Sudan University of Science and Technology
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Simulation of Automatic Sorting and Packaging System Using Programmable Logic Controller

محاكاة نظام الفرز والتعبئة التلقائي بإستخدام المتحكم المنطقي القابل للبرمجة

A Thesis Submitted in Partial Fulfillment to the Requirements for the Degree of M.Sc. in Electrical Engineering (Microprocessor and Control)

Prepared by: Hala Mohyaldin Mohmed Nour

Supervised by: Dr. Awadalla Taifour Ali Ismail

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الآية

بسم الله الرحمن الرحيم

(أَمَّنْ هُوَ قَانِتٌ آنَاءَ اللَّيْلِ سَاجِدًا وَقَائِمًا يَحْذَرُ الْآخِرَةَ وَيَرْجُو رَحْمَةَ رَبِّهِ قُلْ هَلْ يَسْتَوِي الَّذِينَ يَعْلَمُونَ وَالَّذِينَ لَا يَعْلَمُونَ إِنَّمَا يَتَذَكَّرُ أُولُو الْأَلْبَابِ)

صدق الله العظيم

سورة ا لزمر الآية (9)

Dedications

This thesis is dedicated to:

The sake of Allah, my creator and my master,

My great teacher and messenger, Mohammed (May Allah bless and grant him), who taught us the purpose of life.

The spirit of my father, who was my teacher in life and supported me throughout his life .

My great mother, who never stops giving of herself in countless ways, is tender without limits.

My son and my daughters, for whom and for their sake get my strength to continue the struggle.

My beloved family and those people who have guided and inspired me throughout my journey of education.

Acknowledgement

Firstly, I praise God who aids me to complete this research in this way, it gives me great pleasure in expressing my sincere gratitude to everyone who have supported and contributed into making this thesis possible.

I would like to acknowledge my direct supervisor Dr. Awadalla Taifour Ali for his huge efforts to explain things clearly and simply. I would like to thank the Sudan University of Science and Technology for accepting me in its graduate program and motivated me to do this work.

Finally I would like to thank my family and all the people that supported me through my academic way.

Abstract

In this study, the proposed system designed to sort industrial products to two types, according the material and size automatically by sensing of different sensors (capacitive proximity, inductive proximity, and laser) to detect any object which is moving on a conveyor belt. These objects are packaged in suitable boxes according to their size and transported by lifter.

The Programmable Logic Controller (PLC) used as main component and proposed system is simulated using Siemens Semitic S7-300 simulator connector with 3-dimintions system simulation (ITS PLC MHJ edition). The results show that the system has been programmed successfully.

مستخلص

في هذه الدراسة ،صمم النظام المقترح لفرز المنتجات الصناعية تلقائيا لنوعين وفقا لنوع المادة وحجمها بواسطة محساسات مختلفة مثل المحساس السعوي، المحساس الحثي ومحساس الليزر مثبتة على خط الانتاج في اماكن مختلفة للكشف عن اي كائن يمر عبرها.تم تعبئة المنتجات في صناديق مناسبة حسب الحجم وتم نقلها للتعبئة بواسطة رافعة.

تم استخدام المتحكم المنطقي القابل للبرمجة كمكون اساسي في العملية والنظام المقترح تمت محاكاته بواسطة سيمنز سيمتك (S-300) وربطه مع نظام محاكاة ثلاثي الابعاد (ITS PLC MHJ edition) . اثبتت النتائج النهائية أن النظام تمت برمجته بنجاح.

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CHAPTER ONE

INTRODUCTION

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Introduction

1.1 General

In many industries sorting the materials of different sizes is difficult. The process needs more human efficiency to sort the materials, for this purpose was used the automated process to sort the materials of different sizes. After completion of manufacturing the product they automatically moved on the conveyor belts. Used sensor at different places which detect and sense the type of materials and size, they got sorted at different places based upon their sizes and they are placed in their respected containers or `boxes. For sensing the material we used different sensors which are so sensitive. Automating every sector of industry is an important step towards increasing efficiency and reducing human related errors, here we tried to automate the sorting process by using PLC [1].

1.2 Problem Statement

The process of sorting and packaging when carried out manually ,it is need more human effort, with a lot of work and concentration there are mistakes, these negatively affects the production as there is lack of production , wasting time ,increasing damage ,which increases the cost of the product.

1.3 Objectives

This study aims to reduce the human effort and hence, the consequent errors. Moreover, the system helps tackle the tedious sorting. It, furthermore, promotes speed and reliability of sorting, increase in productivity, for better accuracy, and for safety, and reduces manufacturing costs. The main objectives of this study are:

- Design of sorting and packaging system using PLC.
- Simulation of proposed system.

1.4 Methodology

The proposed system consists of two processes, first process is sorting and the second process is packaging. For both processes programmable logic control of type siemens7-300 modular PLC, is used.

- The PLC programed will ladder language software.
- 3-dimantion system simulation for sorting and packaging system.

1.5 Layout

This thesis consists of five chapters including chapter one. Chapter two gives a theoretical background about sorting and backing system and literature review. Chapter three concerns with system methodology and the components used in the study. Chapter four discusses the system simulation and presents the simulation results. Finally, chapter five presents conclusion and recommendations.

CHAPTER TWO

THEORETICAL BACKGROUND AND LITERATURE REVIEW

Chapter Two

Theoretical Background and Literature Review

2.1 Introduction

The original method of the product sorting consisted of manually driven forklifts that took the product from the distribution station to the storage location within the warehouse. With the development of industry, the designers resorted to the controllers of the equipment. The system that has been designed is connected to a programing logic controller. When implemented it is designed to work seamlessly with the distribution center, automatically transporting the different products to their designated location within the warehouse [2].

2.2 Sorting System

Sorting is process of classifying the objects according to their specifications material, status, color, shape etc., and put each similar category in as set apart from the other. The sorting of different kind has proven to be an important part in every sector. So as to accomplish the work of sorting, manual efforts were put in. Earlier, the manual involvement has been commonly imparted for the sorting process from small-scale industries to comparatively high-level large-scale industries. But, due to increase in competition in the global market, the so-called big companies and industries started seeking for better technologies that would reduce human effort and hence the consequent errors which in turn would help them increase their productivity and meet the increasing demand. This further would help them take a huge profit in return and thus the growth of that firm gets kick-started. As a result, the advent of automation in sorting sector has become a boon for such industrial sector. In large-scale industries and multi-national companies, the manual sorting is very less or nearly nil. This has further improved the product quality and reliability as a whole. In various other places where sorting comes into play predominantly are airports, seaports, small-scale industries, super markets, etc. But due to the restricted reach of automation in sorting in these sectors, the thought about automated sorting in such fields ought to be considered with much importance. Thus, to extend the advantages of automated sorting in large-scale sectors to the above mentioned sector, a notion of automation has been thought to implement in small-scale sectors. PLC proposed to control sorting machine this work is a fundamental approach to modeling a manufacturing and automated machines. the sorting sensors, conveyors and other accessories were proper for sorting machine modeling In general, it is recommended that capacitive sensors be used for sorting of complex manufacturing of objects with different chemical properties. It is also observed that the PLC is necessary for the logic programming of the sorting machine. Each object was sorted a cording metal, wood and size objects respectively. The driving range and the speed of the object depend mainly on the control of the PLC and the sensitivity of the sensor that could be adjusted to a suitable distance between object sensor detection distances [3].

2.3 Packaging System

In today’s competitive market, product packaging is playing a more important role than ever before. Changing packet designs, shorter times to the market place, and frequent product introductions are causing manufacturers worldwide to change their approach to the packing and packaging process. In the past, manufacturers have relied on traditional packaging technologies, such as dedicated machinery and manual production techniques. Unfortunately, dedicated equipment cannot always meet today’s needs for increased production flexibility and with higher labor and liability costs, manual alternatives are not always a competitive solution. This call for a new approach to the packing and packaging problem, one which uses automation, but which also provides the flexibility of a manual operator. A key step in developing such a flexible packing system is the integration of intelligent vision feedback. When designing such a system it is of paramount importance to choose a strategy that will deal with the practical constraints involved in automated packing, even if it means sacrificing some volumetric efficiency. This highlights the importance of developing an adaptive packing system within a systems engineering context. By adopting a systems approach, maximum use is made of problem-specific contextual information derived, for example, from the nature of the product being handled, the manufacturing process and the special features of the manufacturing environment. By doing so, we hope to reduce the complexity of the application. For example, in certain packing applications the items must be packed as they arrive at the packing station, therefore, removing the object ordering burden from the packing system. In fact, by taking heed of such constraints in a practical packing application, the packing strategy might well reduce to a standard, well-tried technique. It is our belief that in packing, as happens so often elsewhere, systems considerations are always worth investigating. So the automating every sector of industry is an important step toward increasing efficiency and reducing human related to increase the speed and consume the time. Packaging system is a stage that is important because to make product safe and good and facilitates transportation and storage [4].

2.4 Literatures Review

The studies on the automatic sorting and packing products, the subject was either automatic sorting only or automatic packing only. But no studies were available on automatic sorting and packing with some and all this studies in factories and any places that benefit from this process and despite the different methods of implementation agreed that application reduces working time, reduces labor and increase production speed resulting in an increase in production and reduce the cost of production, leading to the recovery of the industrial economy, which in turn positively affect the overall economy.

Babita Nanda, 2014 discuss automatic sorting machine using delta PLC**,** using the automated process which is used to sort the materials which are of different sizes. After completion of manufacturing the product they automatically move on the conveyor belts. Using sensors at different places which detect and sense the materials of different sizes. They get sorted at different places based upon their sizes and they are placed in their respected containers or boxes. For sensing the material using infrared sensors which are so sensitive. All these process is controlled and handled by PLC. The entire process is controlled by the program dumped in PLC. Delta PLC is a basic type of PLC used for small scale applications. A very commonly used method of programming PLC's are based on the use of ladder diagrams, Implementing of Delta PLC for shorting of machine has greatly reduced the complexity involved in completing this project .Every production unit of mass production can make use of this king of system. Many more industries can be identified for the application of this system [1].

Saurin Mukundbhai Sheth 2015, discuss automatic sorting system using machine vision. Machine vision is one such advancement in automatic systems. It is performs the tasks that are equivalent to human vision. It helps to automate the systems where there are limitations of human vision like detecting various shades of colors or determining high precise dimensions and thus permitting human employees to serve in more appropriate positions. In the system, color based identification of the parts will be done and then it will be sorted according to different colors. After recognizing the color of the object, robotic arm will automatically pick and place it accordingly. If the color of the work piece is not found in accordance to the required one then it will be rejected. The complete sorting system operates on image processing using the MATLAB application and microcontroller which will control different motors in the system. The advantages system fast, accurate, good repeatability, reduce labor cost, Less human interference. The conclusion from the system is can automate the color inspection and sorting of the object with accuracy, good repeatability and high productivity, which can be further plus the sorting include the, number of parts are sorted and Measuring dimension [5].

B.Nantheni Devi and D.Kanimozhi 2016, discusses implementation of PLC based food packaging machine. The introduce a packaging machine using PLC in automation industry. The main aim of the paper is to design and fabricate a small and a simple packaging system using PLC. The food materials are dropped into the hopper and the Direct Current (DC) motor is used to shake the food materials. The weights of the three loads are measured accurately by using weighting unit. The result was able to fully automate the packaging system. In addition the system able to decrease product time and increase the product rate as compared with traditional manual system when we check weight of the object manually then it will take more time for checking the weight and overall speed will decrease. So by using this food packaging machine we totally overcome this problem [6].

Hall, Shell and Slutzky 1990 discuses, the main emphasis of the early research into packing tended to concentrate on the well constrained problem of packing regular shapes. This task usually consists of packing two-dimensional regular shapes into a well-defined scene (the term scene is used, in this paper, when referring to a region of space into which an arbitrary shape is placed), such as a rectangle. The main industrial applications are in the area of pallet packing and container loading (Bischoff and Marriott 1990) More recently researchers in the field of engineering and science have begun to concentrate on the issues involved in the packing of irregular shapes. Research in this area is constrained by the demands of a given application, so as to make the task more manageable [7].

Qu and Sanders (1987) discuss a heuristic nesting algorithm for irregular parts and the factors affecting trim loss. The application discussed is the cutting of a bill-of-materials from rectangular stock sheets. The author takes a systems approach to the problem and produces some good results. These are discussed in the context of performance measurements which they have developed. While the authors review the published work in this area, they make the important point that although a number of techniques have been developed to enable the flexible packing of irregular shapes, very few of these have been published due to commercial confidentiality. The approach described represents the irregular shapes in terms of a set of non-overlapping rectangles. In fact the authors state that each of the parts in their study can be represented by no more than five non-overlapping orthogonal rectangles. The system places each part in an orientation such that (a) its length > height and (b) the largest complimentary area is in the upper-right corner. The parts are then sorted by non-increasing part height. The shapes are packed into a rectangular bounding region in a raster fashion, building up layers of intermeshed packed shapes. The major disadvantage with this approach is (a) the use of rectangles to approximate the shape to be packed and (b) the assumption that good packing patterns will be orthogonal [8].

CHAPTER THREE

SYSTEM METHODOLOGY

Chapter Three

System Methodology

3.1 Introduction

According to national electrical manufacturers association, programmable controller is a digitally operated electronic system, designed for use in industrial environment, which uses a programmable memory for the internal storage of user oriented instructions for implementing specific functions such as logic, sequencing, timing, counting and arithmetic to control, through digital or analog inputs and outputs, various types of machines or processes. This section, describes the block diagram of the proposed system. Figure 3.1 shows the proposed block diagram based on which the interfacing of various inputs and outputs are done with the PLC.

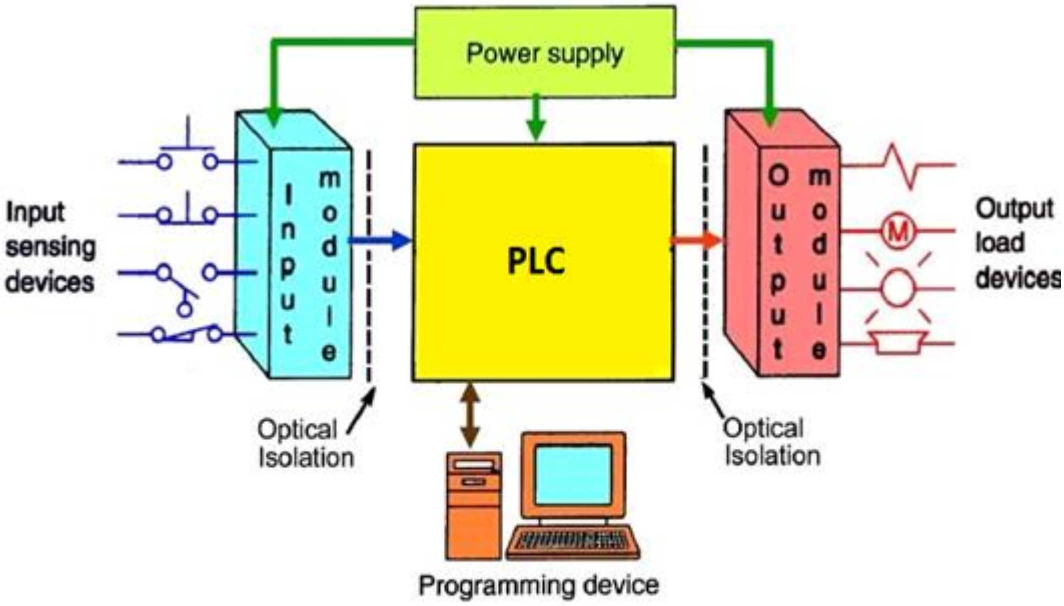


Figure 3.1: Proposed network system

According to the previous mentioned figure, there are three main systems involved. One is the input module to which the object detecting, metal, wood, and size detecting sensors are interfaced. Second one which is the heart of whole system is PLC which processes the signals from input modules and performs actions according to the logic diagram written for it. The last one is the output module interfaced with the output giving devices.

3.2 System Hardware

The components of system hardware are follows:

3.2.1 Programmable logic controller

PLC is a standard industrial control device that provides a simple yet robust method of controlling, manufacturing and dynamic processes. PLCs were first developed by Information Instruments, Inc. (acquired by Allen-Bradley in 1969). The compact physical structure of PLCs significantly reduced the space taken by previous physical components (relays, timers, etc.). Instead of building a large mechanical setup of components to control a process, the same "components" could be dragged-and-dropped in a computer interface, saving setup cost and time as well as long-term maintenance and simpler wiring. The software language created for PLCs, called "ladder logic", retained a very similar look to the wiring diagrams that were used for the physical components it replaced. PLCs are heavily used by industry because of their low cost, adaptability, and reliability, PLCs are by far the most common control mechanism used by manufacturing businesses of all sizes for environment control, food processing, motion control, and automated test equipment [9].

3.2.2 Inductive proximity sensors

Inductive proximity sensors operate under the electrical principle of inductance. Inductance is the phenomenon where a fluctuating current, which by definition has a magnetic component, induces an electromotive force in a target object. To amplify a device's inductance effect, a sensor manufacturer twists wire into a tight coil and runs a current through it. Inductive proximity sensors being contactless sensors can be used for position sensing, speed measurement, counting, etc. They can be used in extreme conditions, such as oily, dusty, corrosive environment. Their application ranges from automobile industries to steel industries, from Computer Numerical Control/Numerical Control (CNC/NC) machines to material handling equipment, process automation, conveyor systems, and packaging machines. The inductive proximity sensor can be used to detect metallic targets only. The main components of the inductive proximity sensor are coil, oscillator, detector and the output circuit. The coil generates the high frequency magnetic field in front of the face. When the metallic target comes in this magnetic field it absorbs some of the energy. Hence the oscillator field is affected. This is detected by the detector. If the oscillation amplitude reaches a certain threshold value the output switches. The inductive proximity sensor works better with ferromagnetic targets as they absorb more energy compare to non-ferromagnetic materials [10]. Inductive proximity sensors operate on the principle that the inductance of a coil and the power losses in the coil vary as a metallic (or conductive) object is passed near to it. Thus, is used to sense the metallic part and is insensitive to non-metallic part as shown Figure 3.2

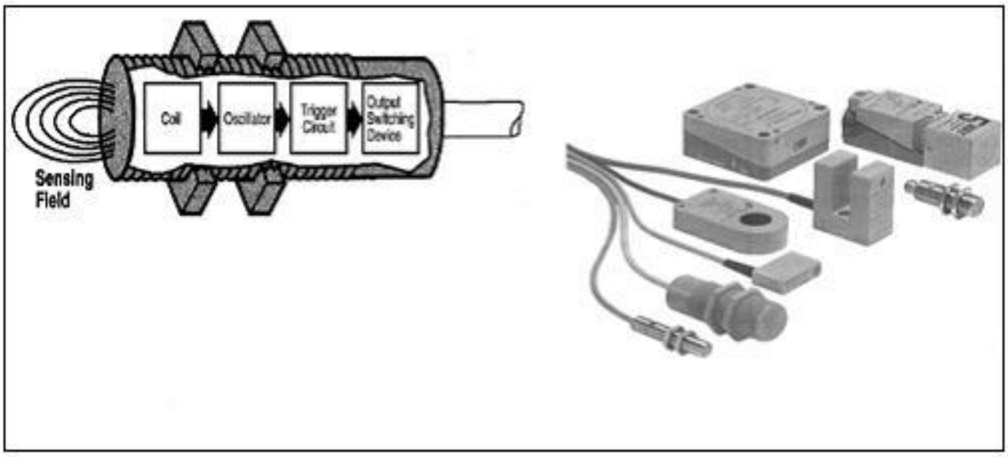


Figure 3.2: Inductive sensor

3.2.3 Proximity capacitive sensors

Capacitive proximity sensors use the face or surface of the sensor as one plate of a capacitor, and the surface of a conductive or dielectric target object as the other. The capacitance varies inversely with the distance between capacitor plates in this arrangement, and a certain value can be set to trigger target detection. The sensing surface of a capacitive sensor is formed by two concentrically shaped metal electrodes of an unwound capacitor. When an object nears the sensing surface it enters the electrostatic field of the electrodes and changes the capacitance in an oscillator circuit. As a result, the oscillator begins oscillating. The trigger circuit reads the oscillators amplitude and when it reaches a specific level the output state of the sensor changes as the target moves away from the sensor the oscillator's amplitude decreases, switching the sensor output back to its original state [10].

The principle of operation of the sensor is that an internal oscillator will not oscillate until a target material is moved close to the sensor face. The target material varies the capacitance of a capacitor in the face of the sensor that is part of the oscillator circuit as shown Figure 3.3.

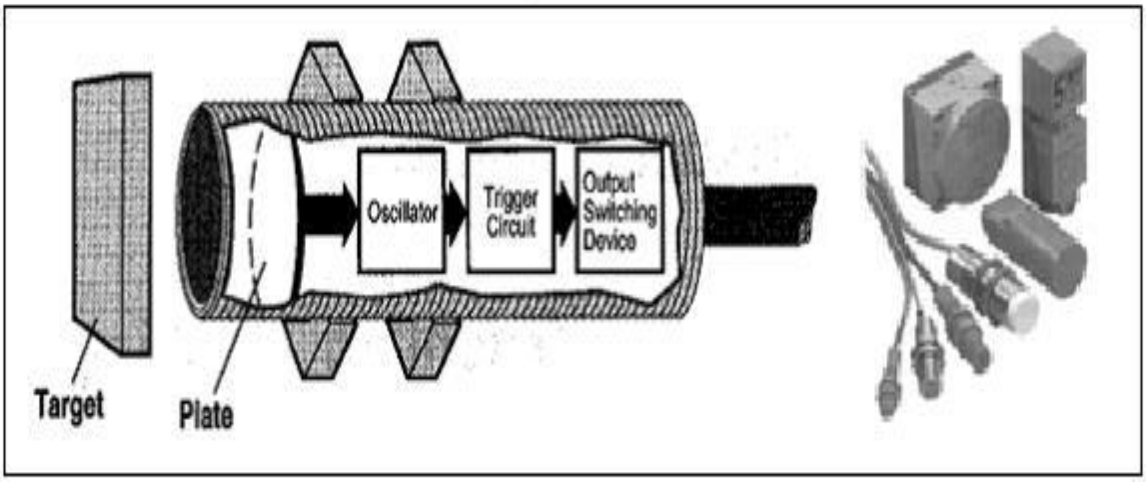


Figure 3.3: Capacitive proximity sensor

3.2.4 Limit switches sensors

Presence sensing is the act of detecting the presence or absence of an object with a contact or non-contact sensing device. The sensors then produce an electrical output signal that can be used to control equipment or processes. Mechanical limit switches are contact sensing devices widely used for detecting the presence or position of objects in industrial applications. The term limit switch is derived from the operation of the device it-self. As an object (or target) makes contact with the operator of the switch, it eventually moves the actuator to the "limit" where the electrical contacts change state. Through this mechanical action, electrical contacts are either opened (in a normally closed circuit) or closed (in a normally open circuit).

3.2.5 Light dependent resistor

Object detection circuit includes Light Dependent Resistor (LDR) as sensor, Wheatstone bridge, differential amplifier, Darlington pair etc. Light from laser is made to fall on LDR in absence of object. Hence LDR is used here as position sensor. As light fall on LDR, its resistance decreases. Since LDR is connected in a comparator circuit, due to change in LDR resistance causes change in voltage of voltage divider circuit which is given to operational amplifier for comparing. Output from comparator circuit is given to transistor to switch relay [11].

Output of relay is given to PLC as input.

Output of LDR:

- When light does not fall : 13.5 kΩ
- When light falls : 2kΩ

3.2.6 DC motor

A DC motor is used to drive the conveyor along with the rollers. The DC motor is interfaced with the PLC through a relay so as to fulfill the requirements of the motor.

- DC motor voltage : 12V
- Motor torque : 2 kg-cm
- Motor RPM : 100 RPM and 10RPM

3.2.7 Lifter

A lifter is used to move the object from one conveyor to another conveyor.

- Operating voltage : 12VDC
- Voltage : 5VDC

3.2.8 Relays

A relays is used to operate DC Motors, LDR's output, operation of CD Drives.

- Operating voltage : 12VDC and 24 VDC
- Type : Electromagnetic PCB relay
- Max. Current : 7A
- Max. Voltage : 250V

Double- Pole Double- throw relay (DPDT): is electromagnetic device used to separate two circuits electrically and connect them magnetically, which works at low voltage 12V or 24V

3.2.9 Laser

A laser is used to supply light to the LDR when the object is to be detected.

- Voltage : 5VDC
- Wavelength : 630-680mm
- Diameter of laser case : 15mm

- Class II laser

3.2.10 Conveyor belt

Conveyor belt provide the platform for the placement of object. Conveyor belt is placed on rollers and is moved by using DC motor. Its dimensions are:

- Length : 1280mm
- Width : 150mm

3.2.11 Conveyor Rollers

Rollers are fitted on bearings using a shaft. It helps in moving conveyor belt.

- Diameter : 50mm
- Length: 160mm

3.2.12 Bearings

Bearings are used to minimize the friction between shaft and conveyor belt. It is fitted inside the wooden socket.

3.2.13 Base board

It is made up of wooden material. It provides the basement to whole assembly. All hardware components like motors, rollers and conveyor belts, etc. are mounted on the base board.

3.3 Flow Chart for the Process

The process flow chart diagram as shown in Figure 3.4.

3.4 Software Programming

The main programs used in this work are:

3.4.1 Siemens S7-300 ladder logic language

The ladder logic language was designed for relay tracks used to control manufacturing and other machine processes. Usually ladder logic is programmed with an additional human computer interface. Although ladder logic is similar, there will not be complete compatibility between the systems that are from different companies. Ladder logic symbols instructors shown in Table 3.1 [12].

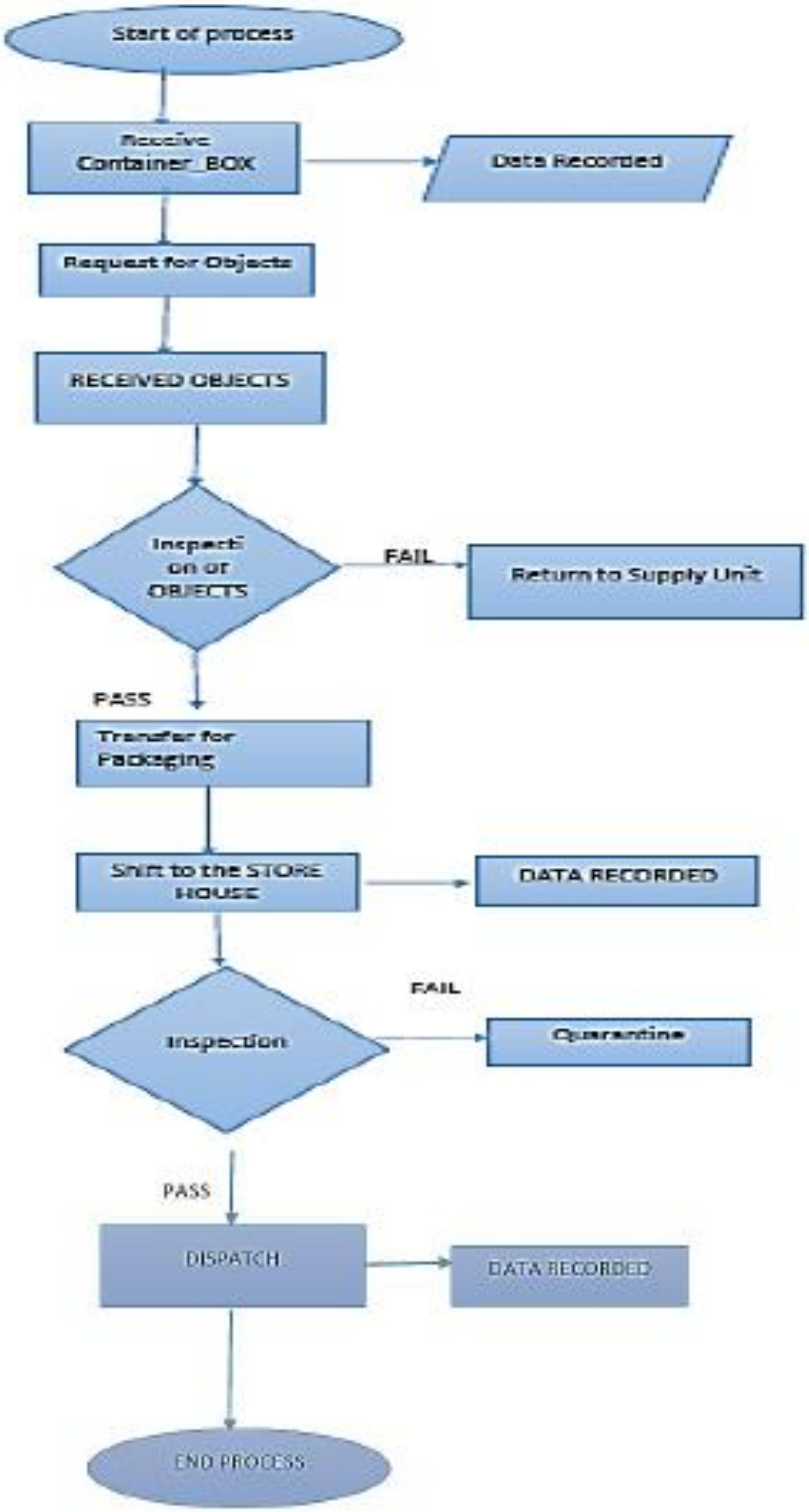


Figure3.4: Process flow chart diagram

Table 3.1: Symbols ladder logic

No.	Bit Logic	Definition
1.	-| |--	Normally Open Contact
2.	--|/|--	Normally Closed Contact
3.	--( )	Coil
3.	--(R)	Reset
4.	--(S)	Set
5.	--(P)--	Positive RLO Edge Detection
6.	--(SD)	On- Delay Timer Coil
7.	--(SF)	Off- Delay Timer Coil
8.	--(SS)	Retentive On - Delay Timer Coil

Writing structures in ladder diagram depends on networks which starts with line from the DC voltage source (24V) and ends with the neutral line (0V) in between single or multi inputs. Siemens has a specific way for addressing inputs and outputs, Inputs start with the letter (I) followed by two numbers (byte, bit in series) and dot between them like (I0.0) and the same for outputs with replacing the letter (I) by (Q) like (Q0.0)). Tables 3.2 and 3.3consist address, respectively of the inputs and outputs.

Table 3.2: The input address

No.	Input	Address
1.	Start PB	I:1/4
2.	Stop PB	I:1/5
3.	Sensor(Wrong)	I:0/0
3.	Sensor(Okay)	I:0/1
4.	Sensor(Box Present)	I:0/2
5.	Sensor (Box Present Detection)	I:0/3
6.	Sensor(X Min limit)	I:0/4
7.	Sensor(Lifter position)	I:0/5

8.	Z Return limit	I:0/6
9.	Z Extend limit	I:0/7
10.	Vacuum _ on	I:1/0

Table 3.3: The outputs address

No.	Output	Address
1.	Parts conveyor	Q:0/0
2.	boxes conveyor	Q:0/1
3.	X minis	Q:0/4
4.	X plus	Q:0/5
5.	Z Extend	Q:0/6
6.	Z Pick	Q:0/7
7.	Green Lamp	Q:1/0

Other items work as output are timers and in this study needed two types, the first one is off delay timer which is normally active after running the system on but will start calculating the set time only if the power cut off from it. The second type is on delay timer which will start calculating the set time when the current deliver to it. Figure 3.5 shows how on and off delay timers work.

The memory unit provides an interface between PLC and the user during program development, start up and troubleshooting .Programming units are liaison between what the engineer desires to occur during the control sequence. With offline programming the user can write a control program by the programming unit, then take the unit to PLC in the field and load PLC with new program, all without removing the PLC, it writing in program like (M0.0).
The program consists of 12 networks in parallel begins with the motor coil as the first output which all of the sequences depend on it and it will run when we switch on the start push button with latch from its coil to keep it on except if we switch it off all this networks shown in Figure 3.6.

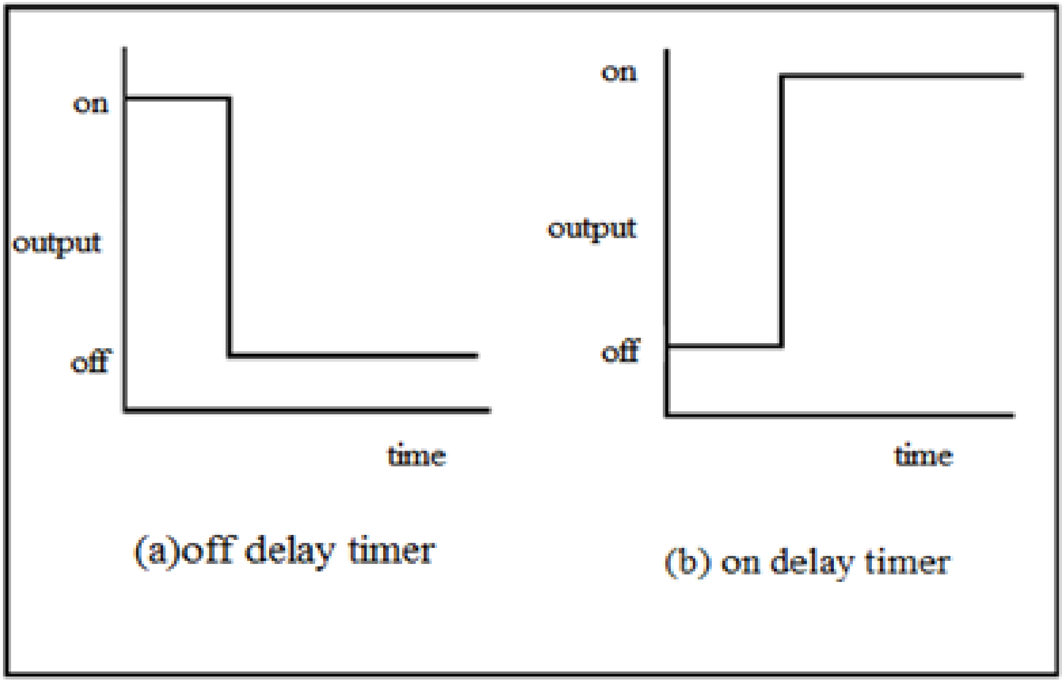


Figure 3.5: On and off delay timers working

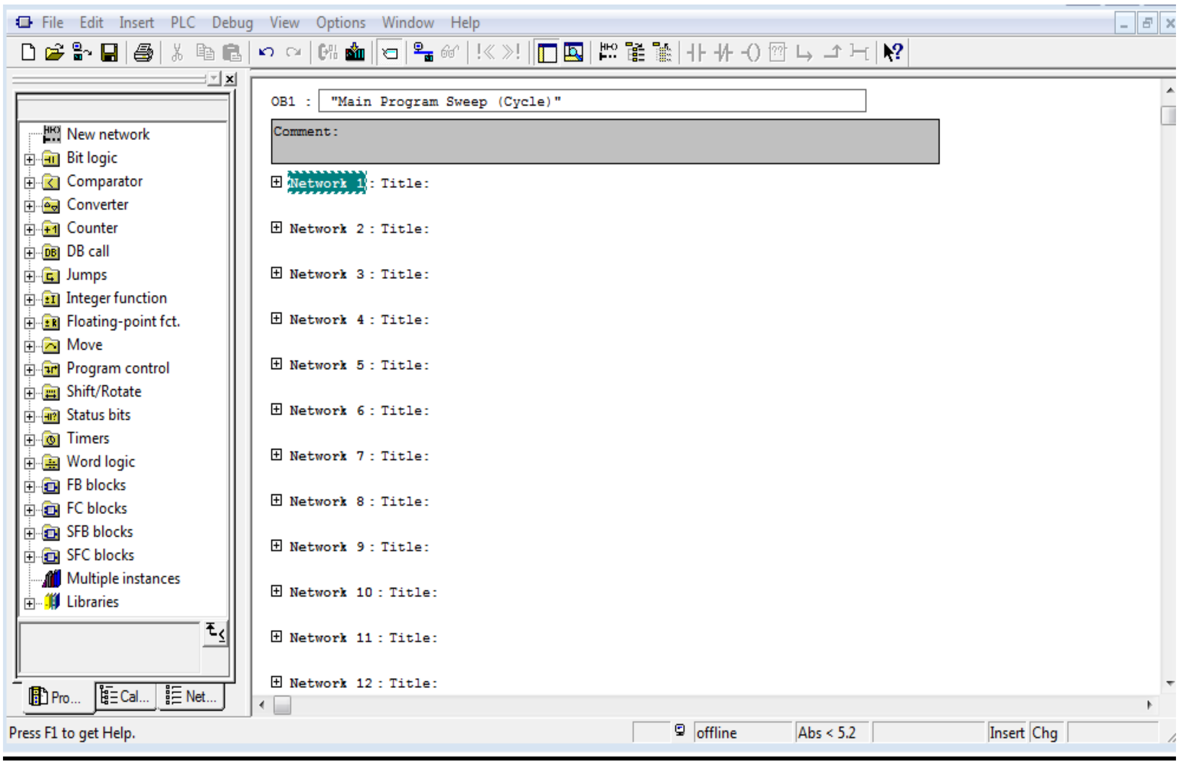


Figure 3.6: The main page of the program

In the first network, after switch on the start push button (I1.4), the lifter moves in negative axis X min (Q0.4) in two steps between set and reset in this steps 2 seconds is set by (T12, T13) until it reach the boxes conveyer, after that the on delay timer (T14) will stop the lifter (reset) and the green lamp (Q1.0) will light as shown in Figure 3.7.

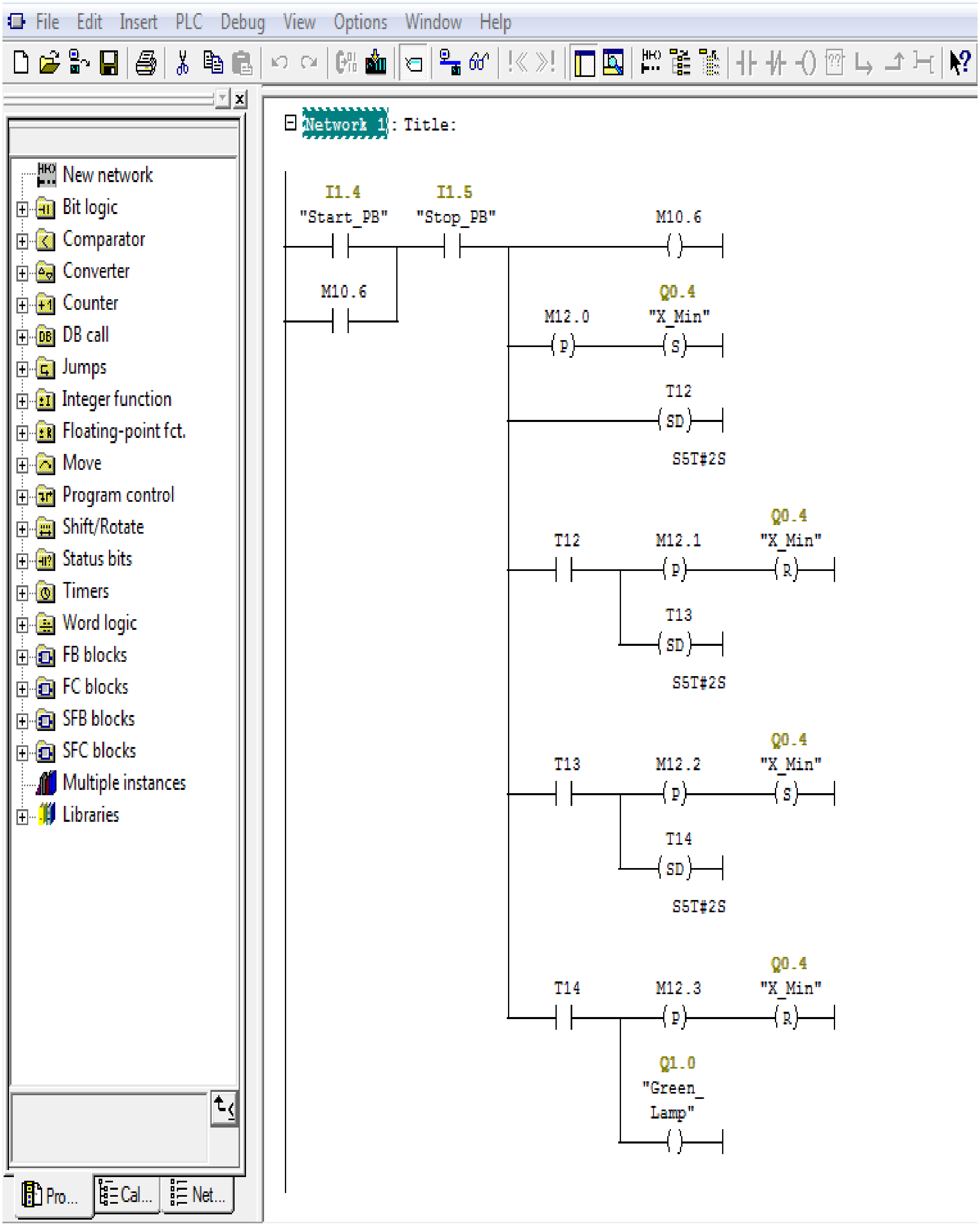


Figure 3.7: Network 1 start system

In the second network, when the light green lamp (Q1.0) activated the boxes conveyor belt (Q0.1) will run (set). In the third network when the boxes conveyor belt (Q0.1) run, the boxes come and passes through it then the sensor (I0.3) detection will activated and according to its activating the parts conveyor belt (Q0.0) will run (S) and the boxes conveyor belt (Q0.1) will stopped (R) as shown Figure 3.8.

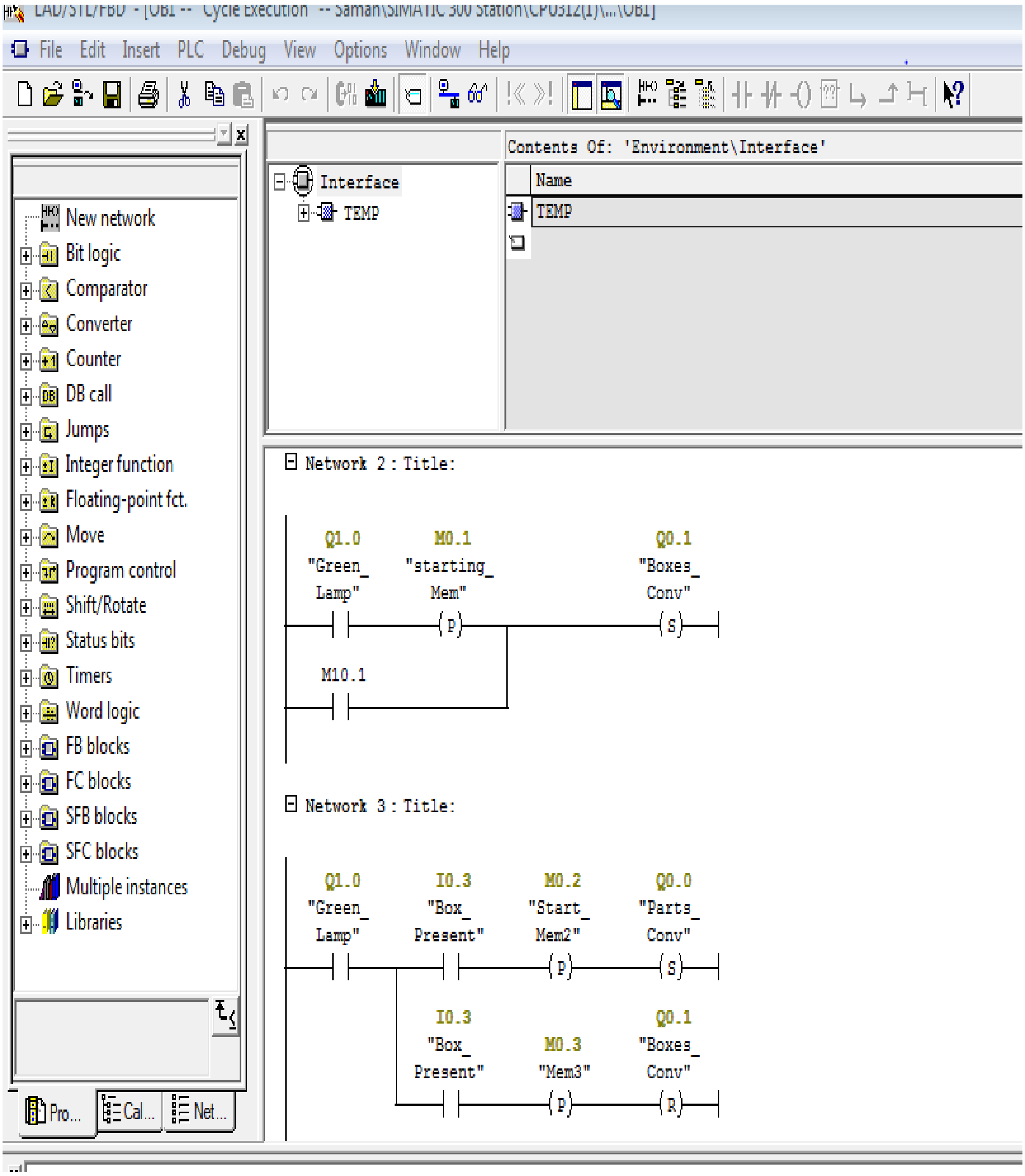


Figure 3.8: Network 2 run the boxes conveyor and network 3 run the parts conveyor

The fourth network when the parts conveyor belt (Q0.0) is running, all the parts dispatch through conveyor, the passage of part is classified as good part, good part 2 and wrong part according to the type of materials by (I0.0) (I0.1) sensors as shown in Figure 3.9.

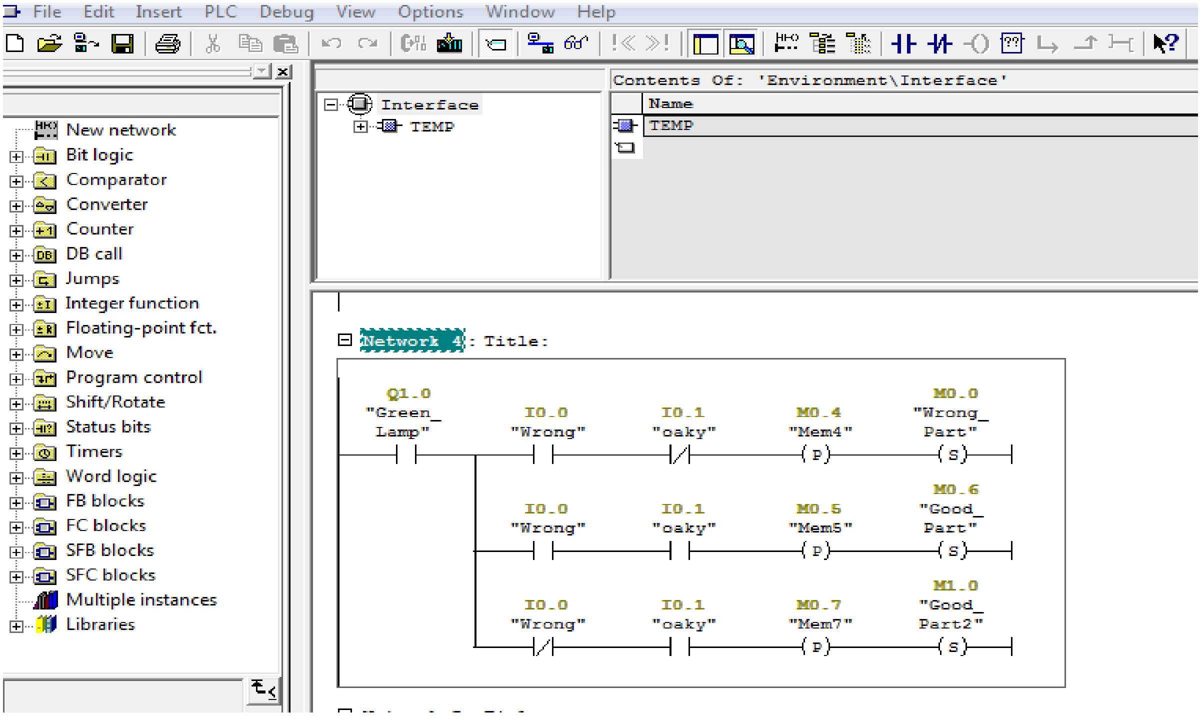


Figure 3.9: Network 4 classified the parts

In the fifth network when the good part is selected, this part pass through conveyer until it reach the sensor (I0.2) to stop (reset) parts conveyer (Q0.0), start packing and reset the memory (M10.0) as shown in Figure 3.10.

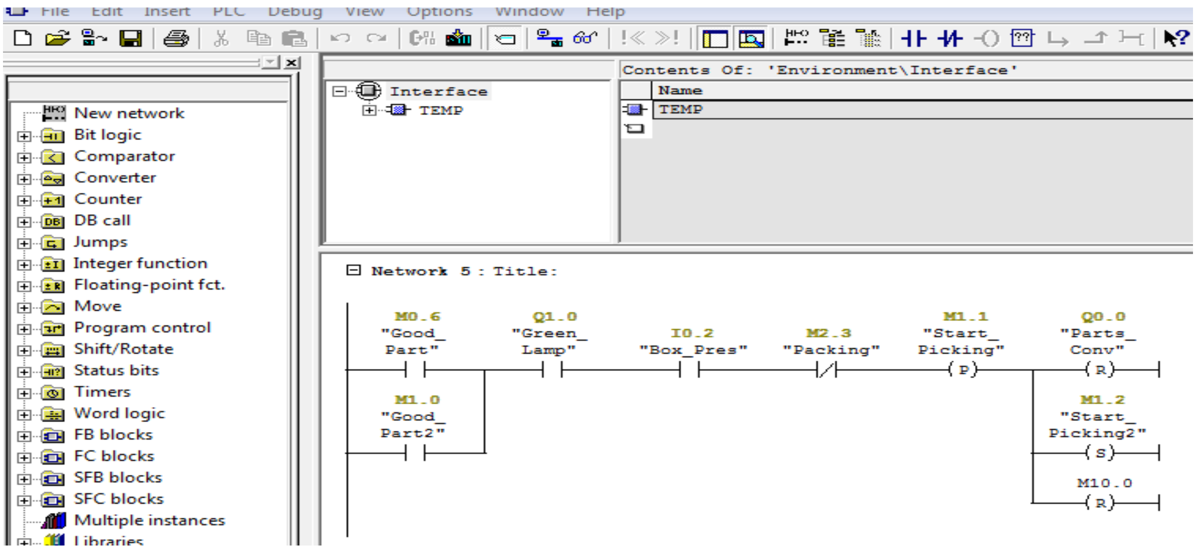


Figure 3.10: Network 5 stop parts conveyor

In the sixth network packing process start after the desired part present stopped by (I0.2) sensor, the pusher will move (set) in the negative X axis (Q0.4) (X_ Min) till the desired part position then reset by (I0.4) (X_ Min_ limit) sensor which stops it and activates the lifter extended on the Z axis (Q0.6) (Z_ Extend) at the same time. After that the lifter will pick up the desired part (Q0.7) (Z_ Pick) when it set by (I0.7) (Z Ext_ limit) sensor with the help of vacuum air and will return to the reset situation (Q0.6) (Z _Extend) by the same sensor accordingly new memories addresses will activate which are packing (M2.3) and start picking (M1.2) as shown in Figure 3.11.

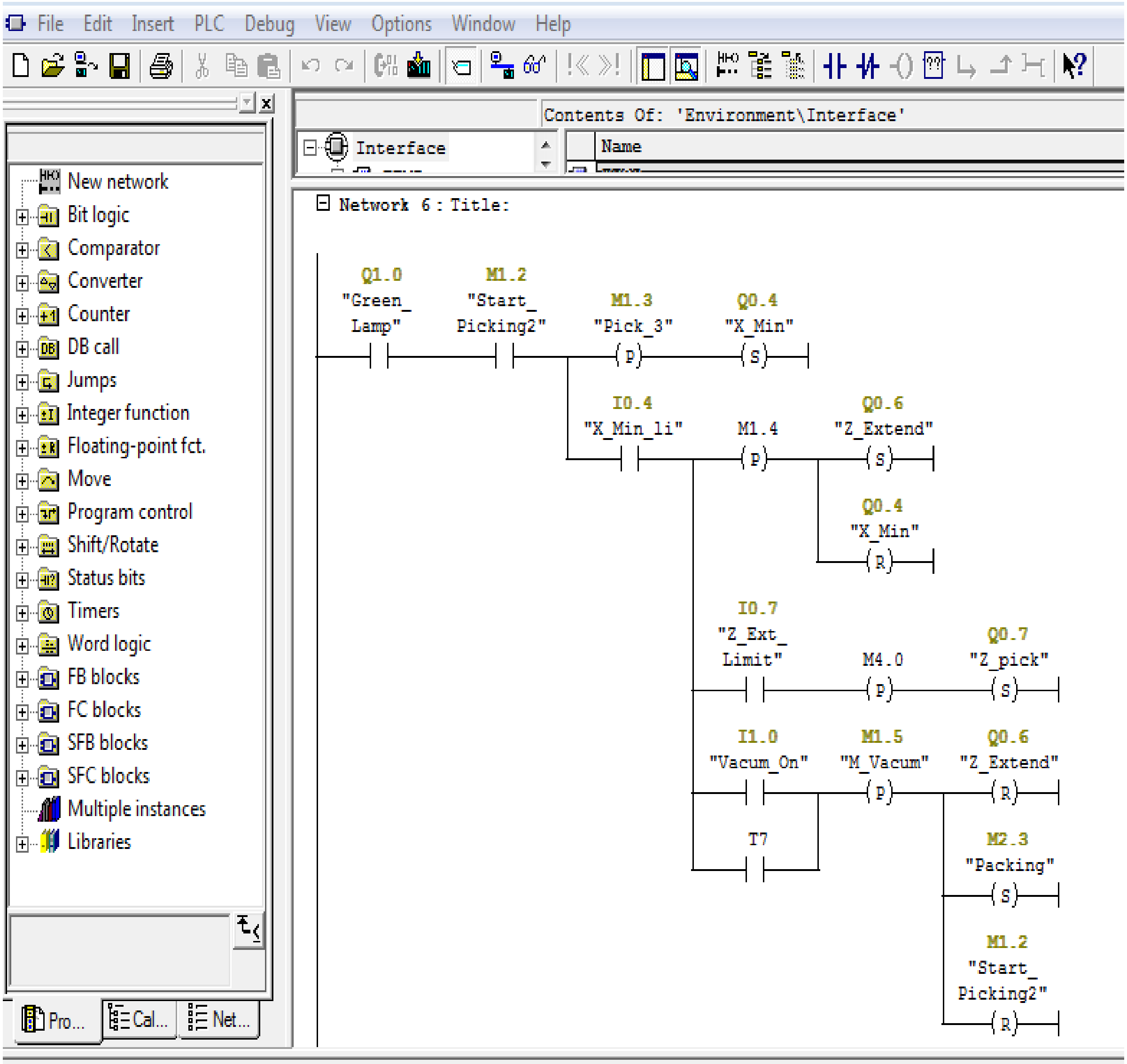


Figure 3.11: Network 6 start packing process

In the seventh network the timer T7 (On _ Daly_ time) is set 2 seconds in the eighth network. After the lifter part present pick up and limited, the pusher move on positive X axis(Q0.5) (X_ Plus_ step), set the (Z_ Extend) and set the end sequins when the time is done as shown Figure 3.12 .

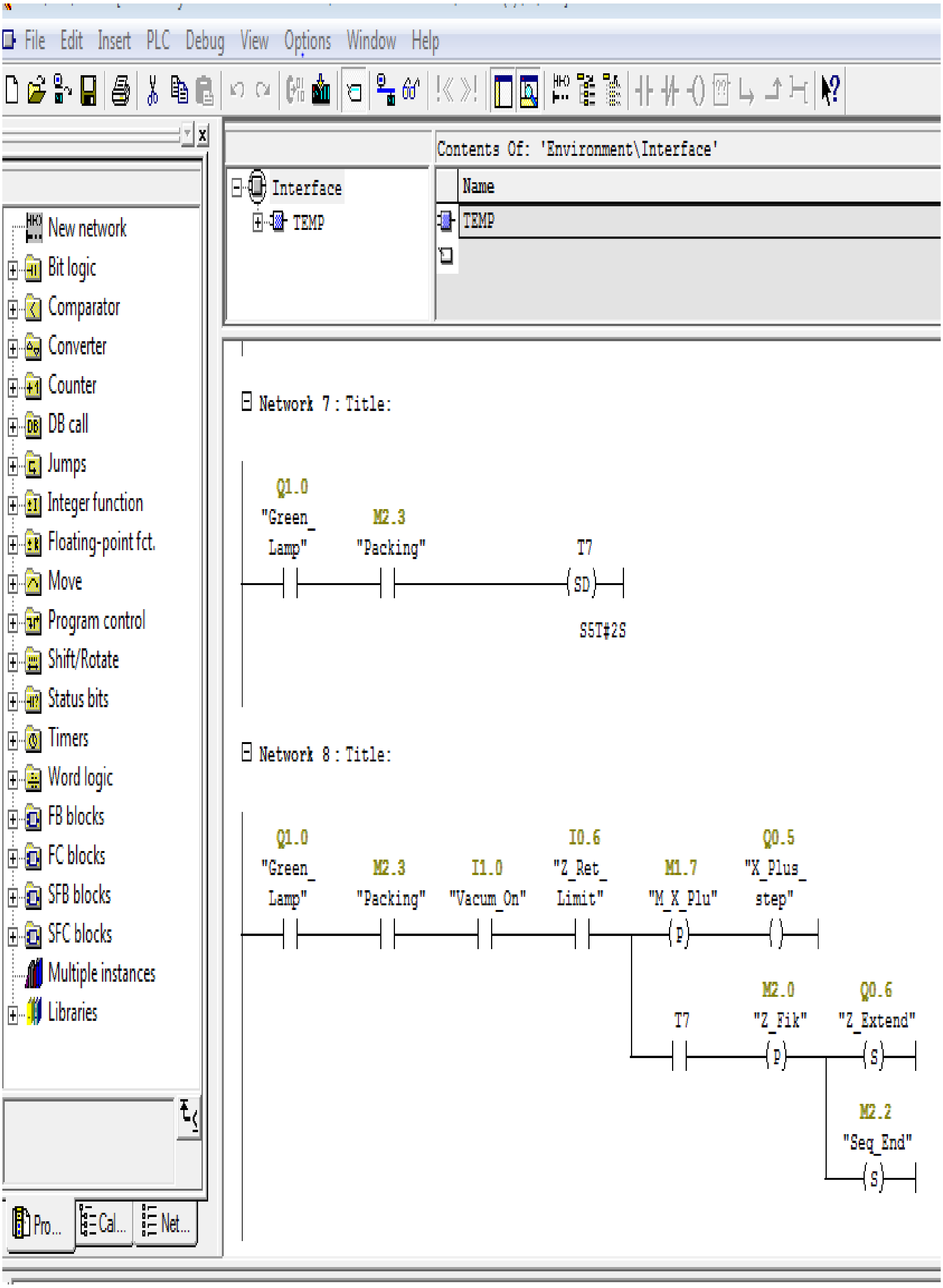


Figure 3.12: Networks 7-8 the part lift

In the ninth network the packing process is completed by placing the part present (piece) in the box. After the lifter released the piece reset the (Z_ pick) (Q0.7), reset the (Z_ Extend) (Q0.6) and register on (M2.7) memory as shown Figure 3.13.

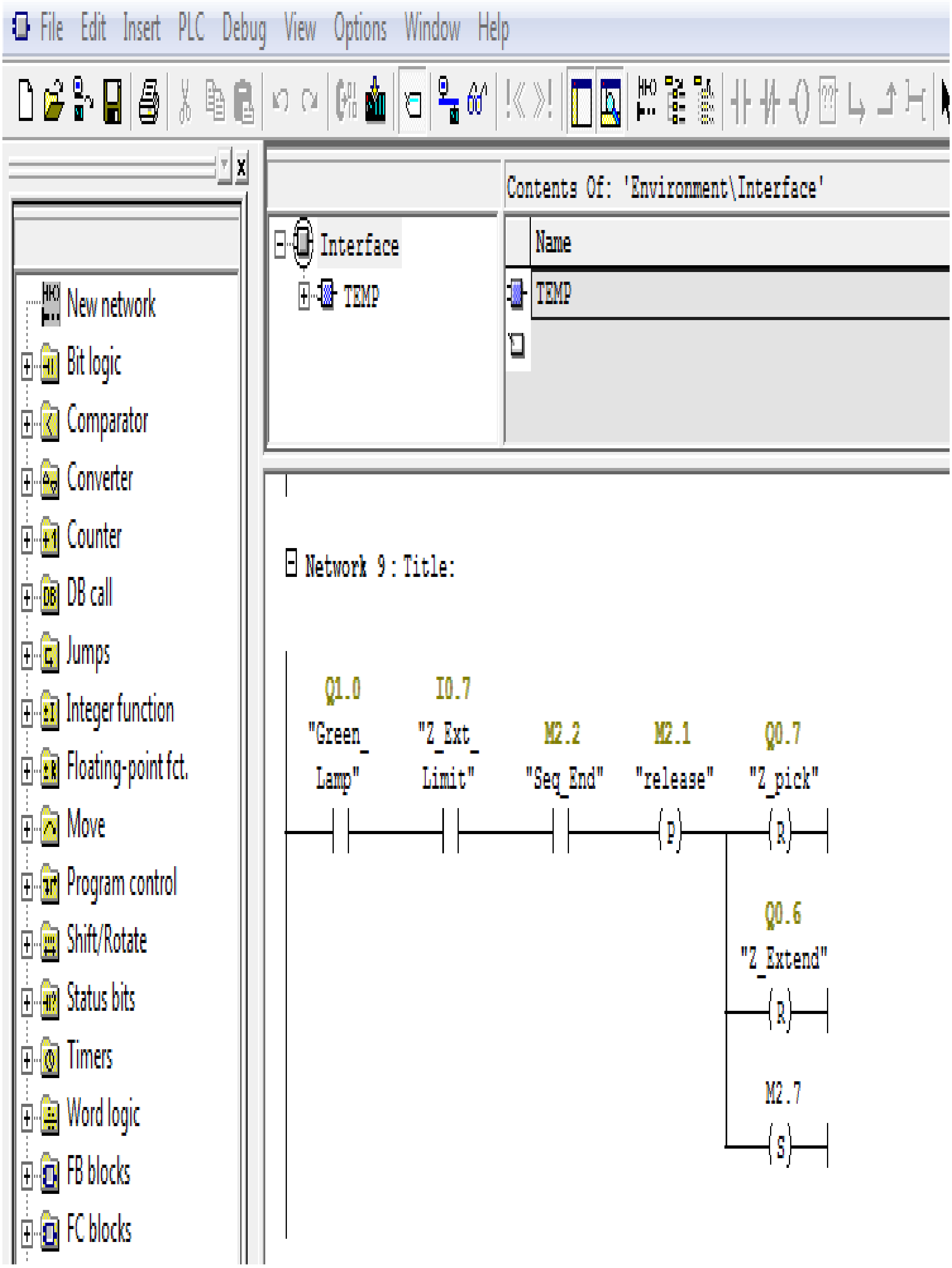


Figure 3.13: Network 9 end packing

In this network to turn off the system, if press the stop push button the (T4) timer is start, after the timer is done was reset for registries wrong part (M0.0), good part (M0.6), good part 2 (M1.0), start picking (M1.2), packing (M2.3), sequins end (M2.2) and (M2.7) as shown Figure 3.14.

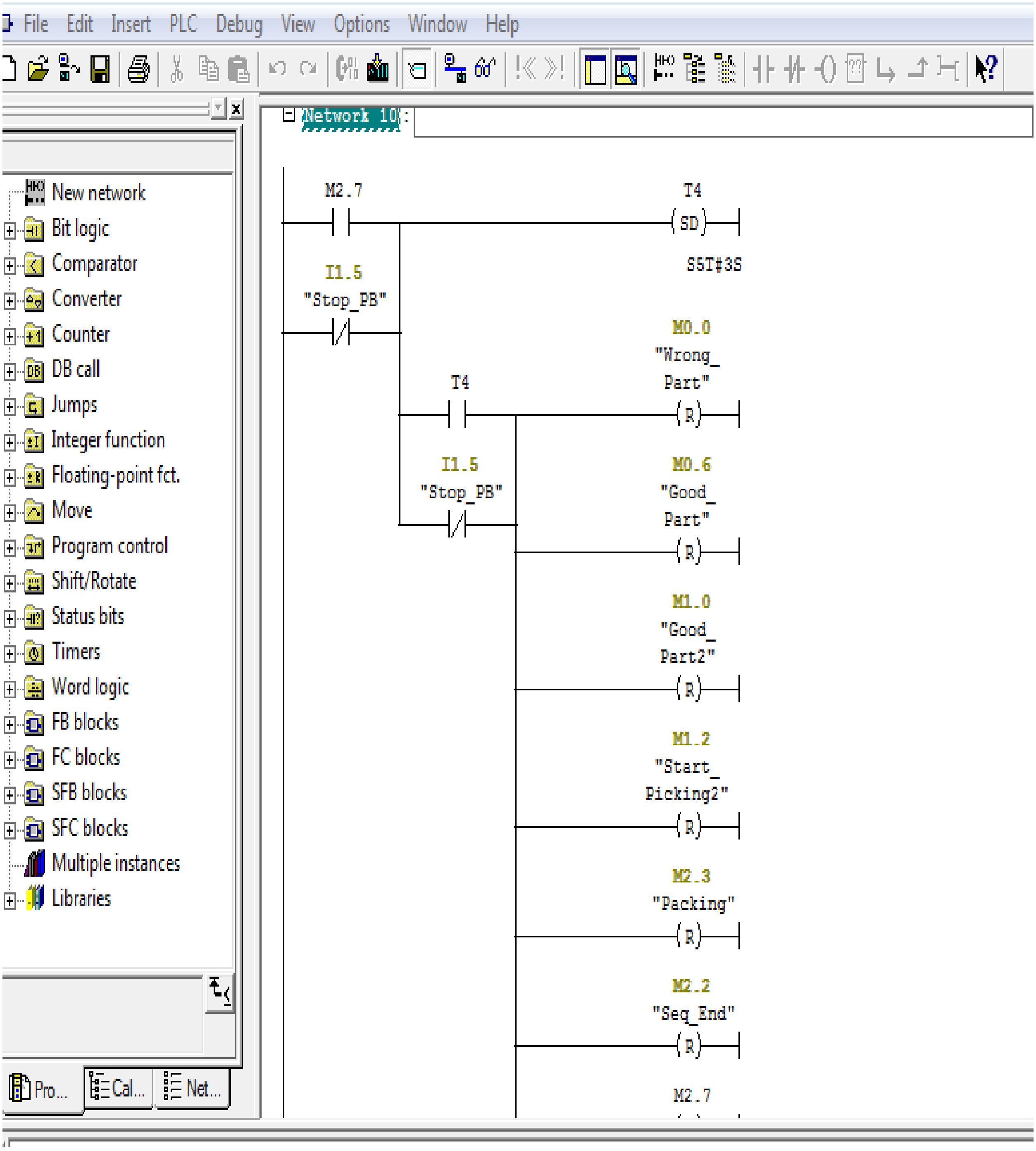


Figure 3.14: Network 10 reset the system

In this network the (T5) timer is set to 5 seconds and then reset to (M10.0) registered after end the timer when the presses stop push button (I1.5) the process has thus ended as shown Figure 3.15.

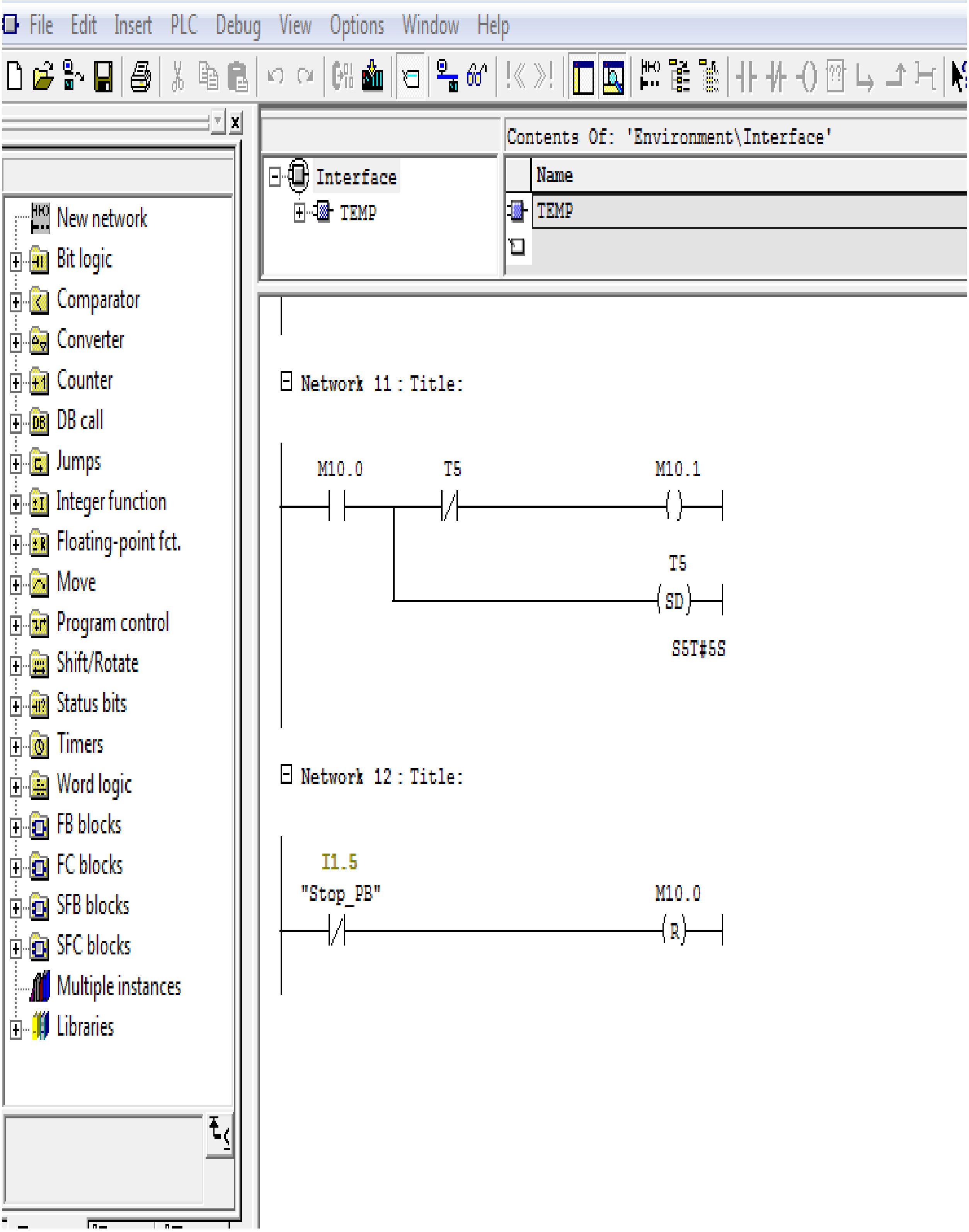


Figure 3.15: Network 11-12 end proces

3.4.2 Three diminutions simulation ITS PLC MHJ edition

The ITS PLC MHJ is 3-diminution simulation for sorting and packaging system is modeling of machine hard ware, shows the activation of various parts of the system, it is represents the interface between man (operator) and process (machine/plant). The hardware 3-diminutions simulation system shown in Figure 3.16.

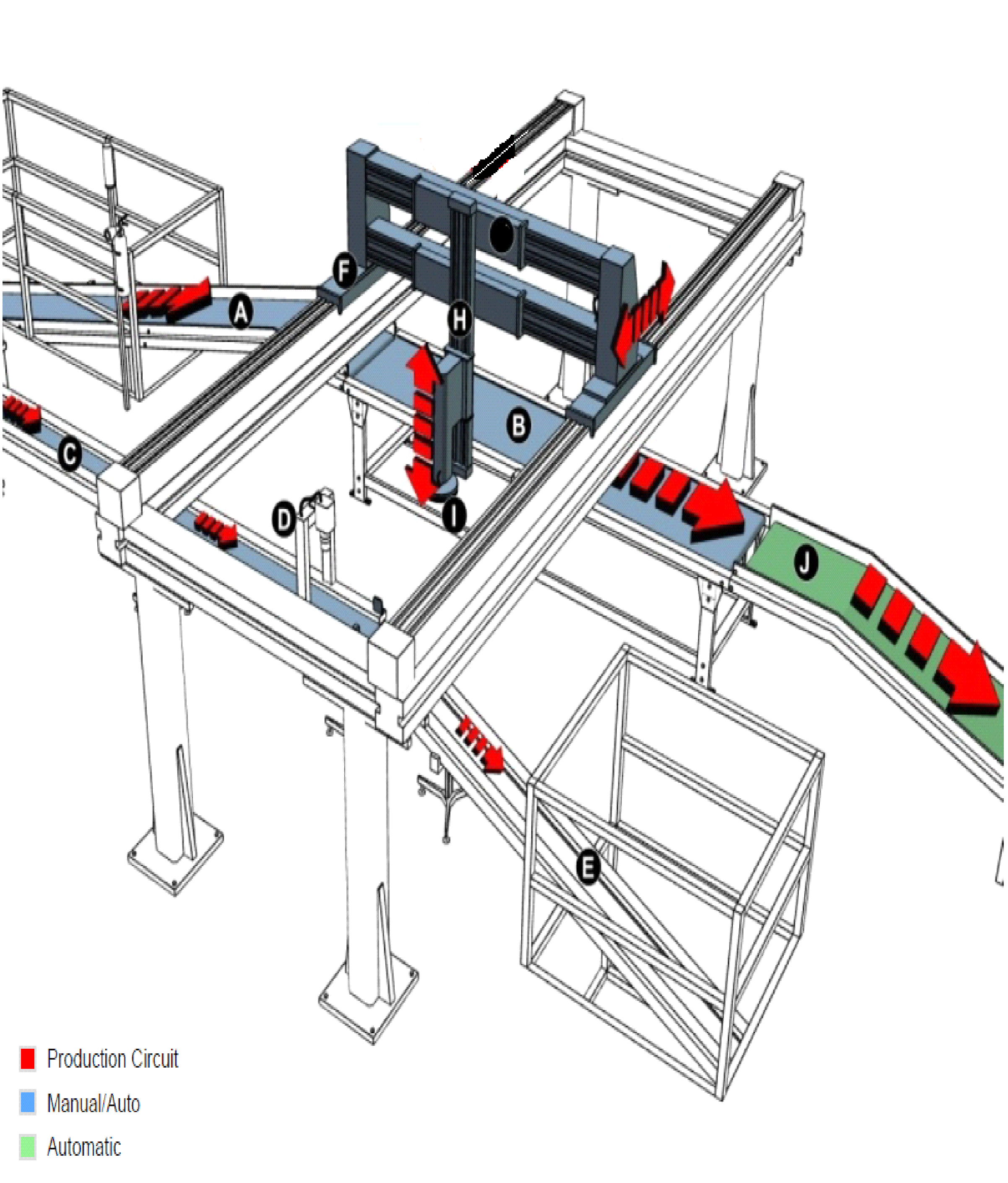


Figure 3.16: Hardware 3-diminution simulation system

CHAPTER FOUR

SYSTEM SIMULATION RESULTS AND DISCUSSIONS

Chapter Four

System Simulation Results and Discussions

4.1 Introduction

After programming the system it must save and compile the errors, if there is an error program must be corrected, then export it to step7- 300 simulators to test it and show the results. This section discus all outputs reactions which happened according to specific actions have given to the inputs before. These reactions made the outputs either active or not active, in another word either on or off. Changing outputs situations happen immediately or may take time because major of inputs depend on timers.

4.2 Inputs and Outputs Addresses

Table 4.1 shows the whole input and output addresses in the program.

Table 4.1: Input and output addresses

Symbol	Address		Data type	
Box_Present	I	0.3	BOOL	
Boxes_Conv	Q	0.1	BOOL	
CYC_INT5	OB	35	OB	35
Cycle Execution	OB	1	OB	1
Good_Part	M	0.6	BOOL	
Good_Part2	M	1.0	BOOL	
Green_Lamp	Q	1.0	BOOL	
M_Vacum	M	1.5	BOOL	
M_X_Plu	M	1.7	BOOL	
Mem3	M	0.3	BOOL	
Mem4	M	0.4	BOOL	
Mem5	M	0.5	BOOL	
Mem7	M	0.7	BOOL	
oaky	I	0.1	BOOL	
p	MD	0	DWORD	
Packing	M	2.3	BOOL	
part_Pres	I	0.2	BOOL	
Parts_Conv	Q	0.0	BOOL	

mbol Table Edit Insert View Options Win

All Symbols

Symbol	Address		Data type
Pick_3	M	1.3	BOOL
qqqq	M	10.1	BOOL
release	M	2.1	BOOL
Seq_End	M	2.2	BOOL
Start_Mem2	M	0.2	BOOL
Start_PB	I	1.4	BOOL
Start_Picking	M	1.1	BOOL
Start_Picking2	M	1.2	BOOL
starting_Mem	M	0.1	BOOL
Stop_PB	I	1.5	BOOL
Vacum_On	I	1.0	BOOL
Wrong	I	0.0	BOOL
Wrong_Part	M	0.0	BOOL
X_1_Step	I	0.5	BOOL
X_Min	Q	0.4	BOOL
X_Min_Ii	I	0.4	BOOL
X_min_rSet	M	1.6	BOOL
X_Plus_step	Q	0.5	BOOL
Z_Ext_Limit	I	0.7	BOOL
Z_Extend	Q	0.6	BOOL
Z_Fik	M	2.0	BOOL
Z_pick	Q	0.7	BOOL
Z_Ret_Limit	I	0.6	BOOL

On the simulator first load the program then put the PLC in the run mode; the program will open, the result lifter is movies until the boxes conveyor. By defaults inside the program on and green color outside outputs activate with the number 4 lighted green color as in the Figure 4.1.

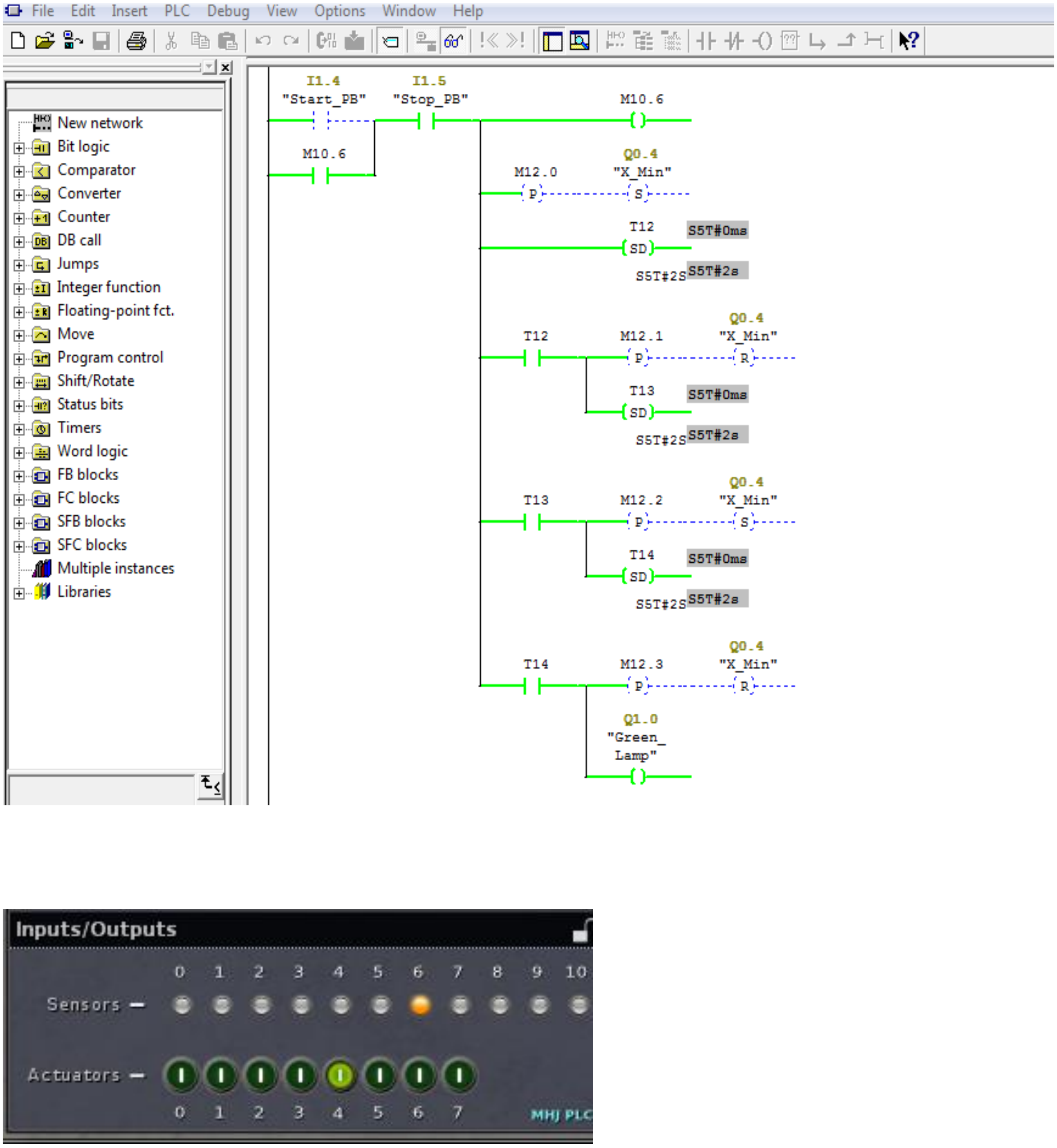
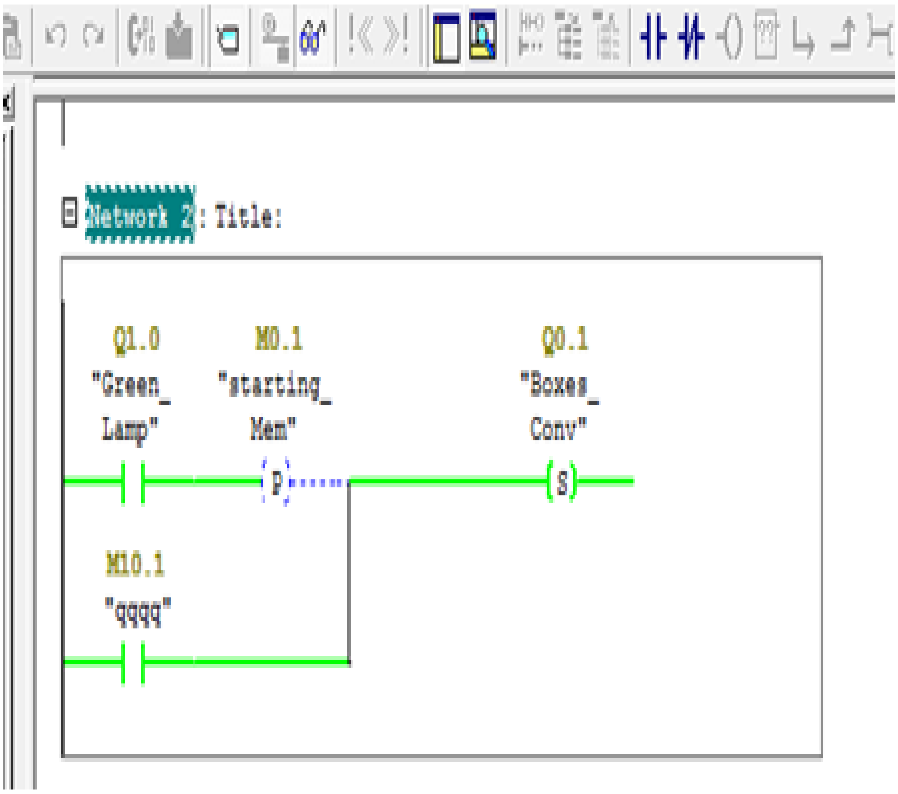


Figure 4.1: Activating the lifter

4.3 Activating the Conveyor Belt

For testing first press the switch number one which refers to the start push button (I0.0) and the result is activating the starting memory (M0.1) and running the boxes conveyor (Q0.1). By defaults inside the program on and green color outside outputs activate with the number1lighted green color as shown in Figure 4.2.



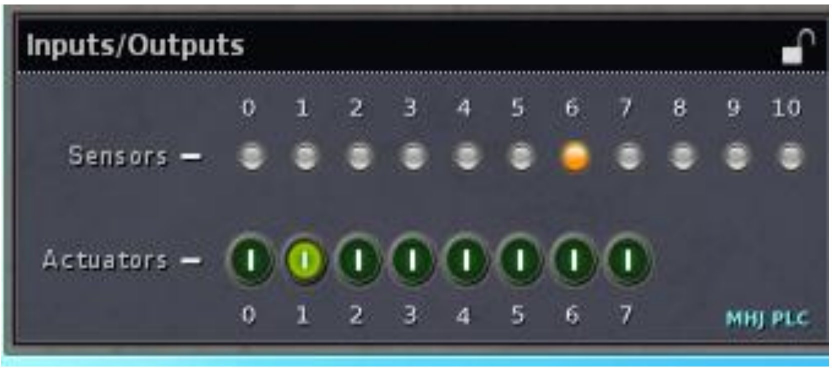


Figure 4.2: Activating the boxes conveyor

The boxes passed thrgue boxes conveyor until abox arrived the sensor (I0.3) (box peresent), the result reset the boxes conveyor (Q0.1) and set the parts conveyor (Q0.0). By defaults the output activate with the number 0 in green color plus green color inside the program as shown Figures 4.3and4.4.

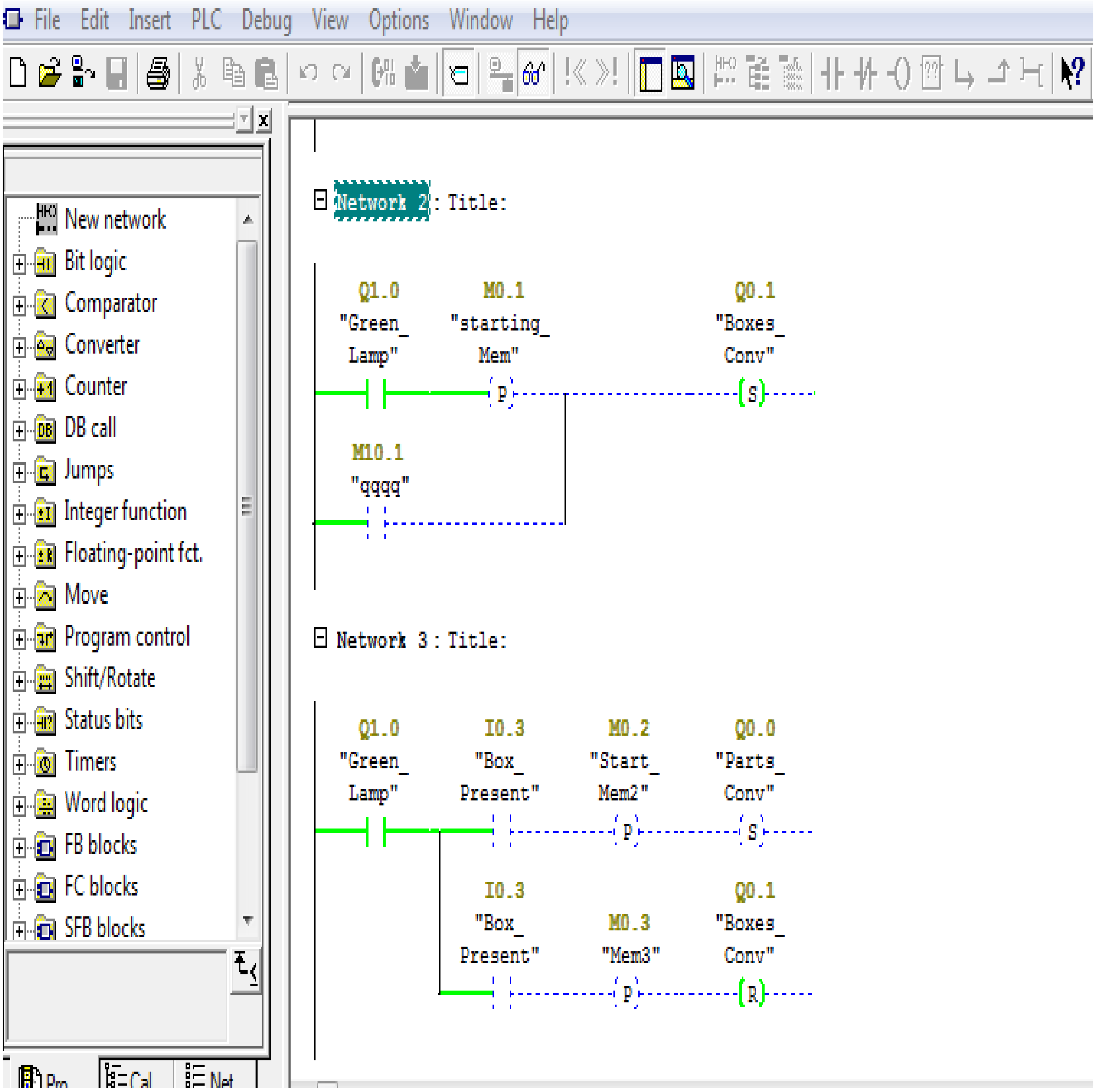


Figure 4.3: Sensors detected the box

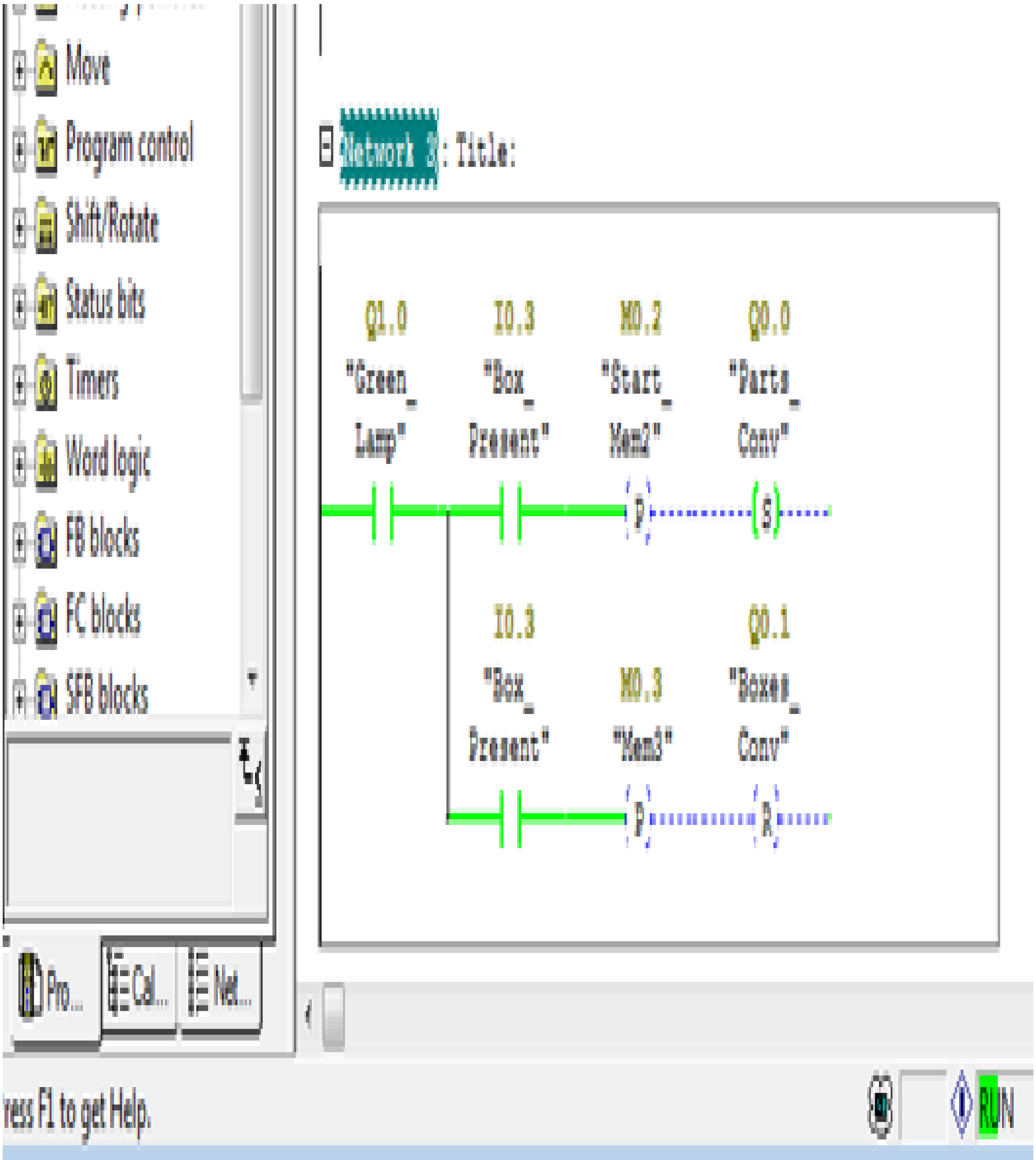


Figure 4.4: Activating the parts conveyor

4.4 Parts Sorting Simulation Results

When the parts conveyor belt (Q0.0) is running, all the parts dispatch through conveyor, the passage of part is classified as good part, good part 2 and wrong part according to the type of materials by (I0.0) (I0.1) sensors, by defaults inputs activate with the number 1 plus green color 0 or1 or 0 and1 ,the output activate with the number 1 plus green color, inside the program as shown in Figures 4.5-4.7.

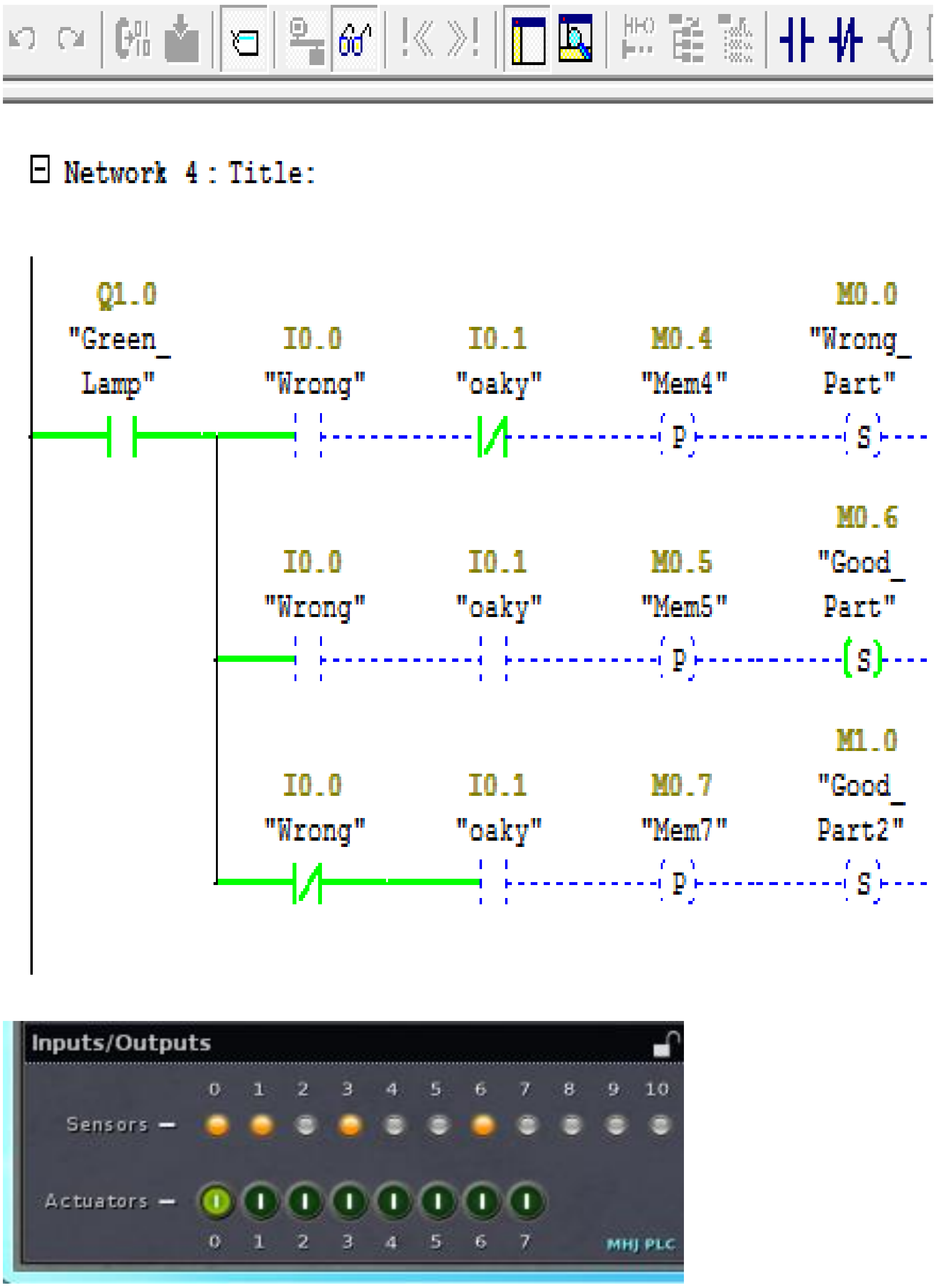


Figure 4.5: Sorting good part

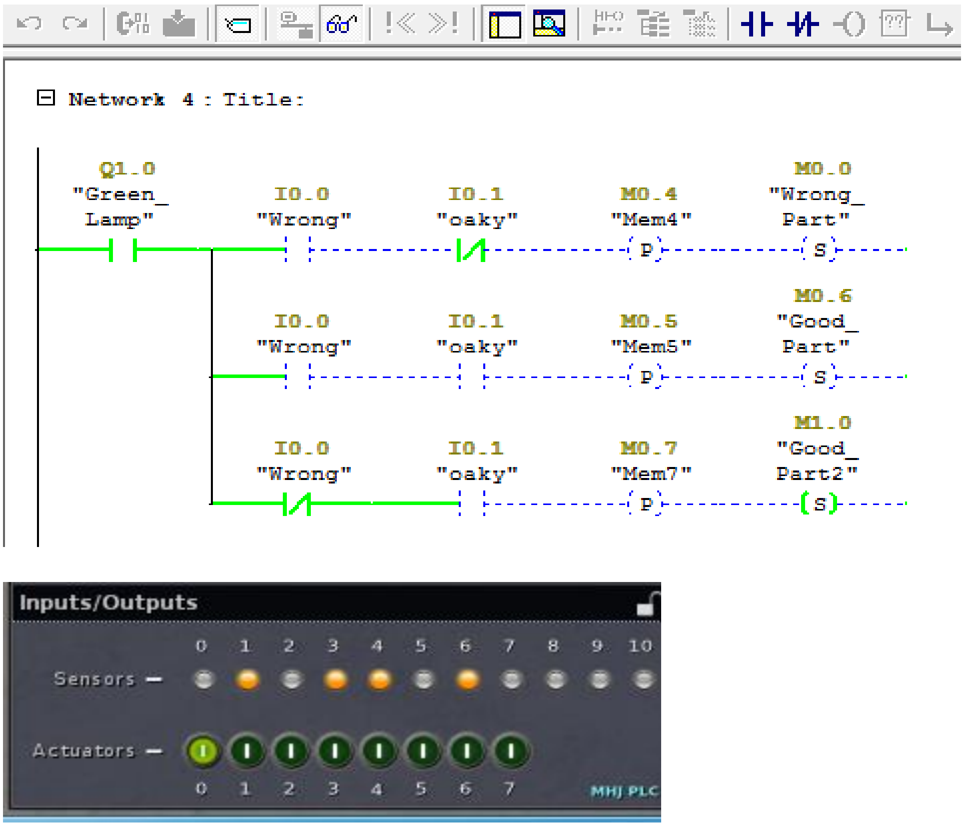


Figure 4.6: Sorting good part2

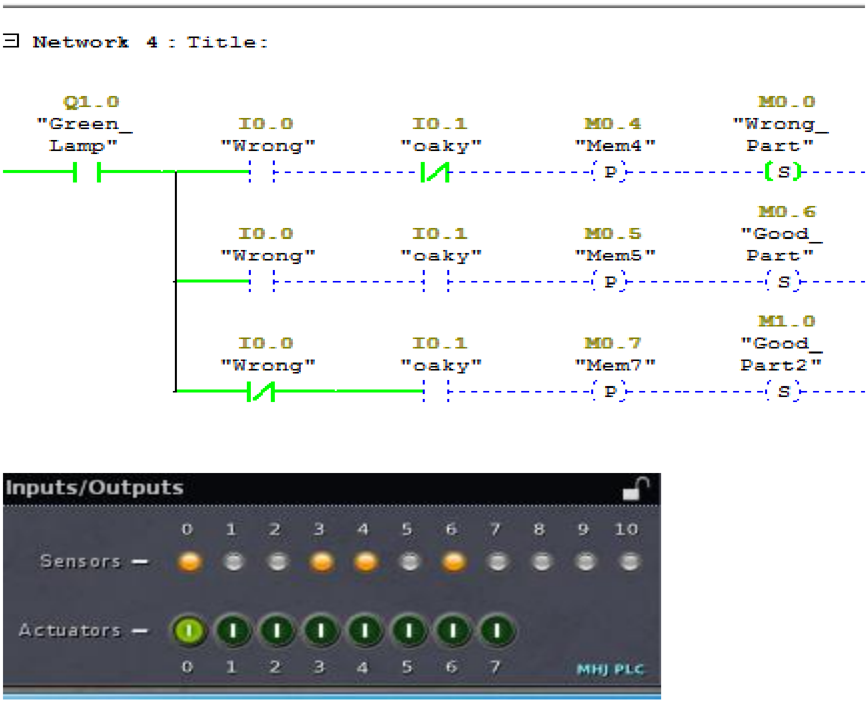


Figure 4.7: Sorting wrong part

After the good part is selected, this part pass through conveyer until it reach the sensor (I0.2), the result stop (reset) parts conveyer (Q0.0), activated start packing and reset the memory (M10.0), By defaults inputs activate with the number 2 plus green color , inside the program activate green color as shown in Figures 4.8and 4.9.

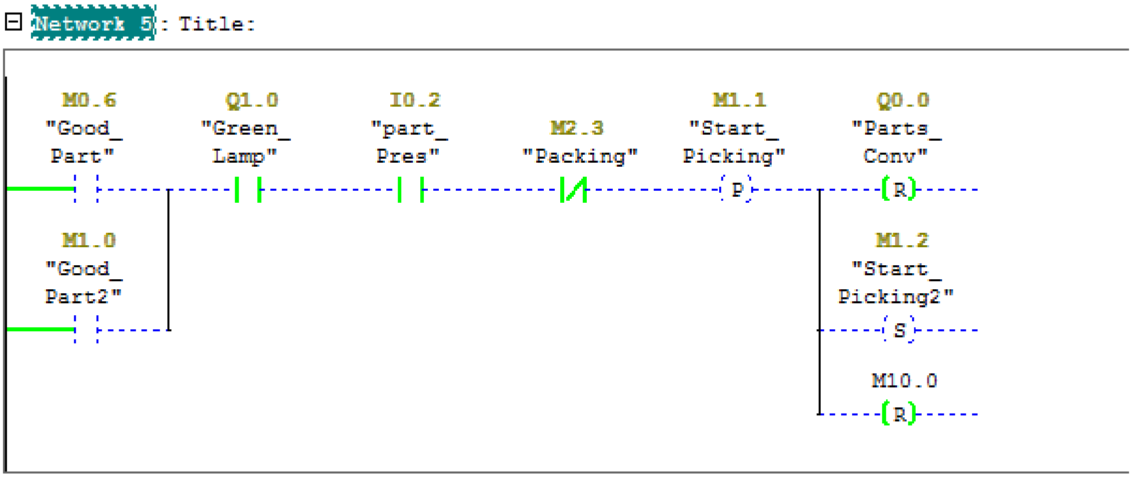


Figure 4.8: Stop the parts conveyer

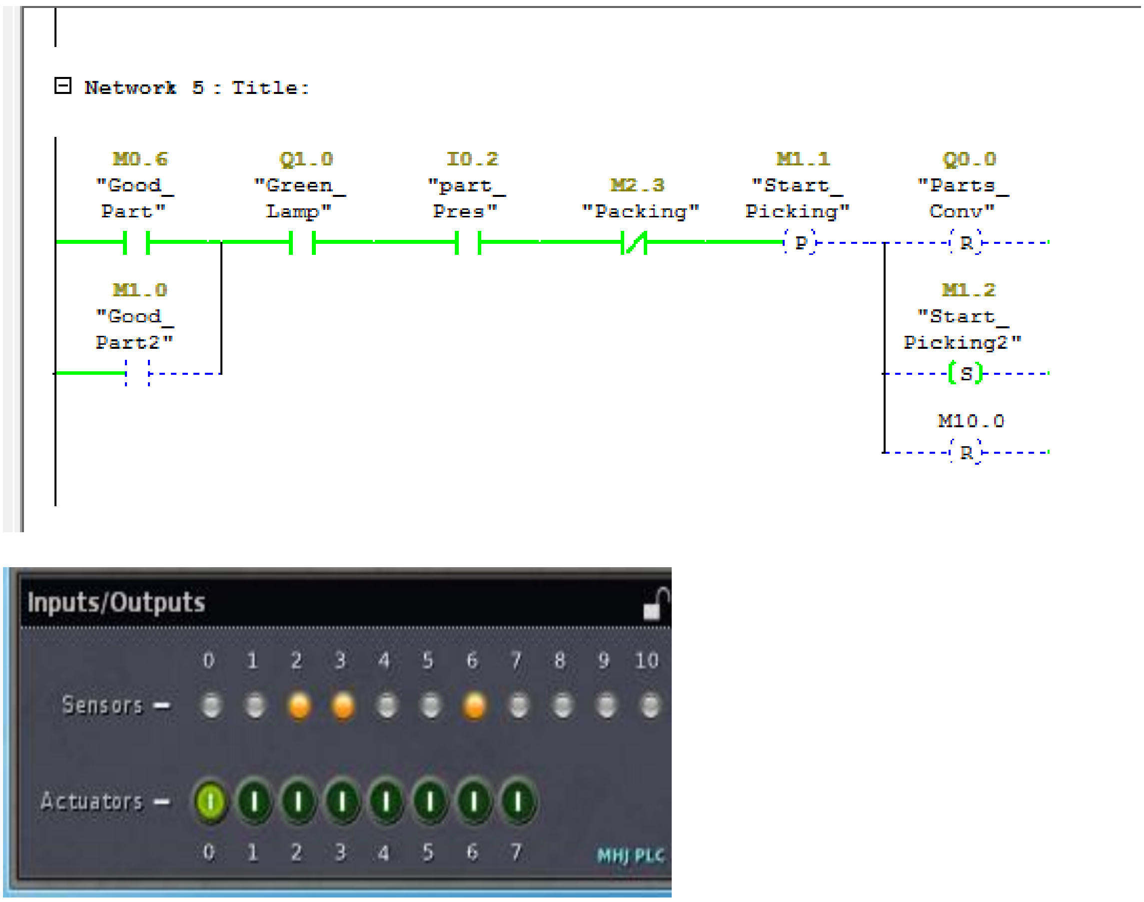


Figure 4.9: Activation start packing process

4.5 Start Packing Simulation Results

The packing process start after the desired part present stopped by (I0.2) sensor, the result pusher will move (set) in the negative X axis (Q0.4) (X_ Min) till the desired part position then reset by (I0.4) (X_ Min_ limit) sensor which stops it and activates the lifter extended on the Z axis (Q0.6) (Z_ Extend) at the same time, the lifter will pick up the desired part (Q0.7) (Z_ Pick) when it set by (I0.7) (Z Ext_ limit) sensor with the help of vacuum air and will return to the reset situation (Q0.6) (Z _Extend) by the same sensor accordingly new memories addresses will activate which are packing (M2.3) and start picking (M1.2). The outputs activate with the number 4, 6and7 in green color plus green color inside the program as shown in Figures 4.10-4.12.

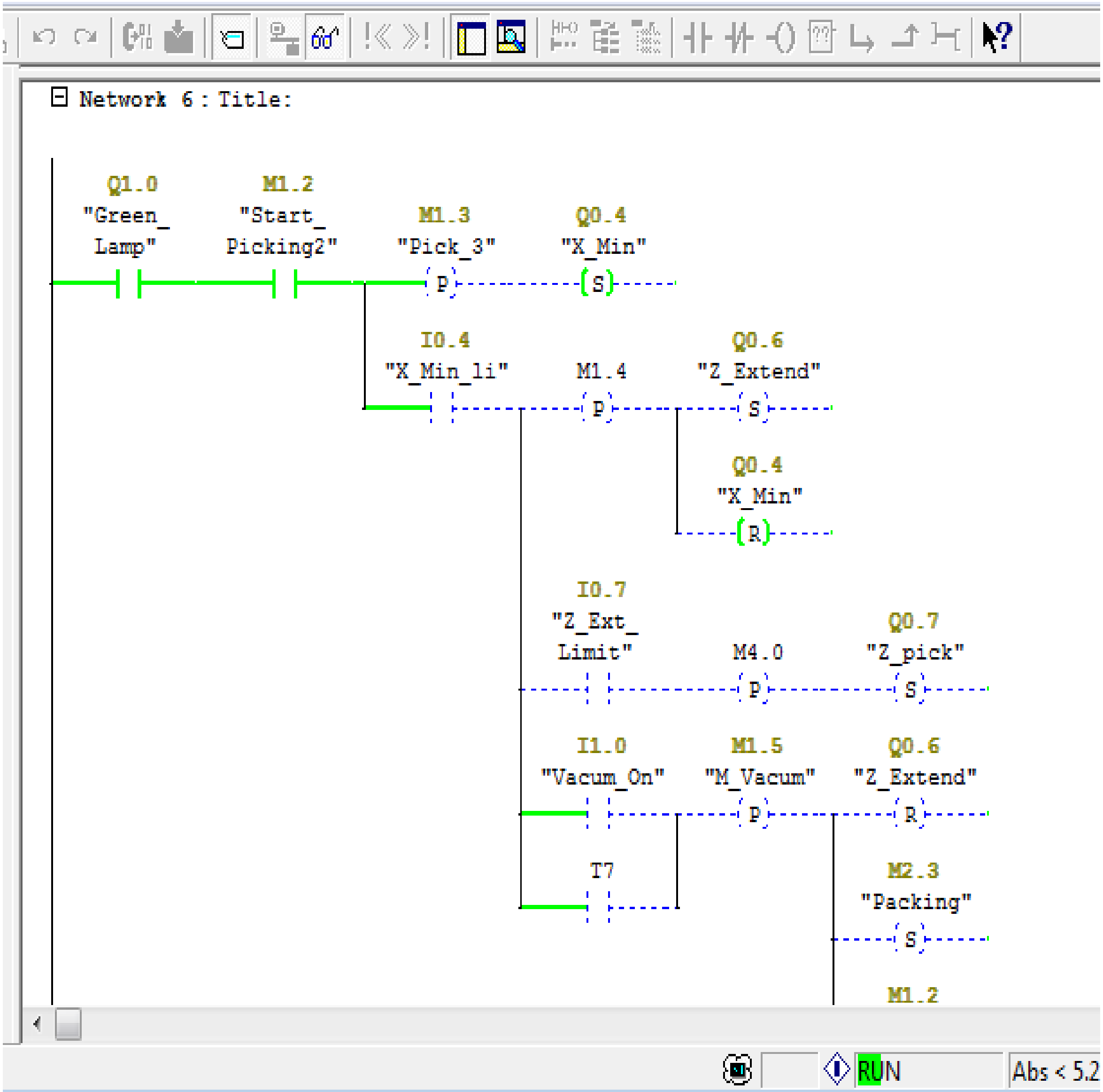


Figure 4.10: Move the pusher

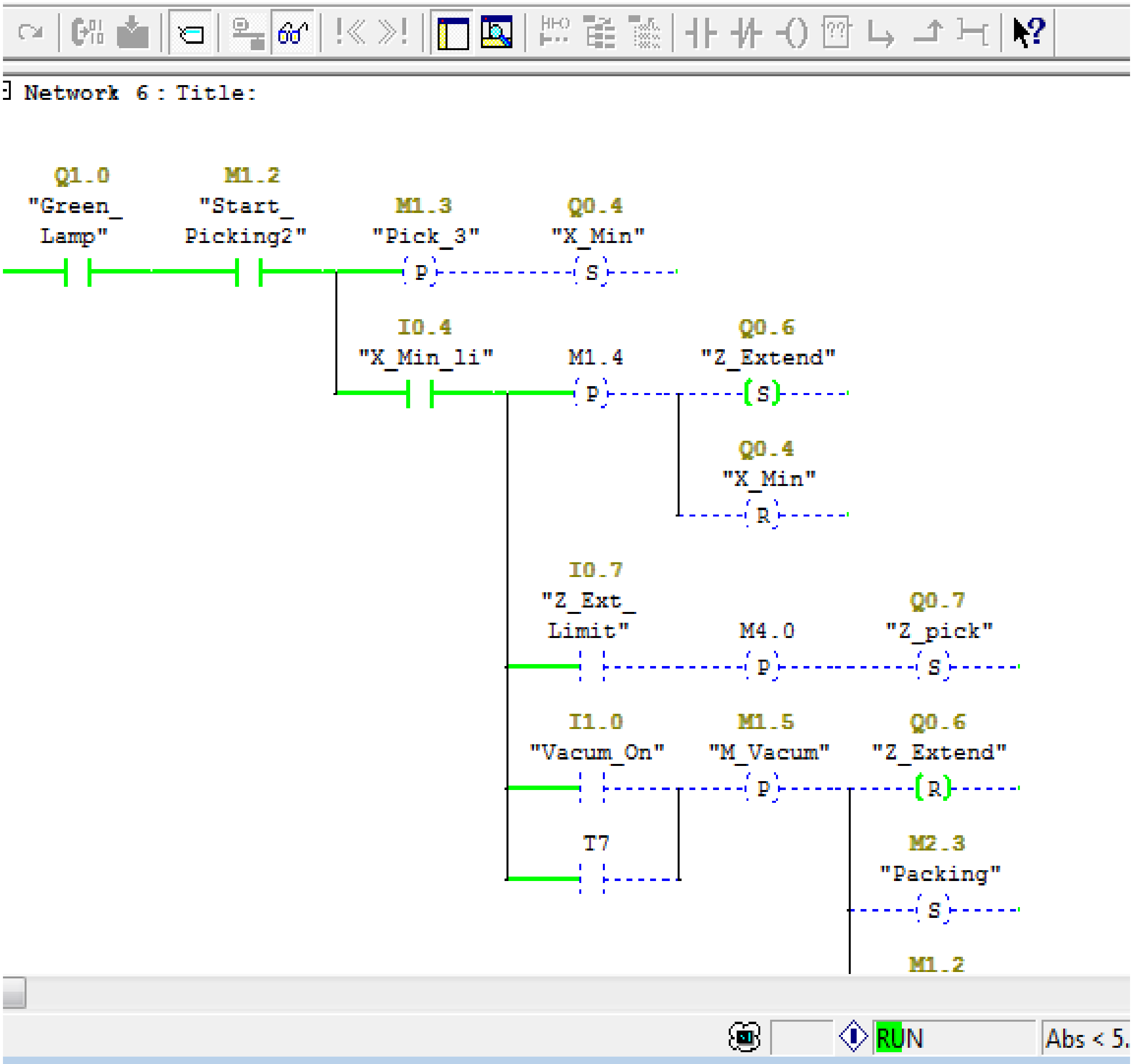


Figure 4.11: Move the lifter

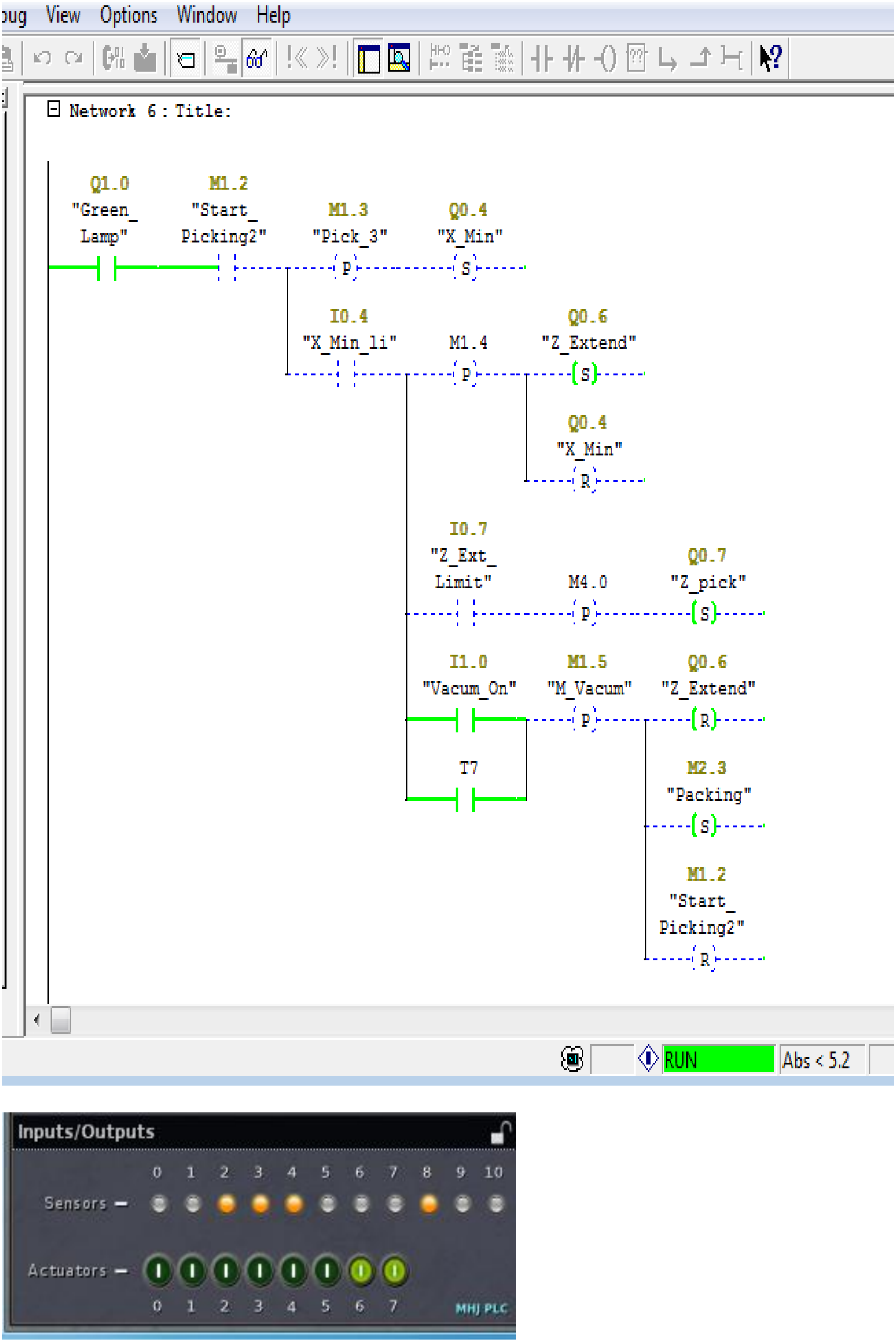


Figure 4.12: Activation of the packing process

4.6 Packaging Process Simulation Results

The timer T7 is set 2secands. When the lifter part present pick up and limited, pusher moved on positive X axis (Q0.5) (X_ Plus_ step), the result After on delay timer (T7) completes its calculating set the (Z_ Extend) (Q.6) and set the end sequins, the outputs activate with the number 5and6 plus green color inside the program on the right side as shown Figures 4.13and 4.14 .

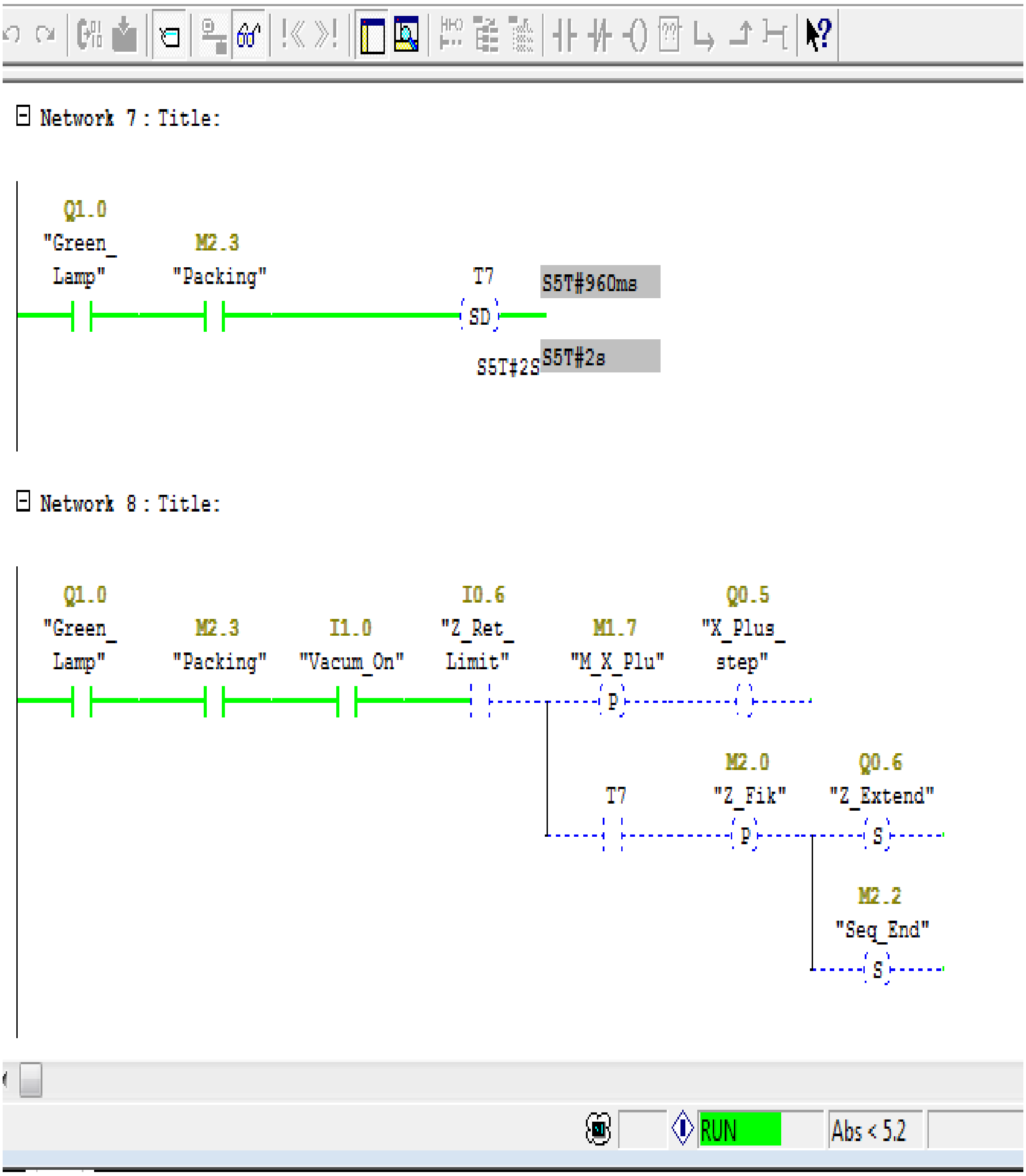


Figure 4.13: Start timer calculating

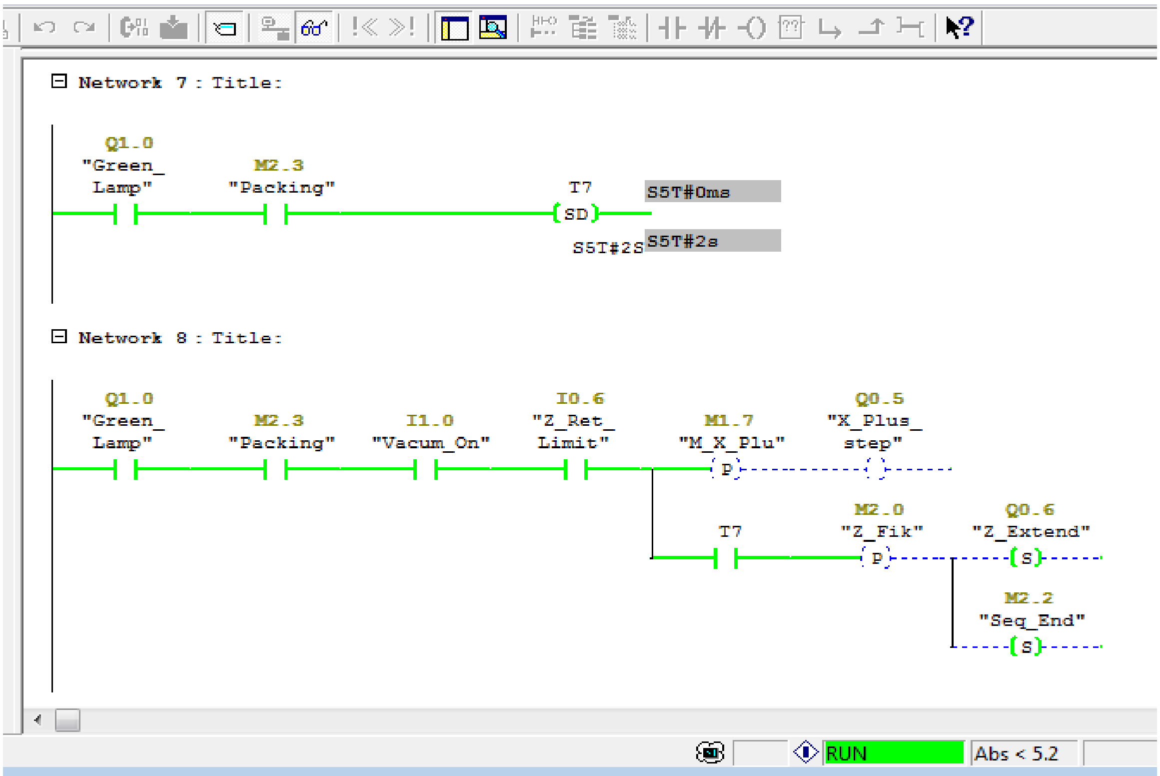


Figure 4.14: Lifter extending

The packing process is completed by placing the sorted part (1piece) in the box. After the lifter released the piece, reset the (Z_ pick) (Q0.7),reset the(Z_ Extend)(Q0.6) and register on (M2.7) memory, the output activated with the numbers 6and7 plus green color inside the program as shown in Figures 4.15and4.16.

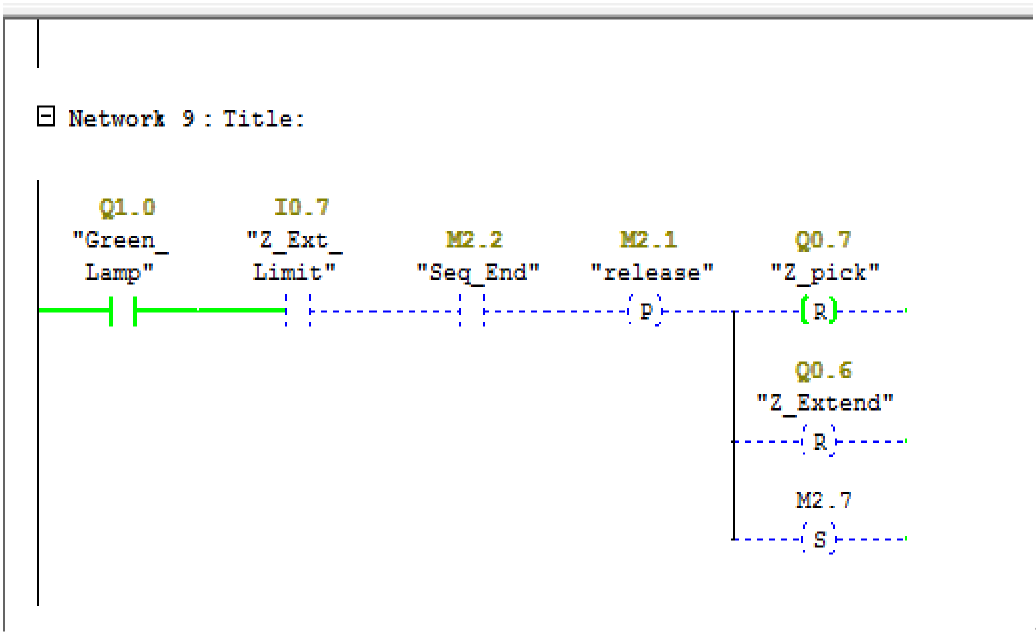
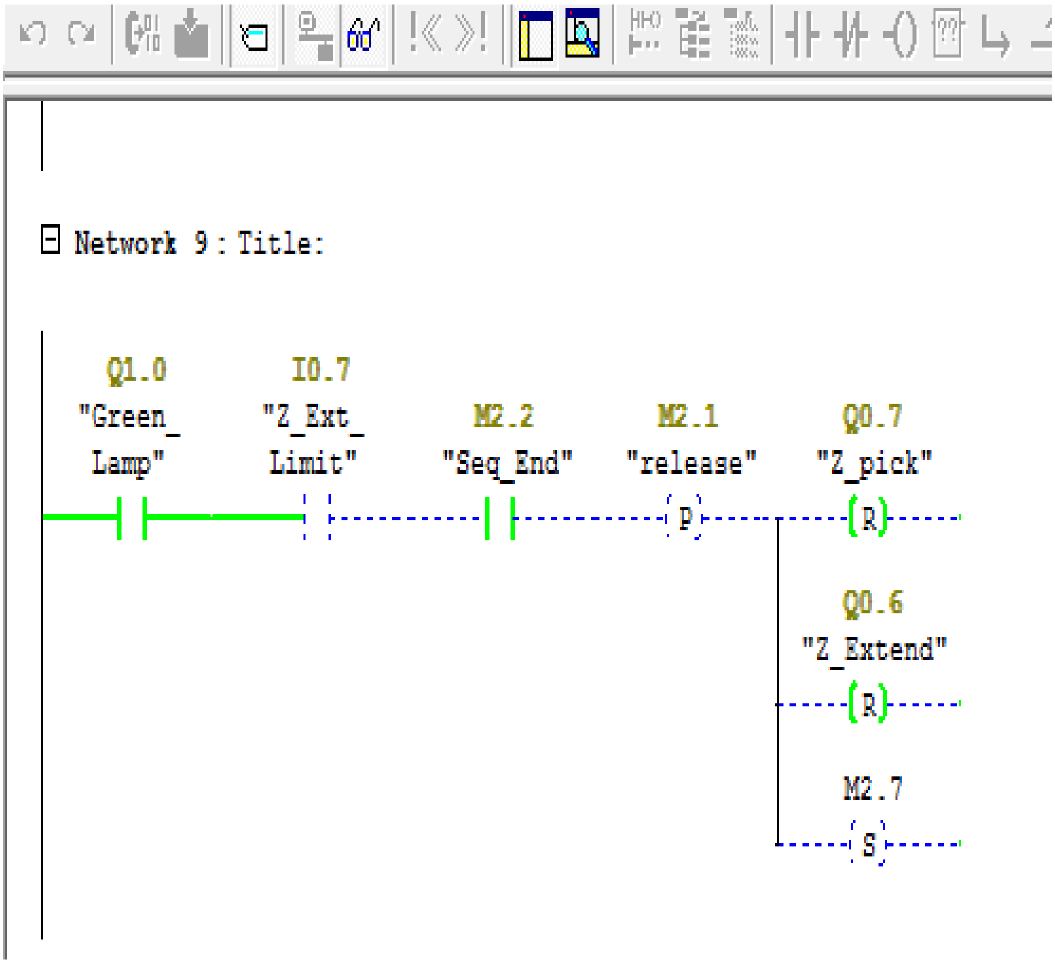


Figure 4.15**:** Lifter release



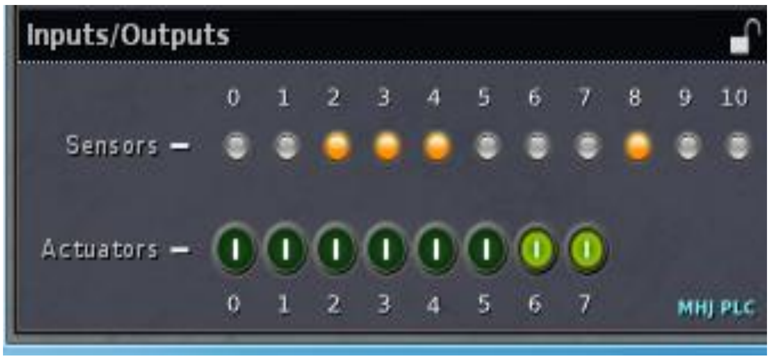


Figure 4.16: Lifter limit

4.7 Ending Process

The system stops when press the stop push button the timer (T4) start counting up to 3 seconds after which all system operations are reset, reset for registries wrong part (M0.0), good part (M0.6), good part2 (M1.0), start picking (M1.2), packing (M2.3), sequins end (M2.2) and (M2.7) as shown in Figure 4.17.

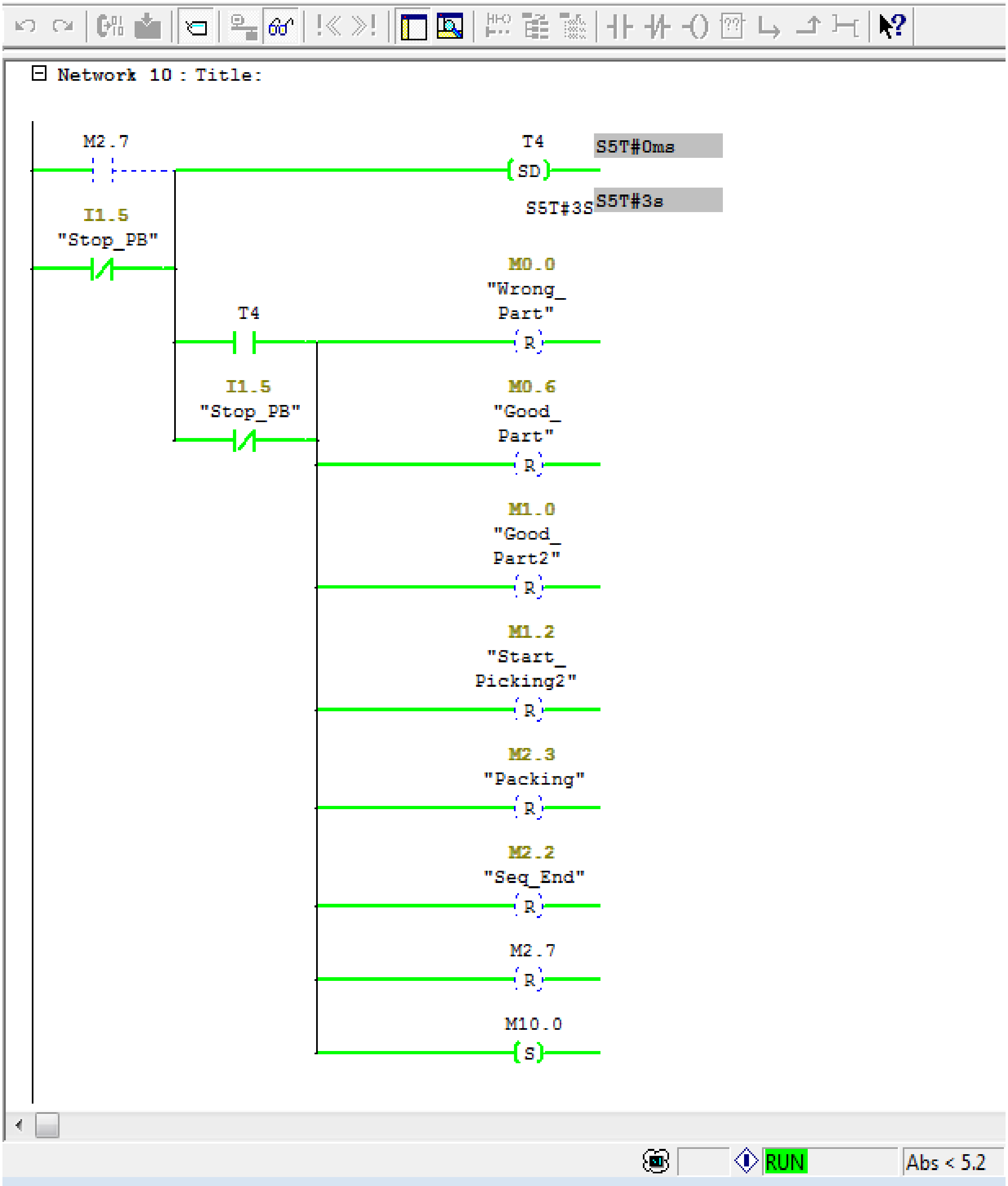


Figure 4.17: Reset system

The timer (T5) also adjusts the account for up to 5 seconds, after counting, the start memory (M10.0) is reset as shown Figure 4.18.

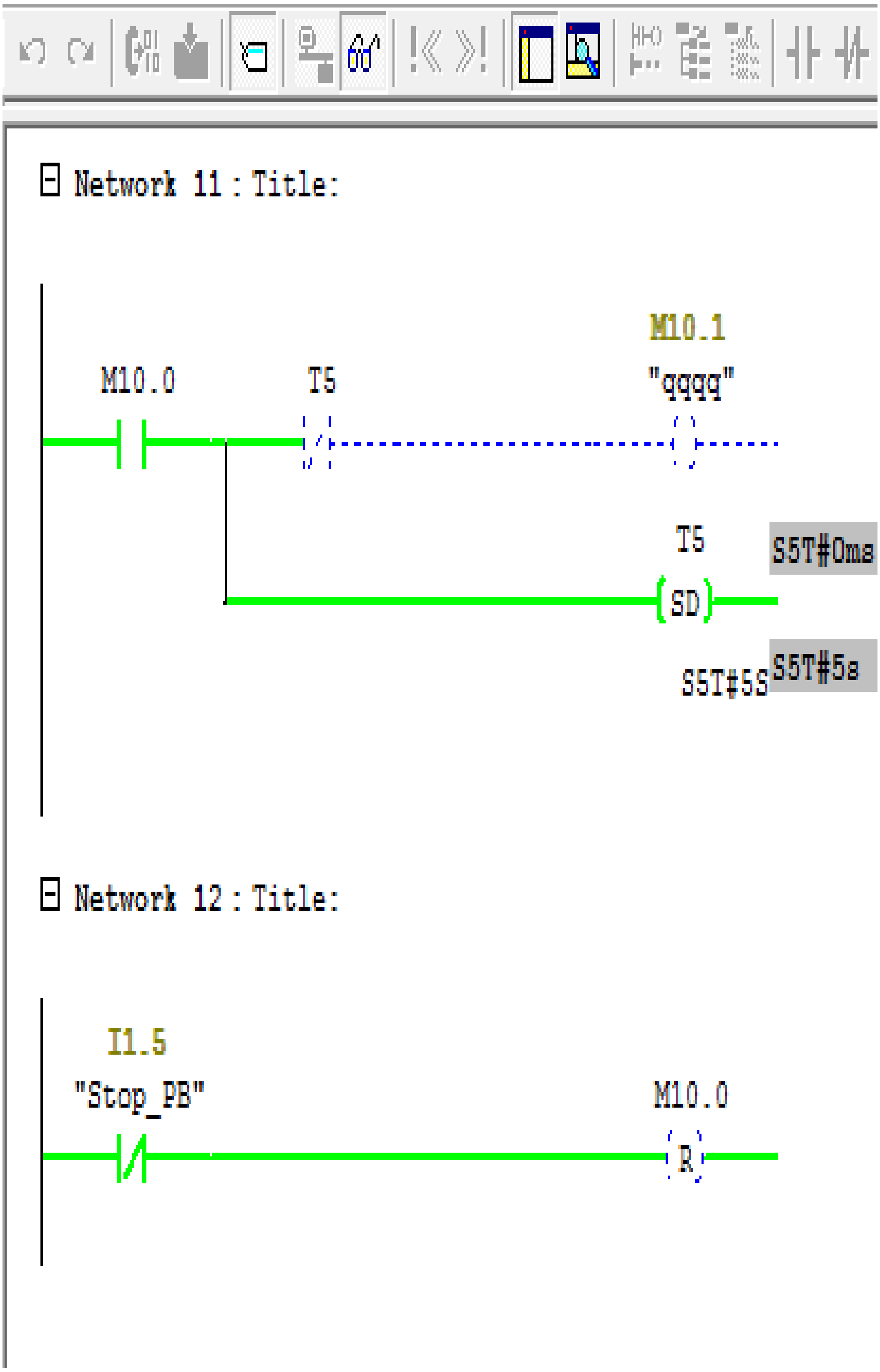


Figure 4.18: End process

Photocopy of 3 diminutions simulation system is show in Figure 4.19.

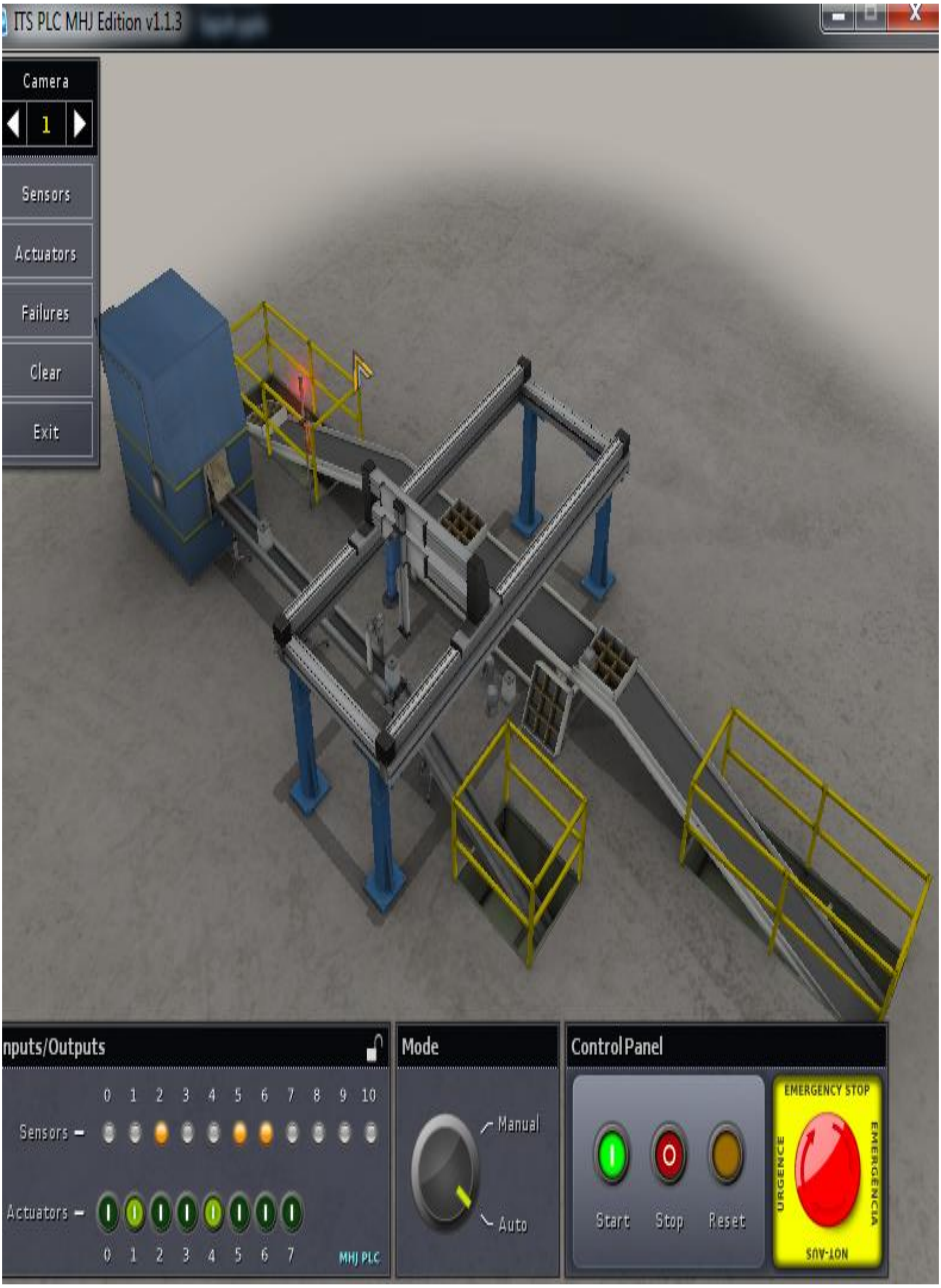


Figure 4.19: Photocopy of the three diminution simulation system

CHAPTER FIVE

CONCLUSION AND RECOMMANDATIONS

Chapter Five

Conclusion and Recommendations

5.1 Conclusion

In present day the automation is of vital importance. Automation is very efficiently put up in practice in many ways; one of them is automatic conveyors system with in-process sorting and packaging mechanism. These automated processes have contributed to the reduction of production time, increased speed and efficiency, resulting in increased production.

This study proposes an automatic soring and packing system using PLC. The proposed system sorts the objects into two types, according to the materials, whether metal or wood when the objects pass through conveyer belt designated by custom sensors. Objects that are not detected by sensors it will be return to supply unit through conveyor belt. The packing process then begins by specifying the size of the object and it transported to the packing box by lifter.

5.2 Recommendations

- Additional sensors can be used to detect more objects.
- Use of camera sensors instead of analog sensors.
- Use of a robotic.
- Implementation of the system.

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