Palestine Polytechnic University
College of Engineering
Electrical Engineering Department

Scrab Metal Crusher Machine Rehabilitation

Prepared by

Ahmad Shreim Mohammad Al Shanti

Supervisor

Prof. Sameer Khader

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➢ Abstract

A baler machine including a charging chamber for receiving material to be baled. The charging chamber has a charging passage through which material is forced into a baling compression chamber by a compression ram to thereby form a bale in the compression chamber. An ejection ram is provided for forcing the compressed material out of the baling compression chamber through an exit passageway. A movable decompression wall functions as one wall of the baling compression chamber. Such wall is located opposite and spaced from the charging passage through which material is forced from the charging chamber. A power cylinder is provided to move the decompression wall in a horizontal direction to effectively increase the volume of the baling compression chamber which, at the same time, increases the size of the exit passageway to thereby permit ejection of an oversized bale from the compression chamber.

➢ Problem Statement

The main problem with the machine is that it does not work correctly due to its lack of many operating tools, as it suffers from damages in the hydraulic pumps, it contains 6 pumps every 3 pumps on the motor, so the problem is that we do not know how to work in the sense that they all work once, or for each there is a pump stage, because there is no previous control panel explaining how the machine works.

➢ Objectives

The main objective for choosing this project is to:

1- Setup a electrical control panel.

2- Increase the efficiency of the machine.

3- Restoration of the hydraulic system.

4- Increase our experience in design and installing pneumatic systems.

➢ Motivation

The main motive for this project is:

1- Enhancing our skill in plc and software control.

2- Enhancing the machine effectiveness.

3- Developing our skills in build hydraulic.

➢ Needed Technology

The main elements that should use in the project:

1- Programmed logic controller (PLC).
2- Sensors.
3- Hydraulic system.
4- Coupling and adapting elements.

➢ Project Description

Scrap metal crusher is also called metal briquette machine, horizontal metal baler, hydraulic metal baler and so on. Its main purpose is to press the metal scraps into a specific shape to reduce the volume, so to facilitate storage, transportation, and recycling.

A baler machine has including a charging chamber for receiving material to be baled. The charging chamber has a charging passage through which it forces material into a baling compression chamber by a compression to thereby form a bale in the compression chamber. It provides an ejection ram for forcing the compressed material out of the baling compression chamber through an exit passageway. A movable decompression wall functions as one wall of the baling compression chamber. Such wall is located opposite and spaced from the charging passage through which it forces material from the charging chamber.

➢ Time Table

Time	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15
Reading research about hydraulic															
Design and simulation of the project															
Choose the pieces to be used in the project															
Write a project summary															
Building the control circuit, programming the project control unit, and the hydraulic															
Practical implementation of the project															

Chapter 2 Machine Operation Concepts

➢ Principle of Machine Operation

Metal crusher machine, as shown in figure 1, have an operation stages to complete the pressing process includes:

1- The scrap is placed in the booth, the scrap is usually large in size and low in weight.
2- The door is closed first, which works to cut the sides emerging from the cabin for scrap whose length exceeds the length of the cabin, and also works to compress the scrap from the top and tighten it at an appropriate height.
3- Two pistons move towards scrap to secure suitable width, which is usually the width of the exit door.
4- The huge piston moves towards the scrap, which usually reaches the maximum capacity of the system, and it is also the most important piston since it is the one that works to hold the scrap together.
5- At the end, the door for taking out is opened and the huge piston works to take the product out of the cabin.

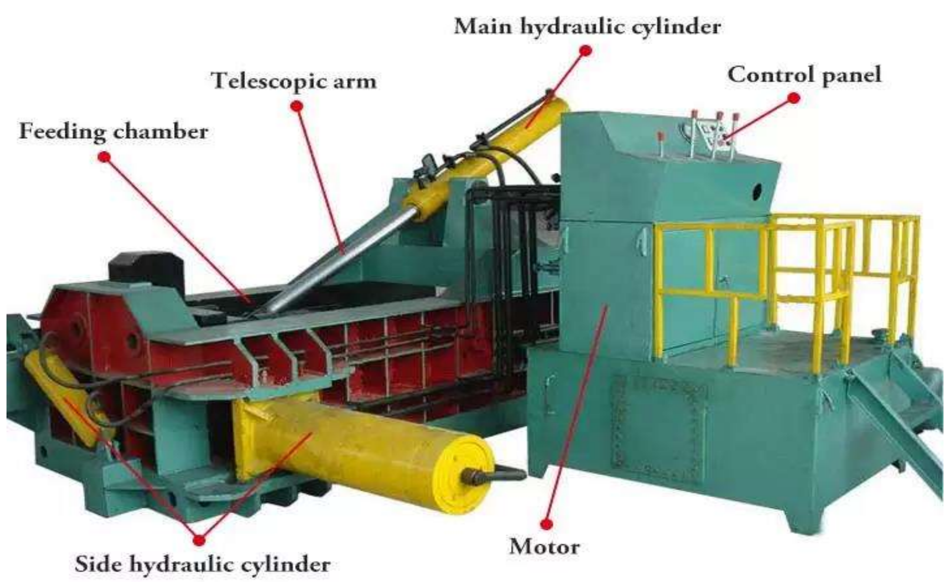

Figure 2.1 scrab metal crusher machine

➢ Machine Working principle

The machine relies on converting the mechanical energy generated by the motor into kinetic energy by means of hydraulic pumps.

1- **The electric motors are started**

An induction motor, as shown in figure 2.2, or asynchronous motor is an AC electric motor in which the electric current in the rotor needed to produce torque is obtained by electromagnetic induction from the magnetic field of the stator winding. An induction motor can therefore be made without electrical connections to the rotor

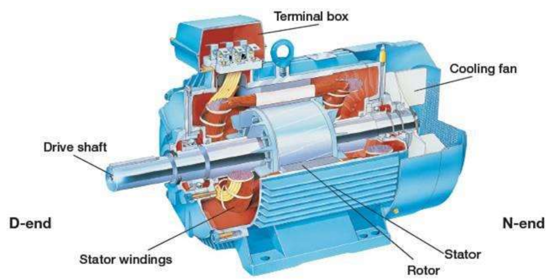

Figure 2.2:Induction motor

2- **Motor pumps rotate the pumps** [1]**.**

Hydraulic pumps are used in hydraulic drive systems and can be hydrostatic or hydrodynamic. A hydraulic pump is a mechanical energy source that converts mechanical energy into hydraulic energy (hydrostatic energy, i.e., flow and pressure). it generates a flow with enough force to overcome the pressure created by the load at the outlet of the pump. When the hydraulic pump works, it creates a vacuum at the inlet of the pump, forcing the fluid from the tank to the inlet line to the pump and through the mechanical action this fluid delivers to the pump an outlet and forcing it to the hydraulic system.

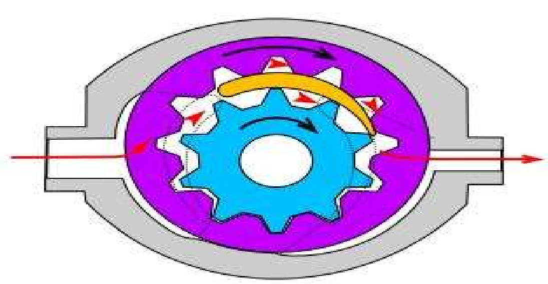

Figure 2.3:Pump Van

3- Power transmission and distribution stage (compressed oil) [1]

This stage is done by directional valve, as shown in figure 2.4, and hoses Directional control valves (DCVs) are one of the most fundamental parts of hydraulic and pneumatic systems. DCVs allow fluid flow (hydraulic oil, water or air) into different paths from one or more sources. DCVs will usually consist of a spool inside a cylinder which is mechanically or electrically actuated. The position of the spool restricts or permits flow; thus, it controls the fluid flow.

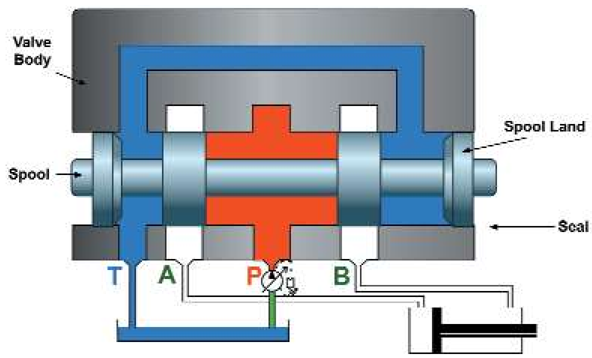

Figure 2.4:Directional valve

4- The rotational movement pushes the oil into the piston [1]

Hydraulic cylinders get their power from pressurized hydraulic fluid, which is typically oil. The hydraulic cylinder, as shown in figure 2.5, consists of a cylinder barrel, in which a piston connected to a piston rod moves back and forth. The barrel is closed on one end by the cylinder bottom (also called the cap) and the other end by the cylinder head (also called the gland) where the piston rod comes out of the cylinder. The piston has sliding rings and seals. The piston divides the inside of the cylinder into two chambers, the bottom chamber (cap end) and the piston rod side chamber (rod end/head-end).

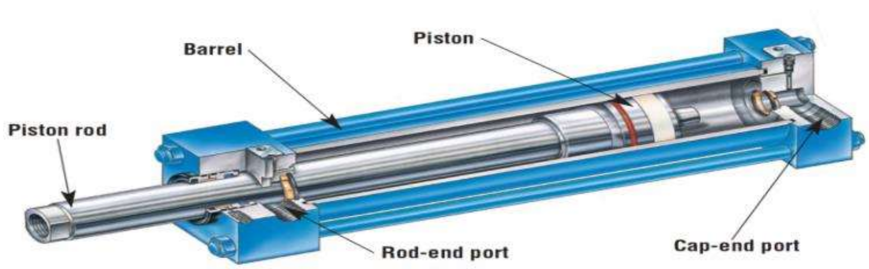

Figure 2.5:tow acting piston

➢ Functional Block Diagram

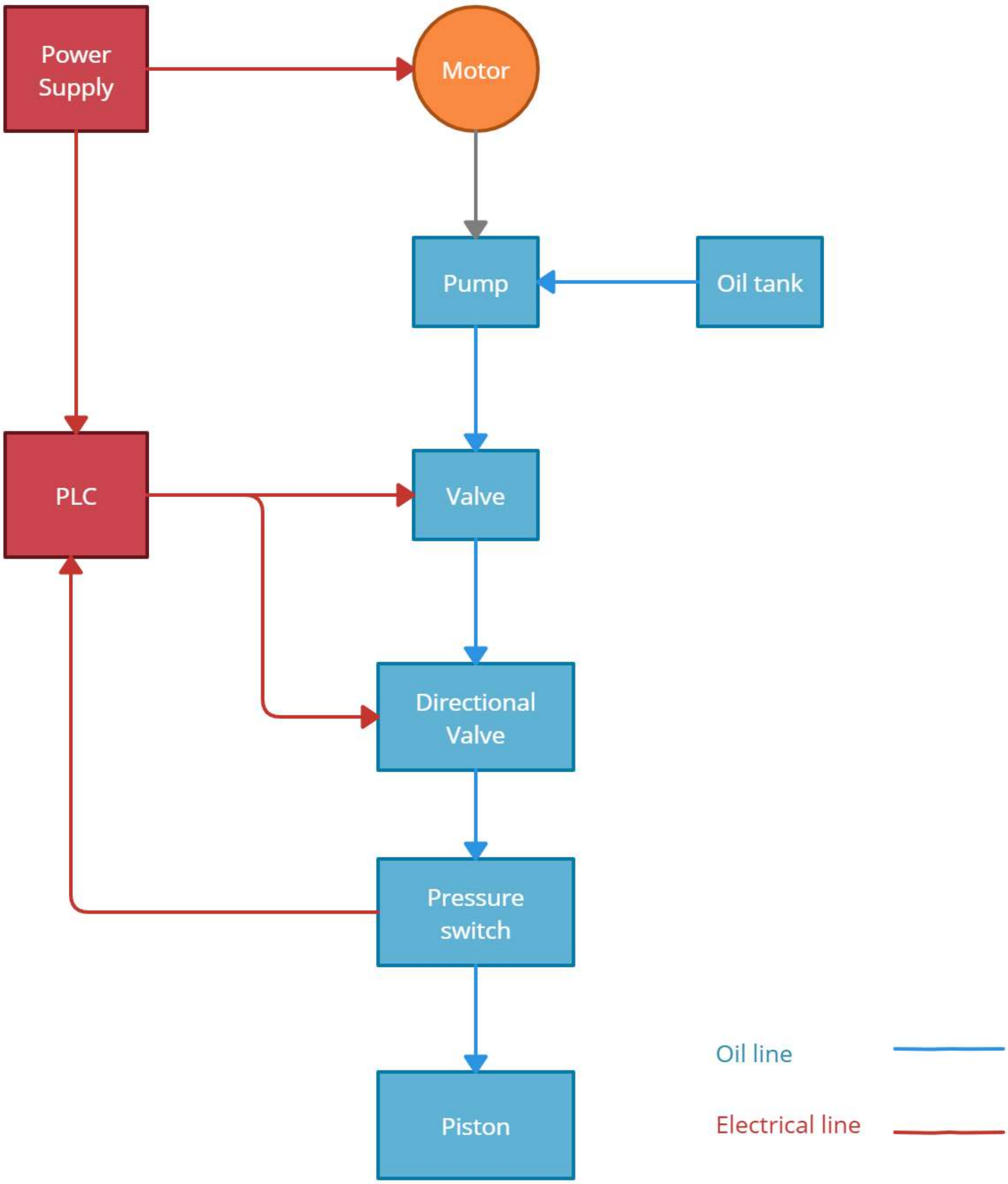

Figure 2.6:Functional Block Diagram

➢ Operational Flow Chart

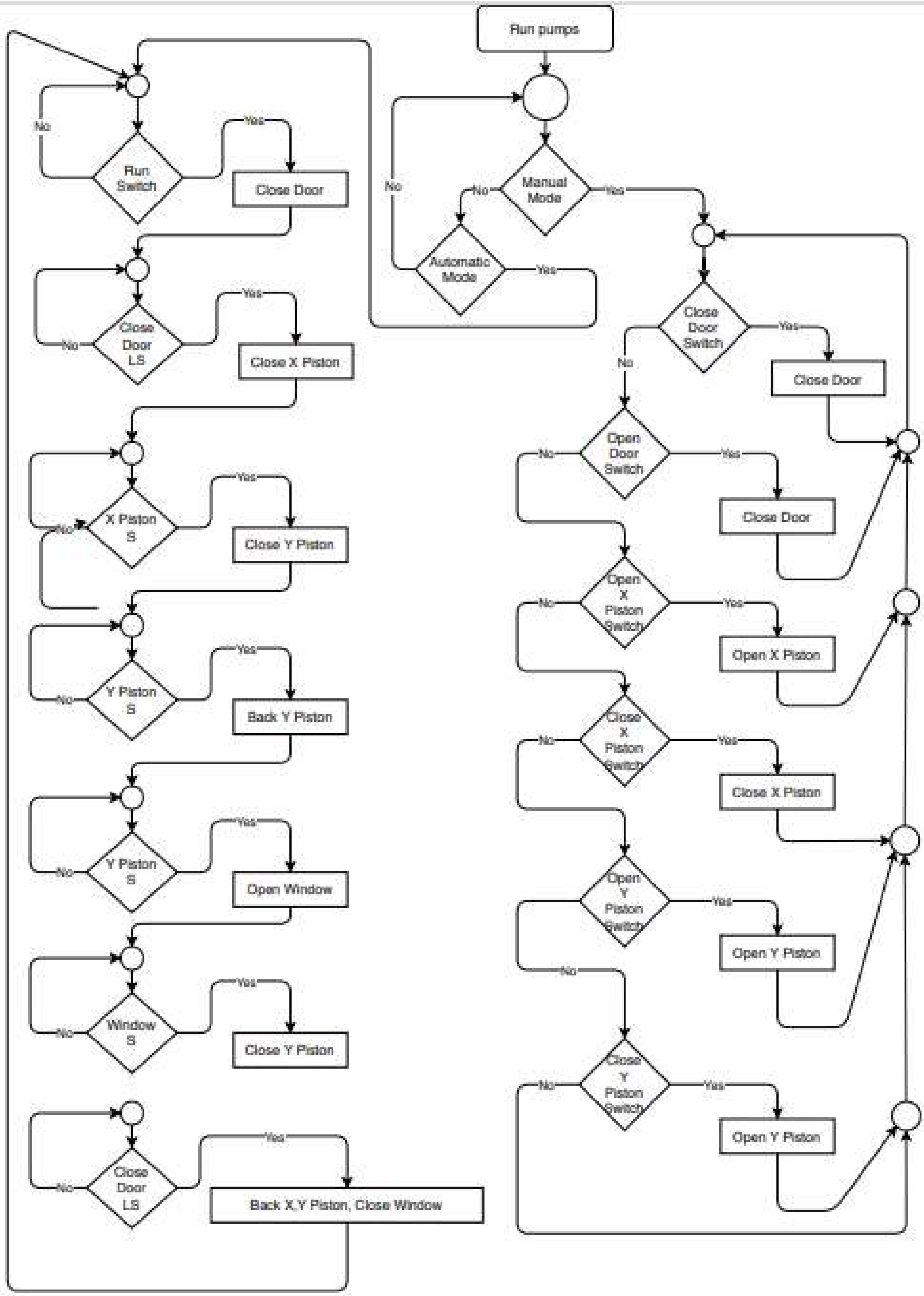

Figure 2.7:Operational Flow Chart

Chapter 3 Machine Design

3.1 Hydraulic design

3.2 Calculations Design

3.3 Hydraulic circuit

3.4 Machine Components

➢ Hydraulic design

I. **Hydraulic pump** [1]

The hydraulic system consists of 6 pumps and two motors, each 3 pumps are installed on the motor, each two pumps are vehicles in parallel, because each of the two pumps in parallel has a specific task, and also every two pumps differ in their types from the others.

1- The first and second type

A pump that gives high speed, i.e., high flow and low torque, its task is in the first stage of piston movement, which has low torque, so the pistons move at high speed and the pumps are of the van type, as shown in figure 3.1.

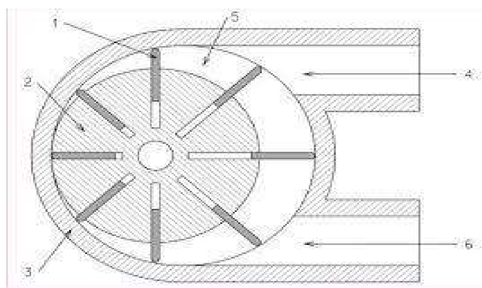

Figure 3.1:Pump van

2- The third type

The pump is low speed and high torque, and it reaches the final pressure of the system, because it overcomes the final assembly of scrap before leaving the system. And the pump is of the Bison type, as shown in figure 3.2.

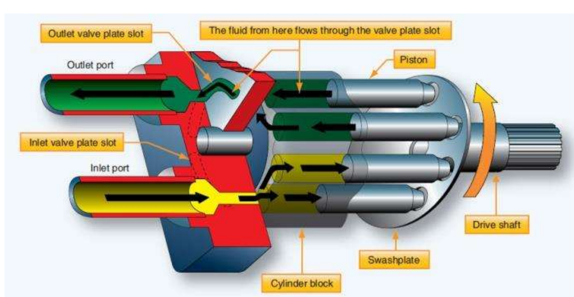

Figure 3.2:Piston pump

II. Valves:

The hydraulic system also consists of 6 valves + the king valve (main), the valves are naturally open and operate on electricity, and they have two ends, one end to the tank and one end to the king valve (the main). In the normal position, the pumps pump the oil tanker and when the electricity is connected to the valves, the pumps pump the oil to the main valve.

We used this method to make it easier for us to control the operation of the pumps. When we want to operate a pump on the load, we connect electricity to its trap, and when we want to disconnect it from the load, we disconnect the electricity from it.

III. Directional valve:

the main valve (king) is connected to the pilot and he distributes pressurized oil to the directional valves that move the pistons.

➢ Calculations design

The design starts with calculating the needed hydraulic elements as follows:

1. **Pistons Calculations** [2]

Referring to figure 3.3, the piston door size and power can be found as follow:

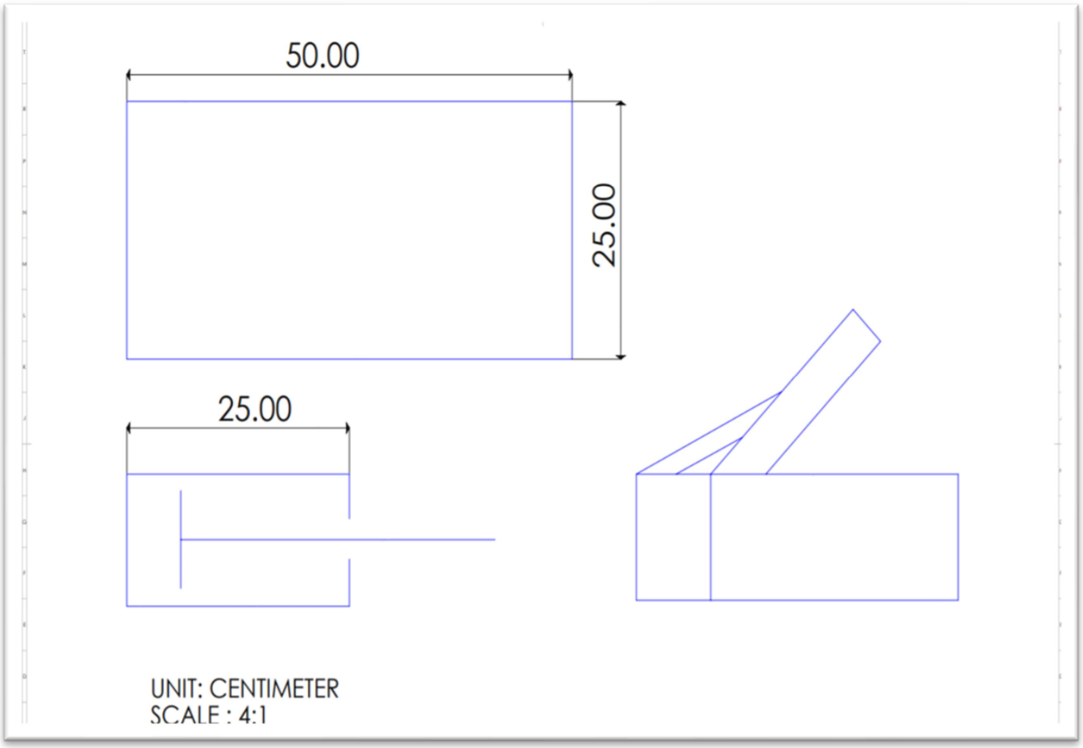

Figure 3.3:Door and Piston design

$$Section\ area\ A = \pi r^2\ , r: radus\ of\ the\ piston \qquad (3.1)$$
$$A = 3.14 \times 9^2 = 254.43\ cm^2$$

$$Volume\ of\ the\ piston = A \times L\ ,\quad A: piston\ sectional\ area, L: Length\ of\ the\ pistn \quad (3.2)$$
$$V = 254.34 \times 100\ = 25.4\ Liter$$

$$for\ closing\ the\ door\ of\ the\ press\ is\ about\ 2.5s$$

$$Flow\ rate\ of\ Hydrolic\ oil\ Q = \frac{V}{t} \times 60\ , t: time \qquad (3.3)$$
$$Q = \frac{25.4}{2.5} \times 60 = 609.6\ {}^{Liter}/_{minute}$$

the maximum working pressure that should be applied to the jack (from manual serves) is 275 bar

The 2-parallel piston's (Z), as shown in figure 3.4:

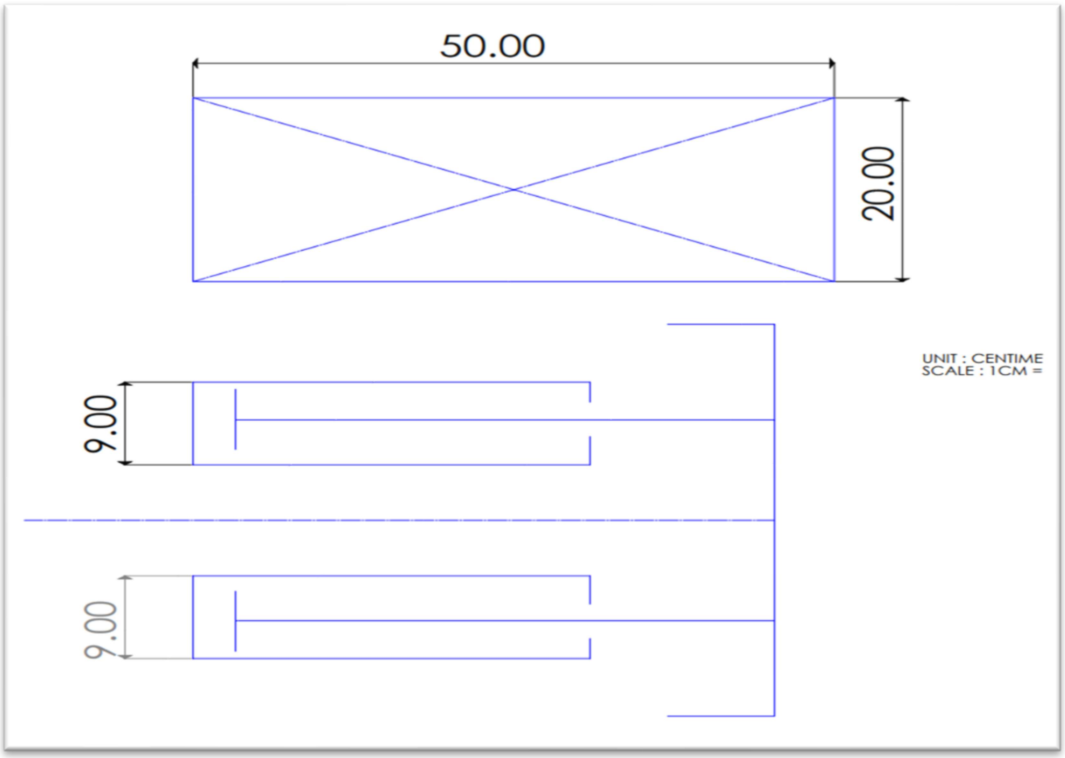

Figure 3.4:Z Pistons design

$$A = \pi r^2 = 3.14 \times 9^2 = 254.3\ cm^2$$

$$A_{total} = 2 \times A \quad (using\ 2\ pistons)$$

$$A_{total} = 2 \times 254.3 = 508.6\ cm^2$$

$$V = A_{total} \times L = 508.6 \times 100\ cm = 50.86\ L$$

for closing the 2 pistons of the press is about 5 second

$$Oil\ flow\ rate\ Q = \frac{V}{t} \times 60 = \frac{80.8}{5} \times 60 = 609\ {}^{L}/_{m}$$

the maximum working pressure that should be applied to the jak (from the manual series) is 290 bar

- The final piston, as shown in figure 3.5

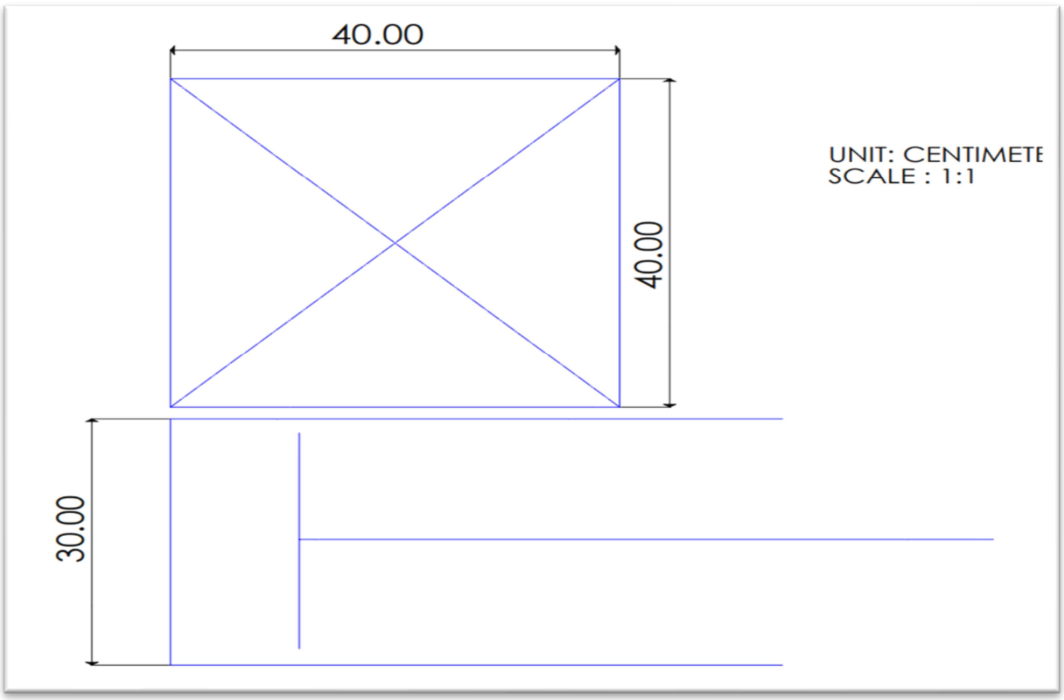

Figure 3.5:Bale Exit Piston

$$A = \pi r^2 = 3.14 * 15^2 = 706.5$$

$$V = A \times L = 706.5 \times 100\ cm = 706500\ cc = 70.65\ L$$

$$Q = \frac{V}{t}\ , t: time\ for\ closing = 5s$$

$$Q = \frac{70.65}{5} \times 60 = 847.2\ {}^{L}/_{s}$$

And from (the manual series) we need 130 kg /cm

$$Bale\ exit\ area = Length\ \times width \qquad (3.4)$$

$$= 40 \times 40 = 1600\ cm^2$$

$$F = 130 \times 1600 = 208000N$$

$$P = \frac{F}{A} = \frac{208000}{706.5} = 300\ bar$$

2. **Motor and pump** [1]

Considering the electrical power available in the factor and the pumps in the local market we adopted the motor power 75 HP

Pump

If we calculate the capacity of the pump that we want, we will see that it is very large and not available in the market as following calculations

$$pump\ power = \frac{P \times Q}{600}, P: Pump\ Pressure \qquad (3.5)$$

$$Q = 609\ {}^{L}/_{m}\ and\ P = 306\ bar$$

$$Pump\ power = \frac{306 \times 609}{600} = 310\ KW = 416\ HP$$

And these is not available in the market, so we well divide the pressure into the stages, as explained previously

Stage (1)

Tow pumps at 100 bar

$$Pump\ Pressure = \frac{motor\ power\ \times 600}{Q} = \frac{55kW\ \times 600}{334} = 98.5\ bar$$

So, in first stage we will get a pressure approximately at 100 par and 670 L/m from the tow pump because the tow pump connected parallel

Stage (2)

Two pumps

$$power\ pump = \frac{55kW \times 600}{160} = 206\ bar$$

So, in second stage we will get P =206 bar and Q = 320 L/m from tow pump that connected parallel

Stage (3): two pumps

$$Power\ pump = \frac{55\ kW\ \times 600}{110} = 300\ bar$$

In third stage we will get pressure = 300 bar and Q = 220 L/m form tow pump connected parallel, so the maximum pressure we get is 300 bar and the maximum Q we get 670 L/m and that we need

Motor power = 55 kw, Maximum press = 300 bar, Maximum Q = 609 L/m

➢ hydraulic circuit

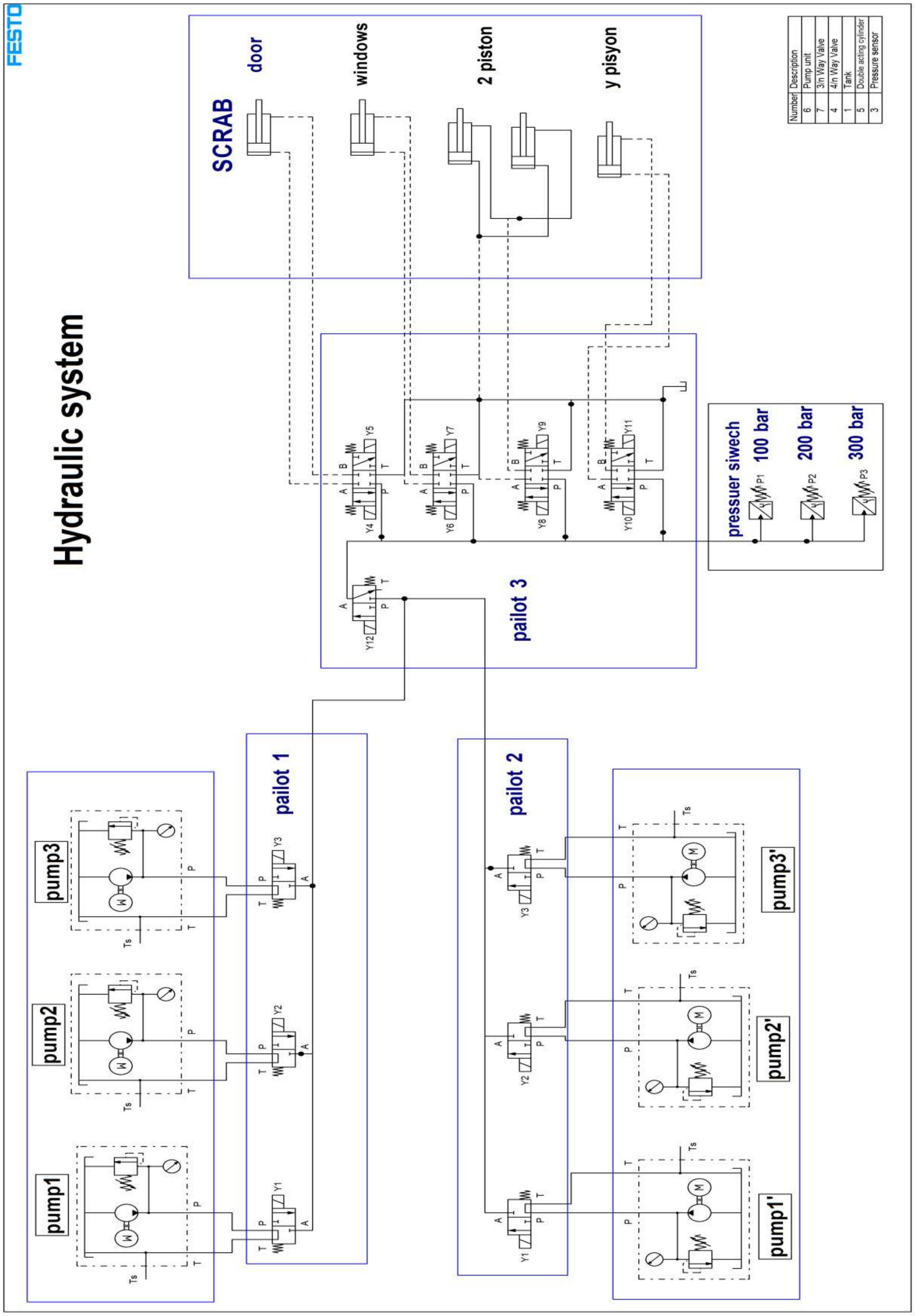

Figure 3.6:Hydraulic circuit

➢ Machine Components

- **Pressure sensor (switch)** [3]

Figure 3.7:Pressure sensor

The electrical switching element in a pressure switch as shown in figure 3.7, opens and closes an electrical circuit in response to the actuating force received from the pressure-sensing element.

There are two types of switching elements:

1. Normally open

2. Normally closed.

A normally open switching element is one in which the current can flow through the switching element only when it is actuated. The plunger pin is held down by a snap action leaf spring and force must be applied to the plunger pin to close the circuit. This is done by an electrical coil which generates an electromagnetic field, when current flows through it. In a normally closed switch, current flows through the switching element until the element is actuated, at which point it opens and breaks the current flow.

- solenoid valve [4]

Figure 3.8:solenoid valve

A solenoid valve, as shown in figure 3.8, is an electrically controlled valve. The valve features a solenoid, which is an electric coil with a movable ferromagnetic core (plunger) in its centre. In the rest position, the plunger closes off a small orifice. An electric current through the coil creates a magnetic field. The magnetic field exerts an upwards force on the plunger opening the orifice. This is the basic principle that is used to open and close solenoid valves.

- 4/3Way Valve [4]

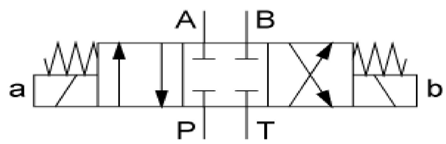

Figure 3.9:Directional valve

The directional control valves, as shown in figure 3.9, can be used to start, stop, and to change the fluid flow in a hydraulic system. The major function of a directional control valve is to control the direction of flow in hydraulic systems. They are capable to determine the path through which the fluid should flow in a circuit. We can use the directional control valve to direct the inlet flow to a specific outlet port. Directional control valves are classified according to certain factors like inlet control element structure, number of ports or ways, number of positions, method of actuation, and centre position flow pattern. In a directional control valve, the internal control element would be a sliding spool, rotary spool or ball. The construction and design of the directional control valves make it suitable for different applications.

Chapter 4 Electrical Design

➢ Protection and control devices

To protect the machine, we had to use protection devices, as we will explain:

1- Circuit Breaker [5]

Figure 4.1:Circuit breaker

Circuit breaker, as shown in figure 4.1, essentially consists of fixed and moving contacts. These contacts are touching each other and carrying the current under normal conditions when the circuit is closed. When the circuit breaker is closed, the current carrying contacts, called the electrodes, engaged each other under the pressure of a spring.

During the normal operating condition, the arms of the circuit breaker can be opened or closed for a switching and maintenance of the system. To open the circuit breaker, only a pressure is required to be applied to a trigger.

In the board we are working on, we used a 163-amp circuit breaker on the basis that we have two motors with a combined power of 150 horsepower and electrical coils.

And we used circuit breakers for each motor. Its value is 80 ampere and circuit breaker are 20 amperes for the control circuit.

2- Over load [5]

Figure 4.2:Over load

When the motor draws excess current, it is referred to as an overload. This may cause overheating of the motor and damage the windings of the motor. Because of this, it is important to protect the motor, motor branch circuit, and motor branch circuit components from overload conditions. Overload relays, as shown in figure 19, protect the motor, motor branch circuit, and motor branch circuit components from excessive heat from the overload condition. Overload relays are part of the motor starter (assembly of contactor plus overload relay). They protect the motor by monitoring the current flowing in the circuit. If the current rises above a certain limit over a certain period of time, then the overload relay will trip, operating an auxiliary contact which interrupts the motor control circuit, de-energizing the contactor. This leads to the removal of the power to the motor. Without power, the motor and motor circuit components do not overheat and become damaged. The overload relay can be reset manually, and some overload relays will reset automatically after a certain period of time. After which, the motor can be restarted.

➢ Power circuit

To run two motors, we will use the Star / Delta method for several reasons:

1- Low conductance
2- Suitable for high power motors
3- Easy to install and maintain

The Star-Delta connection, as shown in figure 4.3, is used in large-sized electric motors and where we need a large torque at the start of operation only, i.e. for a few seconds, and there is a time timer that converts the electrical circuit connection from Star to Delta and at the beginning of operation the curtain connection works, which is the star, which gives less speed but more torque In order for the electric motor to start rotating and after a specified period in seconds, the timer switches the connection to delta after the electric motor has assumed its required speed

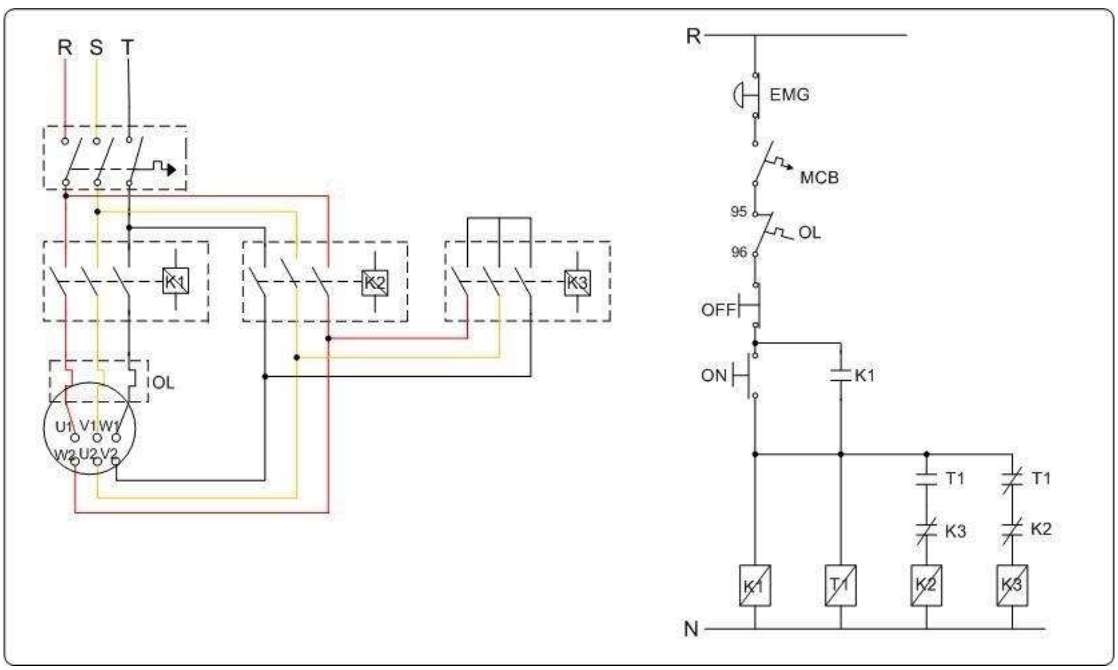

Figure 4.3:Star-Delta Connection

➢ Control Circuit

The control panel is based on PLC, and contains relay, Push-button and limit switches.

1- Mitsubishi PLC

A programmable logic controller (PLC) microprocessor-based piece of hardware that is specifically designed to operate in the industrial environment. The PLC type that will be used is plc Mitsubishi fx1s,as shown in figure 21, that has 48 inputs and 40 outputs. We chose delta PLC because of its good quality, it is easy to be programmed, has accepted price and meet the required purpose.

Figure 4.4:Mitsubishi PLC

2- Relay [5]

Figure 4.5:Relay

A Relay, as shown in figure 4.5, is an electromechanical device that can be used to make or break an electrical connection. It consists of a flexible moving mechanical part which can be controlled electronically through an electromagnet, basically, a relay is just like a mechanical switch but you can control it with an electronic signal instead of manually turning it on or off. Again, this working principle of relay fits only for the electromechanical relay.

3- limit switches

Figure 4.6:Limit Switch

limit switch, as shown in figure 4.6, is a switch operated by the motion of a machine part or presence of an object. They are used for controlling machinery as part of a control system, as a safety interlocks, or to count objects passing a point. A limit switch is an electromechanical device that consists of an actuator mechanically linked to a set of contacts. When an object comes into contact with the actuator, the device operates the contacts to make or break an electrical connection.

4- Push-button

Figure 4.7:Push-button

Push button, as shown in figure 4.7 switches have three parts. The actuator, stationary contacts, and the grooves. The actuator will go all the way through the switch and into a thin cylinder at the bottom. Inside is a movable contact and spring. When someone presses the button, it touches with the stationary contacts, causing the action to take place. In some cases, the user needs to keep holding the button, or to press it repeatedly, for an action to take place. With other push buttons, a latch connects and keeps the switch on until the user presses the button again.

- Table of inputs and outputs

1- input

X0	Limit switch DOOR	NC
X1	Limit switch DOOR	NC
X2	Limit switch 2PISTON	NC
X3	Limit switch 2PISTON	NC
X4	Limit switch WINDOWS	NC
X5	Limit switch WINDOWS	NC
X6	Limit switch FINAL PIATON	NC
X7	Limit switch FINAL PIATON	NC
X8	PUSH BUOTTON DOOR OPEN	NO
X9	PUSH BUOTTON DOOR CLOSE	NO
X10	PUSH BUOTTON WINDOWS OPEN	NO
X11	PUSH BUOTTON WINDOWS CLOSE	NO
X12	PUSH BUOTTON 2PISTON OPEN	NO
X13	PUSH BUOTTON2PISTON CLOSE	NO
X14	PUSH BUOTTON FINAL PIATON OPEN	NO
X15	PUSH BUOTTON FINAL PIATON CLOSE	NO
X16	SWITCH MANUL	NO
X17	SWITCH AUTOMATIC	NO
X18	PRESSUER SWTICH	NC
X19	PRESSUER SWTICH	NC
X20	PRESSUER SWTICH	NC

Table 4-1: Inputs of PLC

2- outputs

Y0	solenoid valve	CONTOL PUMP
Y1	solenoid valve	CONTOL PUMP
Y2	solenoid valve	CONTOL PUMP
Y3	solenoid valve	CONTOL PUMP
Y4	solenoid valve	CONTOL PUMP
Y5	solenoid valve	CONTOL PUMP
Y6	solenoid valve	CONTROL PAILOT 3
Y7	4/3Way Valve	PISTON DOOR
Y8	4/3Way Valve	PISTON WINDOWS
Y9	4/3Way Valve	PISTON FINAL
Y10	4/3Way Valve	2 PISTON

Table 4-2: Outputs of PLC

➢ Control Panel circuit

Number	Description
12	Valve solenoid
12	Relay
8	Pushbutton (make)
1	Pushbutton (changeover)
3	Pressure sensor
20	Make switch
2	Logic module
1	Electrical connection 24V
1	Electrical connection 0V

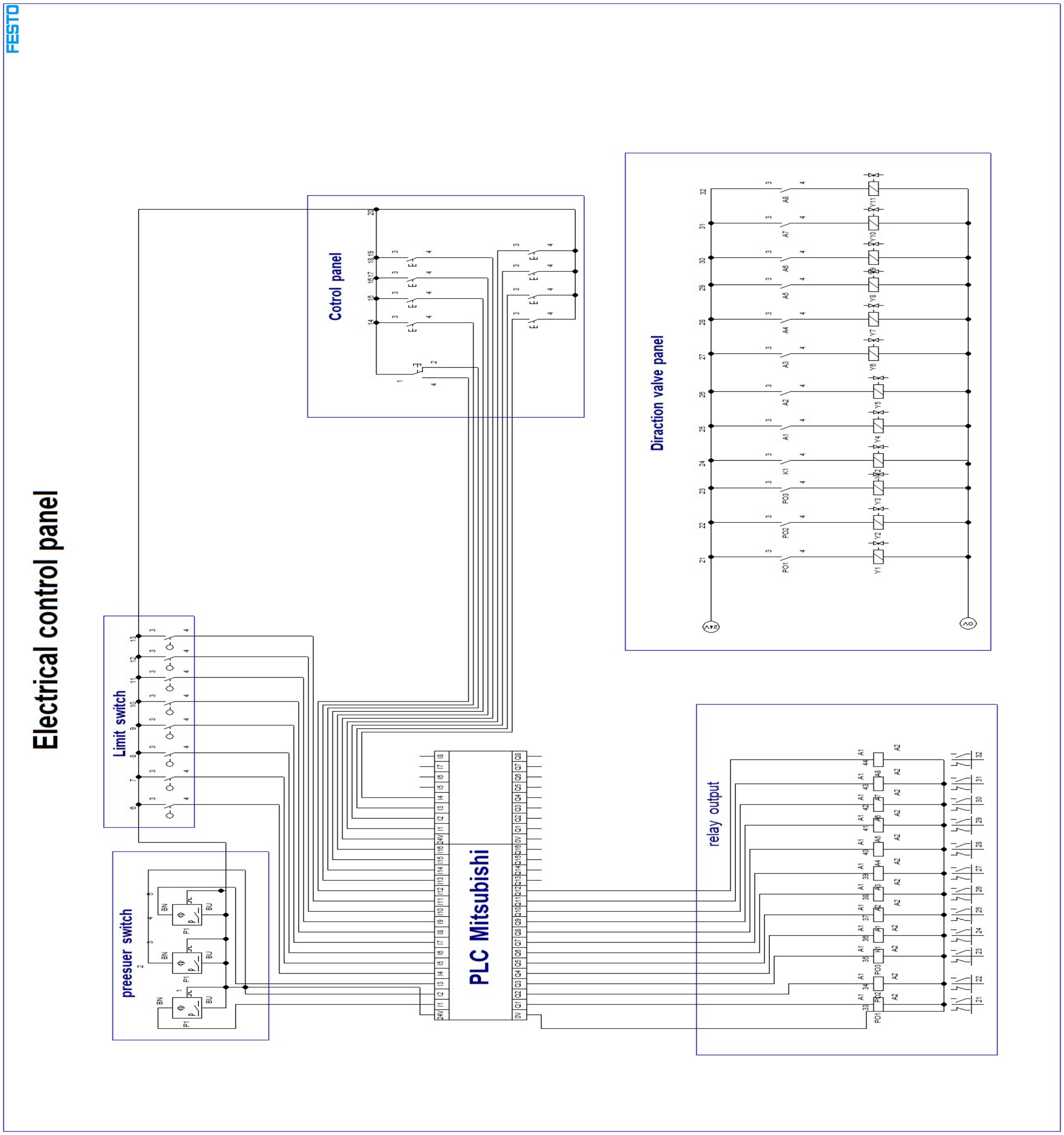

Figure 4.8:Electrical control panel

Chapter 5 Results and Conclusion

➢ Results:

Figure 5.1:Scrab Metal Crusher Machine after installation

- After assembling and installing the required parts in the machine, the machine was started-up, and the required operations were successfully carried out.
- the pressing process was carried out in the machine in a period of time not exceeding 40 seconds, depending on the final pressure, and it was put into service.
- Oil pressure in hydraulic presses up to 300 bar.
- The three stages of hydraulic pressure in the machine work in parallel depending on the appropriate amount of pressure in each stage.
- At the end of the work, a regular metal bale comes out as shown in figure 5.2, conforming to the general specifications

Figure 5.2:Bale from pressing process

➢ Conclusion:

After operating the machine, the results showed the importance of programmed logic control systems in the operation of industrial machines, as a result of the wide possibility of implementing integrated software applications, in addition to employing measurement systems and sensors in the work of these controllers to operate machines within highly efficient procedures.

➢ Recommendations:

- Installing a system to secure the risks while working in the machine.
- Emphasize the importance of regular maintenance of the machine.

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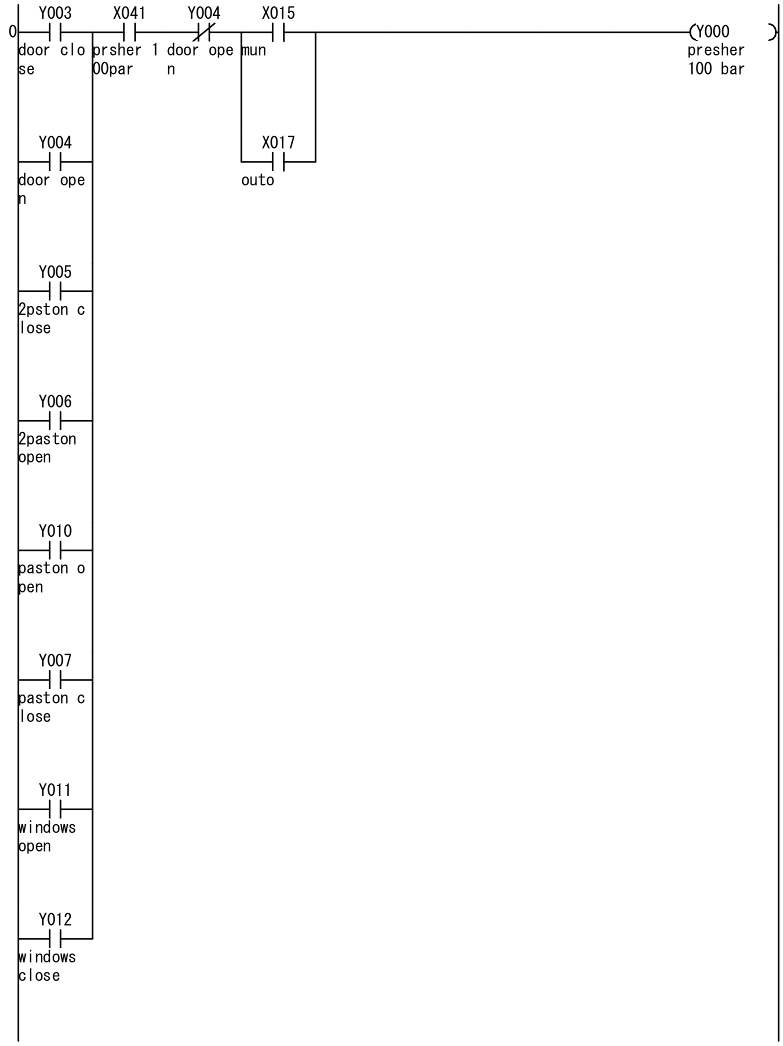
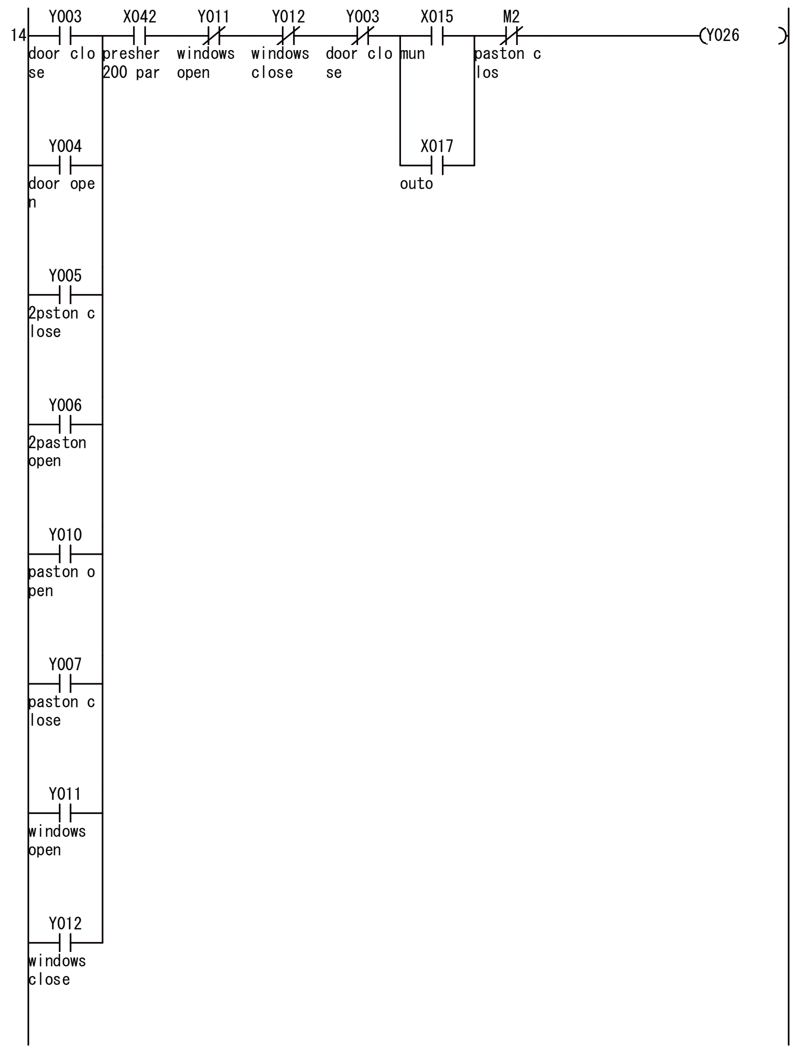
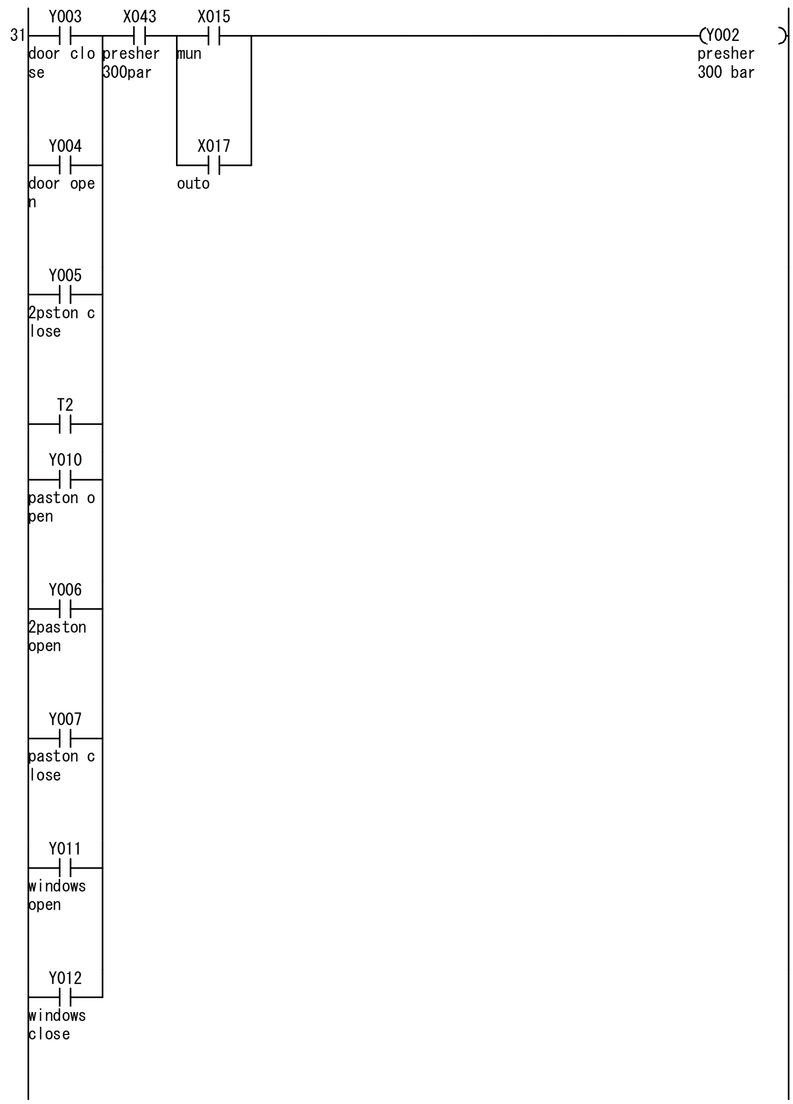
[6] Flurscheim, Charles, Power Circuit Breaker Theory and Design, 1982.

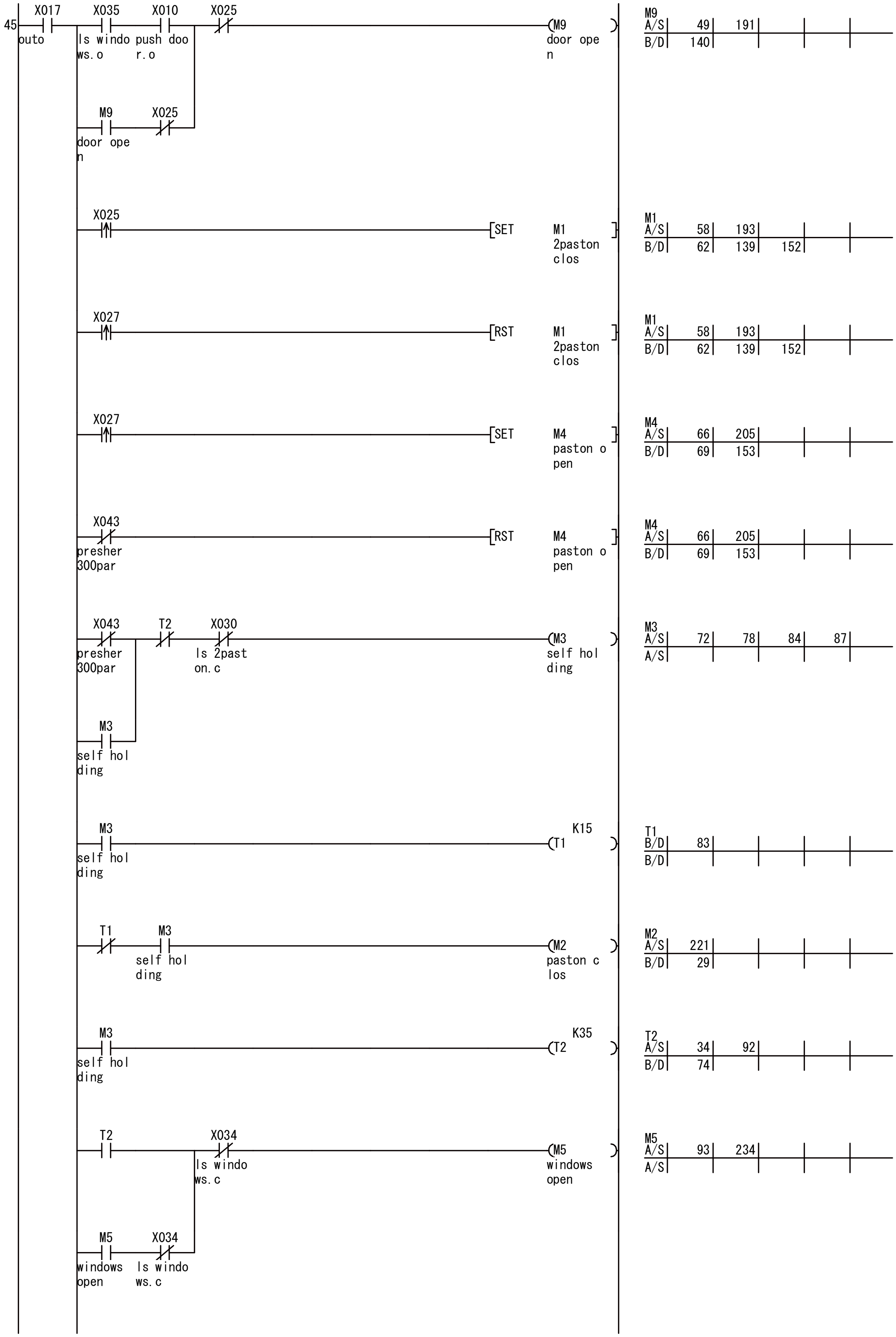
Appendix

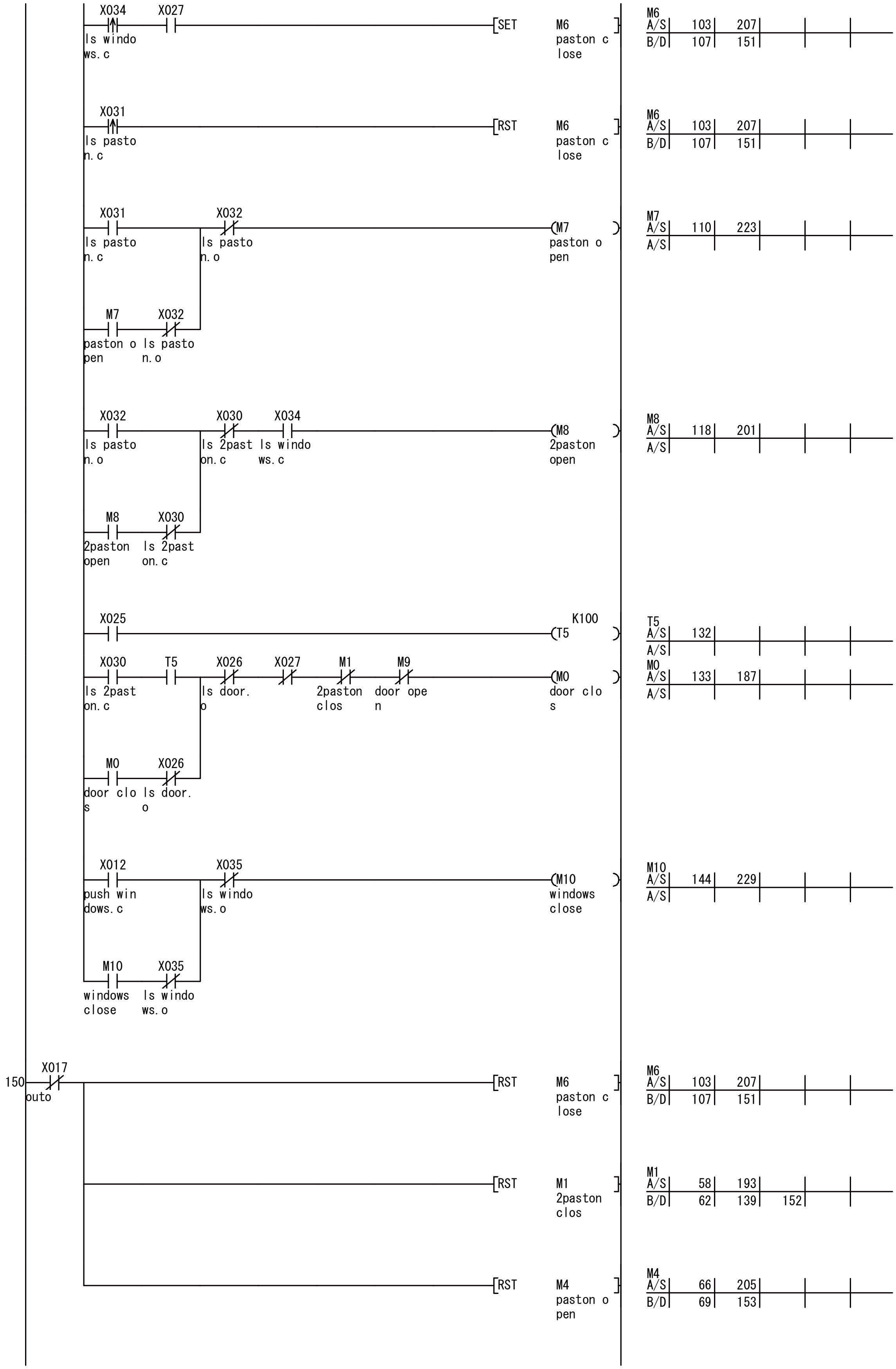
Model	Nominal Force (kn)	Press Box Size (lxwxh)(mm)	Bale Size (wxh)(mm)	Bale Density (kg/m³)	Capacity (kg/h)	Cycle Time (s)
HC81T-1250A	1250	1200×700×600	(250-450) ×300×300	≥1800	1500-2000	80
HC81T-1600A	1600	1600×1000×800	(400-600) ×350×350 (400-600) ×400×400 /Octagon	≥1800	2000-3000	150
HC81T-1600B	1600	1600×1200×800	(400-600) ×350×350 (400-650) ×400×400	≥1800	2000-3000	160
HC81T-2000A	2000	1600×1200×800	(400-700) ×400×400	≥1800	2500-4000	160
HC81T-2000B	2000	1800×1400×900	(400-700) ×400×400	≥1800	2500-4000	160
HC81T-2500A	2500	2000×1400×900	(400-700) ×500×500	≥1800	3500-5000	160
HC81T-2500B	2500	2000×1400×1200	(450-800) ×600×600	≥1800	3500-5000	160
HC81T-3150A	3150	2000×1400×1200	(450-700) ×600×600	≥1800	3500-5000	160
HC81T-3150B	3150	2600×1750×1200	(450-800) ×650×650	≥1800	4000-5000	160
HC81T-4000A	4000	2600×1750×1200	(500-1000) ×650×650	≥1800	5000-6500	160
HC81T-4000B	4000	3000×2000×1200	(600-1100) ×600×700	≥1800	6000-8500	160
HC81T-5000	5000	5000×2000×1200	(600-1100) ×600×700	≥1800	9000-11500	180

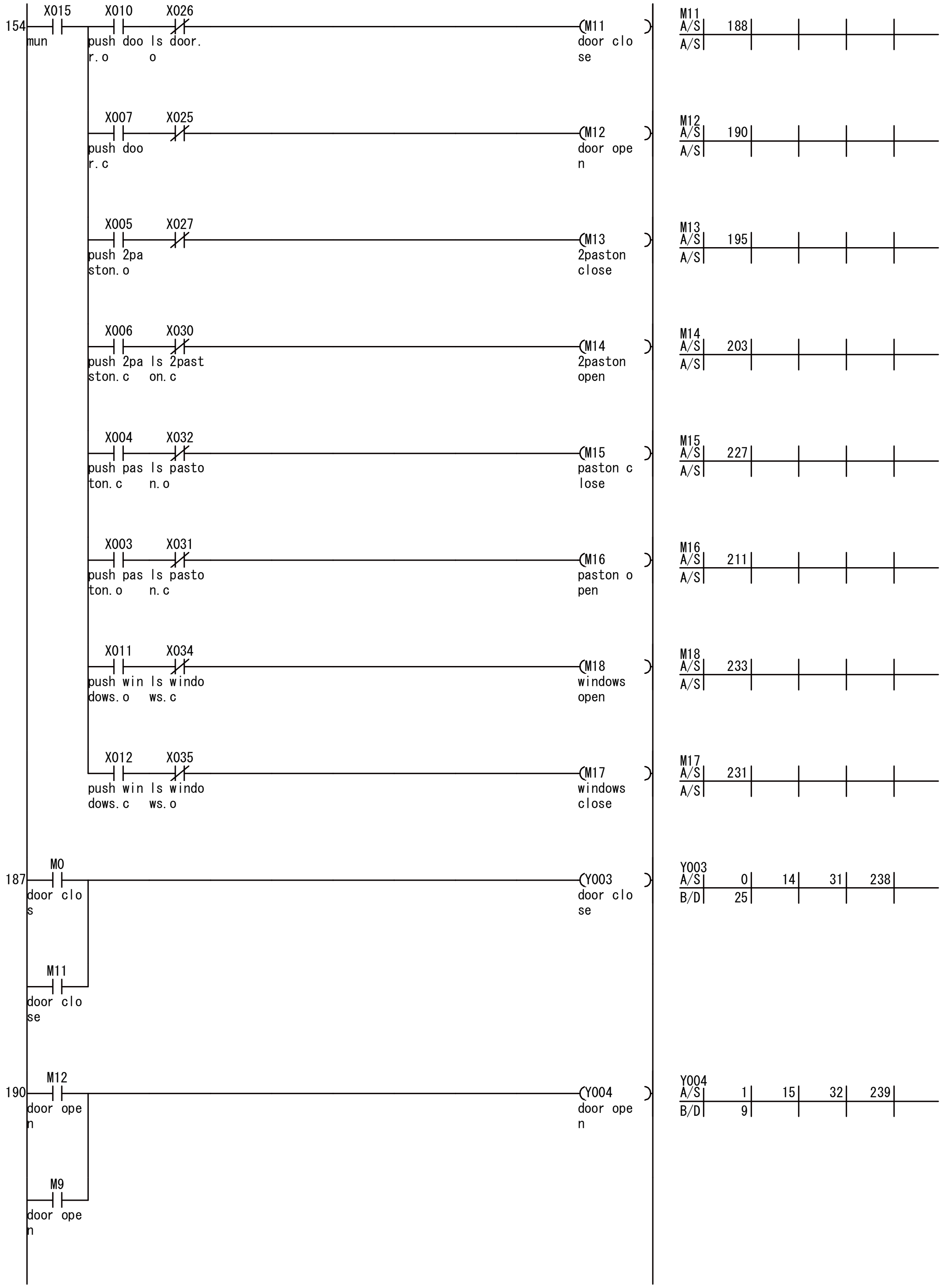

0
Y003
door clo
se
X041
prsher 1
00par
Y004
door ope
n
X015
mun
X017
outo
Y000
presher
100 bar
Y004
door ope
n
Y005
2pston c
lose
Y006
2paston
open
Y010
paston o
pen
Y007
paston c
lose
Y011
windows
open
Y012
windows
close

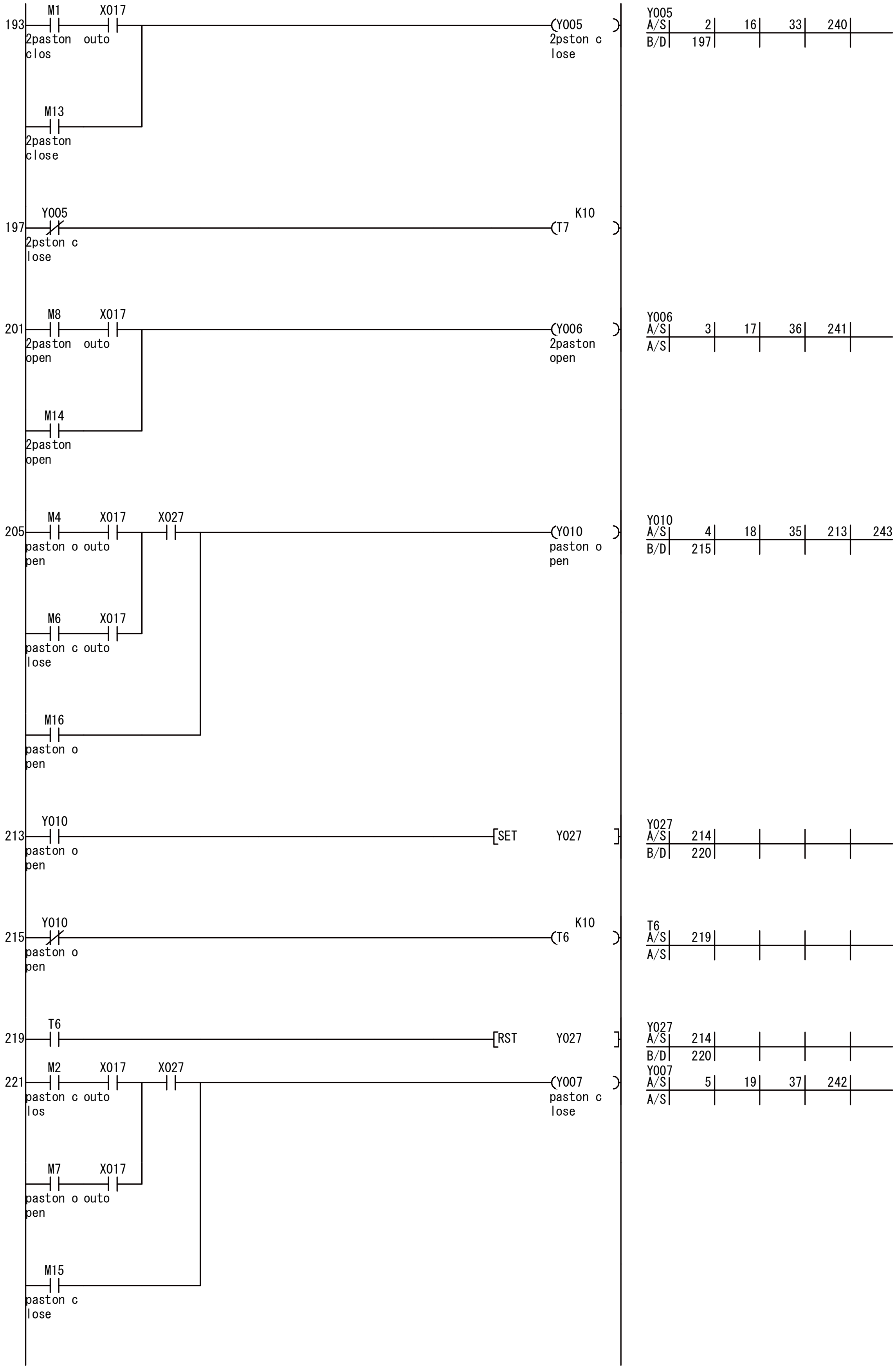

14
Y003
door close
X042
presher 200 par
Y011
windows open
Y012
windows close
Y003
door close
X015
mun
M2
paston clos
Y026
Y004
door open
X017
outo
Y005
2pston close
Y006
2paston open
Y010
paston open
Y007
paston close
Y011
windows open
Y012
windows close

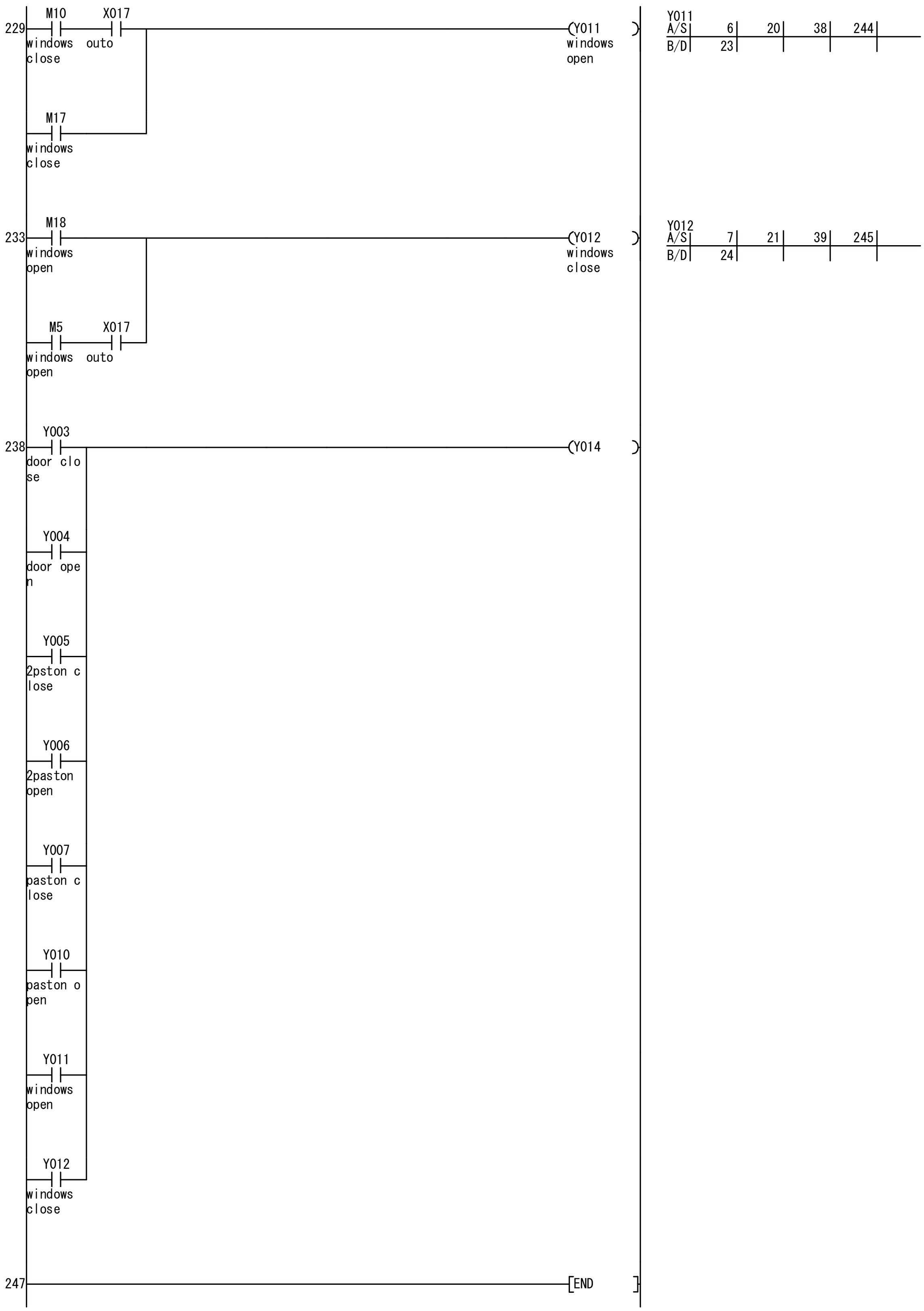

31
Y003
door close
X043
presher 300par
X015
mun
Y002
presher 300 bar
Y004
door open
X017
outo
Y005
2pston close
T2
Y010
paston open
Y006
2paston open
Y007
paston close
Y011
windows open
Y012
windows close


45
X017
outo
X035
ls windo ws.o
X010
push door.o
X025
M9
door open
M9 door open
X025
X025
SET M1 2paston clos
X027
RST M1 2paston clos
X027
SET M4 paston open
X043
presher 300par
RST M4 paston open
X043
presher 300par
T2
X030
ls 2paston.c
M3 self holding
M3 self holding
M3 self holding
K15
T1
T1
M3 self holding
M2 paston clos
M3 self holding
K35
T2
T2
X034
ls windows.c
M5 windows open
M5 windows open
X034 ls windows.c
M9 A/S 49 191 B/D 140
M1 A/S 58 193 B/D 62 139 152
M1 A/S 58 193 B/D 62 139 152
M4 A/S 66 205 B/D 69 153
M4 A/S 66 205 B/D 69 153
M3 A/S 72 78 84 87 A/S
T1 B/D 83 B/D
M2 A/S 221 B/D 29
T2 A/S 34 92 B/D 74
M5 A/S 93 234 A/S


X034 X027
ls windo ws.c
SET M6 paston c lose
M6 A/S 103 207 B/D 107 151
X031
ls pasto n.c
RST M6 paston c lose
M6 A/S 103 207 B/D 107 151
X031 X032
ls pasto n.c
ls pasto n.o
M7 paston o pen
M7 A/S 110 223 A/S
M7 X032
paston o pen
ls pasto n.o
X032 X030 X034
ls pasto n.o
ls 2past on.c
ls windo ws.c
M8 2paston open
M8 A/S 118 201 A/S
M8 X030
2paston open
ls 2past on.c
X025
K100
T5
T5 A/S 132 A/S
X030 T5 X026 X027 M1 M9
ls 2past on.c
ls door. o
2paston clos
door ope n
M0 door clo s
M0 A/S 133 187 A/S
M0 X026
door clo s
ls door. o
X012 X035
push win dows.c
ls windo ws.o
M10 windows close
M10 A/S 144 229 A/S
M10 X035
windows close
ls windo ws.o
150
X017
outo
RST M6 paston c lose
M6 A/S 103 207 B/D 107 151
RST M1 2paston clos
M1 A/S 58 193 B/D 62 139 152
RST M4 paston o pen
M4 A/S 66 205 B/D 69 153


154
X015
mun
X010
push doo r.o
X026
ls door. o
M11
door clo se
M11
A/S 188
A/S
X007
push doo r.c
X025
M12
door ope n
M12
A/S 190
A/S
X005
push 2pa ston.o
X027
M13
2paston close
M13
A/S 195
A/S
X006
push 2pa ston.c
X030
ls 2past on.c
M14
2paston open
M14
A/S 203
A/S
X004
push pas ton.c
X032
ls pasto n.o
M15
paston c lose
M15
A/S 227
A/S
X003
push pas ton.o
X031
ls pasto n.c
M16
paston o pen
M16
A/S 211
A/S
X011
push win dows.o
X034
ls windo ws.c
M18
windows open
M18
A/S 233
A/S
X012
push win dows.c
X035
ls windo ws.o
M17
windows close
M17
A/S 231
A/S
187
M0
door clo s
M11
door clo se
Y003
door clo se
Y003
A/S 0 14 31 238
B/D 25
190
M12
door ope n
M9
door ope n
Y004
door ope n
Y004
A/S 1 15 32 239
B/D 9


193
M1
X017
2paston clos
outo
M13
2paston close
Y005
2pston c lose
Y005
A/S 2 16 33 240
B/D 197
197
Y005
2pston c lose
T7
K10
201
M8
X017
2paston open
outo
M14
2paston open
Y006
2paston open
Y006
A/S 3 17 36 241
A/S
205
M4
X017
X027
paston o pen
outo
M6
X017
paston c lose
outo
M16
paston o pen
Y010
paston o pen
Y010
A/S 4 18 35 213 243
B/D 215
213
Y010
paston o pen
SET Y027
Y027
A/S 214
B/D 220
215
Y010
paston o pen
T6
K10
T6
A/S 219
A/S
219
T6
RST Y027
Y027
A/S 214
B/D 220
221
M2
X017
X027
paston c los
outo
M7
X017
paston o pen
outo
M15
paston c lose
Y007
paston c lose
Y007
A/S 5 19 37 242
A/S

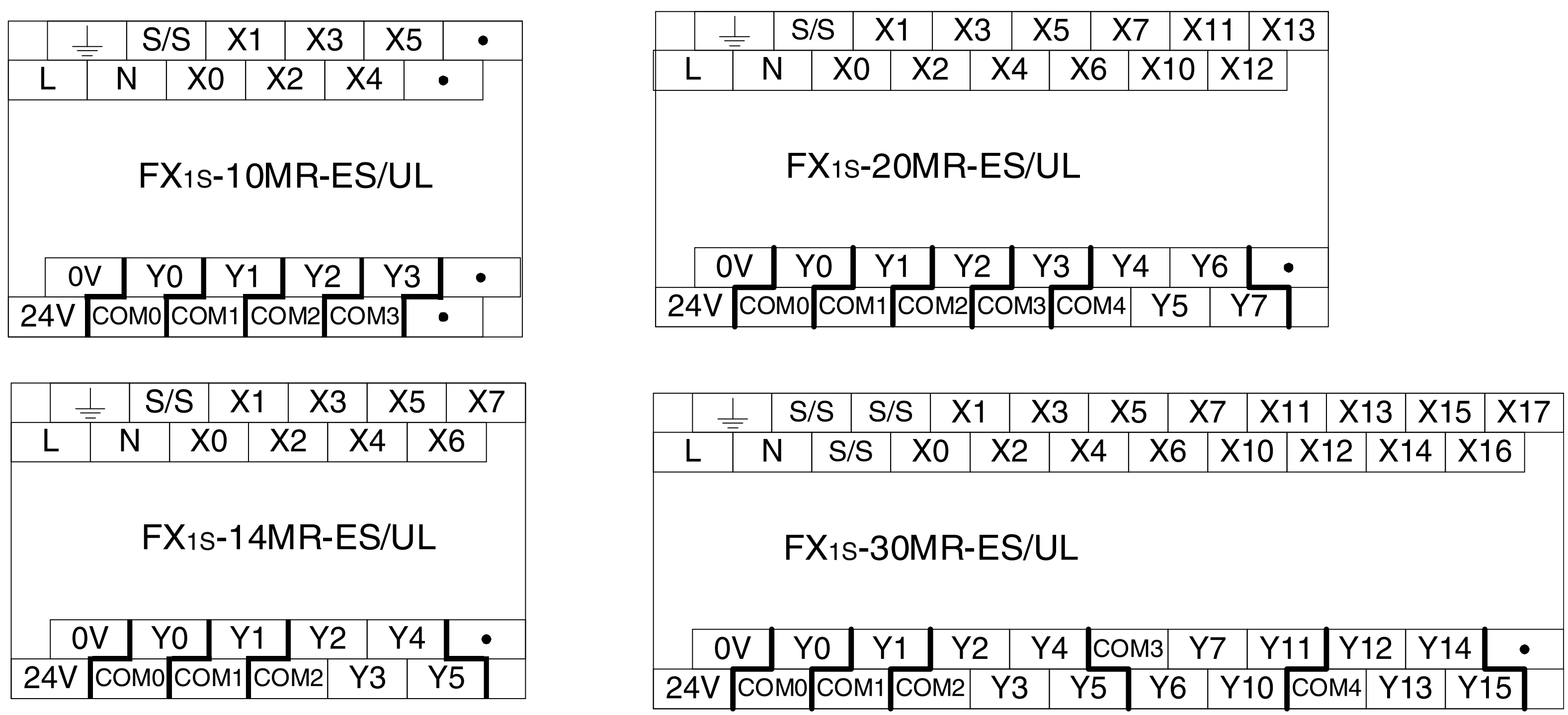

229
M10
windows close
X017
outo
M17
windows close
Y011
windows open
Y011
A/S 6 20 38 244
B/D 23
233
M18
windows open
M5
windows open
X017
outo
Y012
windows close
Y012
A/S 7 21 39 245
B/D 24
238
Y003
door close
Y004
door open
Y005
2pston close
Y006
2paston open
Y007
paston close
Y010
paston open
Y011
windows open
Y012
windows close
Y014
247
END

2. Terminal Layouts

The following selection of terminal layouts are taken from the FX1S product range.
Note: All layouts are schematic only and are intended to aid in the creation of wiring diagrams.

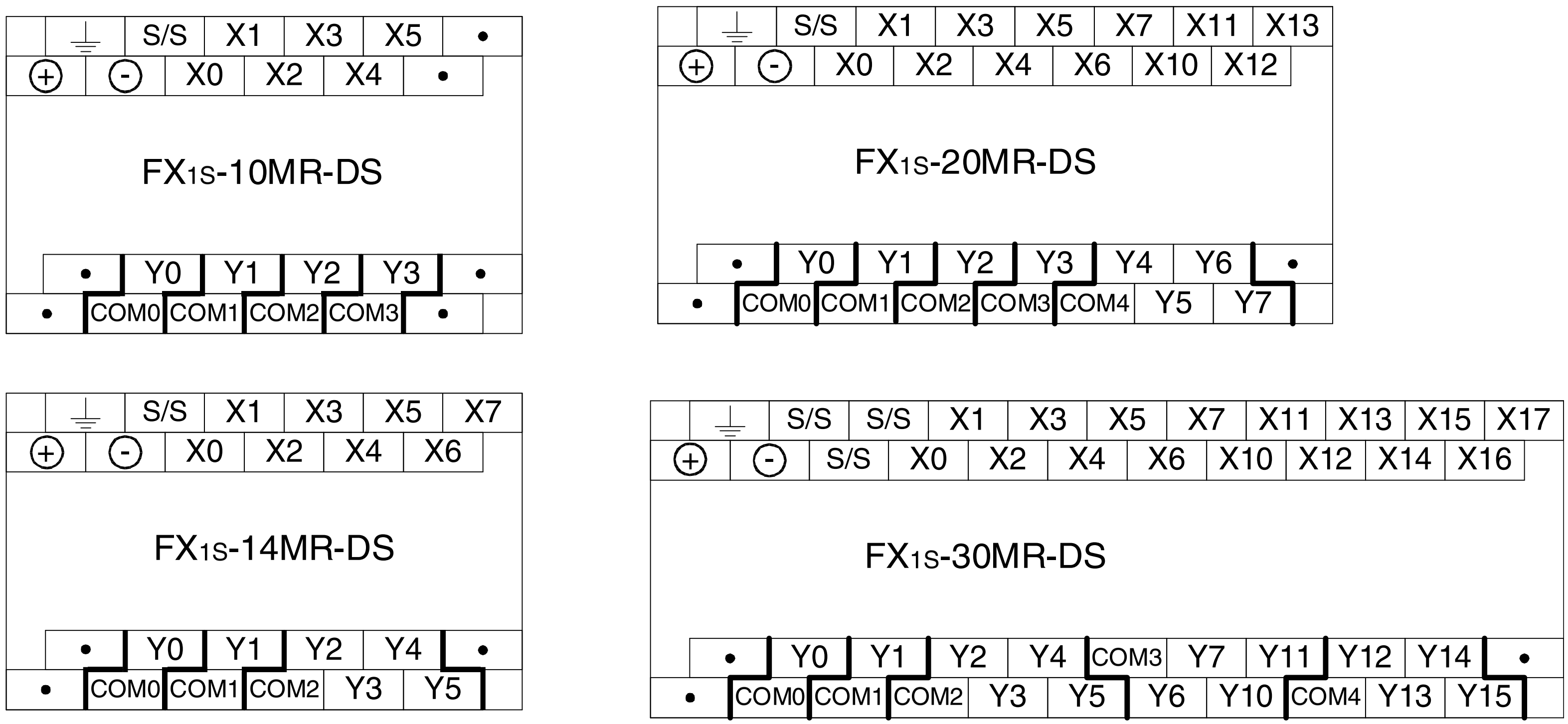
2.1 FX1S-**MR-ES/UL

Figure 2.1: Terminal Layouts, Relay Outputs, AC Power



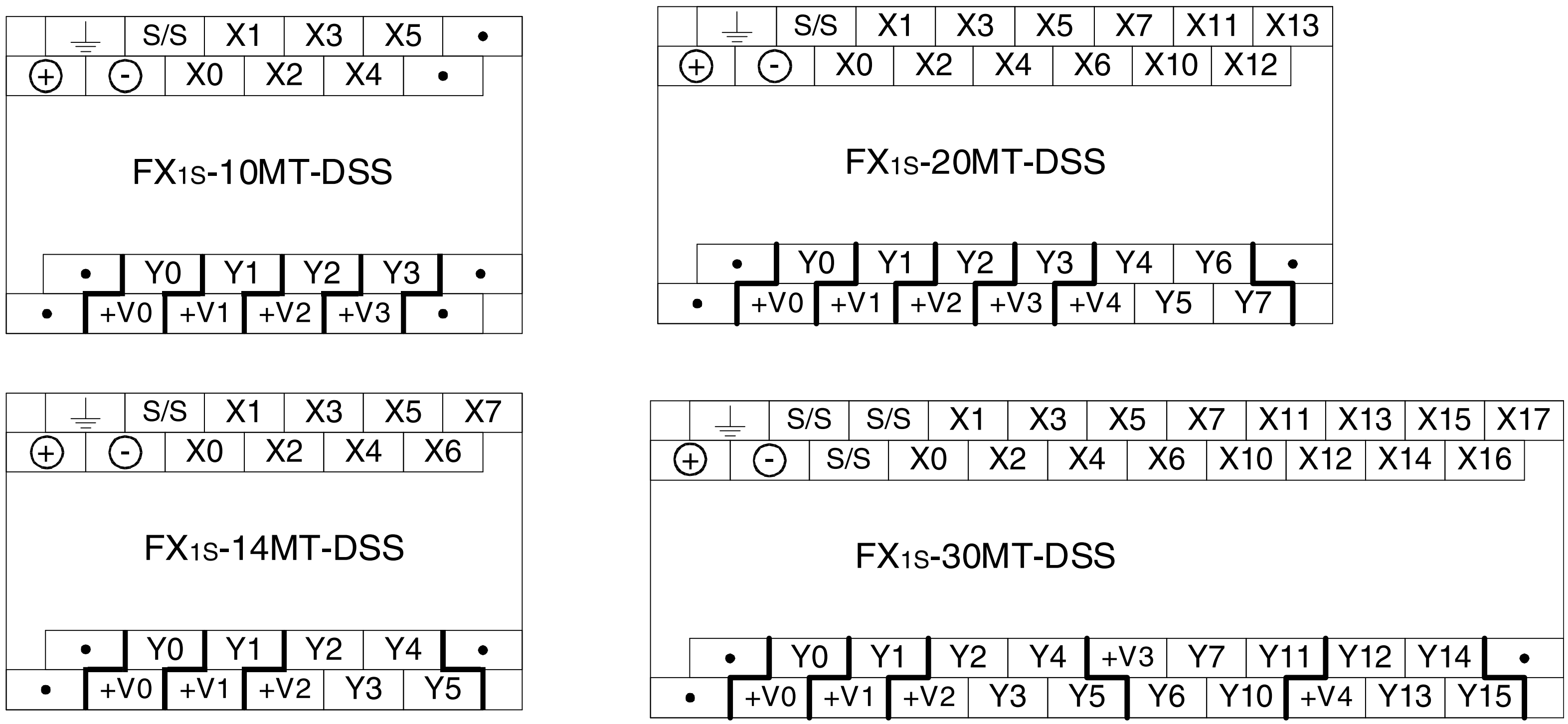
2.2 FX1S-**MR-DS

Figure 2.2: Terminal Layouts, Relay Outputs, DC Power



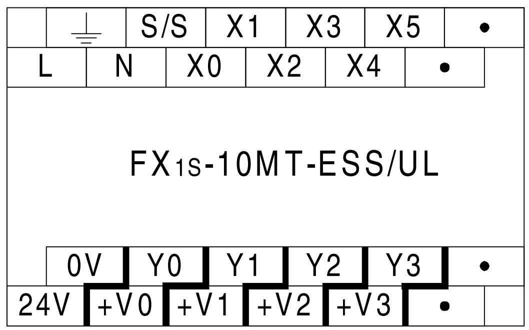
2.3 FX1S-**MT-DSS

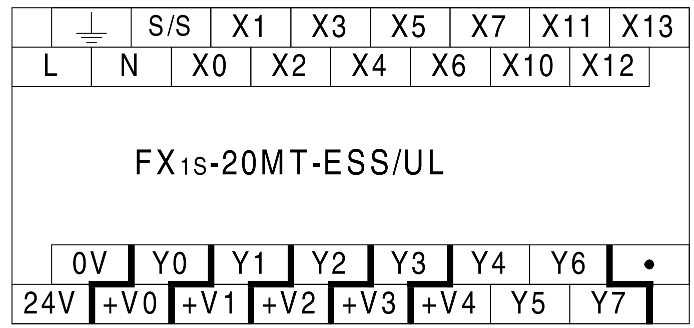
Figure 2.3: Terminal Layouts, Transistor Outputs, DC Power

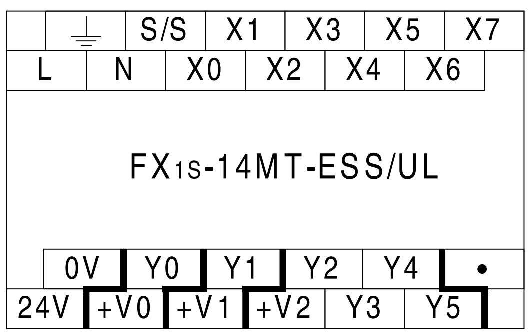


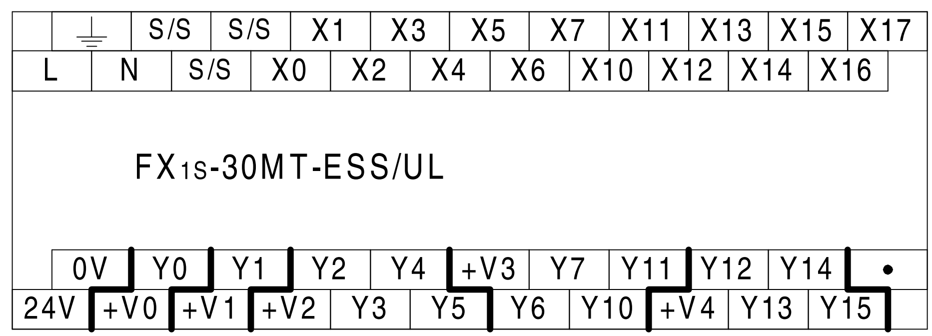
2.4 FX1S-**MT-ESS/UL

Figure 2.4: Terminal Layouts, Transistor Outputs, AC Power









3. Installation Notes

The installation of FX_{1S} products has been designed to be safe and easy. When the products associated with this manual are used as a system or individually, they must be installed in a suitable enclosure. The enclosure should be selected and installed in accordance to the local and national standards.

3.1 Product Outline

Figure 3.1: Features of the FX1S PLC

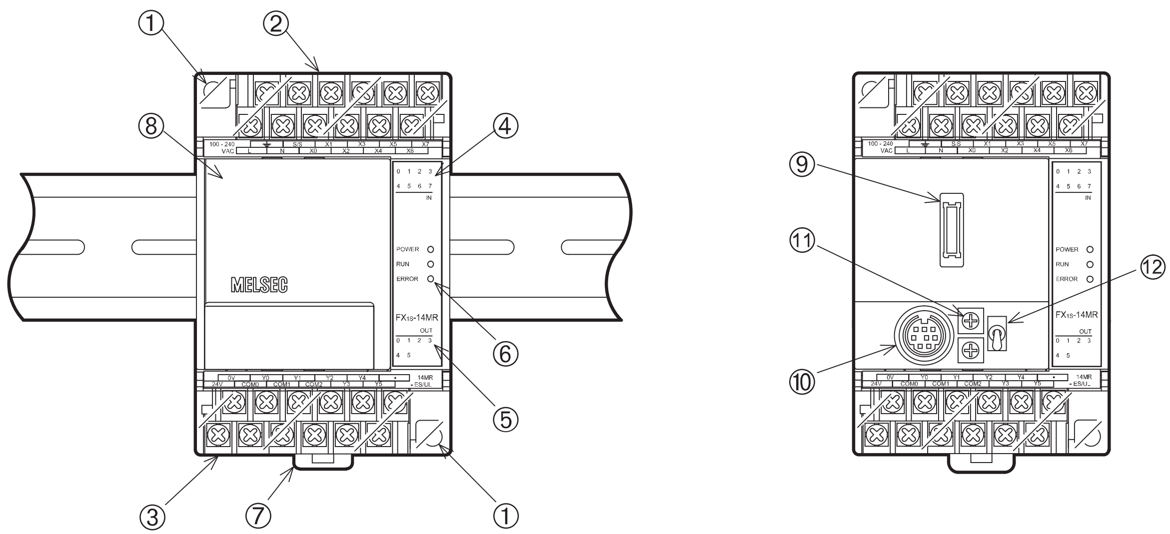


Table 3.1: Feature Table

1	Direct Mounting Holes (4.5 mm<0.17"> Diameter)	**7**	DIN Rail Mounting Clip
2	Input Terminals (24V DC) and Power Supply Terminals	**8**	Top Cover
3	Output Terminals and Power Supply Source Terminals	**9**	Optional Equipment port - Memory Cassette, FX1N-232, 422, 485, 8AV, 4EX, 2EYT, 2AD, 1DA and CNV BDs, FX1N-5DM
4	Input LED Status Indicators	**10**	Programming Port
5	Output LED Status Indicators	**11**	Analog Trim Pots. D8030 read from VR1, the top trim pot. D8031 read from VR2, the bottom trim pot.
6	PLC Status Indicators (POWER, RUN, ERROR)	**12**	Run/Stop Switch

3.2 FX1S RUN/STOP Control

RUN or STOP of the FX1S can be controlled by:

➊The RUN/STOP switch mounted next to the programming port.

➋A standard input (X000 to X017) defined by the system parameters.

➌Remotely from a personal computer or other programming peripheral.

Note:The FX1S RUN/STOP switch works in parallel with the RUN input terminal. Please refer to Table 3.2.

During remote operation the FX1S RUN/STOP status is determined by the most recently operated control.
E.g. If the RUN/STOP switch is in RUN and a remote STOP is made from a personal computer, the PLC can only be restarted with the RUN/STOP switch by first moving the switch to STOP and then back to RUN.

Figure 3.2: RUN/STOP Input Wiring Diagram

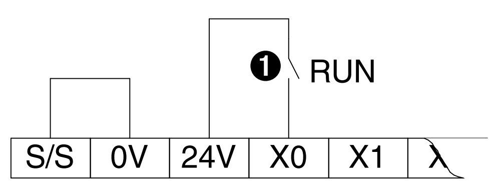


Table 3.2: Run Status Table

RUN/STOP SWITCH	➊ RUN INPUT TERMINAL	FX1S MPU STATUS
RUN	ON	RUN
RUN	OFF	RUN
STOP	OFF	STOP
STOP	ON	RUN

3.3 General Specifications

Table 3.3: General Specifications

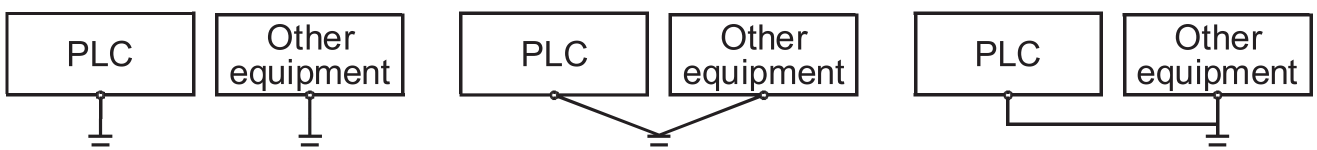
Item	Description
Operating Temperature	0 to 55 °C (32 to 131 °F)
Storage Temperature	-20 to 70 °C (-4 to 158 °F)
Operating Humidity	35 to 85% Relative Humidity, No condensation
Storage Humidity	35 to 90% Relative Humidity, No condensation
Vibration Resistance*1 - Direct Mounting	10 - 57 Hz: 0.075 mm Half Amplitude 57 - 150 Hz: 9.8 m/s^2 Acceleration Sweep Count for X, Y, Z: 10 times (80 min. in each direction)
Vibration Resistance*1 - DIN Rail Mounting	10 - 57 Hz: 0.035 mm Half Amplitude 57 - 150 Hz: 4.9 m/s^2 Acceleration Sweep Count for X, Y, Z: 10 times (80 min. in each direction)
Shock Resistance*1	147m/s^2 Acceleration, Action Time: 11 ms 3 times in each direction X, Y, and Z
Noise Immunity	1000 Vp-p, 1microsecond, 30 - 100 Hz, tested by noise simulator
Dielectric Withstand Voltage	1500 VAC > 1 min., tested between all points, terminals, and ground*2 500 VAC > 1 min., tested between all points, terminals and ground*2
Insulation Resistance	5 MΩ > at 500 V DC, tested between power terminals and ground*2
Ground	Class D grounding (grounding resistance: 100 Ω or less) <Common grounding with a heavy electrical system is not allowed>*3
Working atmosphere	Free from corrosive or flammable gas and excessive conductive dust
Working altitude	<2000m*4
Certification	UL/cUL (UL508)
EC Directive	EMC (EN61131-2:2007), LVD (EN61131-2:2007)

*1 The criterion is shown in IEC61131-2.

*2 Perform dielectric withstand voltage and insulation resistance tests at the stated voltage between each terminal and the main unit's ground terminal.

Between terminals	Dielectric strength		Insulation resistance	Remarks
	AC Power Supply Units	DC Power Supply Units		
Between power supply terminal and ground terminal	1.5kV AC for 1 min	500V AC for 1 min	5MΩ or more on 500V DC Megger	–
Between 24V DC service power supply connected to input terminal (24V DC) and ground terminal	500V AC for 1 min			–
Between output terminal (relay) and ground terminal	1.5kV AC for 1 min			–
Between output terminal (transistor) and ground terminal	500V AC for 1 min			–

*3 Ground the PLC independently or jointly.



Independent grounding
Best condition

Shared grounding
Good condition

Common grounding
Not allowed

*4 Do not use the PLC under pressure higher than the atmospheric pressure. Doing so may damage the PLC.


PALSTAR SAE 100 R2AT-DIN EN 853 2SN 1 1/4" W.P. 125B