CONTROL AND MONITOR OF PRODUCT FILLING AUTOMATION SYSTEM IN PLC-BASED PACKAGING USING HMI OMRON NB7W-TW00B

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Abstract— This study aims to design and create an automation system for filling products into packaging. PLC CP1E-N30DR-A system can be controlled and monitored via Omron NB7W-TW00B HMI. HMI programming using NB-Designer software. The product used is a steel ball. The number of steel balls is set via HMI. The HMI screen display consists of inputs: Push Button Start, Push Button Stop, input the number of products in the packaging, packaging sensor, and steel ball sensor; outputs: conveyor and counter display. The test results show that HMI could provide variations in the number of products in the packaging. The present value counter can be displayed on the HMI. The control and monitor automation system of filling the product in the packaging worked well.

Keywords— PLC, HMI, counter, sensor

1. Background

Packing is a coordinated system for preparing goods to be ready for distribution, storage, and sale. The existence of a container or wrapper can help prevent or reduce damage and protect the product in it from the dangers of pollution and physical disturbances (friction, impact, vibration). One of the packaging processes is filling the product into the packaging. With the development of technology for filling products into packaging, automation systems have been used to replace manual processes. Most automation systems in the industry use PLC (Programmable Logic Controller) devices as controllers. Recently, automation systems have been developed with the HMI (Human Machine Interface). HMI is a two-way electronic system device that connects humans and machines. HMI makes the interaction between the PLC system and the operator possible via a screen with dynamic icons, numbers, and text. Operators through HMI can monitor and control the production process.

Research in packaging systems in the form of product filling into packaging in automation systems has been widely carried out. Most product-filling devices in the packaging are designed only to fill a certain amount of product. The thing that can be done when the industry wants production with different sizes and packaging contents is to add sensors or change the program. This is deemed ineffective. From this background, the idea arose to control the filling of the product into the packaging with the number of products that could vary or according to the user's wishes set through the HMI

2. Device Design

The block diagram of the Number of Products in Packages is shown in Figure 1.

Device controller using PLC Omron CP1E-N30DR-A. HMI is used for setting counter values & monitoring devices. The input consists of a Push Button Start to turn on the system, a Push Button Stop to turn off the system work, a photoelectric sensor to detect the presence of a container, and an inductive proximity sensor to see a steel ball. The system's output consists of a conveyor motor and a steel ball reservoir motor to drop the steel balls into the container/packaging.

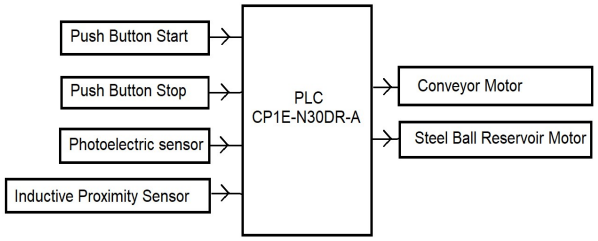
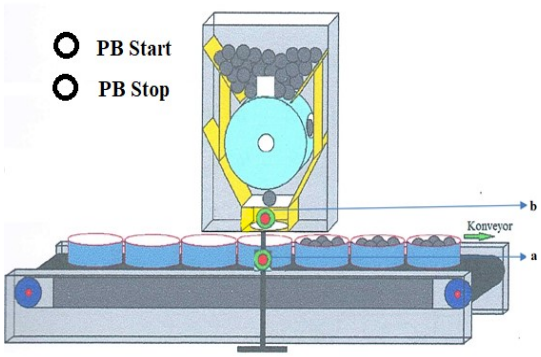


Fig. 1. Block Diagram

2.1. Work Description

When the Push Button Start is pressed for a moment, the conveyor will run carrying the container/package. The conveyor will stop when the container/package is detected by a photoelectric sensor (the container/package is just below the steel ball reservoir). The steel ball reservoir motor will rotate, dropping the steel balls into the box. When the steel ball falls into the package, an inductive proximity sensor will be detected and used as an input pulse calculated by the counter. When the inductive proximity has seen several steel balls according to the setting value counter/number of products entered in the HMI, the motor for the steel ball reservoir will stop. The container/package conveyor will run again, so the process repeats for the next container/package, and the process will stop when the stop button is pressed.



a. Container/packaging sensors
b. Steel balls sensor

Fig. 2. Product Filling Automation System

2.2. PLC I/O addressing

The work system controller uses a PLC (Programmable Logic Controller). PLC is an electronic system that operates digitally and is designed for use in industrial environments. This system uses a programmable memory for internal storage of instructions that implement specific functions such as logic, sequencing, timing, counting, and operation via modules digital and analog I/O modules. This PLC is designed to install a sequential relay circuit in a control system.

Fig. 3. PLC Omron Type CP1E N30DR-A

The PLC used in this research is PLC Omron CP1E-N30DR-A.

The PLC addressing and I/O equipment of the Curtain Control device are shown in Table 1.

Table 1.
I/O PLC Omron CP1E-N30DR-A

Input Address	Input Device
00.00	Push Button Start
00.01	Push Button Stop
00.02	Photoelectric sensor
00.03	Proximity Inductive Sensor
Output Address	**Output Device**
100.00	Conveyor Motor
100.01	Steel Ball reservoir Motor

2.3. Time Chart

Figure 4 shows a time sequence diagram of the system's work.

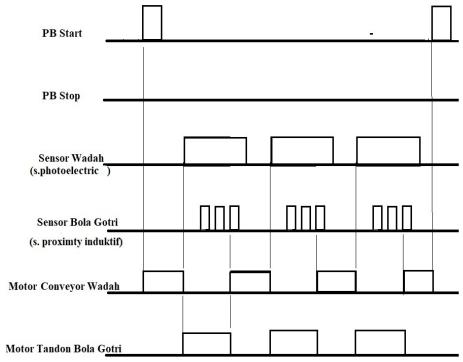


Fig. 4. Time Chart

2.4. Ladder Diagram

Figure 5. Shows the program control ladder diagram of the device.

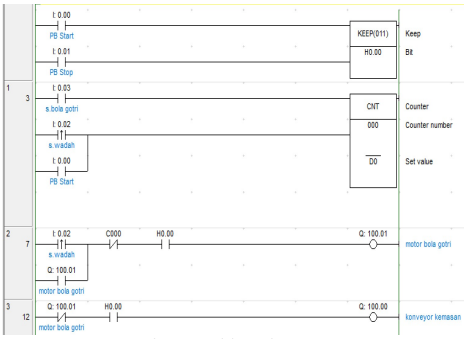


Fig 5. Ladder Diagram

3. Result and Discussion

3.1 Photoelectric Sensor

The sensor that detects the presence of containers/packages is the BYD30-DDT series photoelectric sensor.

Fig. 6. Physical Form of Photoelectric Sensor

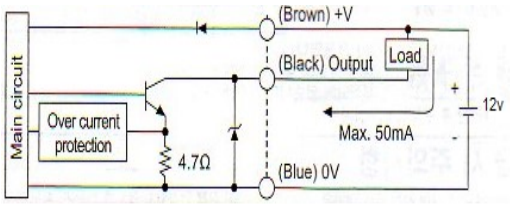


Fig. 7. NPN Photoelectric Sensor Schematic

The Photoelectric Sensor wiring picture with PLC is shown in Figure 10.
When the Photoelectric sensor detects the presence of packaging on the conveyor, input 0.02 PLC '1' is used to stop the conveyor.

Table 2.
Photoelectric Sensor Working Range Test

No	distance packing with photoelectric sensor (cm)	in PLC 00.02
1	1	'1'
2	2	'1'
3	3	'1'
4.	4	'0'

The maximum working distance of the Photoelectric sensor is 3 cm.

3.2 Steel Ball Sensor

The sensor for detecting the presence of steel balls is an inductive proximity sensor Lj18A3-8-Z/BX, NPN NO.

Fig. 8. Physical Form of Proximity Inductive Sensor

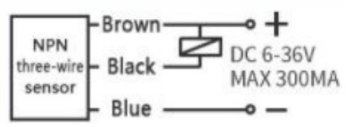


Fig. 9. Inductive Proximity Sensor Schematic

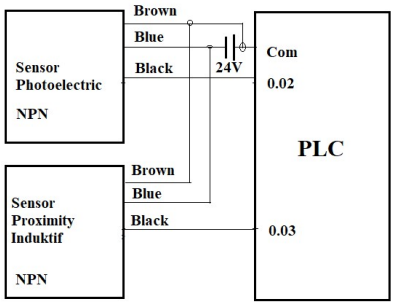


Fig. 10. Wiring Photoelectric Sensors and Inductive Proximity Sensors

The Inductive Proximity Sensor detects steel balls that fall into the packaging. When the Inductive Proximity sensor detects a steel ball input 00.03 PLC '1'. The change of the 00.03 PLC input from '0' to '1' is used as the pulse input, which is calculated by the counter.

Table 3.
Testing Sensor working range Inductive Proximity

No	distance packing with Inductive Proximity sensor (mm)	in PLC 00.03
1	1	'1'
2	2	'1'
3	3	'1'
4.	4	'1'
5.	5	'1'
6.	6	'1'
7.	7	'1'
8.	4	'0'

The max working range of the Inductive Proximity sensor is 8 mm.

3.3 Conveyor Motor

The conveyor serves to carry containers/packaging. The conveyor uses a 12 VDC power window motor drive. The conveyor works when the output address 100.00 PLC is on.

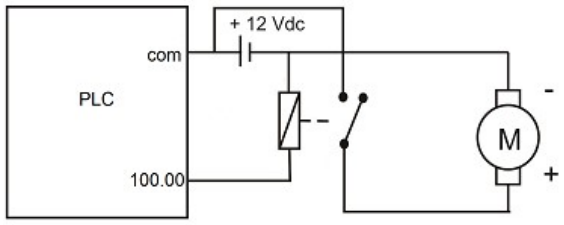


Fig. 11. Motor Wiring Circuit on Conveyor

Table 4.
Conveyor Test Results

voltage (V)	Current (mA)	Condition
12	900	Active

3.4 Steel Ball Reservoir Motor

The steel ball reservoir motor drops the steel balls into the packaging. Motor with 12V working voltage rotates when 100.01 PLC output is on.

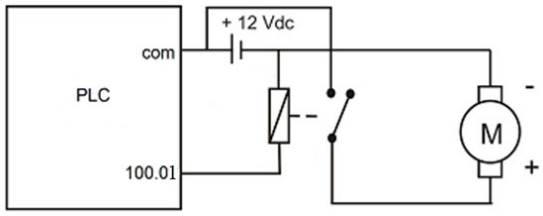


Fig. 12. Motor Wiring Circuit in Steel Ball Reservoir

Table 5. Test Results of Steel Ball Reservoir Motor

voltage (V)	Current (mA)	Condition
12	900	Active

3.5 PC, PLC, and HMI Communication

The HMI is programmed using a PC via a USB cable and communicates with the PLC by an RSS232 serial cable.

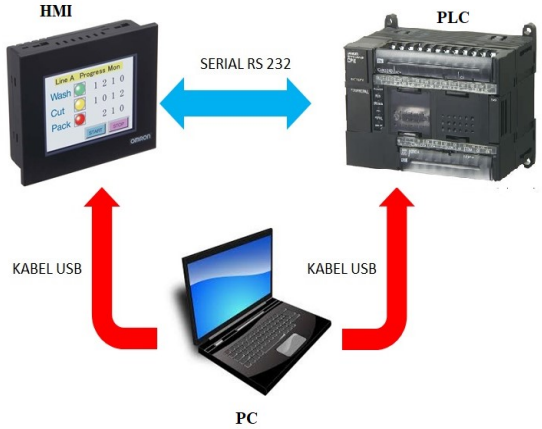


Fig. 13. PC, PLC, and HMI Communication

The HMI can access the address bits in the PLC to function as buttons or light displays. The HMI can also access the data memory on the PLC to display the data. Communication between the HMI and the PLC uses COM Port RS232 on the HMI with a DB9 connector cable component and wiring provisions, as shown in Figure 12.

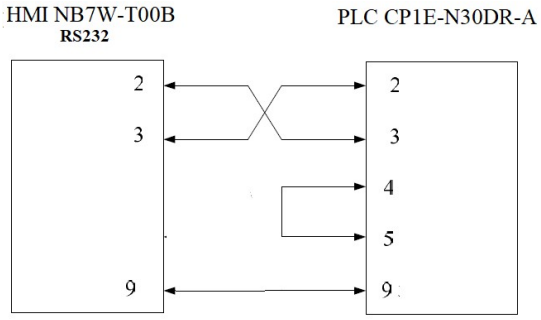


Fig 14. DB9 Male Connector Wiring Diagram

3.6 HMI display

The HMI screen display consists of inputs: Push Button Start, Push Button Stop, input setting value counter/number of products loaded into the package, container/packaging sensors, and steel ball sensors; output in the form of a conveyor, a steel ball reservoir motor and a present value counter.

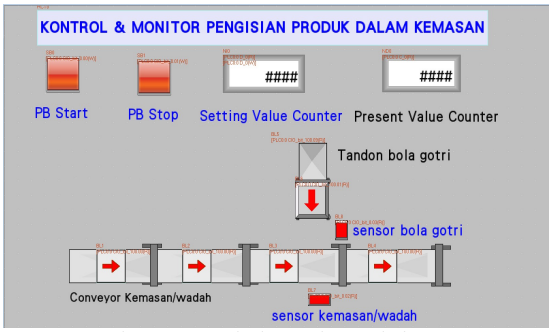


Fig. 15. HMI Display Design on designer

The HMI display is designed on a PC using the NB designer software, then downloaded to the HMI using a USB cable.

Fig. 16. Setting Value Counter 3.

Setting Value Counter is done before the system starts. Click part number input, and a window appears, as shown in Figure 14. Enter the desired value counter setting, then press ENTER. After that, run the system by pressing the Push Button Start button. Figure 17 shows the HMI display after setting the value counter = 3 and pressing the Start button.

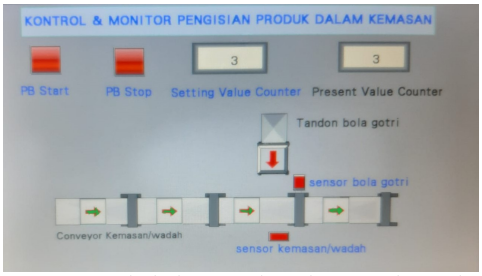


Figure 17. HMI Control Display & Product Charge Monitor Packaged

4. Conclusion

Omron CP1E-N30DR-A PLC-based product filling automation control and monitor using HMI NB7W-TW00B can work according to its function. The HMI program uses the NB Designer software. Variation of setting value counter can be done through HMI. Present value counter data is displayed on the HMI.

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