pay 5 (₪) ,Then activates the sensor of the refrigerator then the Come down the piece of dough from the refrigerator goes down to the conveyor and when the piece of dough arrives at the sauce sensor will be placed the sauce , as well the cheese and vegetables ,and When the piece of dough reaches the entrance to the oven, the sensor activates and run a timer for 3 seconds to ensure that the piece reaches the middle of the oven, the cooking timer will start after 3 seconds finished, for another 5 minutes in this time the Convery will stopped, after the cooking time finished the timer count 3 second then the machine turned off.

5.6 Recommendations

1. Study the possibility of producing more than one type of pizza.
2. Study the possibility of Packaging pizza by this machine.
   Improve the project through of decrease or increase the materials of pizza.

6

Chapter 6: Manual User

6.1 System basics.
6.2 Main features.
6.3 Operation and setting.
6.4 Check and maintenance.
6.5 Safety.
6.6 Electrical circuit.

6.1 System basics

This system is designed to produce pizza cooked with dimensions of L=300, W=50, H=150 cm, suitable for the markets local and global.

6.2 Main features

1) medium size, heavy weight.
2) fully automatic system.
3) mass production line with short time.
4) easy installation.
5) easy maintenance.

6.3 Operation and setting

1. make sure that the electric current reaches the production line, refrigerator and motor.
2. make sure that the controller (PLC) is working through the exist of power light.
3. make sure that the materials are Existing in distribution tanks are sufficient for production (sauce, cheese and distribution).
4. Pay 10 ₪ to start the process of the system, then the system will run automatically from A to Z.
5. To stop the process at any time press "stop" button.
6. If any danger or unnormal states happened, press "emergency" button immediately to move the system to the most safety conditions.
7. If the process stopped for any reason press "Run" button to complete the operation from the stop point.

6.4 Check and maintenance

1. If any motor stops working, check the overload circuit breaker. If the cutter is disconnected, disconnect the power supply from the motor and look for the load and fix it then reconnect the power and start working.
2. In the case of giving the appropriate pressure for the valve, check the selector and if there is no problem in it make sure of work the air compressor.
3. When making sure all electrical parts are working and there is no electrical fault, but the system does not work when you paying 10 (₪) in coins detector , make sure the controller (PLC) electrical connections (Power / Input / Output) If there is no defect, the problem is in the programming of the plc, so reprogram the plc the code.

6.5 Safety

1. Do not use flammable gasses such as anesthetic gas ,oxygen or hydrogen ,or flammable liquid such as ethanol ,near the system because there is danger of explosion.
2. Make sure that the electrical source is proportional to the electrical characteristics of the production line
3. When maintaining or changing the used parts make sure that their characteristics appropriate to the original parts of the system and take down the cutter.
4. Replace damaged electrical cables with electrical cables with the same characteristics for fear of electric shock.
5. Keep the production line away from any water source, especially the control panel because the system does not have a protection system against water, there is a risk of electric shock when exposed to water.
6. If any problem is observed during the operation or scan, stop the process immediately and turn off the system
7. Before cleaning the system, turn it off and remove the power cable from the plug to avoid electric shock
8. To avoid damage to the system or electrical failure, do not remove the cable from the plug until the system is turned off

6.6 Electrical circuit:

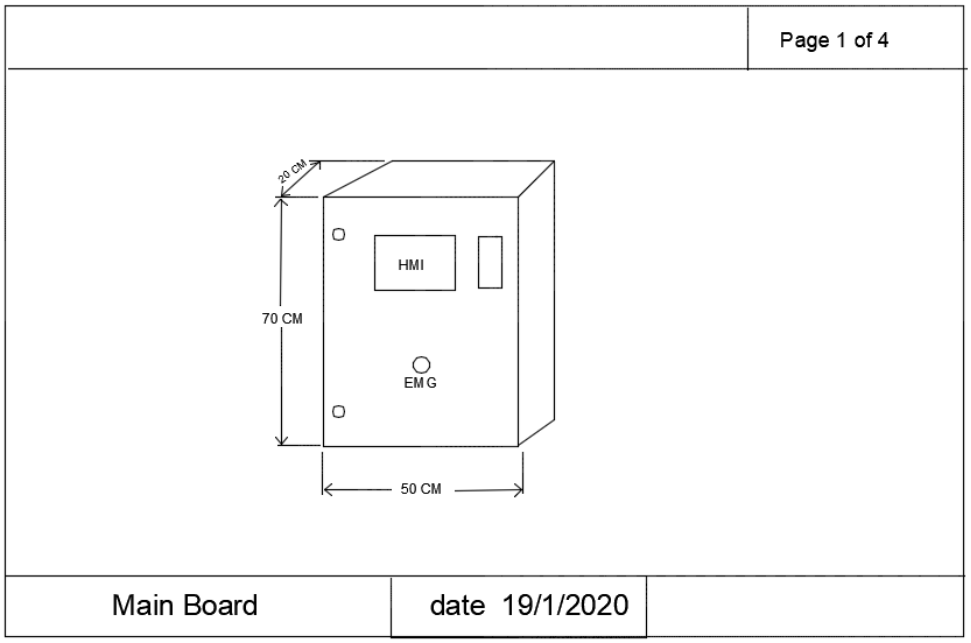


Figure (6.6.1): Main Board.

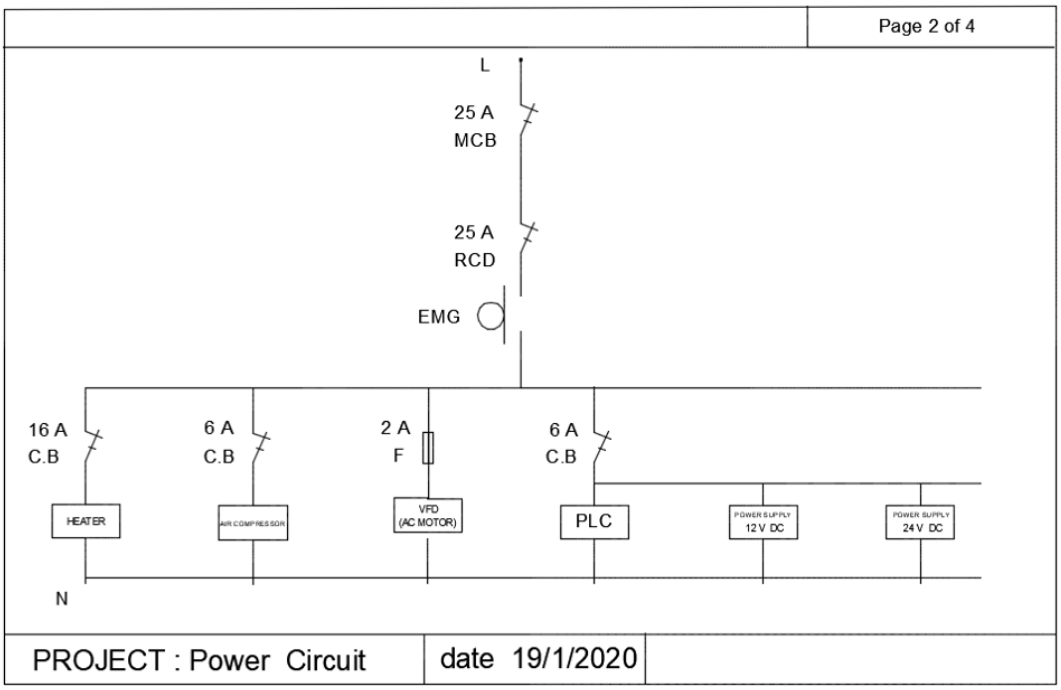


Figure (6.6.2): Power Circuit.

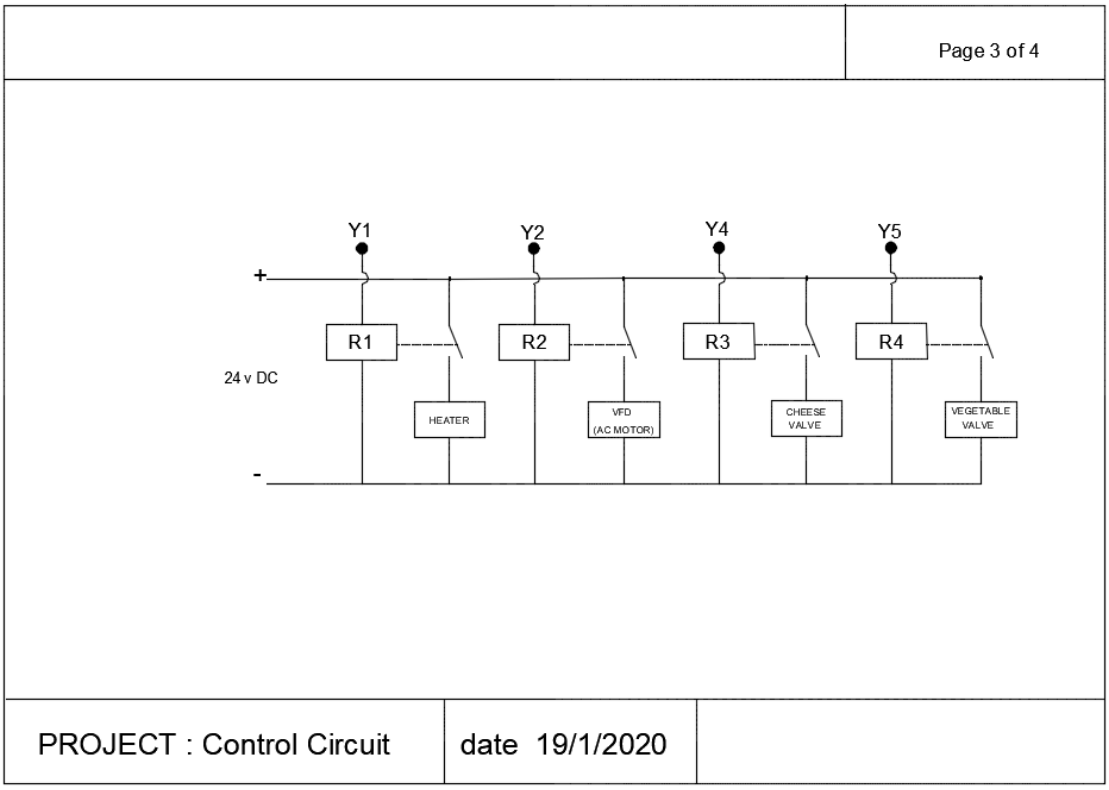


Figure (6.6.3): Control Circuit 24 V DC

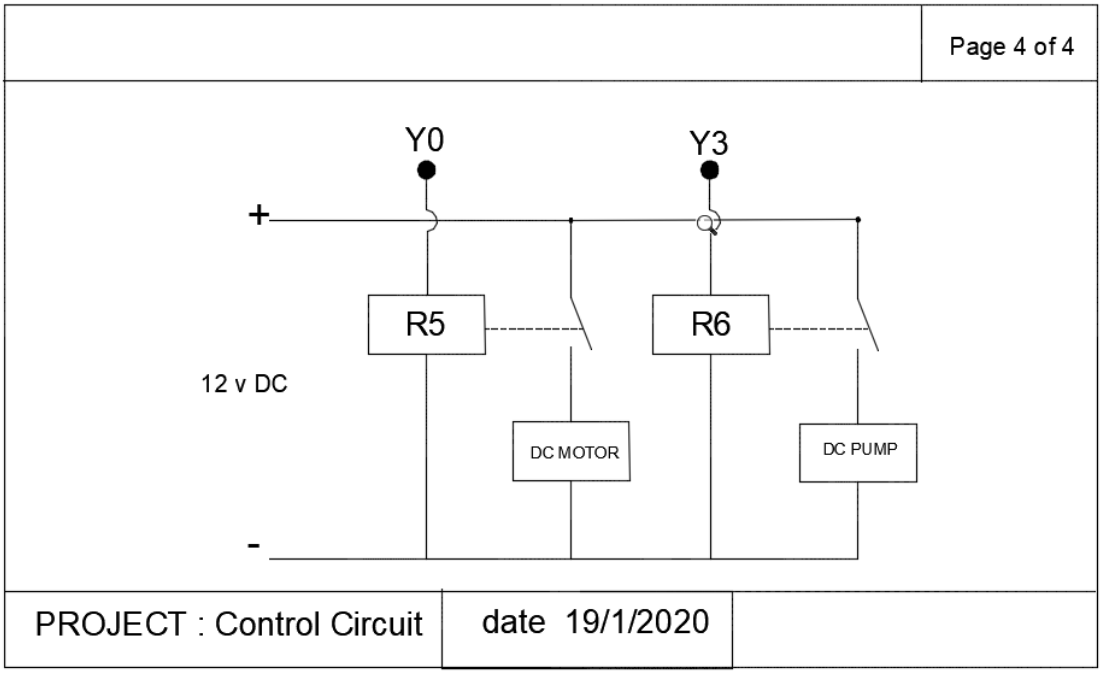


Figure (6.6.4): Control Circuit 12 V DC ..

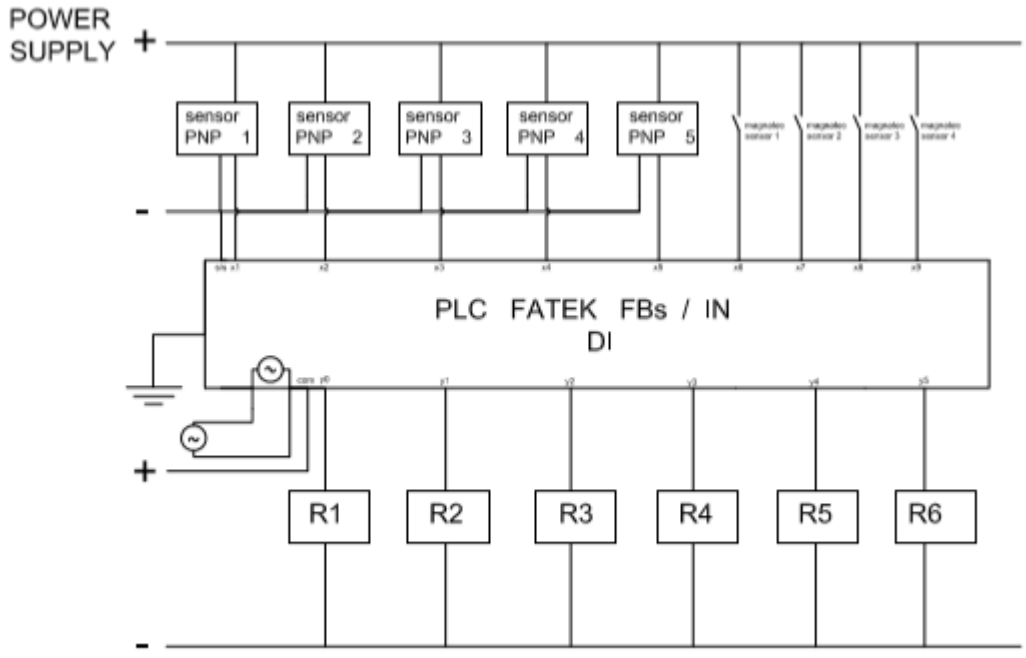


Figure (6.6.5): PLC Circuit.

Appendix

Table A.1: Data sheet for motor Convery

Voltage Delta/Star	**230/400 v**
Rated Power	**0.18 KW**
Cos (ϕ)	**0.66**
Rated Current	**1.2/0.7A**
Frequency	**50 H**
Rated speed	**1340 rpm**

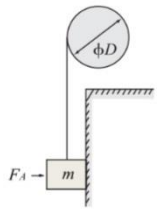
Table A.2: Data sheet for motor refrigerator

Voltage	**12DC v**
Rated Power	**8.6 W**
Torque	**(20.01-30) Kgf.cm**
Current	**< 1 A**
Rated speed	**(40-80) rpm**

◇Pulley Drive

$$T_L = \frac{\mu F_A + mg}{2\pi} \times \frac{\pi D}{i}$$

$$= \frac{(\mu F_A + mg)\, D}{2i} \text{ [N·m]} \quad \cdots\cdots ③$$



m : Total mass of the table and load [kg]
μ : Friction coefficient of sliding surface (0.05)
F_A : External force [N]
D : Final pulley diameter [m]
g : Gravitational acceleration [m/s^2] (9.807)
i : Gear ratio (This is the gear ratio of the mechanism and not the gear ratio of the Oriental Motor's gearhead you are selecting.)

Figure 1: Motor torque sheet calculation

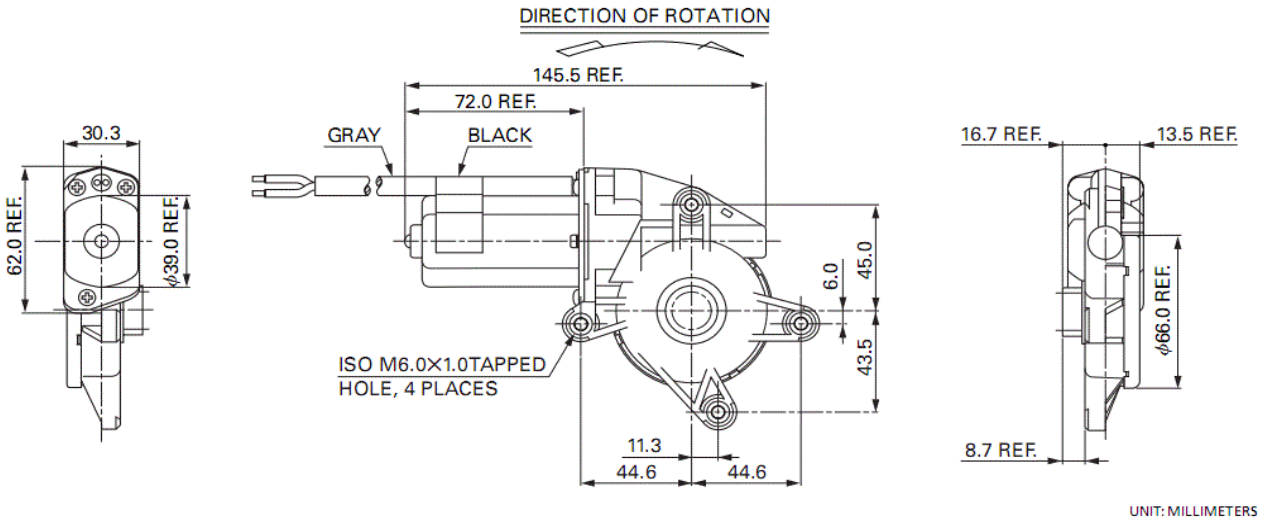


Figure 2: Refrigerator motor diminution

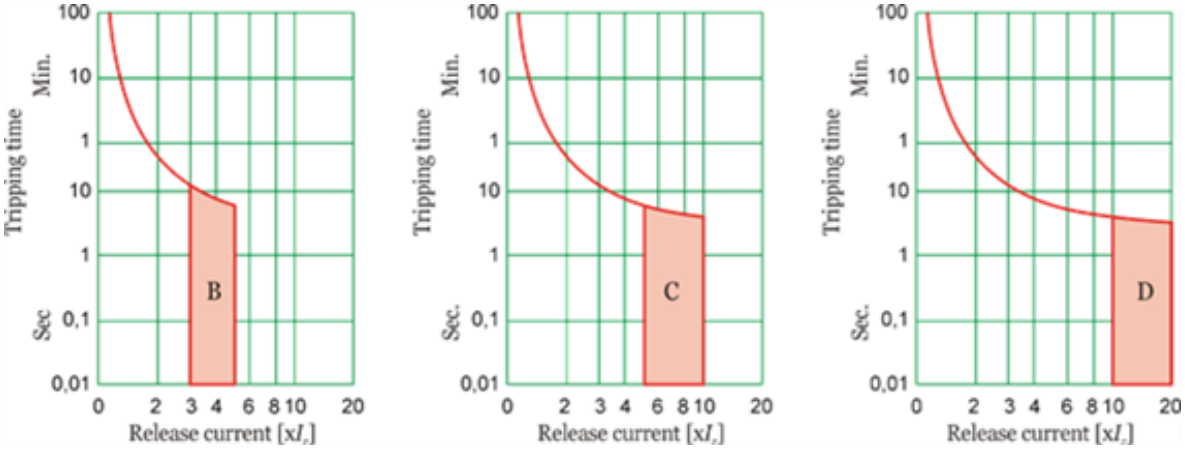


Figure 3: MCB characteristics

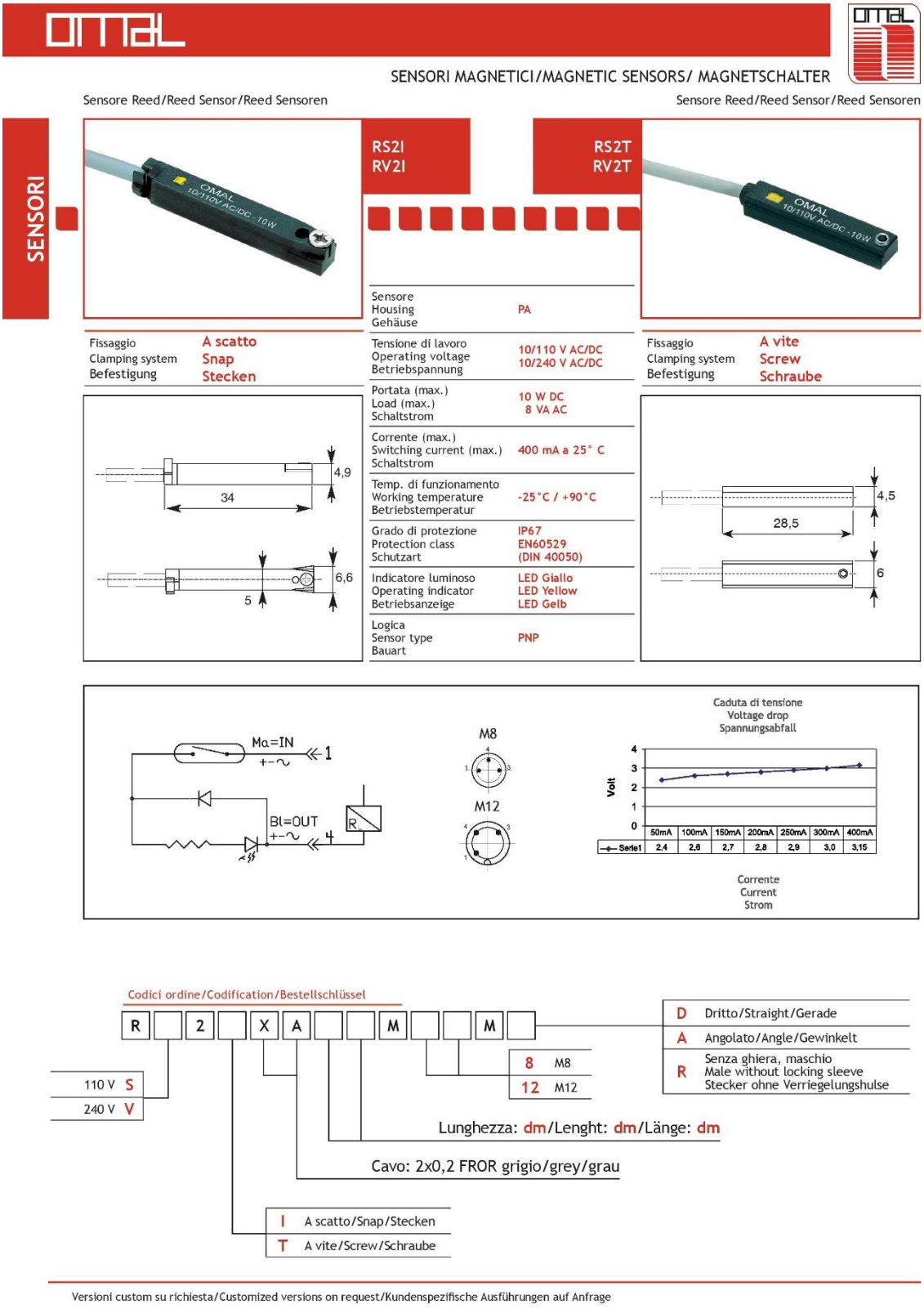


Figure 4: Reed sensor datasheet

Figure 5: Coins detector datasheet

Index

1. Alter Log

Date/Author	Simple Introduction	Version
2010/06 DG	Basic functions are completed。	1.0

2. Introduction

DG600F Series of coin acceptor is a electronic coin acceptor with high reliability, Which is widely used in amusement facilities, vending machines and so on.

2.1 Main Features:

- Enable to recognize 6 groups of coins in different denomination. (can exceed to 8 groups if need)
- Enable to forbid accepting all coins
- Industrial standard connector ---10Pin Parallel port
- Special connector ---5Pin Serial port
- Enable to release coins in jam
- Enable to self-diagnose

2.2 Specification:

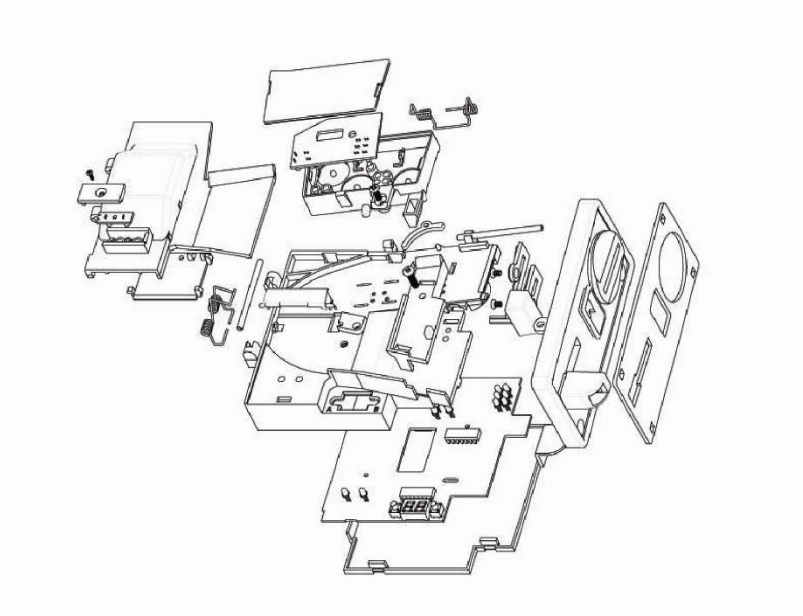
- **Coin Size:**

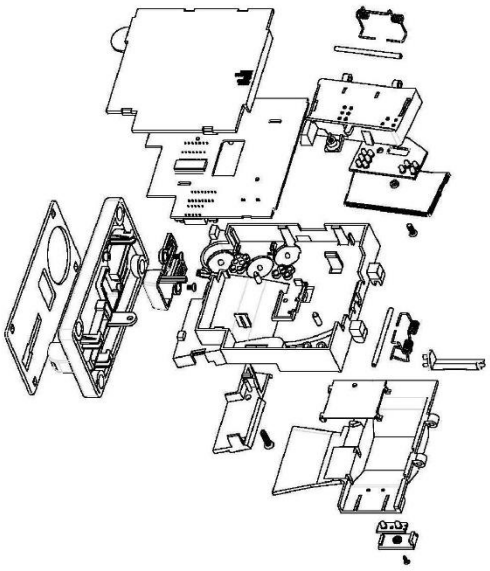
  Diameter: 17 – 30.5mm
  Thickness: 1.25 – 3.2mm

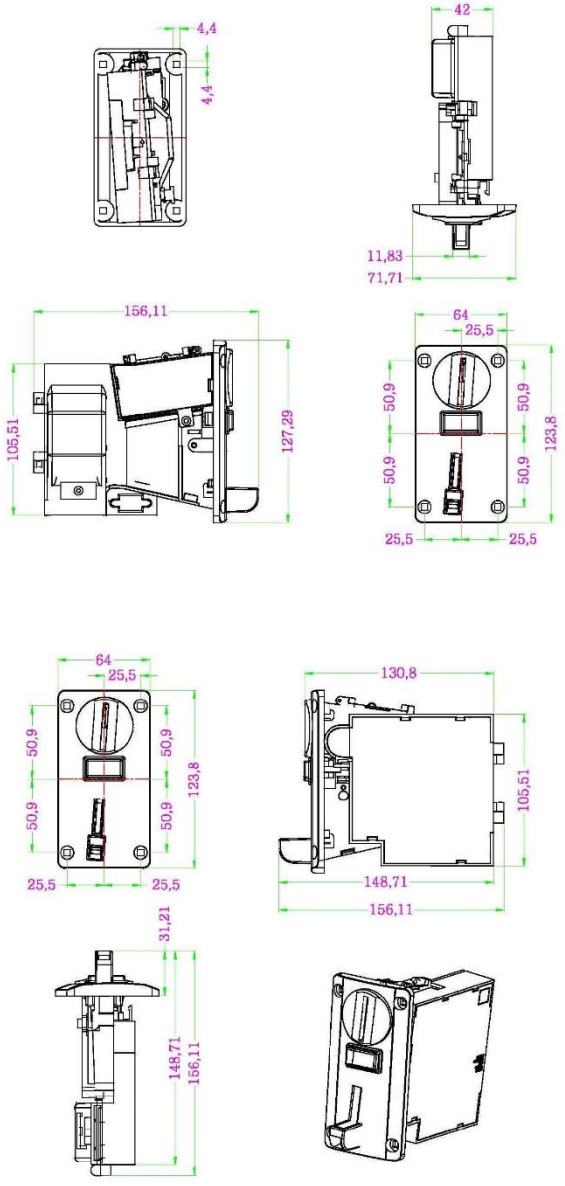
- **Working Environment:**

Working Temperature:	0℃ to 50℃
Storage Temperature:	-30℃ to55℃
Ambient Humidity:	Up to 95% RH non-condensing
Working Voltage:	Normal 12VDC
	Min 10VDC
	Max 15VDC
Working Current:	Standby 50mA
	Max 450mA （At the instant of collecting coin）
Communication Interface:	Standard parallel port -- 10Pin
	Special serial port -- 5Pin
Installation Position:	On any plane, the angle can't be more than 2 degrees between coin acceptor and vertical

3. Product Structure and Size






4,4
4,4
42
11,83
71,71
156,11
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25,5
50,9
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50,9
50,9
123,8
25,5
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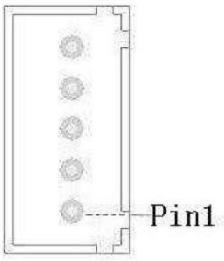
123,8
25,5
25,5
130,8
105,51
148,71
156,11
31,21
148,71
156,11

4. Serial Output Mode

4.1 Ports Instruction

Serial connector

Special connector：5Pin

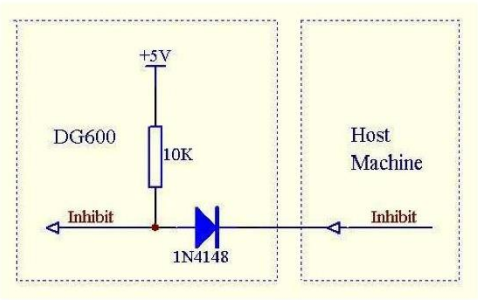


◎Serial Port

PIN	FUNCTION	ACTIVE
1	+12V	
2	Serial Signal Output	
3	0 V	
4	Counter Output	Low
5	Inhibiting port（**refer to item 4.2**）	

4.2 Forbid Accepting Coins

◎Inhibiting port connection



4.2.1 Forbidden Mode 1 -- Low Level forbid accepting coins

When SW4 is on “OFF” position，

If the 5th Inhibiting port is disconnected or connected to a high level（>+3V）, coin acceptor will accept all coins.

If the 5th Inhibiting port is connected to a low level（<+1V）, coin acceptor will refuse all coins.

4.2.2 Forbidden Mode 2 — High Level forbid accepting coins

When SW4 is on "ON" position，

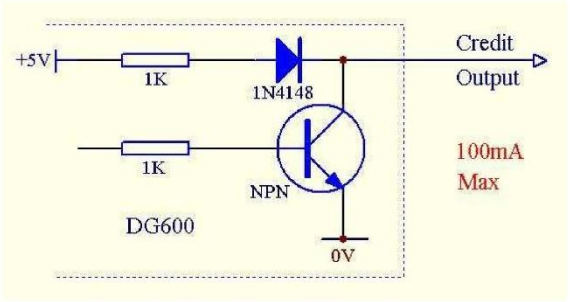
If the 5th Inhibiting port is disconnected or connected to a high level（>+3V）, coin acceptor will refuse all coins。

If the 5th Inhibiting port is disconnected or connected to a high level（<+1V）, coin acceptor will accept all coins。

4.3 Serial Signal Output

Serial signal output consists of a NPN transistor

◎ Signal output port



- In serial pulse signal output mode, on acceptance of enough coins (no less than machine charge amount), NPN transistor is turned on for a period of 25ms/45ms/65ms/100ms (+/-20%).

  Machine will detect not only the edges of credit pulses, but also credit pulses width is not less than 20ms in valid, as to eliminate noise or incorrect pulse in output line 。

Note: It can set the period of 25ms/45ms/65ms/100ms in coin acceptor parameter A2.

- In serial RS232 signal output mode, on acceptance of enough coins (no less than machine charge amount), NPN transistor is turned on by RS232 signal
- Output signal quantity= Deposited coin amount / Machine charge amount

E.G.:

Coin $0.1 is set as 01, coin $0.5 is 05, coin $1.00 is 10, machine charge amount is set as 02.

It means that,

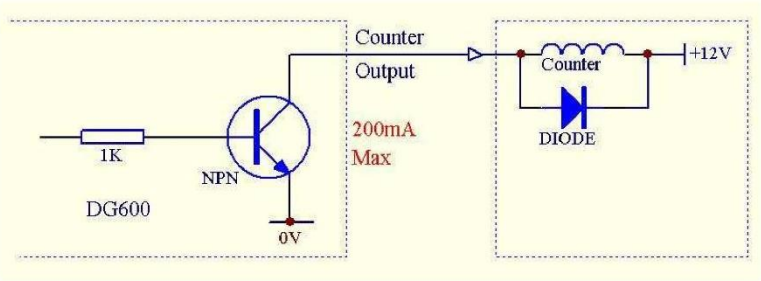
Deposit 2pcs of coins $0.1 to send out a signal

Deposit a coin of $0.5 to send out 2pcs of signals and remain a coin $0.1 amount

Deposit a coin of $1.00 to send out 5pcs of signals

4.4 Counter Output

◎Counter Output



Counter output consists of a open-collector NPN transistor , on acceptance of enough coins (no less than machine charge amount), NPN transistor is turned on to short circuit for a period of 25ms/45ms/65ms/100ms (+/-20%).here output voltage should be less than 0.7V and max 200mA is available for electric current.

The pulse quantity Counter outputs is same to that signal outputs

5. Parallel Output Mode

5.1 Ports Instruction

Parallel connector

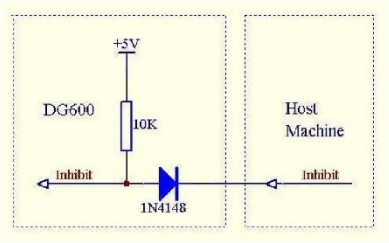
Industrial standard connector：10Pin DIL

◎Parallel ports

PIN	FUNCTION	ACTIVE
1	0 V	
2	+12V	
3	Accept C5	Low
4	Accept C6	Low
5	None	
6	Inhibiting port（**refer to item 5.2**）	
7	Accept C1	Low
8	Accept C2	Low
9	Accept C3	Low
10	Accept C4	Low

5.2 Forbid Accepting coins

◎Inhibiting port connection



5.2.1 Forbidden Mode 1 — Low Level forbid accepting coins

When SW4 is on “OFF” position,

If the 6th Inhibiting port is disconnected or connected to a high level（>+3V）, coin acceptor will accept all coins.

If the 6th Inhibiting port is connected to a low level（<+1V）, coin acceptor will refuse all coins.

5.2.2 Forbidden Mode 2 — High Level forbid accepting coins

When SW4 is on "ON" position

If the 6th Inhibiting port is disconnected or connected to a high level（>+3V）, coin acceptor will refuse all coins.

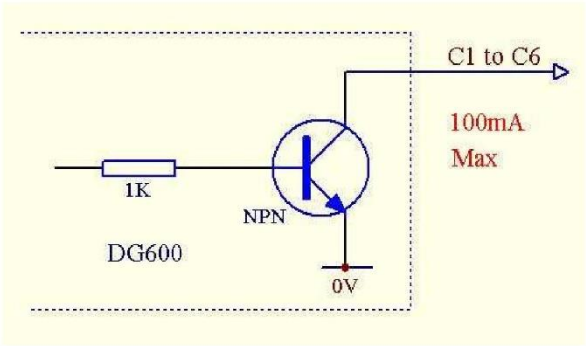
If the 6th Inhibiting port is connected to a low level（<+1V）, coin acceptor will refuse all coins.

5.3 Coin Receiving Signal Output

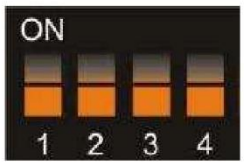
6 groups of coin receiving signal output consist of 6pcs open-collector NPN transistors , on acceptance of a valid coin, the related NPN transistor is turned on to short circuit for a period of 100ms (+/-20%).here output voltage should be less than 0.7V and max 100mA is available for electric current.

Machine will detect not only the edges of credit pulses, but also credit pulses width is not less than 50ms in valid, as to eliminate noise or incorrect pulse in output line

◎Coin receiving signal output



6. Dip Switch Functions Setting



◎Dip Switch funcitons

	SW1 Port Level	SW2 Security	SW3 Transmitting	SW4 Inhibiting
ON	NC	Special	RS232	< +1V
OFF	NO	Normal	Pulse	> +3V

6.1 Serial Port Output Level

Note: The two mode options as blow are not suitable for parallel port output mode.

6.1.1 Mode 1—N.O.

When SW1 is on “OFF” position,
On standby, coin receiving output NPN transistor is open collector; on acceptance of enough coins (no less than machine charge amount), NPN transistor is turned on to short circuit for a period of 25ms/45ms/65ms/100ms (+/-20%).here output voltage should be less than 0.7V and max 100mA is available for electric current.
Note: it can set the period of 25ms/45ms/65ms/100ms in coin acceptor parameter A2.

6.1.2 Mode 2—N.C.

When SW1 is on “ON” position,
On standby, coin receiving output NPN transistor is short circuit, max 100mA is available for electric current; on acceptance of enough coins (no less than machine charge amount), NPN transistor is turned on to open circuit for a period of 25ms/45ms/65ms/100ms (+/-20%).
Note: It can set the period of 25ms/45ms/65ms/100ms in coin acceptor parameter A2.

6.2 Coin Identification Security

When SW2 is on "OFF" position, it means the high security of coin acceptor identifies coins.
When SW2 is on "ON" position, it means the low security of coin acceptor identifies coins, acceptor can accept some defected coins.

6.3 Serial Output Signal Format

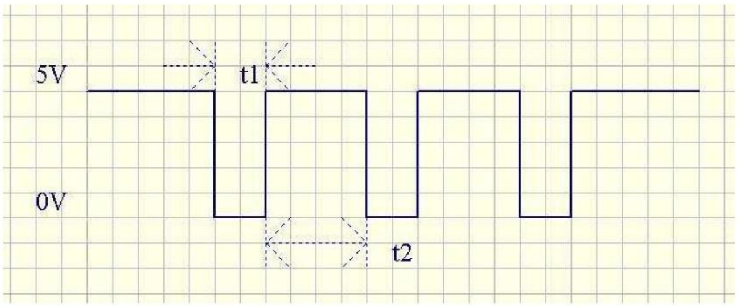
Note: This option is not suitable for parallel port output mode.

6.3.1 Pulse Signal

When SW3 in on "OFF "position, on acceptance of enough valid coins, Serial port sends out pulse signal.

6.3.1.1 Select mode 1-N.O.， In serial port output mode. (SW1 is on "OFF" position)

◎N.O. Pulse output oscillogram



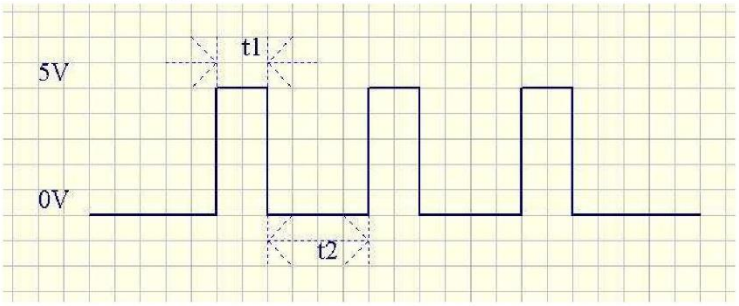
t1：Pulse duration of (25ms/45ms/65ms/100ms)

The duration is set in coin acceptor parameters A2.

t2：Pulse interval of 100ms

6.3.1.2 Select mode 2-N.C.， In serial port output mode. (SW1 is on "ON" position)

◎N.C. Pulse output oscillogram



t1：Pulse duration of (25ms/45ms/65ms/100ms)

The duration is set in coin acceptor parameters A2.

t2：Pulse interval of 100ms

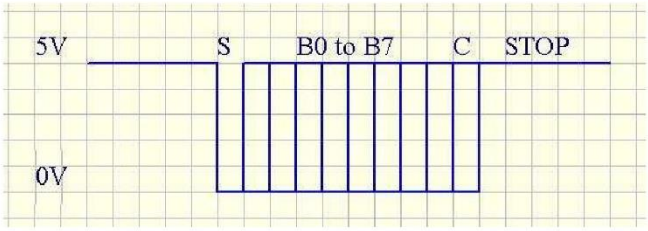
6.3.2 RS232 Signal

When SW3 in on "ON "position, on acceptance of enough valid coins, Serial port sends out RS232 signal.

6.3.2.1 Select mode 1-N.O.， In serial port output mode. (SW1 is on "OFF" position)

Note: Please select this mode when coin acceptor is connecting to machine's single port.

◎RS232 output oscillogram



S：Start bit

B0 to B7：8 data bits

C：Even check

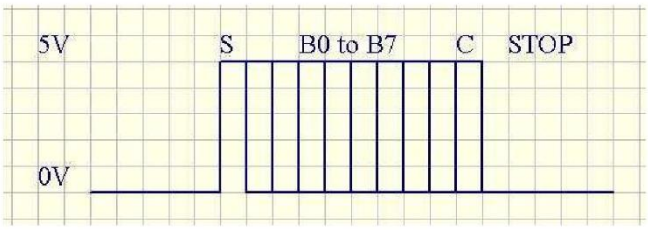
STOP：Stop bit

It can set the transmit rate（1200bps/2400bps/4800bps/9600bps）in coin acceptor parameter A2.

6.3.2.2 Select mode 2-N.C.， In serial port output mode. (SW1 is on "ON" position)

Note: Please select this mode when coin acceptor is connecting to PC's RS232 port.

◎RS232 output oscillogram



S：Start bit

B0 to B7：8 data bits

C：Even check

STOP：Stop bits

It can set the transmit rate（1200bps/2400bps/4800bps/9600bps）in coin acceptor parameter A2.

6.4 Inhibiting Port Output Level

6.4.1 Forbidden Mode 1--Low Level forbid accepting coins

When SW4 is on “OFF” position,

If Inhibiting port is disconnected or connected to a high level（>+3V）, coin acceptor will accept all coins.

If Inhibiting port is connected to a low level（<+1V），coin acceptor will refuse all coins.

6.4.2 Forbidden Mode 2--High Level forbid accepting coins

When SW4 is on "ON" position,

If Inhibiting port is disconnected or connected to a high level（>+3V）, coin acceptor will refuse all coins.

If Inhibiting port is connected to a low level（<+1V）, coin acceptor will accept all coins.

7. Coin Parameters Setting

7.1 Access To Coin Parameters Setting

Keep pressing button A till CP is displayed.
LED displays CP , press button A to select one of six groups of coins.

7.2 Clean Up All Coin Parameters

When it displays CP , keep pressing button B till CC is displayed, it will clean up all six groups of coin parameters .

7.3 Clean Up Group Coin Parameters

When it displays CP , press button A to select one group of coins parameters needed among the six(C1~C6),
and then press button B to display coin values currently stored.
Keep pressing B key till 00 is displayed, then release, it means this group of coins parameters are cleaned up.

7.4 Reset All Coin Parameters

7.4.1 Clean up all existing coin parameters firstly

When it displays CP, keep pressing button B till CC is displayed, then release, it will clean up all six groups of coins parameters.

7.4.2 Set the first group of coins

Press button A to display C1, press button B to display the current coin value as 00,
press button B to adjust from 01 to A0 (A0=100).

Press button B to select the right coin value, and then deposit coins with same denomination but different year issued (it prompts "bi" each time deposit a coin),max 20 pieces coin for each group is available.
When there are 20 coins fully stored, it will prompt “bi.bi.bi”, and display F.
Press button A to next group setting, and display C2

7.4.3 Set the next group of coins

Please refer to steps 7.4.2 to set coins parameters of another 5 groups in C2~C6

7.5 Add New Coin Parameters

When it displays CP , press button A to select the needed coin group （C1~C6） , then press button B to displays the current coin value stored , deposit coins needed (it prompts "bi" each time deposit a coin), when it prompts “bi.bi.bi”and displays F ,it means this group is fully stored and don't need to add coins anymore.

7.6 Exit Coin Parameters Setting

After finish coins parameter setting, keep pressing button A for 2 seconds, release after it displays 88.

8. Coin Acceptor Parameters Setting

8. 1 Acess To Coin Acceptor Parameters Setting

Keep pressing button B buton till AP is displayed, it enters into setting mode.
LED displays AP , press button A to select working parameters.

8. 2 Recover Coin Acceptor Parameters To The Defaulted Value

Keep pressing B button when it displays AP , and release after "CC" is displayed, then all parameters is recover to the defaulted value.

Defaulted value:

A1 machine charge amount: 01
A2 serial output signal pulse-width/ RS232 transmit baud rate: 02 (45ms / 4800bps)
A3 faulty alarm option : 01 (rings only one time)
A4 serial port RS232 signal length: 01 (one byte)
A5 serial port output: 01

8. 3 Machine Charge Amount Setting A1

When it displays A1, press button B to display existing charge credit stored in machine.
Press button B to adjust from 01 to A0(A0=100).

Press button B to select the charge amount needed, press button A to next group working parameters A2.

Machine charging instructions:

E.g.: Set machine charge credit as 01, then serial port sends out one signal once when it receives one coin with credit 01, and sends five signals once when it receives one coin with credit 05.

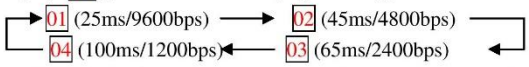
E.g.: Set machine charge credit as 05, then serial port sends out one signal once when it receives five coins with credit 01, and sends two signals once when it receives one coin with credit 10.

E.g.: Set machine charge credit as 02, then serial port sent two signals once when it received one coin with credit 05(05/02=02), and there is remaining a coin credit, it will be cleaned up if there is no new coin coming within 60 seconds.

NOTE: Machine charge credit setting is not suitable for parallel port output mode.

8. 4 Serial Output Signal Pulse-width/ RS232 Transmit Baud Rate Setting A2

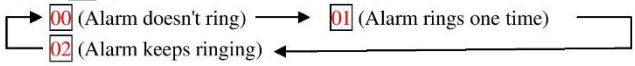
When it displays A2, press button B to display existing parameters stored in machine.



Press button B to adjust the needed parameter, and then press button A to next group of Coin Acceptor parameters A3.

8.5 Faulty Alarm Option A3

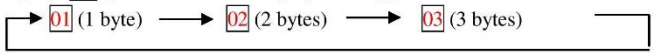
When it displays A3, press button B to display existing parameters stored in machine.



Press button B to adjust the needed parameter, press button A to next group of coin acceptor parameters A4.

8.6 Serial Port RS232 Signal Output Format A4 (can alter the format if needed)

When it displays A4, press button B to display existing parameters stored in machine.



01 (1 byte)：Transmit coin parameters via one byte.

E.g.: Coin parameters date is 01， then date transmitted is 0x01.

02 (2 bytes)：Transmit a title of 0xAA, and then follow with coin parameters data in one byte.

E.g.: coin parameters date is 01， then data transmitted is 0xAA + 0x01.

NOTE：Interval between two bytes transmitted is 1ms.

03 (3 bytes)：Transmit a title of 0xAA, and then follow with coin parameters data in one byte, at last a verification value (XOR value for two former bytes)

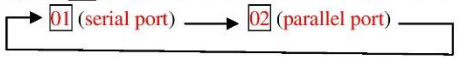
E.g.: coin parameters date is 01， then data transmitted is 0xAA + 0x01+ 0xAB.

NOTE：Interval between two bytes transmitted is 1ms

Press button B to select coin acceptor parameters as needed, and press button A to next group of Coin Acceptor parameters A5.

8.7 Serial Or Parallel Port Option A5

When it displays A5, press button B to show existing parameters setting stored in machine



01：On acceptance of enough coins, Serial port (5Pin) sends out signal but parallel port doesn't send.

02：On acceptance of enough coins, Parallel port (10Pin) sends out pulse signal but serial port doesn't send

Press button B to select coin acceptor parameters as needed, and press button A to back to AP .

8.8 Exit The Setting

After finished Coin Acceptor parameters setting, keep pressing button A for 2 seconds, release after 88 is displayed.

9. Common Faulties

9.1 Error Code(E1 – E7, EE)

Error code E1
It displays E1 after power on, it means that the first pair of sensor is out of order.
It displays E1 after deposit coin, it means that coin duration at the first pair of sensor is too long.

Error code E2
It displays E2 after power on, it means that the first pair of sensor is out of order.
It displays E2 after deposit coin, it means that coin duration at the second pair of sensor is too long.

Error code E3
It displays E3 after power on, it means that the first pair of sensor is out of order.
It displays E3 after deposit coin, it means that coin duration at the third pair of sensor is too long.

Error code E4
It displays E4 after power on, it means that the first pair of sensor is out of order.
It displays E4 after deposit coin, it means that coin duration at collection gate is too long.

Error code E5
It displays E5 after power on, it means that the first pair of induction coil is out of order.

Error code E6
It displays E6 after power on, it means that the second pair of induction coil is out of order.

Error code E7
It displays E7 after power on, it means that button A or B is stuck.

Error code EE
It displays EE after deposit coin, it means that there are coins not collected in coin box.

9.2 Coins Are Refused And Returned

- Inhibiting port output level mode is selected incorrect, please refer to **6.4** to check if switch SW4 is on the proper position; or check if the controlling electric level outputted from machine meets requirements or not.
- There isn't this coin parameters stored in coin acceptor, please refer to **7.5** to add new coin parameters.

9.3 Send No Signal After Deposit Coins

- Check if the machine charge amount setting is right or not, if coin value deposited falls short of the charge amount, Coin Acceptor would not send any signal. For instance, coin value deposited is 01, but machine charge amount is set as 02, then it would not send signal when only one coin is deposited, but send signals after deposit two coins. Please refer to **8.3** to check the machine charge amount settings.
- Check output port selection is right or not, please firstly confirm that connection ports of machine and coin acceptor are serial port or parallel port, and then check the selection according to **8.7.**

9.4 Send Error Signals After Deposit Coins

- When parallel port mode outputs error signal, please check if the settings of group （C1~C6） the coin belongs to are correct.
- When parallel port mode outputs error signal, please refer to **6.1** to check SW1 (serial port electric level option) is on right position or not.
- Please refer to **6.3** to check SW3 (serial port electric level option) is on right position or not.
- Please refer to **8.4** to check signal pulse-width and transmit baud rate is set right or not.

9.5 Coins Are Not Easy To Be Identified, Coins Are Returned Frequently

- Since coins issued year, outline, used duratin is different, coin parameters will be little differ from data stored in Coin Acceptor, please dial switch SW2 to ON position to loose coin identification security
- Plesae refer to **7.5,** add new coin parameters.

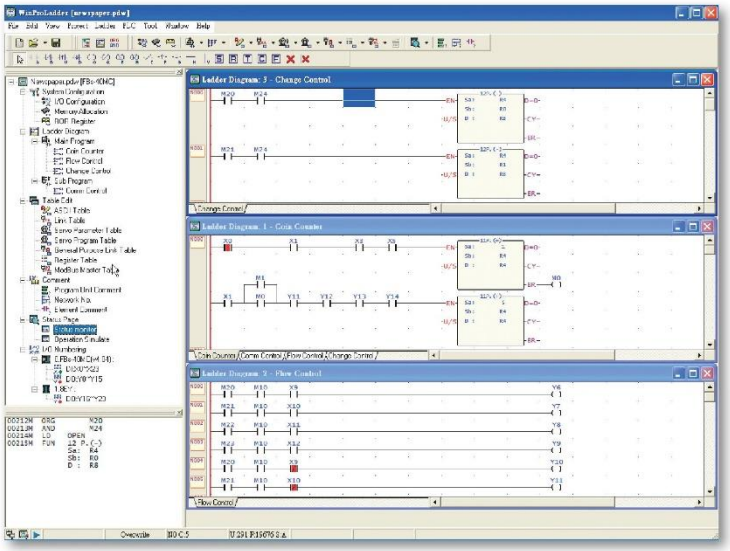
Figure 6: PLC Fatek datasheet

Program Development Software

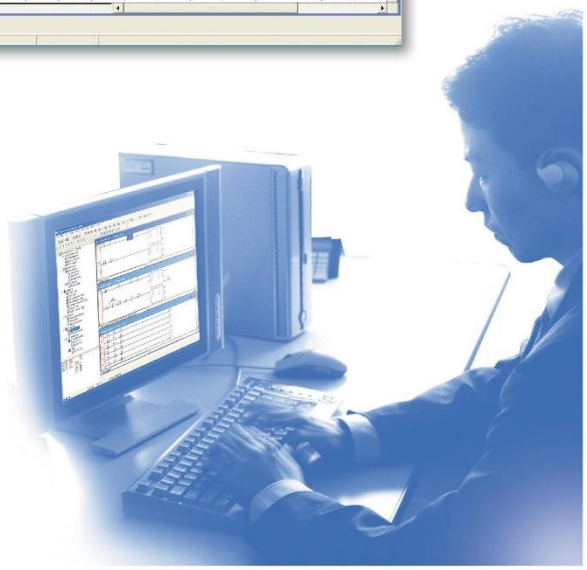
FATEK The Brand You Can Rely on!

General Features

- Windows based application program following the standard conventions of a windows environment for ease of learning and operation regardless of whether the user is a beginner or frequent user.
- Application environment for project development is via a hierarchical tree. All the elements of the project can be activated by directly clicking the mouse button on the tree object providing comprehensive access and views of the working project.
- Easy entry methods which incorporate both the keyboard and mouse as entry devices. No matter whether on site or in an office environment the software can be operated with ease and efficiency.
- Provides various types of connections to the PLC via a PC. Connections include serial, USB, Ethernet / Internet and Modem. For every different connection WinProladder provides a session name to associate the setting of the communication parameters, such as port no., baud rate, IP address, phone number, etc.



- On-Line, Run-Time program editing
- Program testing
- Program comments
- Project oriented program
- Ladder program editing screen
- Status monitor and control
- Mnemonic ladder instruction display window
- Ladder diagram with comments
- Element comment editing
- Off-Line Simulation



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Instruction Sets

Sequential instructions

Instruction	Operand	Ladder symbol	Function
ORG	X,Y,M, S,T,C		Network starts by an A contact
ORG NOT			Network starts by a B contact
ORG TU			Network starts by a TU contact
ORG TD			Network starts by a TD contact
ORG OPEN			Network starts by an open contact
ORG SHORT			Network starts by a short contact
LD	X,Y,M, S,T,C		Branch line starts by an A contact
LD NOT			Branch line starts by a B contact
LD TU			Branch line starts by a TU contact
LD TD			Branch line starts by a TD contact
LD OPEN			Branch line starts by an open contact
LD SHORT			Branch line starts by a short contact
AND	X,Y,M, S,T,C		Serial connect with an A contact
AND NOT			Serial connect with a B contact
AND TU			Serial connect with a TU contact
AND TD			Serial connect with a TD contact
AND OPEN			Serial connect with an open contact
AND SHORT			Serial connect with a short contact

Instruction	Operand	Ladder symbol	Function
OR	X,Y,M, S,T,C		Parallel connect with an A contact
OR NOT			Parallel connect with a B contact
OR TU			Parallel connect with a TU contact
OR TD			Parallel connect with a TD contact
OR OPEN			Parallel connect with an open contact
OR SHORT			Parallel connect with a short contact
ANDLD			Concatenate two blocks in series
ORLD			Merge two blocks in parallel
OUT	Y,M,S	( )	Output result to coil
OUT NOT		(/)	Output the inverse of result to a coil
OUT L	Y	(L)	Output result to a retentive coil
OUT	TR		Store node status in temporary relay
LD			Retrieve node status from temporary relay
TU			Take differential up of node status
TD			Take differential down of node status
NOT			Inverse node status
SET		(S)	Set a coil
RST		(R)	Reset a coil

Step ladder instructions (SFC)

Instruction	Operand	Ladder symbol	Function
STP	Snnn	STP	Define STEP program
STPEND		STPEND	STEP program end

Instruction	Operand	Ladder symbol	Function
TO	Snnn	TO	STEP divergence
FROM		FROM	STEP convergence

Function instructions

Category	NO.	Instruction	Derivative	Function
Timer		Tnnn		General timer instruction (T0 ~ T255)
Counter		Cnnn		General counter instruction (C0 ~ C255)
	7	UDCTR	D	16 or 32-bit up/down counter
Setting / Resetting		SET	DP	Set all bits of register or a discrete point to 1
		RST	DP	Clear all bits of register or a discrete point to 0
	114	Z-WR	P	Zone set or clear
Digital operation	4	DIFU		Take differential up of the node status to operand
	5	DIFD		Take differential down of the node status too operand
	10	TOGG		Toggle the coil status
Mathematical operation	11	(+)	DP	Sa+Sb → D
	12	(–)	DP	Sa–Sb → D
	13	(×)	DP	Sa × Sb → D
	14	(/)	DP	Sa / Sb → D
	15	(+1)	DP	Add 1 to D
	16	(–1)	DP	Subtract 1 from D
	23	DIV48	P	48 bits integer division Sa / Sb → D
	24	SUM	DP	Sum of N consecutive registers
	25	MEAN	DP	Average of N consecutive registers
	26	SQRT	DP	Square root of S
	27	NEG	DP	Two's complement of D (Negative number)
	28	ABS	DP	Absolute value of D
	29	EXT	P	Extend 16 bits into 32 bits
	30	PID	P	PID calculation
	31	CRC16	P	CRC16 calculation
	32	ADCNV		Offset and full scale conversion for analog input
	33	LCNV	P	Linear conversion
	34	MLC	P	Multiple linear conversion

Category	NO.	Instruction	Derivative	Function
Mathematical operation	200	I→F	DP	Integer to floating point number conversion
	201	F→I	DP	Floating point number to integer conversion
	202	FADD	P	Addition of floating point number
	203	FSUB	P	Subtraction of floating point number
	204	FMUL	P	Multiplication of floating point number
	205	FDIV	P	Division of floating point number
	206	FCMP	P	Comparison of floating point number
	207	FZCP	P	Zone comparison of floating point number
	208	FSQR	P	Square root of floating point number
	209	FSIN	P	SIN trigonometric function
	210	FCOS	P	COS trigonometric function
	211	FTAN	P	TAN trigonometric function
	212	FNEG	P	Change sign of floating point number
	213	FABS	P	Absolute value of floating point number
	214	FLN	P	Floating point napierian logarithm
	215	FEXP	P	Floating point exponential function
	216	FLOG	P	Floating point logarithm
	217	FPOW	P	Floating point power function
	218	FASIN	P	Floating point arc sine function
	219	FACOS	P	Floating point arc cosine function
	220	FATAN	P	Floating point arc tangent function
Logic operation	18	AND	DP	Sa AND Sb
	19	OR	DP	Sa OR Sb
	35	XOR	DP	Sa XOR Sb
	36	XNR	DP	Sa XNR Sb
Comparison	17	CMP	DP	Value Compare
	37	ZNCMP	DP	Zone Compare

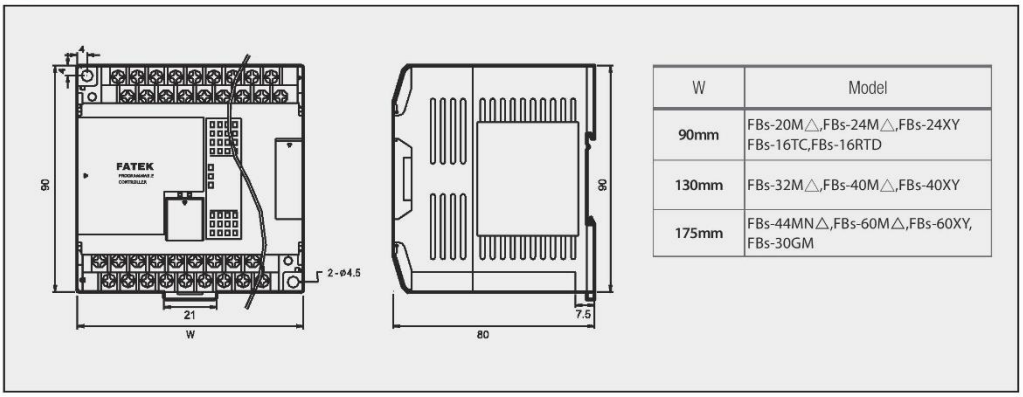
(Continue)

Category	NO.	Instruction	Derivative	Function
Move operation	8	MOV	DP	Move S to D
	9	MOV/	DP	Inverse S and move to D
	40	BITRD	DP	Move the Bit-N of S to F0
	41	BITWR	DP	Write INB input to the Bit-N of D
	42	BITMV	DP	Move the Bit-Ns of S to the Bit -Nd of D
	43	NBMV	DP	Move the Nibble-Ns of S to the Nibble-Nd of D
	44	BYMV	DP	Move the Byte-Ns of S to the Byte-Nd of D
	45	XCHG	DP	Exchange Da and Db
	46	SWAP	P	Swap the High-Byte of D with the Low-Byte of D
	47	UNIT	P	Take Nb0 of N words to form a Word
	48	DIST	P	Distribute N Nb of S to Nb0 of N Words
	49	BUNIT	P	Low byte of words re-unit
	50	BDIST	P	Words split into multi-byte
	160	RW-FR	DP	File register access
	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	SHFL	DP	Shift D left N bits
	52	SHFR	DP	Shift D right N bits
	53	ROTL	DP	Rotate D left N bits
	54	ROTR	DP	Rotate D right N bits
Code conversion	20	→BCD	DP	Convert S into BCD
	21	→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 Ns ~ Nl of S
	58	ENCOD	P	Encode the Ns ~ Nl of S
	59	→7SG	P	Convert N+1' Nb of S into 7-segment code
	60	→ASC	P	Convert character/number into ASCII code
	61	→SEC	P	Convert hour, minute, second by seconds
	62	→HMS	P	Convert second by 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)
	22	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
	76	TKEY	D	10 keys input convenient instruction
	77	HKEY	D	16 keys input convenient instruction
	78	DSW	D	Thumbwheel switch input convenient instruction
	79	7SGDL	D	7-segment multiplexing display convenient Instruction
	80	MUXI		Multiplexing input convenient instruction
	81	PLSO	D	Pulse output(PSO) instruction
	82	PWM		Pulse Width Modulation (PWM) output instruction
	83	SPD		Pulse speed detection instruction
	84	TDSP		7/16-segment LED display control
	86	TPCTL		PID temperature control
	139	HSPWM		High speed PWM pulse output

Category	NO.	Instruction	Derivative	Function
Accumulative Timer	87	T.01S		0.01S time base accumulative timer
	88	T.1S		0.1S time base accumulative timer
	89	T1S		1S time base accumulative timer
Monitor and control	90	WDT	P	Set watchdog timer
	91	RSWDT	P	Reset watchdog timer
HSC/HST	92	HSCTR	P	Read CV of hardware high speed counter/timer
	93	HSCTW	P	Write CV or PV of hardware high speed counter/timer
Text	94	ASCWR		Output ASCII message
Ascend/ Descend	95	RAMP		Ascending/Descending convenient instruction
	98	RAMP2		Tracking type RAMP function for D/A output
Com-munication	150	M-BUS		Modbus protocol communication
	151	CLINK		Fatek CPU link/Generic protocol communication
Table operation	100	R→T	DP	Move register Rs to the table Td
	101	T→R	DP	Move the Rp of table Ts to register Rd
	102	T→T	DP	Move the Rp of table Ts to the Rp of table Td
	103	BT_M	DP	Move table Ts to table Td
	104	T_SWP	DP	Swap Ta and Tb
	105	R-T_S	DP	Search Rs from table Ts
	106	T-T_C	DP	Compare table Ta and table Tb
	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	BKCMP	DP	Compare Rs with zone defined by two tables
	113	SORT	DP	Sort the table
Matrix operation	120	MAND	P	AND two matrixes
	121	MOR	P	OR two matrixes
	122	MXOR	P	Exclusive OR (XOR) two matrixes
	123	MXNR	P	Exclusive NOR (XNR) two matrixes
	124	MINV	P	Inverse matrix
	125	MCMP	P	Compare two matrixes and find out the differences between two matrixes
	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 bit whose value is 1 or 0 in the matrix
NC position control	140	HSPSO		High-speed pulse output
	141	MPARA		Set NC position parameters
	142	PSOFF	P	Force to stop pulse output
	143	PSCNV	P	Convert pulse count into mechanical value for display
	147	MHSPO		Multi-Axis high speed pulse output
	148	MPG		Manual pulse generator for positioning
Interrupt control	145	EN	P	Enable external input or peripheral interrupt
	146	DIS	P	Disable external input or peripheral interrupt
In Line Comparison Instructions	170	=	D	Equal to compare
	171	>	D	Greater than compare
	172	<	D	Less than compare
	173	<>	D	Not equal to compare
	174	>=	D	Greater than or equal to compare
	175	=<	D	Less than or equal to compare
Other	190	STAT		Read system status

Dimensions

Figure 1



W	Model
90mm	FBs-20M△,FBs-24M△,FBs-24XY FBs-16TC,FBs-16RTD
130mm	FBs-32M△,FBs-40M△,FBs-40XY
175mm	FBs-44MN△,FBs-60M△,FBs-60XY, FBs-30GM

Figure 2

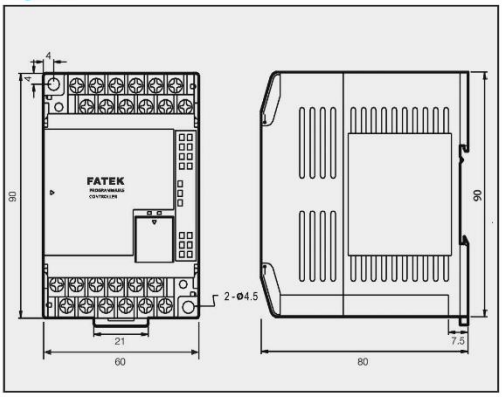


Figure 3

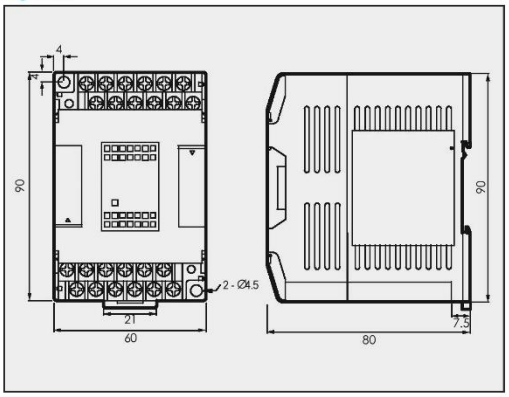


Figure 4

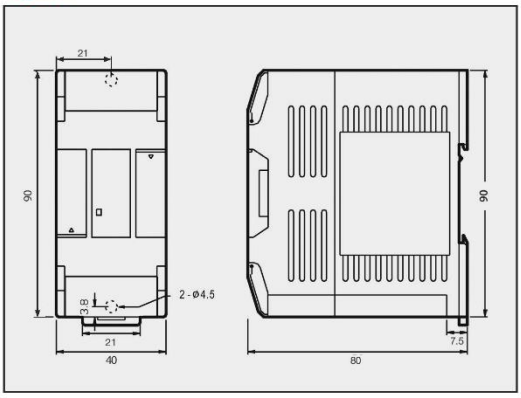


Figure 5

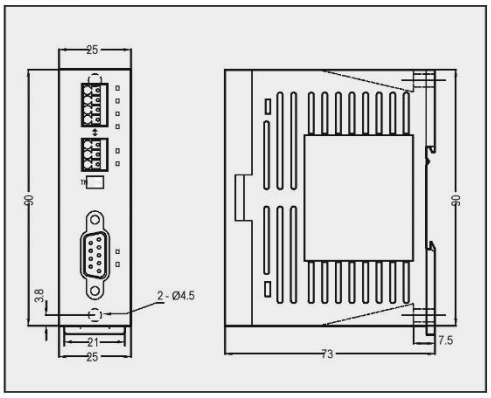


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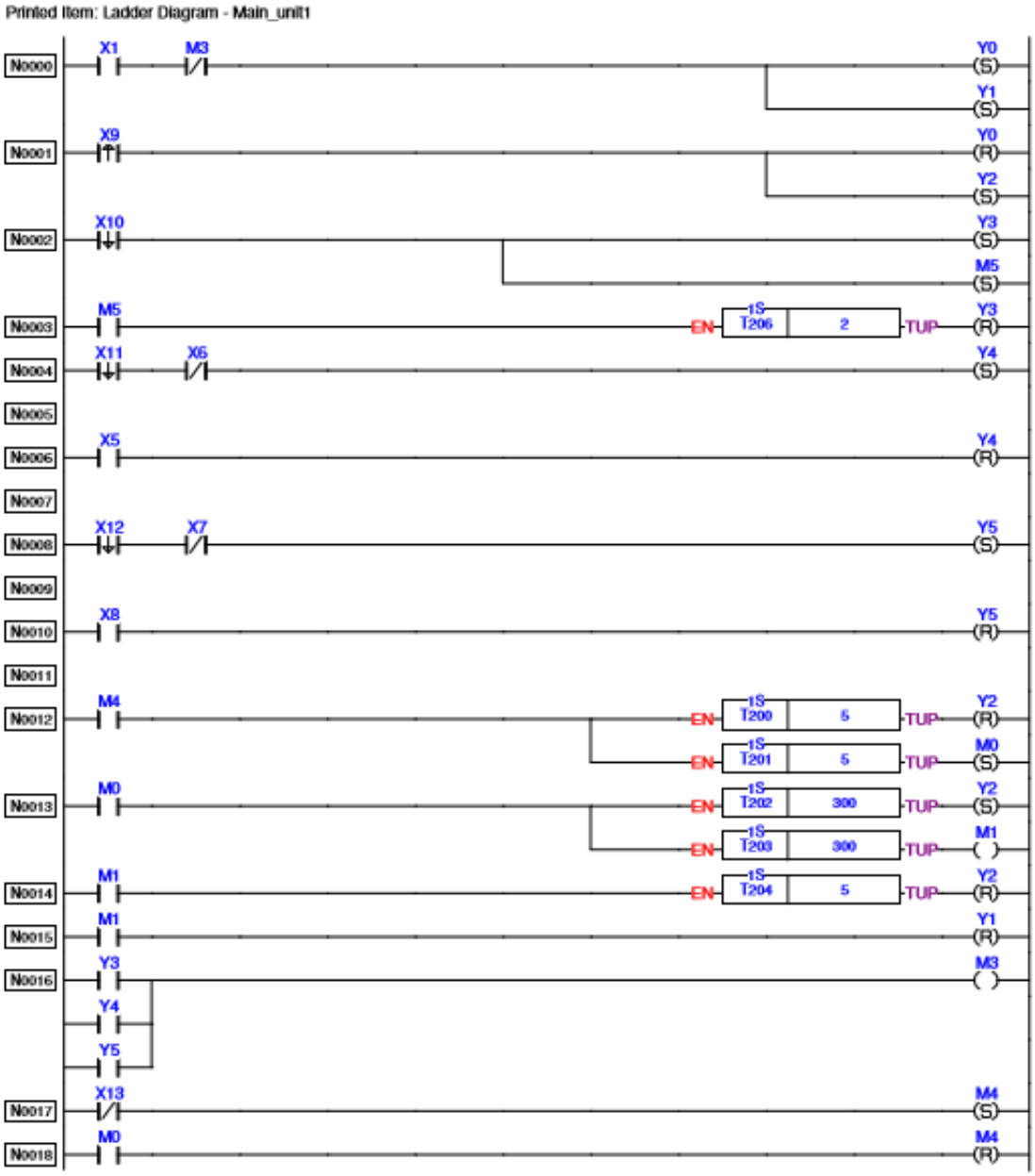
Table A. 3.1: PLC Output

Table A. 3.2: PLC Input

Output	symbol
Refrigerator Conveyor	Y0
Heater	Y1
Main conveyor	Y2
Sauce Pump	Y3
Cheese Valve	Y4
Vegetable Valve	Y5

Input	symbol
Coins Detector	X1
Forward cheese Valve	X5
Backward cheese Valve	X6
Backward Vegetable Valve	X7
Forward Vegetable Valve	X8
Refrigerator Sensor	X9
Sause sensor	X10
Cheese sensor	X11
Vegetable sensor	X12
Heater sensor	X13

PLC Code:


Printed Item: Ladder Diagram - Main_unit1
N0000
X1
M3
Y0
(S)
Y1
(S)
N0001
X9
Y0
(R)
Y2
(S)
N0002
X10
Y3
(S)
M5
(S)
N0003
M5
EN
1S
T206
2
TUP
Y3
(R)
N0004
X11
X6
Y4
(S)
N0005
N0006
X5
Y4
(R)
N0007
N0008
X12
X7
Y5
(S)
N0009
N0010
X8
Y5
(R)
N0011
N0012
M4
EN
1S
T200
5
TUP
Y2
(R)
EN
1S
T201
5
TUP
M0
(S)
N0013
M0
EN
1S
T202
300
TUP
Y2
(S)
EN
1S
T203
300
TUP
M1
( )
N0014
M1
EN
1S
T204
5
TUP
Y2
(R)
N0015
M1
Y1
(R)
N0016
Y3
M3
( )
Y4
Y5
N0017
X13
M4
(S)
N0018
M0
M4
(R)

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