International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 12 Dec 2023, pp: 212-219 www.ijaem.net ISSN: 2395-5252

Building a Model of Automatic Storage System Using Plc FX5UJ

Duc-Trong Doan, Quang-Thu Nguyen, Thi-Thanh Pham
Department of Electrical and Mechanical Engineering, HaiPhong University, HaiPhong, Vietnam

Date of Submission: 15-12-2023 Date of Acceptance: 25-12-2023

ABSTRACT: Today, with the strong development of science and technology, people's lives have changed for the better, with modern equipment serving the industrialization and modernization of the country. Instead of manually storing goods, which takes up a lot of space and labor, many companies and enterprises have equipped with automatic warehouse systems to help manage their goods scientifically and systematically. and has high flexibility, thereby improving operational efficiency, reducing labor and operating costs.This article presents the process of building a monitoring and control system for the automatic storage model. The system control and monitoring program uses Mitsubishi's FX5UJ PLC and HMI interface. The product of the article is a complete system model that is applied to teaching and scientific research for Electrical students at the Faculty of Electrical and Mechanical Engineering, Hai Phong University.

KEYWORDS: Automated storage system, QR Code , PLC FX5UJ.

I. INTRODUCTION

Today, with the strong development of science and technology, people's lives have changed for the better, with modern equipment serving the industrialization and modernization of the country. Instead of manually storing goods, which takes up a lot of space and labor, many domestic and world companies have equipped their companies and factories with automatic warehouse systems [3,4,5].

Currently, there are studies to successfully build automatic storage systems. In the systems that have been built, the process of driving conveyor belts to
transport goods, the process of storing goods and taking goods out of the warehouse is using one-way motors or stepper motors [2,3]. These systems are controlled and monitored using PLC S7-1200 and WinCC [4,5]; Monitor and manage the automatic storage system on the Web Server [2], manage inventory in the warehouse using QR codes through mobile applications [6].

In the article, the author presents the process of building a model of an automatic storage system based on QR code. The process of controlling goods and storing them in warehouses is controlled by FX5UJ PLC. The drive motor used in the model is Mitsubishi's Secvor engine. The system is monitored on the HIM interface.

II. DESIGN HARDWARE MODEL OF THE SYSTEM

1. THEORETICAL BASIS FOR MODEL BUILDING

The conveyor belt for transporting stored and exported products has a length of 40cm and a width of 6cm.

Products that need to be stored and shipped have an allowable weight of 0.2kg - 0.5kg; and has a square box size of 4cmx4cm.

X-direction lead screws: Length 30 cm, width 5 cm; Y direction: Length 50 cm, width 2 cm.

The gripper has a clamp opening of 1.2 cm and a clamp retract of 0.6 cm;

The storage cells are 8 cells, each cell has dimensions of 10 cmx10 cm.

2. THE MAIN DEVICES IN THE MODEL

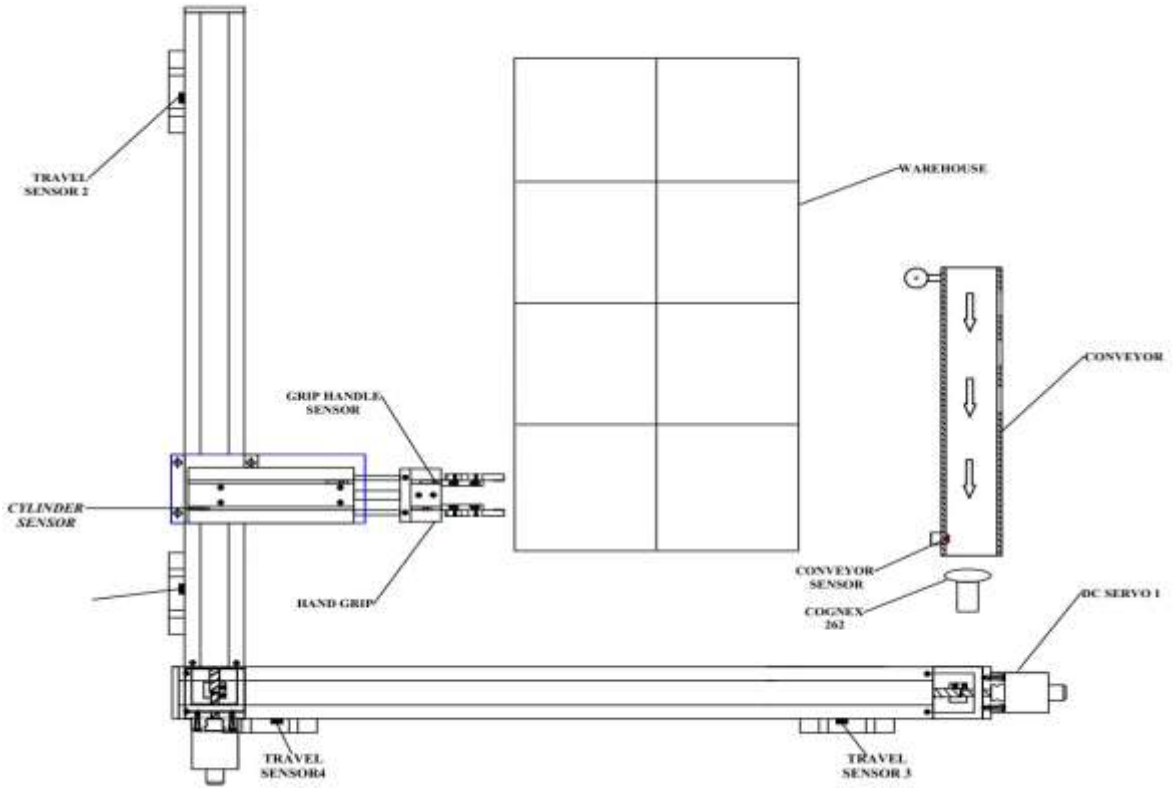
Table 1: Calculation of equipment selection for the model

NUBER	DEVICE NAME	TECHNICAL SPECIFICATIONS
1	PLC Mitsubishi FX5UJ-24MR/ES	Source voltage: 100 to 240VDC (-15%, +10%) frequency: 50/60Hz;

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 12 Dec 2023, pp: 212-219 www.ijaem.net ISSN: 2395-5252

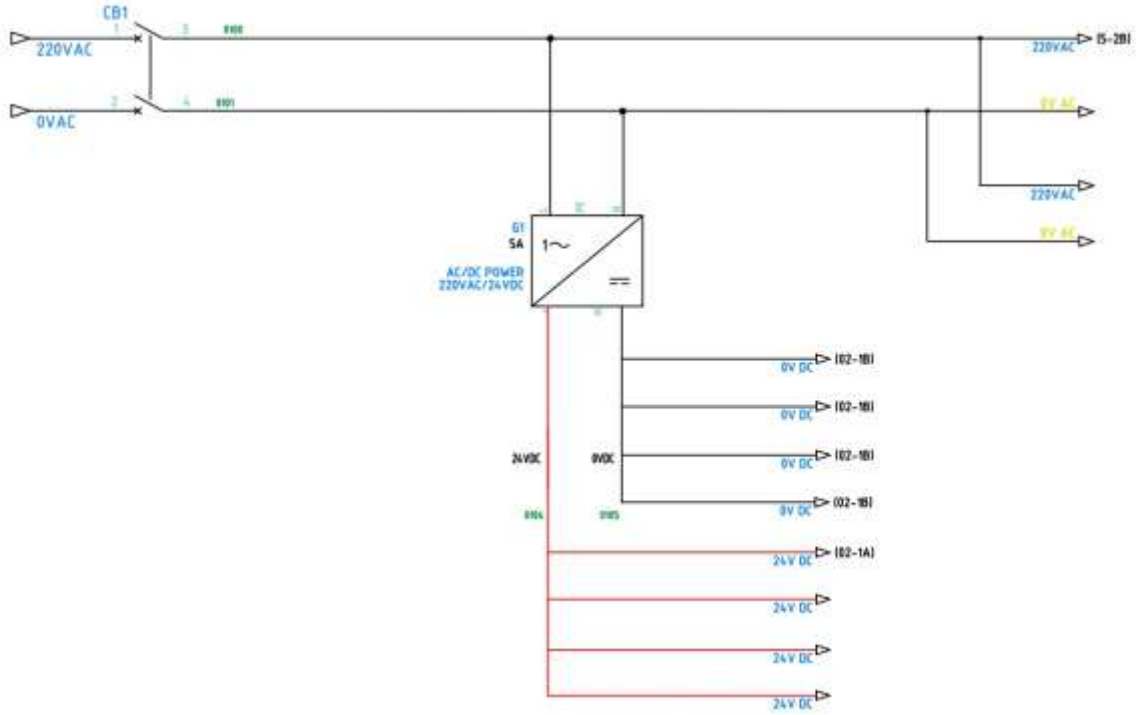
2	Barcode scanners	The firm: Cognex Dataman DMR-262S-0542-F; size: 42.5 mm x 22 mm x 76.1 mm; resolution: 1280x960; Communications: Integrated USB-C
3	Infrared sensorE3F-DS30C4	Source voltage: 6 ~ 36VDC; detection distance: 5 ~ 30cm; output stream: 300mA; size: 1.8cm (D) x 7.0cm (L).
4	SensorEE-SX674.	Source voltage 5 to 24 VDC ± 10%
5	Double acting cylinder	Body size: 12mm;Trip: 100mm; Impact type Two impacts;
6	The source S-120-24	Output voltage DC: 24V; Output stream DC: 0~8.4A; wattage: 120W; Output voltage AC: 85~264VAC; efficiency: 85%; Size(mm):160x98x40mm.
7	5 port network switch	Phoenix Contact 5 ports industrial network signal converter has standard RJ45 network connection output, operating voltage range from 12VDC to 48VDC, aluminum compact outer shell helps to dissipate heat and prevent interference, quickly mounted on DIN rail.
8	Circuit breaker	Rated current 06 - 63A;
9	Intermediate relays	Relay Omron G2R-2-SND 24VDC; 24VDC 10A;

III. SYSTEM HARDWARE CONNECTION DRAWINGS



MODEL MECHANICAL DRAWING

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 12 Dec 2023, pp: 212-219 www.ijaem.net ISSN: 2395-5252



SYSTEM POWER SUPPLY DRAWING

IV. OPERATING PRINCIPLE OF THE SYSTEM

The system includes a conveyor belt to transport goods with QR code barcodes to the Cognex barcode scanner. The goods continue to be delivered until they reach the impact sensor. At this time, the driver of the servo motors (X and Y) and Z gripper puts the stored products into QR code-encoded cells that match the QR code on the product.

The system control program uses PLC FX5UJ from Mitsubishi. The system is monitored on the HMI interface.

After the mechanical model proposal, the article will calculate and select equipment for the system, servo motors, central control devices, HMI screens, pneumatic valves, sensors... This is the premise for the design. Circuit design and controller programming in the next section.

V. PLC PROGRAM CONTROLS THE SYSTEM

1. PRINCIPLE OF AUTOMATIC CONTROL

Products labeled with a QR code are transported by the conveyor belt until at the end of the journey, the optical sensor is activated, stopping the conveyor belt. At this time, start the pick-up system to pick up products to store them in boxes in the warehouse that have been coded according to the QR Code according to regulations.

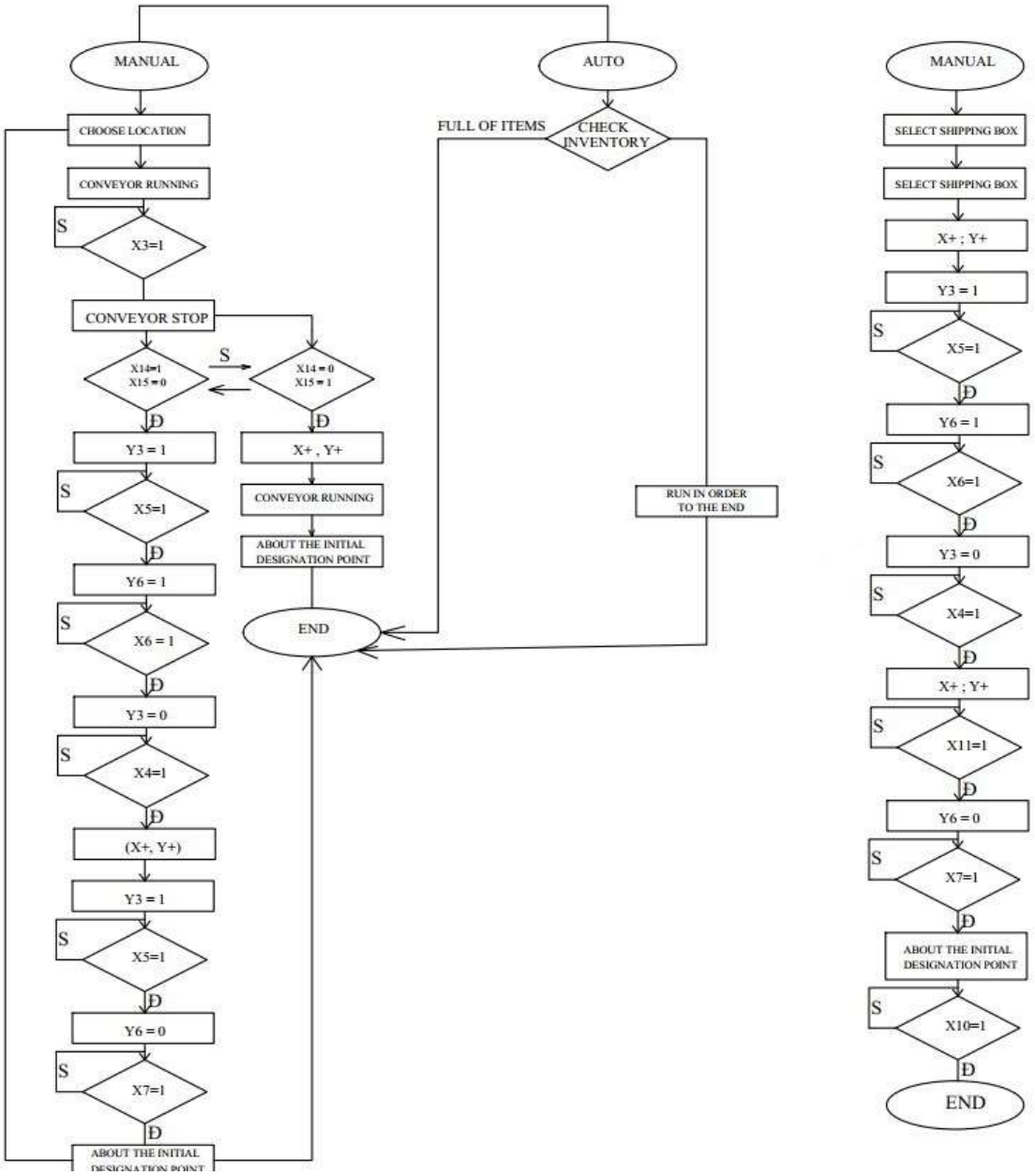
Process of storing goods in the warehouse: Turn on the Aptomat to power the system, in the initial state the red light is on to indicate that the system is not operational, sensor lights X4, X7 are on to indicate that the cylinder and gripper are in the correct position, X12 may or may not light up (axis in HOME position or not). Press START, the green light lights up to indicate that the system is starting to operate. First, we must press the HOME button to return the axis to the specified HOME position (X10 = 1, X12 = 1), select Manual mode, the conveyor starts operating, The onveyor brings the object to the X3 sensor (X3 = 1), the conveyor stops, cognex scans the QR code on the product's face. Case 1: Cognex cannot read the QR code on the item's face (X15 = 1, X returns to the specified HOME position. Case 2: Cognex scans the QR code on the face of the goods (X14 = 1, X15 = 0), the cylinder fires (Y3 = 1) touches the sensor Retracting cylinder (Y3 = 0) sensor X5 = 0, X4 = 1 = 1, X5 = 1, the pick-up handle drops the item into the empty box (Y6 = 0), sensor X12 (X12 = 1) then stops, the X axis begins to move to the specified HOME position (X10 = 0) ending the process. Select a blank box to continue the storage process.

Process of exporting goods from the warehouse: Press START, the green light lights up

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 12 Dec 2023, pp: 212-219 www.ijaem.net ISSN: 2395-5252

to signal the system is operating, select MANUAL mode, select the cell with goods to be exported, the X axis moves to the X+ position, the Y axis begins to move to the X+ position. Y+, to coordinates (X+, Y+) cylinder fires (Y3 = 1) touches sensor (Y3 = 0) touches sensor X4 (X4 = 1) Y axis moves down until it touches sensor X12 (X12 = 1) then stops, X axis moves forward until it touches sensor) then stops, the pick-up arm drops the goods into the box (X7 = 1) and the axis system moves to the specified HOME position (X10 = 1). Finish the process of selecting the cell to be exported so that the warehouse export process can continue.

2. ALGORITHM FLOWCHARTU

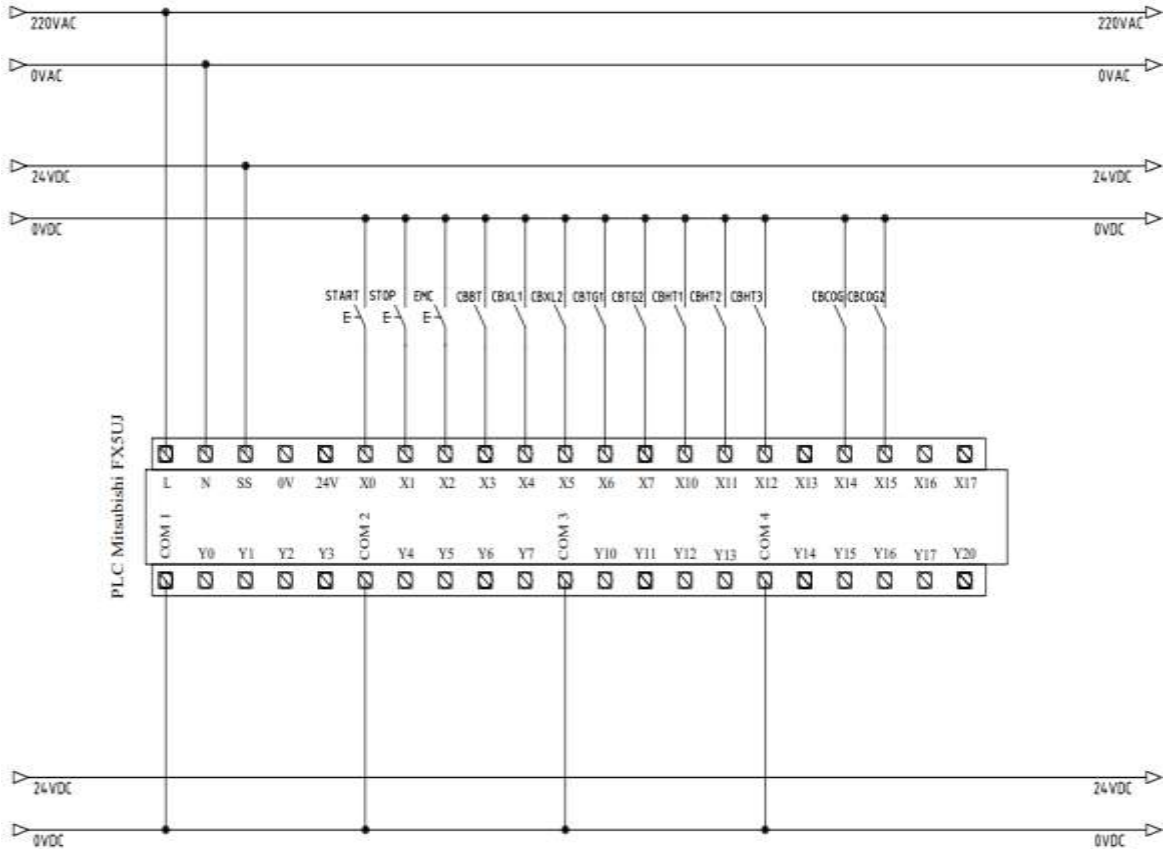


A - FLOW CHART DRAWING OF STORAGE ALGORITHM

B - FLOW CHART OF THE ALGORITHM FOR REMOVING GOODS FROM THE WAREHOUSE

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 12 Dec 2023, pp: 212-219 www.ijaem.net ISSN: 2395-5252

3. PLC HARDWARE CONNECTION DIAGRAM

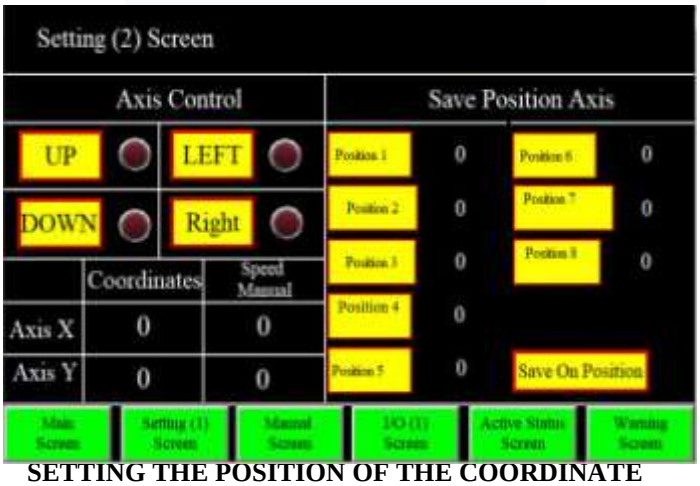


PLC INPUT DRAWING

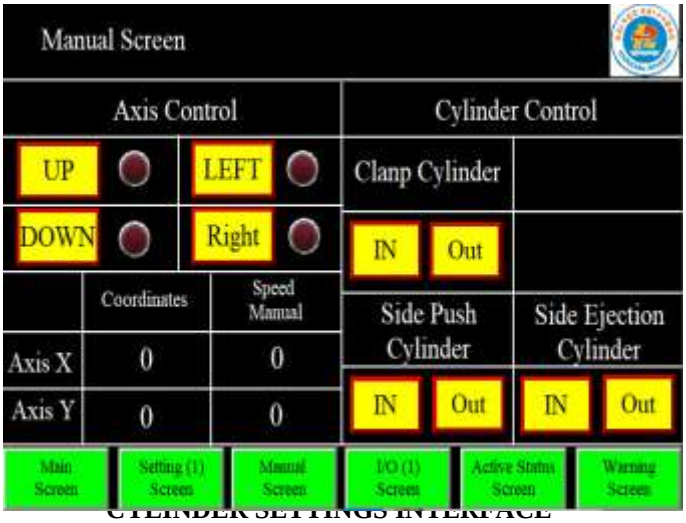
MAIN INTERFACE OF THE SYSTEM

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 12 Dec 2023, pp: 212-219 www.ijaem.net ISSN: 2395-5252

SERVO MOTOR SPEED SETTING



SETTING THE POSITION OF THE COORDINATE AXES

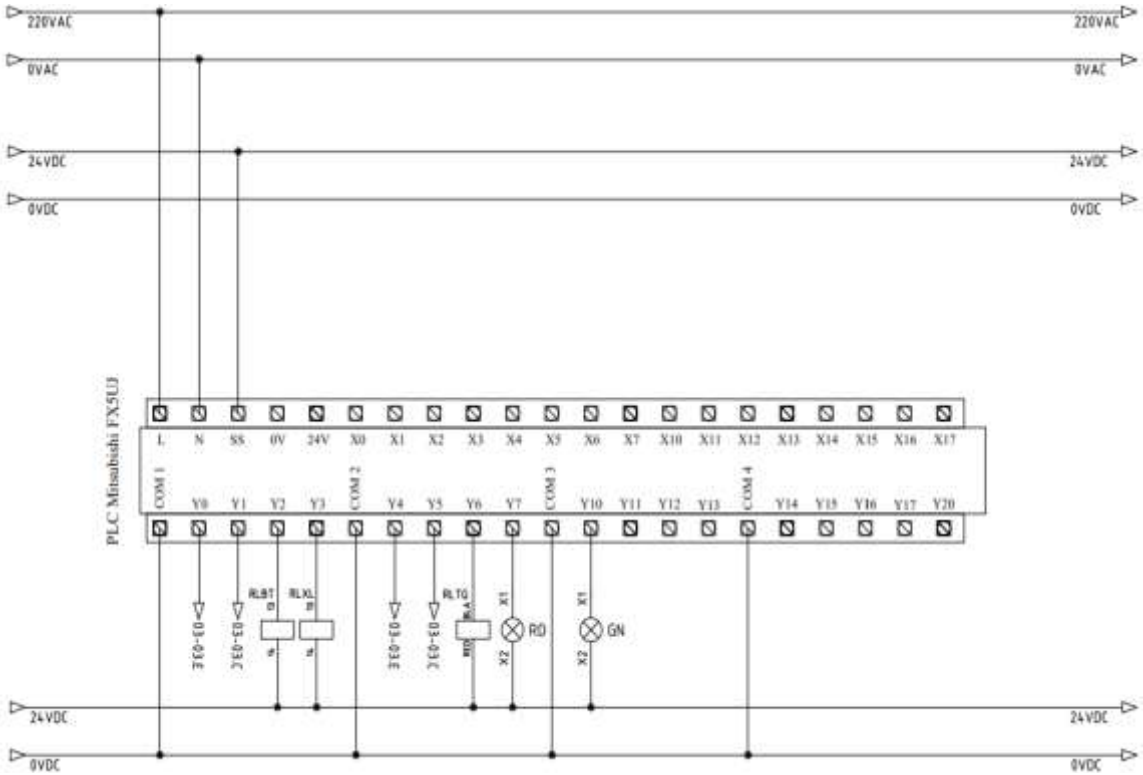


CYLINDER SETTINGS INTERFACE

I/O ADDRESS SETTING INTERFACE

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 12 Dec 2023, pp: 212-219 www.ijaem.net ISSN: 2395-5252

COMPLETE SYSTEM MODEL

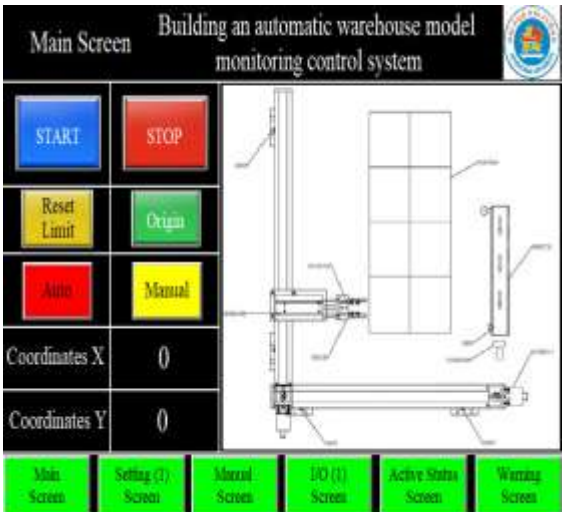


PLC OUTPUT DRAWING

International Journal of Advances in Engineering and Management (IJAEM)
Volume 5, Issue 12 Dec 2023, pp: 212-219 www.ijaem.net ISSN: 2395-5252

VI. DESIGN SYSTEM MONITORING INTERFACE

The monitoring part of the system is built on the Easy bulider interface with settings parameters like a real production system. The main screen interface of the system is presented in figure 7. Set Secvor motor parameters on screen 8.9. Install Cylinder on screen 10. Declare input and output addresses on screen 11. Create a complete automatic storage model monitoring control system.



VII. CONCLUSION

The article has completed the initial design, from choosing the system model to designing the connecting circuit, programming the control and monitoring on the HMI screen. The system was successfully tested at the Department of Electrical Engineering, Faculty of Electrical and Mechanical Engineering, Hai Phong University with results that met the requirements. In the coming time, the research team will continue to improve so that it can apply research results to future professional work, especially applying the PLC system in actual production in control, classification, and arrangement. Smart warehouses, automated stores.

REFERENCES

[1]. Hoang, H.H. (2022). Control and monitor the automatic storage system model using PLC S7-1200.

[2]. Nguyen, V. L. (2022). Design and manufacture an automatic warehouse storage model using PLC S7-1200 and monitoring on the Web Server.

[3]. Nguyen Hoang Vu, Tran Đinh Tuan, Duong Đuc Hung, Vu Đinh Bien (2022) project, Research and build an automatic storage model.

[4]. Le, T. K. N., & Nguyen, T. N. (2023). Design a smart warehouse storage system with QR code using PLC S7-1200 and WinCC.

[5]. Nguyen, H. Q. (2022). Design and construction of automatic storage system using S7-1200.

[6]. MORALES-HERNÁNDEZ, M., MORALES-JIMÉNEZ, I., OSORIO-HERNÁNDEZ, L. E., & DIAZ-SARMIENTO, B. (2021). Prototype of a web and mobile application for inventory management of a parts store using QR code.