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PLC Based Bottling System in Industrial Automation

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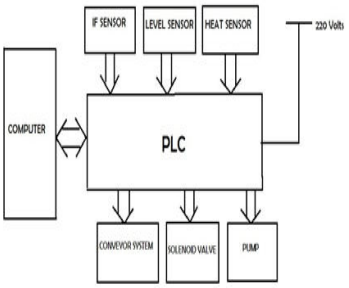
Abstract: *Nowadays, the application of PLC is widely known and used in the digital world for the development of various operation automatically. PLC's application is obviously applied in the Industrial Sector. Normally, the PLC's that have been used at the industrial field is usually to control a mechanical movement either of the machines or instruments in order to create an efficient production and accurate signal processing. In this project, an area of PLC's application will be explained in more detail and specified. Whereby, a system that used for automatic bottle filling is fully controlled by the "ALLEN BRADLY MICROLOGIX-1000", which acts as the heart of the system. The sequence of operation is designed by ladder diagram and the programming of this project by using "RS LOGIX" software. Several electronic and electric devices are being controlled by PLC.*

Keywords: PLC, Ladder Logic, Electronic & Electrical Devices

1. Introduction

PLC plays an important role in the world of automation industry .It acts a major function in the automation field which tends to reduce the complexity, increases safety and cost efficient. In this system we have applied a PLC based system in an automatic bottle filling station. In particular, the modern market for product quality increasing, expanding market demand, enterprises for efficient automated production requirements. In this case, Injection Molding Machine and Filling Machine is becoming hot filling equipment. Bottle filling machines provide the link between the bulk containers of mass production and the finalized industrial or consumer shelf product. This project filled the liquid in the bottle with a fixed quantity or fixed level at fixed temperature, it eliminates the chances like varied quantity from bottle to bottle or inaccuracy which can be happen with the manually filling . These projects reduce the labour effort and make work more accurate and reliable. The aim of this project is to design PLC Based automatic bottle filling system that sense the presence of bottle and level of liquid in it and then fills it accordingly up to a fixed level. Filling is done by using various methods using motor, sensors, conveyor belt, PLC, solenoid valve.



Block Diagram of Bottling System

2. Description of Our Proposed Device

It is based on plc automation, which consists of various components and are divided into two parts.

Our device consist of a PLC, 12V DC Relay, Infrared sensor , Level sensor, RTD, Solenoid valve, DC motor, conveyer belt, 24 V DC Source, ON/OFF button and some connectors. The ON/OFF button, Infrared sensor and Level sensor work as the input device. The PLC controls the input and output according to the program given.

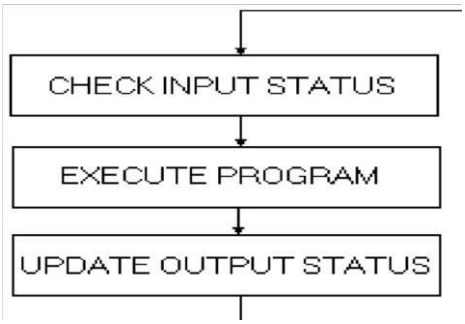
- **PLC:**

Figure 2.1: Typical of PLC

Programmable logic controller is an industrial computer which monitors the state of input based on the ladder logic fed to it and changes the state of output accordingly.

- **OPERATIONS OF PLC:**

A PLC works by continually scanning a program. We can think of this scan cycle as consisting of 3 important steps. There are typically more than 3 but we can focus on the important parts and not worry about the others. Typically the others are checking the system and updating the current internal counter and timer values.



Check Input Status- First the PLC takes a look at each input to determine if it is on or off. In other words, is the sensor connected to the first input on? How about the second input? How about the third... It records this data into its memory to be used during the next step.

Execute Program- Next the PLC executes your program one instruction at a time. Maybe your program said that if the first input was on then it should turn on the first output. Since it already knows which inputs are on/off from the previous step it will be able to decide whether the first output should be turned on based on the state of the first input. It will store the execution results for use later during the next step.

Update Output Status- Finally the PLC updates the status of the outputs. It updates the outputs based on which inputs were on during the first step and the results of executing your program during the second step. Based on the example in step 2 it would now turn on the first output because the first input was on and your program said to turn on the first output when this condition is true.

i. Hardware Part

- **Motor**

Motor is a small electronic device that can move if the power supply is connected. It is a main part to make the conveyor belt moves perfectly. There are many type of DC Motor at market such as gear DC motor, motor servo and stepper motor but in this project DC motor will be used because it can spin 360° continuously. Moreover, it is strong enough to move the trek.

- **Conveyor system**

A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Conveyor systems allow quick and efficient transportation for a wide variety of materials, which make them very popular in the material handling and packaging industries

- **Pump**

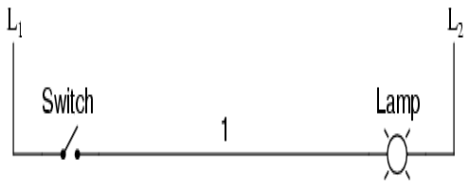
A pump is a device that moves fluids by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid direct lift, displacement, and gravity pumps.

- **Sensor**

A sensor is an electronic component, module, or subsystem whose purpose is to detect events or changes in its environment and send the information to other electronics, frequently a computer processor. A sensor is always used with other electronics. In this Project, we are using three sensor

1. Infrared sensor
2. Temperature sensor
3. Level sensor

- **Solenoid Valve**



A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports. Multiple solenoid valves can be placed together on a manifold.

ii. Software Part

Our Device consists of RS Logix and ladder diagram. Process is controlled by ladder diagram through this we can fed logic to our system.

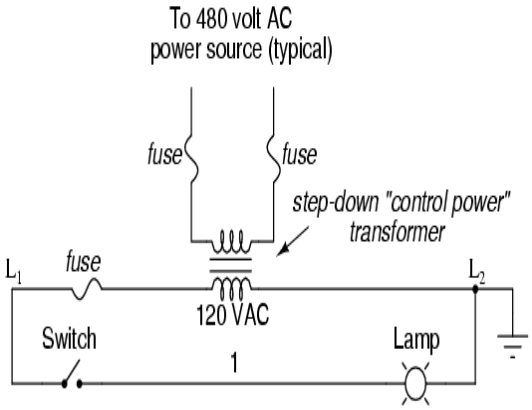
- **RS Logix**

The RS Logix™ family of IEC-1131-compliant ladder logic programming packages helps you maximize performance, save project development time, and improve productivity. This family of products has been developed to operate on Microsoft Windows® operating systems. Supporting the Allen-Bradley SLC™ 500 and MicroLogix™ families of processors, RS Logix™ 500 was the first PLC® programming software to offer unbeatable productivity with an industry-leading user interface.

RS Logix 500 programming package is compatible with programs created with Rockwell Software DOS-based programming packages for the SLC 500 and MicroLogix families of processors, making program maintenance across hardware platforms convenient and easy.

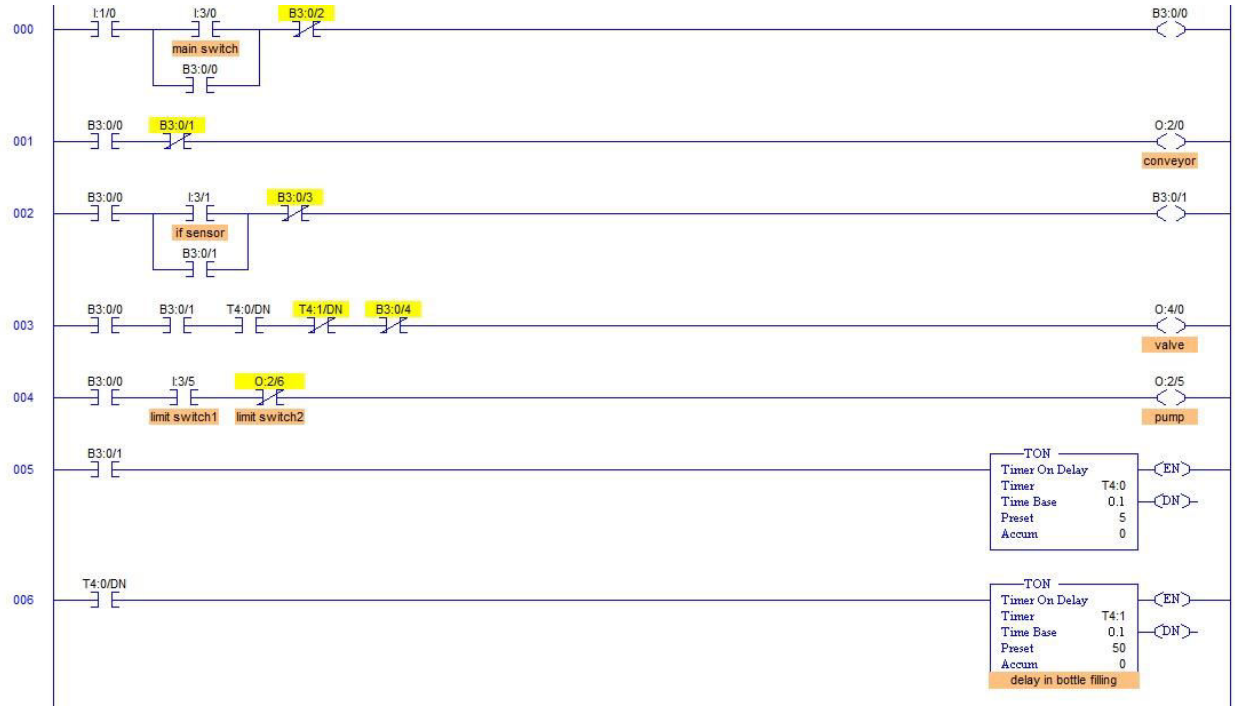
- **Ladder Diagram**

Ladder diagrams are specialized schematics commonly used to document industrial control logic systems. They are called "ladder" diagrams because they resemble a ladder, with two vertical rails (supply power) and as many "rungs" (horizontal lines) as there are control circuits to represent. If we wanted to draw a simple ladder diagram showing a lamp that is controlled by hand switch, it would look like this:



The "L_1" and "L_2" designations refer to the two poles of a 120 VAC supply, unless otherwise noted. L_1 is the "hot" conductor, and L_2 is the grounded ("neutral") conductor. These designations have nothing to do with inductors, just to make things confusing. The actual transformer or generator supplying power to this circuit is omitted for simplicity. In reality, the circuit looks something like this:

The Ladder Diagram for our bottling system is given like this:



3. Selection of PLC

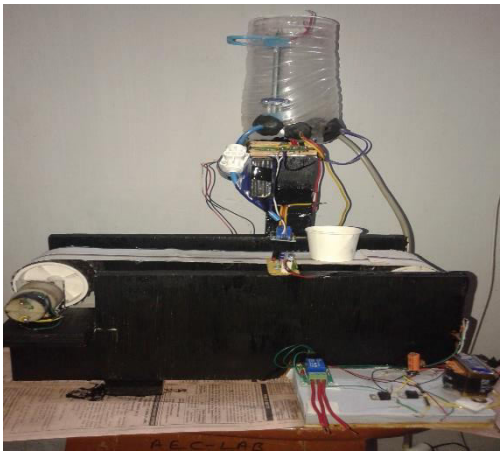
There are some main factors to choose a PLC for any application. They are:

- Input and output
- Memory size
- System speed
- Compatibility to HMI
- Easily communicable

Different PLCs have different number of I/O ports. And in some, adding external I/O cards can increase number of I/O ports

In the proposed device ALLEN BRADLY is used. In ALLEN BRADLY there are 8 inputs and 4 relay type outputs. 4 MS full programs scanning time and memory is enough for the automatic bottle filling. So it is chosen.

4. Prototype Design of PLC Based



Automatic Bottle Filling Station

5. System Specification

1. Input: 220 V AC
2. Capacity: 3 BPM
3. Maximum bottle height: 6.6’’
4. Maximum bottle diameter: 4.6’’
5. Maximum pressure: 200 Pascal
6. 3 filling Nozzle
7. Automatic shut off when bottle is full
8. Best liquid: Water

6. Limitation

It can only fill approximately one bottle at a time. The process can be efficiently used in water filling system. These types of fluids are handled mainly by the solenoid valve and nozzle used. So the range of fluid types is not so wide. Positioning the solenoid valve is a critical issue and proper care is needed. Another disadvantage is, no proper guidance for the bottles to move. And making the system to cause imbalance vibration.

7. Results

There is no need of any external pumps and only three types of sensors are used. It is a time based control by which the pulse is generated in level sensor & temperature sensor and filling process is done. It can be used commercially in various field like coffee shop etc. It can reduce human effort. So the practical research result is much satisfactory. It also helps to understand the necessity of PLC in industrial automation and also to realize the necessity of studying it.

8. Future Work

By using better solenoid valve, we can reduce the time to fill bottles and can increase productivity. A capping section can also be introduced. We can also introduced the system which can detect defect in the bottles. The system could be redesigned for increased bottle size and productivity.

9. Conclusion

The theory and concept of the automatic filling water system is based on the control system. In electrical design, the features and functions of the electrical components are required to determine the system requirement. Furthermore, the theoretical of the wiring system is required for connecting the inputs and outputs devices to PLC. In programming design, understandings of the desired control system and how to use the Ladder Diagram to translate the machine sequence of operation are the most important parts, because it have direct effect on the system performance. The main aim in this process is to apply PLC to design automatic filling water system and all objectives in this project were successfully done as planned. Finally, the basis control system and logic design apply in this project can be used as a references to design other applications of automation system,

and also can be used as a teaching material for the Industrial Control subject.

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