A MONOGRAPH ON PROGRAMMABLE LOGIC CONTROLLER BASED BOTTLE FILLING AND CAPPING SYSTEM

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Preface

The objective of our project is to design, develop and monitor "Automatic bottle filling system using PLC". This work provides with a lot of benefits like low power consumption, low operational cost, less maintenance, accuracy and many more. This project is based on Industrial automation and is a vast application used in many industries like milk industries, chemical, food, mineral water and many industrial manufacturers. A prototype has been developed to illustrate the project.

Filling is the task that is carried out by a machine and this process is widely used in many industries. In this project, the filling of the bottle is controlled by using a controller known as PLC which is also the heart of the entire system. For the conveyor system, a dc motor has been selected for better performance and ease of operation. A sensor has been used to detect the position of the bottle. In our project we have used a smaller number of systems hence the overall cost has been reduced to an extent. Ladder logic has been used for the programming of the PLC, which is the most widely used and accepted language for the programming of the PLC. The PLC used in this system Delta DVP14SS211R which makes the system more flexible and easily useable. Ladder logic has been used for programming the PLC, WPLsoft software is used for programming the PLC.

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1. INTRODUCTION

1.1 OVERVIEW

Automation is the use of control system and information technology to pacify the more work in less time. The production of goods and services is a moving trend for today's world, so to fulfill their demand need of automation has increase, hence the use of PLC is increasing day by day. The word 'Automation' itself says on making a tedious process very simple and without the use of man power. Day by day industries are using high end technologies so the use of simpler versions circuit is in demand, so the PLC came to an existence.

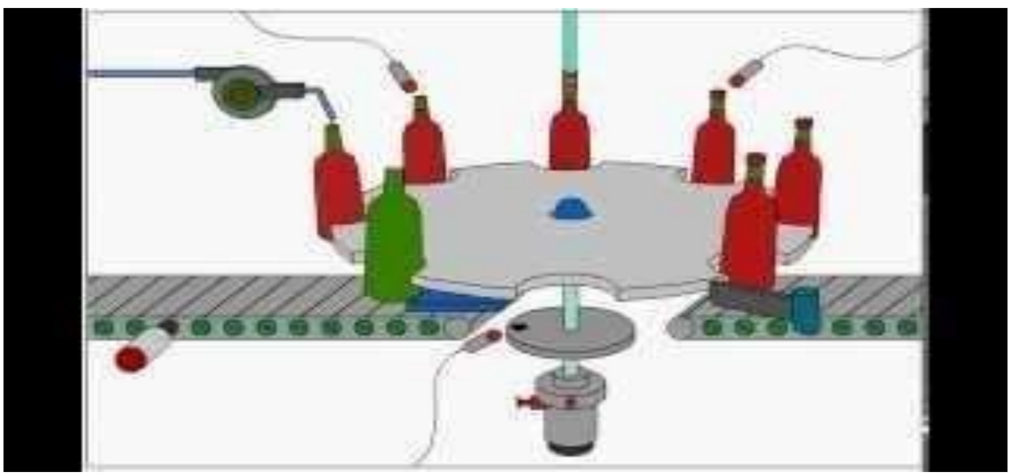

Fig 1.1 SYSTEM OVERVIEW

PLC plays an important role in the world of automation. A bottle filling system allows the user to fill definite amount of liquid in the bottle without any wastage. Ladder logic is used to manage whole sequence of the PLC. The PLC works on 24Volts DC 1.85Amp and is a compact system with fixed amount of 8 inputs and 6 outputs. For future use we can also monitor the whole system using the SCADA software.

1.2 PROBLEM STATEMENT

1. Our project aims at filling and capping bottles simultaneously. The filling and capping operation takes place in a synchronized manner. It also includes a user-defined volume selection menu through which the user can input the desired volume to be filled in the bottles. The entire system is more flexible and time saving.
2. The filling and capping operations are controlled using a Programmable Logic Controllers (PLC'S). This is because PLC's are very flexible, cost effective, space efficient and reduces complexity. By programming the PLC, we control the entire system.

1.3 HARDWARE DESCRIPTION

The PLC requires 24V 1.85A supply, the PLC input signals are 24V 5mA and the outputs are 24V 1.5A and 12V 1.5A. For regulating the voltage and current to specified level, voltage regulators and current limiters are used. LM317 IC's are used to limit the current level to specified level. IC 7824,7818,7812 are used to regulate the voltage levels. The IR sensors require 5V supply for operation. Hence IC 7805 is used for regulating voltage for IR sensors. IR sensor gives 5V output, but PLC's input signal is 24V 5mA.

Hence relays are used for isolating 5V and 24V circuit so as when IR sensor gives 5V output, PLC will get 24V 5mA input. 24V regulated voltage supply is used to drive the whole circuitry. The piston is the highest current rated actuator. Hence separate current regulator IC LM317 is used for driving solenoid piston.

1.4 SOFTWARE DESCRIPTION

The languages in which PLC can be programmed are

1. Structure Text
2. Instruction list
3. Ladder Diagram
4. Flow Chart
5. Functional Block Diagram

From these languages, we have used ladder diagram for programming PLC. The actual real time simulation can be done by connecting PLC to the PC by RS 232 port and simulating in WPLsoft software in online mode.

1.5 OBJECTIVE

Our objective aims at filling and capping operation takes place in synchronized manner. It. also includes defined volume selection of liquid that to be filled in bottle which makes system a time saving. The monitoring of such system using PLC is very feasible, that makes it cost effective, space efficient and less complex.

1.6 METHODOLOGY

First empty bottles are placed on the disc slots corresponding to filling and input stages. Also empty bottles are placed on conveyor belt. The presence of liquid in the tank is detected using limit switch. If there is no liquid present in the tank, then the whole operation is stopped. Again, the presence of bottles on the conveyor belt is detected using IR sensor placed above the conveyor belt. If there is no bottle present the conveyor belt will not move but, the bottles present on the disc on the respective stages will be processed till the end.
Initially, when the machine is turned on, first the bottle present in the filling stage will be filled using peristaltic pump and after certain time delay disc motor will start rotating till the rod placed at 45 degree is not detected by IR sensor, which signifies the complete rotation of the disc motor for the next stage. After this, the conveyor motor will run using the arrangement of two DC motors till no bottle is detected in the input stage of the disc by the IR sensor. Similarly, in the next turn bottles will be present in the filling and capping stage. In this turn the bottle present at the filling stage is filled, as well as the bottle present at capping stage is capped using solenoid piston. Before that caps are mounted on the filled bottle using cap hopper arrangement. After that the completely processed bottle will be thrown from the machine by slant slope on the base of the disc.

The control signals are given by the DELTA PLC DVP 14SS2 according to the input sensors such as IR sensors and limit switch. Ladder logic is used in PLC so as multiple tasks can be carried out simultaneously.

1.7 LITERATURE SURVEY

1. Filling is a task carried out by a machine that packages liquid products such as cold drinks or water .Traditional methods of bottle filling involved placing bottles onto a conveyor and filling only one bottle at a time. This method is time consuming and expensive.
2. Filling and capping are controlled by PLC (Programmable Logic Controller) using the ladder logic method.
3. PLC's are used for a wide range of applications especially in the field of control and automation.
4. PLC is a solid-state device. They are well-adapted to a range of automation tasks. Thus, depending on the logic developed the various operations take place and the filling and capping of bottles are done.
5. Early plc's were designed to replace relay logic systems. This plc's were programmed in "ladder logic", which strongly resembles a schematic diagram of relay logic. This program notation was chosen to reduce training demands for the existing technicians. Other early plc's used a form of instruction list programming, based on a stack-based logic solver.
6. Modern plc's can be programmed in a variety of ways, from the relay-derived ladder logic to programming languages such as specially adapted dialects of BASIC and C.
7. Another method is state logic; a very high-level programming language designed to program plc's based on state transition diagrams.
8. Most PLC systems today adhere to the IEC 61131/3 control systems programming standard that defines 5 languages: Ladder Diagram (LD), Structured Text (ST), Function Block Diagram (FBD), Instruction List (IL) and sequential function chart (SFC).

2. LITERATURE REVIEW

A brief survey of technologies explored during the past decade and some of them are given below to provide an understanding of the level of research interest in this domain. In this paper, researcher outlined the various phases of operation involved in the adaptation of a manually operated boiler towards a totally automated boiler. The first part of the paper focuses on passing the inputs to the boiler at a required temperature, to constantly maintain a temperature in the boiler. The Air pre-heater and Economizer helped in this method. And the paper mainly focused on level, pressure and flow control at the various stages of the boiler plant. Thus, the temperature in the boiler is constantly monitored and brought to a constant temperature as required by the power plant.

At the automated power plant, the boiler is controlled by Variable Frequency Drive (VFD) to put in action the required processes to be carried out at the boiler. Thus, the entire cycle is carried out as a paper and at various stages each phase is detailed out. This paper has proved to be very efficient practically as the need for automation grows day by day.

This paper also gives an automatic method of changing a production from as there is no manual shifting required. This paper gives a way to get rid of excess production. It also provides the facility to the user to override the any one of the unit hardware operation from the control room.

Researchers developed a design of re-usability using modular modeling techniques. Reimplementation of program of existing PLC program based on formulization and visualization. It is done by transformation of FSM in XML format into IEC 61131-3 POUs and project is to be creating to control machine using new controller.

Prior to the development of data acquisition and control system, collecting data from remote field instruments, distributed throughout the plant in huge manufacturing industries, was a quite challenging and multifaceted task.

The team of researcher has been developed an industrial data acquisition and control systems equipped these industries with facilities to gather and process data, and perform control actions right from a centralized location, i.e. control room, without going to the plant. They introduction of programmable logic controllers (PLC) as a data acquisition and control hardware in these systems increased its reliability and robustness. This paper highlights the design work carried out to develop

a cost efficient, simple, robust and intelligent industrial standard data acquisition and control system for two physical field plants that are 50 meters apart from the control room. This work highlights process control application and indeed is an application of industrial electronics engineering.
Automation, which is meant to optimize processes and manufacturing procedures at the same time. At present, the PLC has been widely used in the industry area. But the shortcoming of this controller appears along with the growth of the industry equipment's. Such as inferior compatibility cooperates with the new equipment's, poor satisfaction of the high calculation and weak communication and so on. Thus, there need new technology to satisfy the increasing industry demands. The soft PLC comes into the world from on kind of condition.
The function of PLC is imitated through software on the PC platform. But the soft PLC has shortage also. The sturdiness and instantaneity are worse than the traditional PLC. Therefore, the embedded PLC Combine the advantages of traditional PLC and soft PLC, increase the computing power, express the advantages of ladder diagram and open construction to bring a universal platform to The controlled members.

In this research paper, the group of authors took efforts on the improvement of demonstrating How industrial temperature automation can be achieves using modest hardware and more refined Software details. The prime concern was to generate firing pulse for an HVAC controlling Actuator while displacing them at the same time to vary the magnitude of the ac voltage output. The direction of displacement of the pulse was described by the SETPOINT definition from an HMI using AT commands, and FEEDBACK from the temperature sensor installed in the Industrial background. The mathematical modeling was done in LabVIEW for investigating the Effect of varying firing angle on the magnitude of the ac voltage. This controlled variation of Output ac voltage can be subjected to controlling temperature of the industrial Environment. With the help of PLC, researcher has been built and implements logic for Industrial Crane Automation & Monitoring. The soft wiring advantage provided by programmable controllers is Tremendous. In fact, it is one of the most important features of plc. Soft wiring makes changes in the control system easy and cheap. If it wants a device in a PLC system to behave differently or to control a different process element, all must do is change the control Program. In a Traditional system, making this type of change would involve physically changing the wiring between the devices, a costly and time-consuming attempt. In future PLC is dominated On all other controlling methods. The team of authors developed ladder logic in MICROLOGIX software and is verified in Allen Bradley PLC. A ladder logic program of a typical application often results in complex software. That is difficult to manage during configuration, and especially, during maintenance. The difficulty lies in a typical problem with real-time control software that is exacerbated by ladder Logic. Individual components of PLC software are characteristically asynchronous, resulting in Unpredictable interactions. This makes the initial configuration of the software (i.e., Commissioning) extremely difficult and labor-intensive, but also makes reconfiguration risky.

However, the system creates a fast, real-time decision-making environment. Also, the use of SCADA in the industry will not only allow them to minimize the cost associated with the display and recording instruments but will also account for better quality and higher productivity. The Process is adaptable to any changes in production capacity or safety requirements. In short Integrated automation process produces a reliable quality hardboard production industry with the Help of PLC. This paper focus on an innovative and intelligent monitoring system of process Using SCADA. The main concept of paper is data acquisition & controlling by using SCADA Software with the help of PLC. Here PLC is a medium between electrical system & Personal Computer for SCADA to take input and output bits. Automating electrical distributions systems By implementing a supervisory control and data acquisition (SCADA) system is the one of the Most cost-effective solutions for improving reliability, increasing utilization, increasing efficiency and saving costs.

This paper presented an automatic control of temperature and level of Continues Stirred Tank Reactor (CSTR) using PLC and SCADA. The CSTR is heated using heating-coil and its Temperature and level are measured by RTD and float type level sensor respectively. The Accurate control of temperature and level are the realistic feature of this system and balances the Process. Automation required gaining the complete control of manufacturing process to achieve Consistency in manufacturing with increased productivity by shortening manufacturing time. In This paper we consider both Batch and Continues process control using PLC and SCADA. The PLC and SCADA control the process parameters with good accuracy and results are found to be satisfactorily. This is a simple automated process and can be applied in many mixing processes Used in industries. In this research paper, the device temperature parameter of different zones of Furnace has been constantly monitored and hence it can be further controlled by using DAQ and Control system. The constant monitoring of such different furnace zone temperature can produce Data-base for scheduling of the machine servicing, troubleshooting and for future Processing. Due to use of microcontroller the computation task has been handled most Effectively. Hence group of authors proposed system has been widely used in automotive Engineering, instrumentation and power quality monitoring and control applications. Data Acquisition system for monitoring such temperature of brazing furnace provides advantages of Design simplicity, portability and less cost.

This paper reveals the design of LabVIEW based SCADA system for centralized control. It Makes use of PLC as a field controller to operate the prototype design of Stenter Machine, Widely used in textile industries. LabVIEW, which is a commonly accepted graphical user Interface environment also provides HMI front end. The PLC controller and the LabVIEW Based SCADA are communicating through the RS-232 link. The control system is flexible and Modular. Due to the intuitive programming of LabVIEW, this system is cost efficient and Reliable solution for automation of small-scale textile industries. The system introduced by a group of researchers is an experimental study which helps in controlling the characteristics and ON/OFF states of a control valve. A graphical user Interface has been developed using supervisory control and data acquisition (SCADA) and the Programming of the control system has been done using programmable logic control (PLC).

3. Work done

ABOUT PLC

The CPU has an internal power supply that provides power for the CPU, the signal modules, signal board and communication modules and for other 24VDC user power requirements. 5VDC logic budget supplied by the CPU and the 5VDC power requirements of the signal modules, signal boards and communication modules.

The CPU provides a 24 VDC sensor supply that can supply 24 VDC for input points, for relay coil power on the signal modules, or for other requirements. If your 24 VDC power requirements exceed the budget of the sensor supply, then you must add an external 24 VDC power supply to your system. Some of the 24 VDC power input ports in the DVP-SS2 system are interconnected, with a common logic circuit connecting multiple terminals. For example, the following circuits are interconnected when designated as "not isolated" in the data sheets: the 24 VDC power supply of the CPU, the power input for the relay coil of an SM, or the power supply for a no isolated analog input. All non-isolated terminals must connect to the same external reference potential.

A Programmable Logic Controller, PLC is a digital computer used for automation of industrial processes, such as control of machinery on factory assembly lines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed or non-volatile memory. A PLC is an example of a real time system since output results must be produced in response to input conditions within a bounded time, otherwise unintended operation will result.[8] A PLC (i.e. Programmable Logic Controller) is a device that was invented to replace the necessary sequential relay circuits for machine control. The PLC works by looking at its inputs and depending upon their state, turning on/off its outputs. The user enters a program, usually via software, that gives the desired results. PLC are used in many “real world” applications. If there is industry present, chances are good that there is a plc present. Almost any application that needs some type of electrical control has a need for a PLC. Ladder logic is the main programming method used for PLC. As mention before, ladder logic has been developed to mimic relay logic. The decision to use the relay logic diagrams was strategic one. By selecting ladder logic as the main programming method, the amount of retraining needed for engineers and trades people was greatly reduce. [8] Modern control systems still include relay, but these are rarely used for logic. A relay is a simple device that uses a magnetic field to control a switch. Relay are used to let one power source close a switch for another power source, while keeping isolated. An example of a relay in a simple control application is shown in Figure2.2. In this system the first relay on the left is used as normally closed, and will allow current to flow until a voltage is applied to the input A. The second relay is normally open and will not allow current to flow until the voltage is applied to the input B. If current is flowing through the first two relay then current will flow though the coil in the third relay, and closed the switch for output C. This circuit would normally be drawn in the ladder logic form. This can be read logically as C will be on if A is off and B is on. [6] 2.3.1 Ladder Logic Inputs PLC inputs are easily represented in ladder logic. In Figure 2.3 there are three types of inputs shown. The first two are normally open and normally closed inputs, discussed previously. The IIT (Immediate Input) function allows inputs to be read after the input scan, while the ladder logic is being scanned. This allows ladder logic to examine input values more often than once every cycle. (Note: This instruction is not available on the Control Logic processors but is still available on older models.) 2.3.2 Ladder Logic Outputs In ladder logic there are multiple types of outputs, but these are not consistently available on all PLC. Some of the outputs will be externally connected to devices outside the PLC, but it is also possible to use internal memory locations in the PLC. Six types of outputs are shown in Figure 2.4. The first is a normal output, when energized the output will turn on, and energize an output. The circle with a diagonal line through is a normally on output. When energized the output will turn off, this type of output is not available on all PLC types. When initially energized the OSR (One Shot Relay) instruction will turn on for one scan, but then be off for all scans after, until it is turned off. The L (latch) and U (unlatch) instructions can be used to lock outputs on. When an L output is energized the output will turn on indefinitely, even when the output coil is reenergized. The output can only be turned off using a U output. The last instruction is the IOT (Immediate Output) that will allow outputs to be updated without having to wait for the ladder logic scan to be completed. [6] Figure 2.4 Ladder Logic Diagram 2.4 Programming software CX-Programmer has been utilized in this project. CX Programmer is a PLC programming tool for the creation, testing and maintenance of programs associated with OMRON's CPM2A series. It provides facilities for the support of PLC devices and address information and for communications with OMRON PLCs and their supported network types. An example of ladder logic can be seen in Figure 2.5.

To interpret this diagram imagines that the power is on the vertical line on the left-hand side, we call this the hot rail. On the right-hand side is the neutral rail. In the figure there are two rungs, and on each rung, there are combinations of inputs (two vertical lines) and outputs (circles). If the inputs are opened or closed in the right combination the power can flow from the hot rail, through the inputs, to power the outputs, and finally to the neutral rail. An input can come from a sensor, switch, or any other type of sensor. An output will be some device outside the PLC that is switched on or off, such as lights or motors. In the top rung the contacts are normally open and normally closed. This means if input A is on and input B is off, then power will flow through the output and activate it. Any other combination of input values will result in the output X being off. [7] Figure 2.5: A Simple Ladder Logic Diagram 2.5 Operation 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. [5] Step 1-CHECK INPUT STATUS- First the PLC looks 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. Step 2-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. Step 3-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. After the third step the PLC goes back to step one and repeats the steps continuously. One scan time is defined as the time it takes to execute the 3 steps listed above. 2.6 Time Response the PLC can only see an input turn on/off when it's looking. In other words, it only looks at its inputs during the check input status part of the scan. In the diagram, input 1 is not seen until scan 2. This is because when input 1 turned on, scan 1 had already finished looking at the inputs. Input 2 is not seen until scan 3. This is also because when the input turned on scan 2 had already finished looking at the inputs. Input 3 is never seen. This is because when scan 3 was looking at the inputs, signal 3 was not on yet. It turns off before scan 4 looks at the inputs. Therefore signal 3 is never seen by the plc. Now let's consider the longest time for an output to turn on. Let's assume that when a switch turns on, we need to turn on a load connected to the plc output. The diagram below shows the longest delay (worst case because the input is not seen until scan 2) for the output to turn on after the input has turned on.[8] The maximum delay is thus 2 scan cycles – 1 input delay time. Pulse stretch function. This function extends the length of the input signal until the plc looks at the inputs during the next scan.(i.e. it stretches the duration of the pulse.) Interrupt function. This function interrupts the scan to process a special routine that you have written. i.e. As soon as the input turns on, regardless of where the scan currently is, the plc immediately stops what it's doing and executes an interrupt routine. (A routine can be thought of as a nonprogram outside of the main program.) After its done executing the interrupt routine, it goes back to the point it left off at and continues with the normal scan process.

3.1 PLC CONCEPTS

The CPU supports the following types of code blocks that allow us to create an efficient structure for our user program:

- Organization blocks (OBs) define the structure of the program. Some OBs have predefined behavior and start events, but we can also create OBs with custom start events.
- Functions (FCs) and function blocks (FBs) contain the program code that corresponds to specific tasks or combinations of parameters. Each FC or FB provides a set of input and output parameters for sharing data with the calling block. An FB also uses an associated data block (called an instance DB) to maintain state of values between execution that can be used by other blocks in the program. Valid FC and FB numbers range from 1 to 65535.
- Data blocks (DBs) store data that can be used by the program blocks. Valid DB numbers range from 1 to 65535. Execution of the user program begins with one or more optional start-up organization blocks (OBs) which are executed once upon entering RUN mode, followed by one or more program cycle OBs which are executed cyclically.

3.2 OPERATING MODES OF THE CPU

The CPU has three modes of operation: STOP mode, STARTUP mode, and RUN mode. Status LEDs on the front of the CPU indicate the current mode of operation.

- In STOP mode, the CPU is not executing the program. We can download a project.
- In RUN mode, the program cycle OBs are executed repeatedly. Interrupt events can occur and be processed at any point within the RUN mode.

3.3 PlC DATA TYPES

The PLC data type editor lets us define data structures that we can use multiple times in our program. We create a PLC data type by opening the “PLC data types” branch of the project tree and double – clicking the "Add new data type" item. On the newly created PLC data type item, we use two single-clicks to rename the default name and double-click to open the PLC data type editor.

We create a custom PLC data type structure using the same editing methods that are used in the data block editor. We then add new rows for any data types that are necessary to create the data structure that we want.

If a new PLC data type is created, then the new PLC type name will appear in the data type selector drop drop-lists in the DB editor and code block interface editor.
Potential uses of PLC data types:

 PLC data types can be used directly as a data type in a code block interface or in data blocks.
 PLC data types can be used as a template for the creation of multiple global data blocks that use the same data structure.

3.4 PROGRAMMING CONCEPTS

Structuring the user program
When we create a user program for the automation tasks, we insert the instructions for the program into code blocks:
 An organization block (OB) responds to a specific event in the CPU and can interrupt the execution of the user program. The default for the cyclic execution of the user program (OB 1) provides the base structure for your user program and is the only code block required for a user program. If we include other OBs in our program, these OBs interrupt the execution of OB 1. The other OBs perform specific functions, such as for start-up tasks, for handling interrupts and errors, or for executing specific program code at specific time intervals.

 A function block (FB) is a subroutine that is executed when called from another code block (OB, FB, or FC). The calling block passes parameters to the FB and identifies a specific data block (DB) that stores the data for the specific call or instance of that FB. Changing the instance DB allows a generic FB to control the operation of a set of devices. For example, one FB can control several pumps or valves, with different instance DBs containing the specific operational parameters for each pump or valve.
 A function (FC) is a subroutine that is executed when called from another code block (OB, FB, or FC). The FC does not have an associated instance DB. The calling block passes parameters to the FC. The output values from the FC must be written to a memory address or to a global DB.
 LAD (ladder logic) is a graphical programming language. The representation is based

on circuit diagrams.

 FBD (Function Block Diagram) is a programming language that is based on the graphical logic symbols used in Boolean algebra.

 SCL (structured control language) is a text-based, high-level programming language. Ladder Logic (LAD) The elements of a circuit diagram, such as normally closed and normally open contacts, and coils are linked to form networks. To create the logic for complex operations, you can insert branches to create the logic for parallel circuits. Parallel branches are opened downwards or are connected directly to the power rail. You terminate the branches upwards.

LAD provides "box" instructions for a variety of functions, such as math, timer, counter, and move.

Function Block Diagram

Like LAD, FBD is also a graphical programming language. The representation of the logic is based on the graphical logic symbols used in Boolean algebra.

Mathematical functions and other complex functions can be represented directly in conjunction with the logic boxes.

3.5 ECONOMIC AND COMPACT MODEL

► 32-bit CPU for high-speed processing

► Max. I/O: 480 points

► Program capacity: 8 k steps

► Data register: 5 k words

► Max. execution speed of basic instructions: 0.35 as

► Built-in RS-232 and RS-485 ports (Master / Slave)

► Supports standard Modbus ASCII / RTU protocol and PLC Link Function

3.6 MOTION CONTROL FUNCTIONS

► 4 points of 10 kHz pulse output

► 8 points of high-speed counters: 20 kHz / 4 points, 10 kHz / 4 points

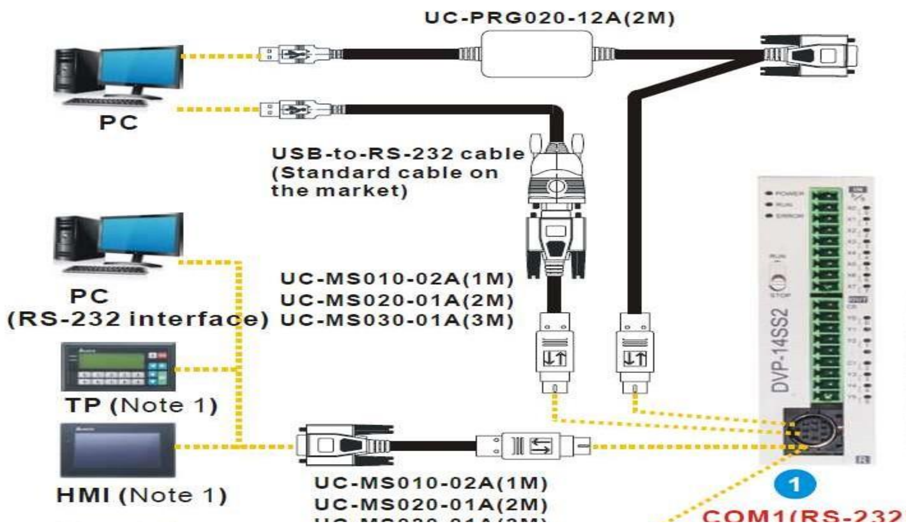

Fig 3.1 PLC COMMUNICATION CABLE

Specifications

Electrical Specifications

	AC	DC
Power Supply Voltage	100~240 V_{AC} (-15%~10%), 50/60Hz ±5%	24 V_{DC} (-15%~20%)
Fuse Capacity	2A/250 V_{AC}	ES: 2A/250 V_{AC}; SV: 2.5A/30 V_{DC}
Spike Voltage Durability	1500 V_{AC} (Primary-secondary); 1500 V_{AC} (Primary-PE); 500 V_{AC} (Secondary-PE)	
Insulation Impedance	>5 MΩ (all I/O point-to-ground: 500 V_{DC})	
Noise Immunity	ESD: 8 kV Air Discharge EFT: Power Line, 2 kV Digital I/O: 1 kV Analog & Communication I/O: 1 kV RS: 26 MHz~1 GHz, 10 V/m	
Earth	The diameter of grounding wire shall not be shorter than that of the power supply cable. (When many PLCs are in use at the same time, please make sure every PLC is properly grounded.)	
Storage/Operation	Storage: -25°C~70°C (temperature); 5%~95% (humidity) Operation: 0°C~55°C (temperature); 5%~95% (humidity); pollution degree 2	

Table 3.1: Electrical Specifications

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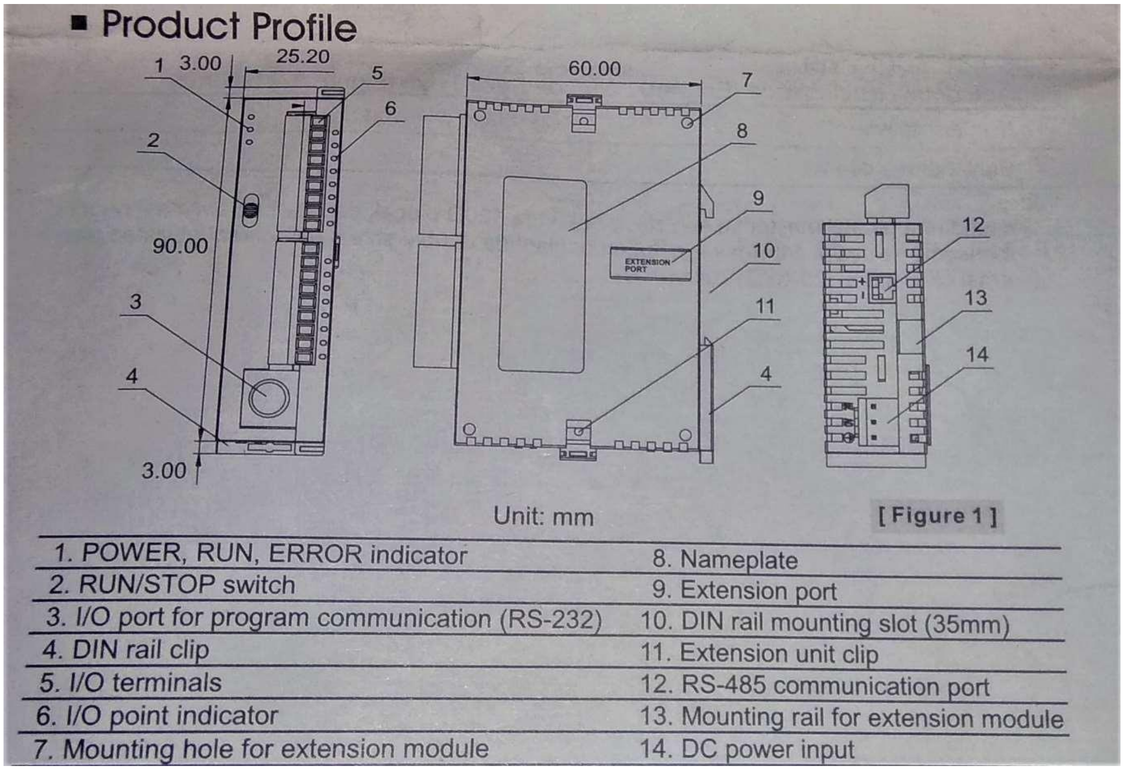
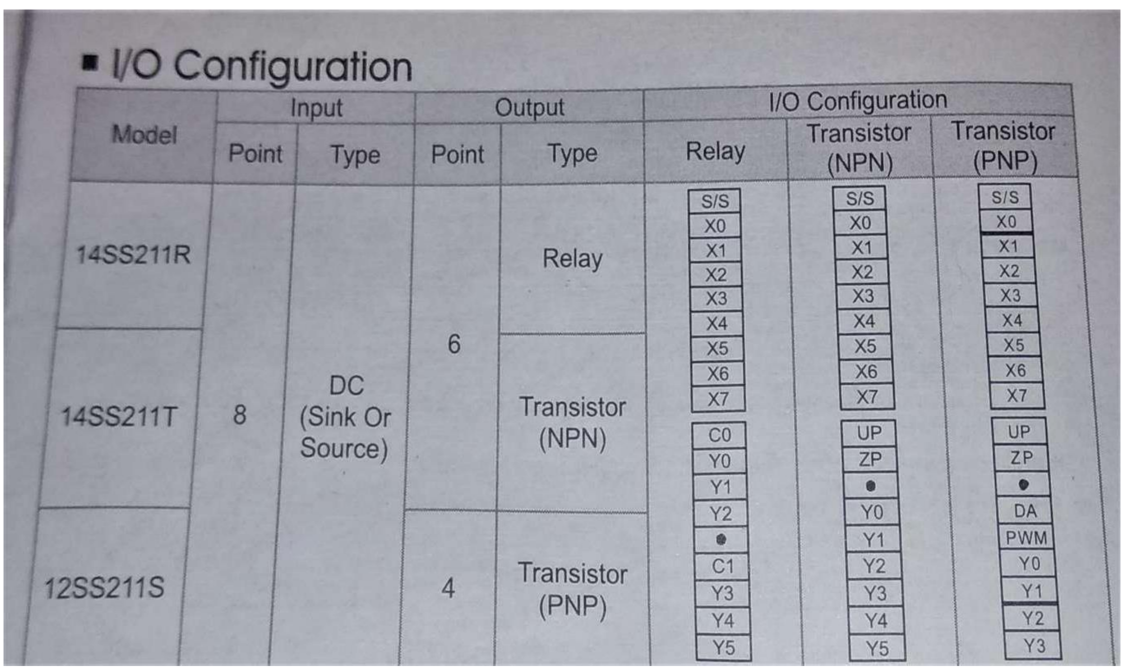


Fig 3.2 PLC OUTER LAYOUT



I/O Configuration

Model	Input		Output		I/O Configuration		
	Point	Type	Point	Type	Relay	Transistor (NPN)	Transistor (PNP)
14SS211R	8	DC (Sink Or Source)	6	Relay	S/S X0 X1 X2 X3 X4 X5 X6 X7 C0 Y0 Y1 Y2 ● C1 Y3 Y4 Y5	S/S X0 X1 X2 X3 X4 X5 X6 X7 UP ZP ● Y0 Y1 Y2 Y3 Y4 Y5	S/S X0 X1 X2 X3 X4 X5 X6 X7 UP ZP ● DA PWM Y0 Y1 Y2 Y3
14SS211T				Transistor (NPN)			
12SS211S			4	Transistor (PNP)			

Fig 3.3 PLC I/O CONFIGURATIONS

Item \ Model	DVP14SS211R	DVP14SS211T	DVP12SS211S
Fuse capacity	1.85A/30VDC, Polyswitch		
Power consumption	1.8W	1.5W	
Power protection	With counter-connection protection on the polarity of DC input power		
Insulation resistance	> 5MΩ (all I/O point-to-ground: 500VDC)		
Noise immunity	ESD (IEC 61131-2, IEC 61000-4-2): 8kV Air Discharge EFT (IEC 61131-2, IEC 61000-4-4): Power Line: 2kV, Digital I/O: 1kV, Analog & Communication I/O: 1kV RS (IEC 61131-2, IEC 61000-4-3): 26MHz ~ 1GHz, 10V/m		
Grounding	The diameter of grounding wire cannot be smaller than the wire diameter of terminals L and N (All DVP units should be grounded directly to the ground pole).		
Operation / storage	Operation: 0°C ~ 55°C (temp.), 5 ~ 95% (humidity), Pollution degree2 Storage: -25°C ~ 70°C (temp.), 5 ~ 95% (humidity)		
Vibration / shock resistance	International standards: IEC61131-2, IEC 68-2-6 (TEST Fc)/IEC61131-2 & IEC 68-2-27 (TEST Ea)		
Weight (g)	97g	82.5g	90g

Items \ Spec.		Input Point	
		24VDC (-15% ~ 20%) single common port input	
Input No.		X0 ~ X3	X4 ~ X7
Input type		DC (SINK or SOURCE)	
Input Current (± 10%)		24VDC, 5mA	
Input impedance		4.7kΩ	
Max. frequency		20kHz	10kHz
Action level	Off→On	> 15VDC	
	On→Off	< 5VDC	
Response time	Off→On	< 10μs	< 20μs
	On→Off	< 20μs	< 50μs
Filter time		Adjustable within 0 ~ 20ms by D1020 (Default: 10ms)	

Items \ Spec.		Output Point		
		Relay	Transistor	
Output No.		Y0 ~ Y5	Y0 ~ Y3	Y4, Y5
Max. frequency		1Hz	10kHz	1kHz
Working voltage		250VAC, < 30VDC	5 ~ 30VDC #1	
Max. load	Resistive	1.5A/1 point (5A/COM)	0.5A/1 point (3A/COM)	
	Inductive	#2	15W (30VDC)	
	Lamp	20WDC/100WAC	2.5W (30VDC)	
Response time	Off→On	Approx. 10ms	20μs	100μs
	On→Off		30μs	100μs

Fig 3.4 PLC SPECIFICATIONS

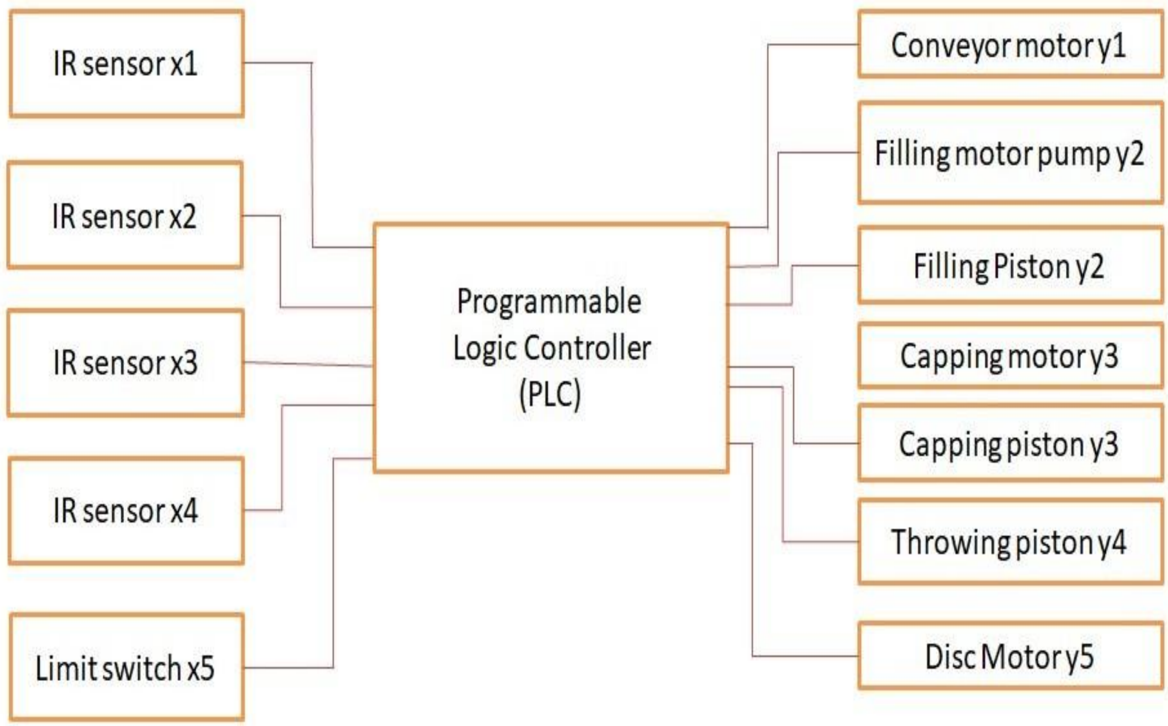


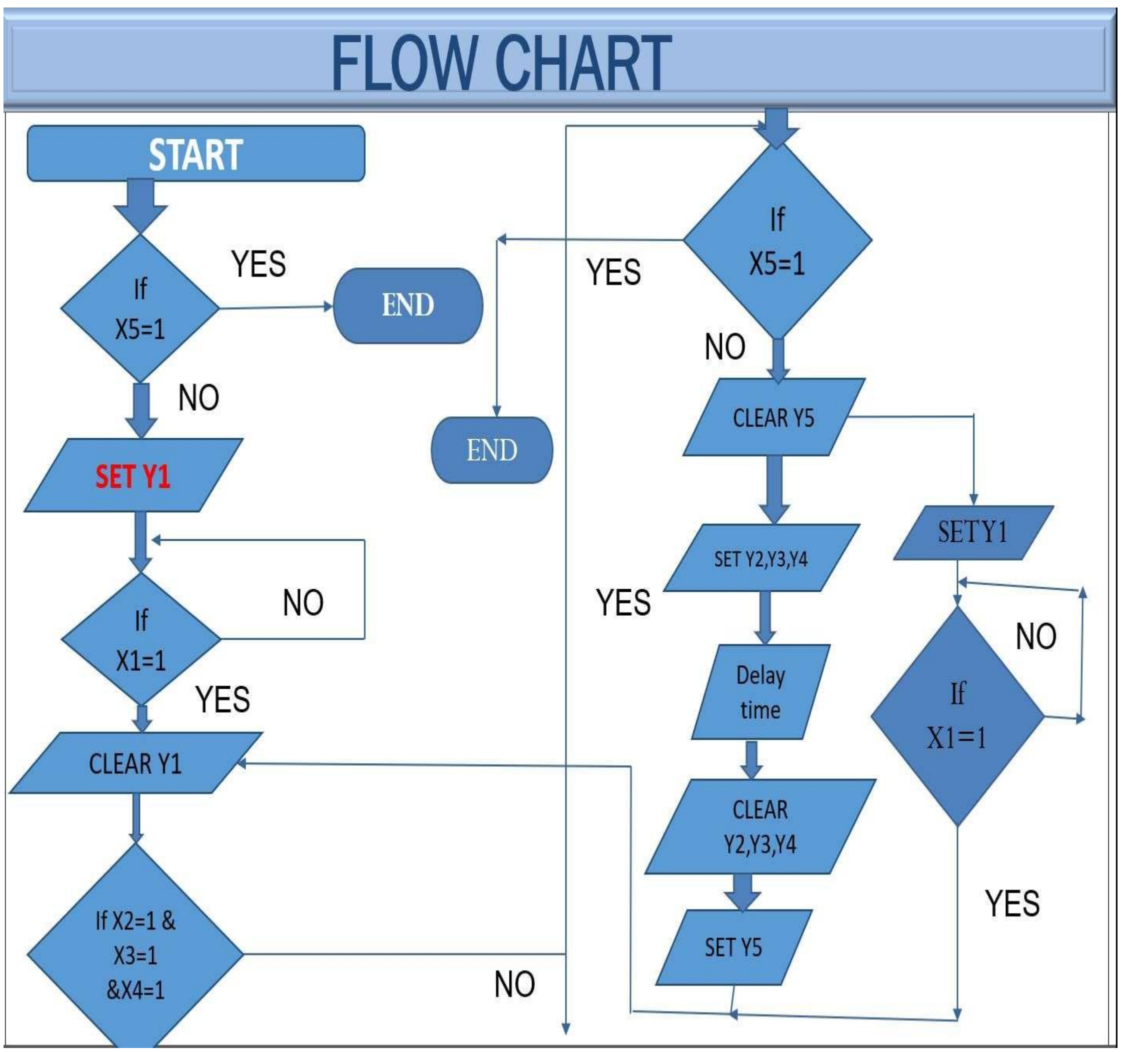
Fig 3.5 BLOCK DIAGRAM FOR PLC CONTROLS

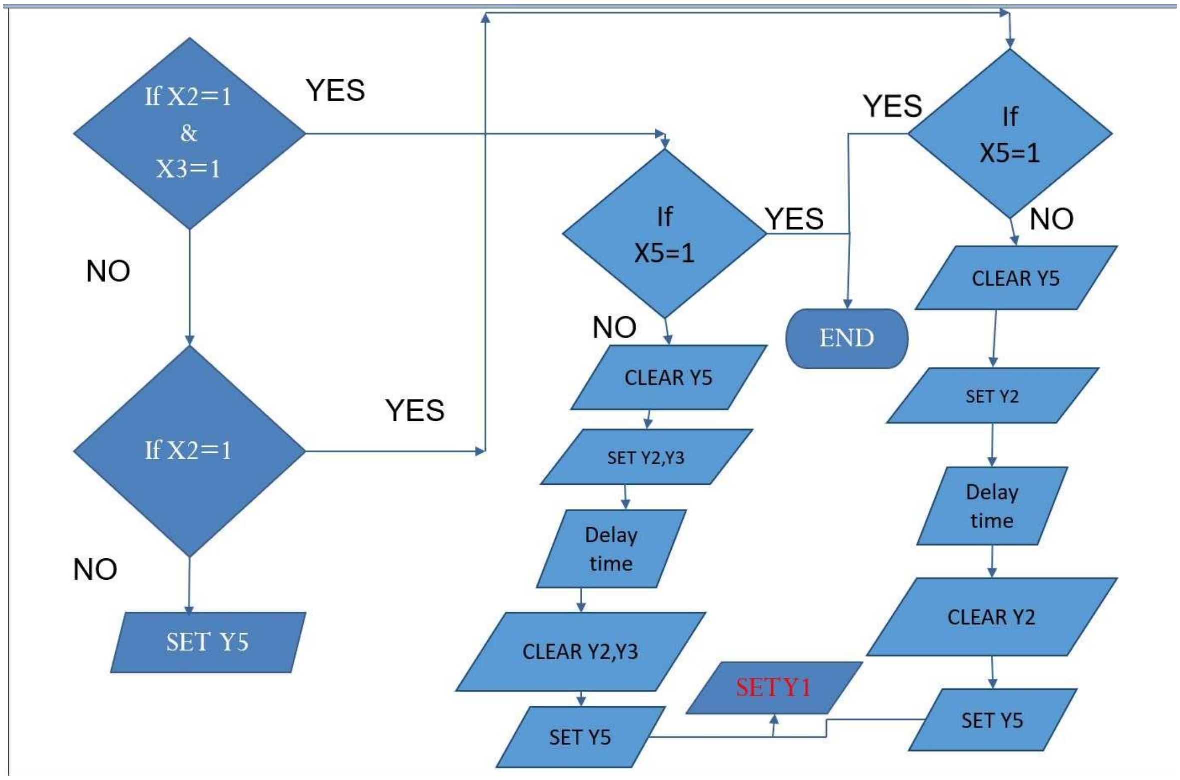
First empty bottles are placed on the disc slots corresponding to filling and input stages. As well as empty bottles are placed on conveyor belt. The presence of liquid in the tank is detected using limit switch. If there is no liquid present in the tank, then the whole operation is stopped. Again, the presence of bottles on the conveyor belt is detected using ir sensor placed above the conveyor belt. If there is no bottle present the conveyor belt will not move but, the bottles present on the disc on the respective stages will be processed till the end.

Initially, when the machine is turned on, first the bottle present in the filling stage will be filled using peristaltic pump and after certain time delay disc motor will start rotating till the rod placed at 45 degree is not detected by ir sensor, which signifies the complete rotation of the disc motor for the next stage. After this, the conveyor motor will run using the arrangement of two DC motors till no bottle is detected in the input stage of the disc by the ir sensor. Similarly, in the next turn bottles will be present in the filling and capping stage. In this turn the bottle present at the filling stage is filled, as well as the bottle present at capping stage is capped using solenoid piston. Before that caps are mounted on the filled bottle using cap hopper arrangement. After that the completely processed bottle will be thrown from the machine by slant slope on the base of the disc.

The control signals are given by the DELTA PLC DVP 14SS2 according to the input sensors such as IR sensors and limit switch. Ladder logic is used in PLC so as multiple tasks can be carried out simultaneously.

3.7 SOFTWARE IMPLEMENTATION





3.8 SOFTWARE DESCRIPTION

The languages in which PLC can be programmed are

1. Structure Text
2. Instruction list
3. Ladder Diagram
4. Flow Chart
5. Functional Block Diagram

From these languages, we have used ladder diagram for programming PLC. The actual real time simulation can be done by connecting PLC to the PC by RS 232 port and simulating in WPLsoft software in online mode

3.9 ALGORITHM

The PLC does not work like microcontrollers which work on machine cycles and cannot do two tasks simultaneously. The PLC can monitor each step simultaneously as well as execute each step simultaneously.

Step I – If limit switch x0 = 0 go to last step.

Step II – If conveyor belt ir sensor x1 = 0 stop conveyor belt.

Step III – If x0 = 1 & x2 = 0 & y1 = 0 & x1 = 1 set y0.

Step IV – While (x5 = 1) & while (x5 = 0) reset y1.

Step V – If x5 = 1 & x4 = 1 set y3 for time t2.

Step VI – If x5 = 1 & x3 =1 set y2 for time t1.

Step VII – After t1 = 1 & t2 = 1 start t3.

Step VIII – After t3 = 1 set y1.

Step IX – END.

3.10 LADDER LOGIC

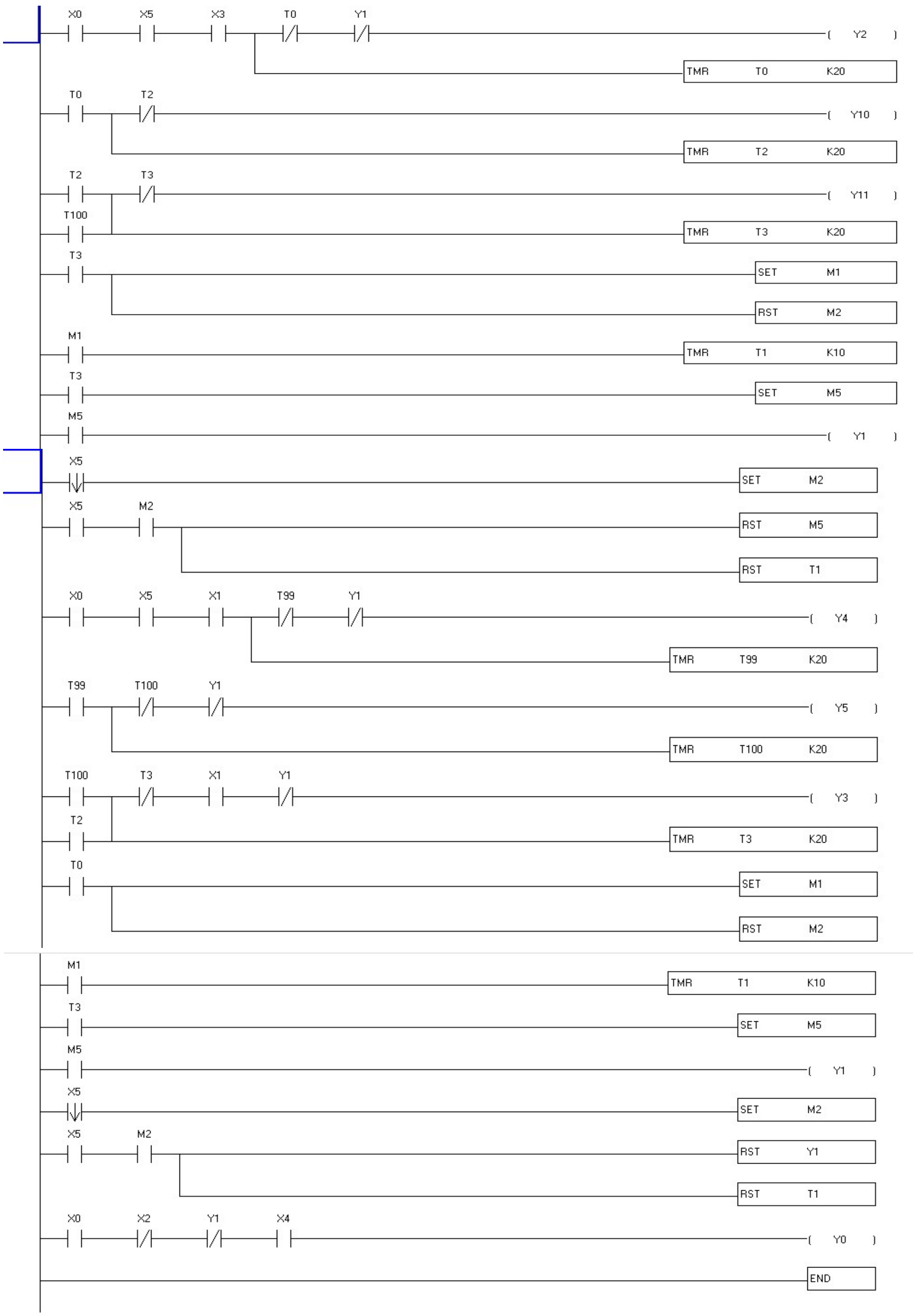
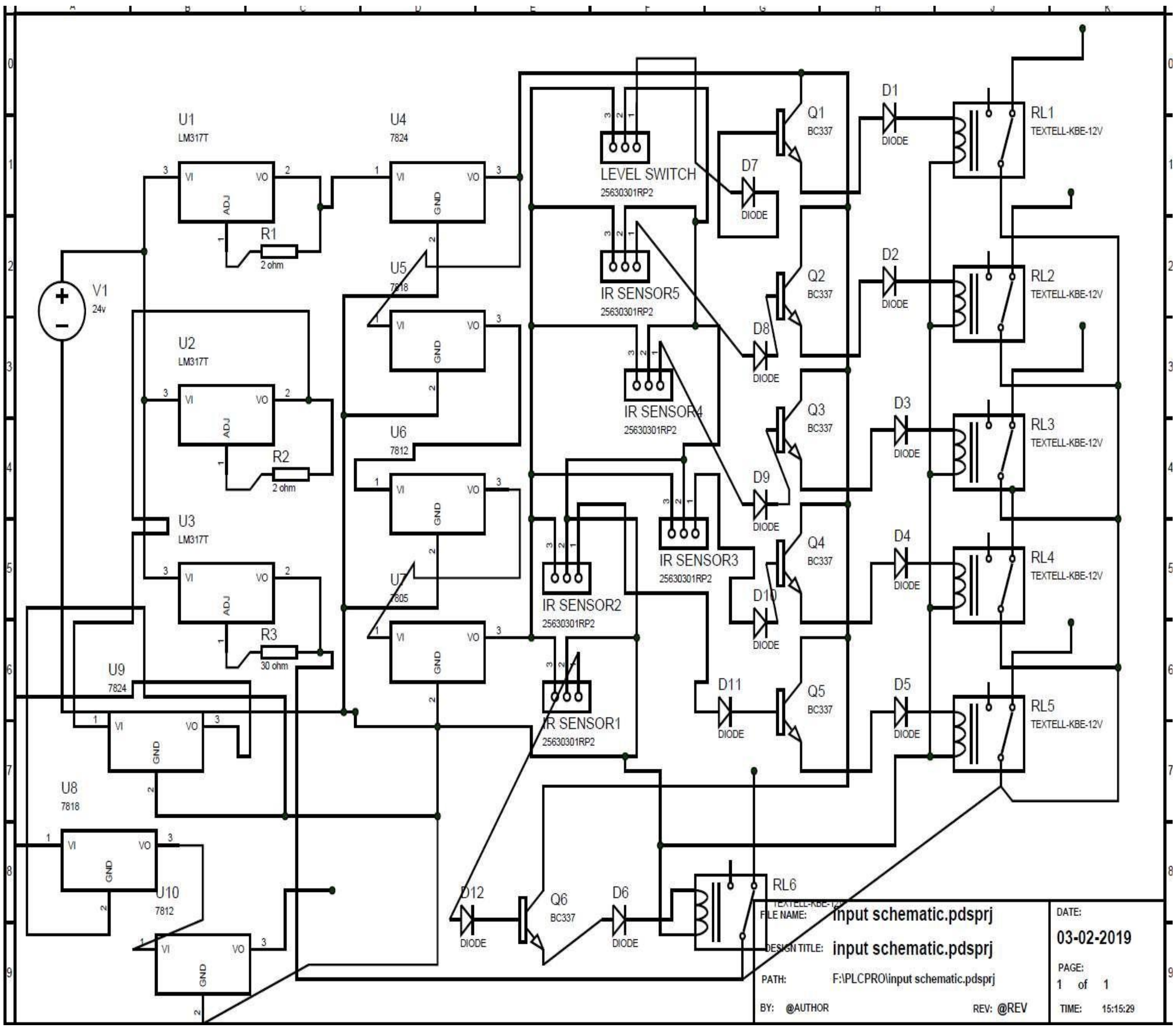
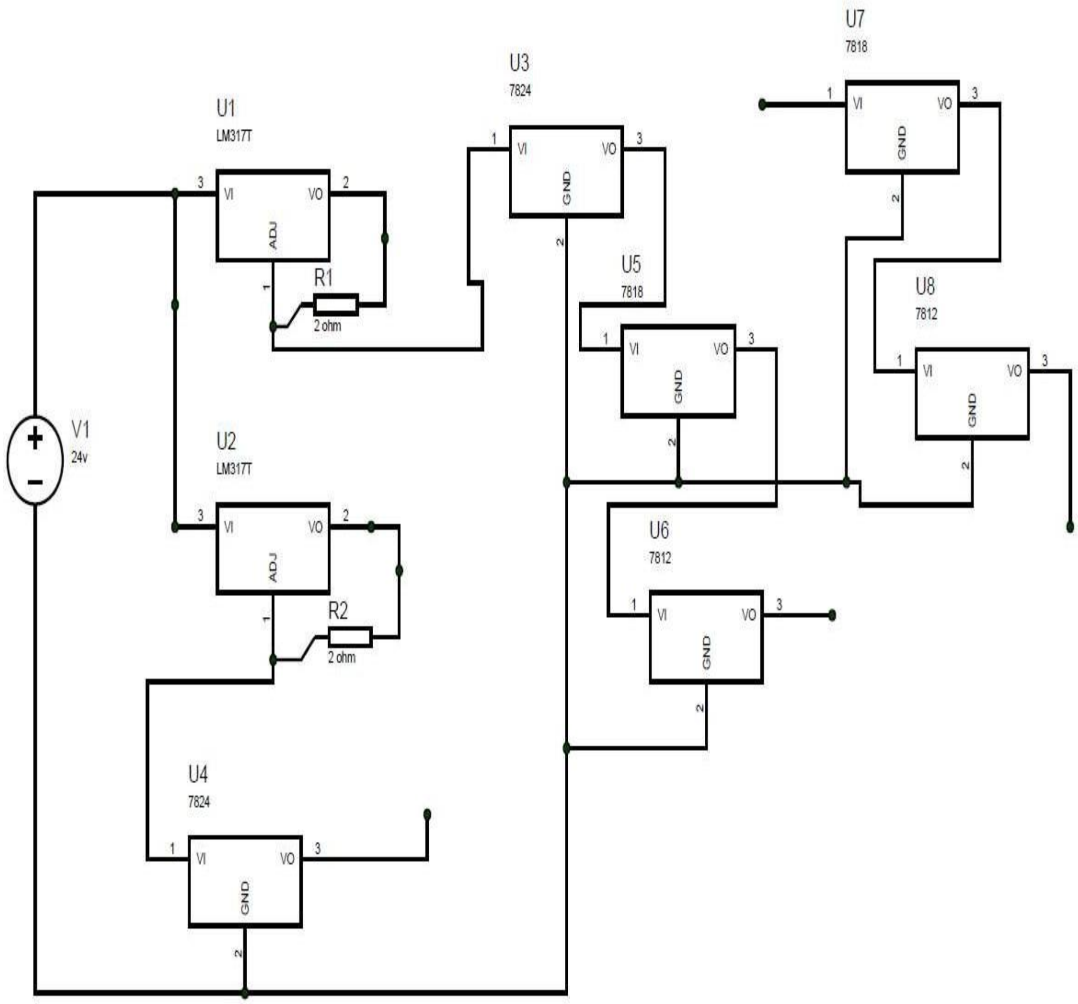


Fig 3.6 LADDER DIAGRAM FOR PLC CONTROLS

3.11 CIRCUIT DIAGRAM FOR INPUT



3.12 CIRCUIT DIAGRAM FOR OUPUT



3.13 PRINTED CIRCUIT BOARD (PCB)

A printed circuit board (PCB) mechanically supports and electrically connects electronic components or electrical components using conductive tracks, pads and other features etched from one or more sheet layers of copper laminated onto and/or between sheet layers of a non-conductive substrate. Components are generally soldered onto the PCB to both electrically connect and mechanically fasten them to it.

Printed circuit boards are used in all but the simplest electronic products. They are also used in some electrical products, such as passive switch boxes.

Alternatives to PCBs include wire wrap and point-to-point construction, both once popular but now rarely used. PCBs require additional design effort to lay out the circuit, but manufacturing and assembly can be automated. Specialized CAD software is available to do much of the work of layout. Mass-producing circuits with PCBs are cheaper and faster than with other wiring methods, as components are mounted and wired in one operation. Large numbers of PCBs can be fabricated at the same time, and the layout only must be done once. PCBs can also be made manually in small quantities, with reduced benefits.

PCBs can be single-sided (one copper layer), double-sided (two copper layers on both sides of one substrate layer), or multi-layer (outer and inner layers of copper, alternating with layers of substrate). Multi-layer PCBs allow for much higher component density, because circuit traces on the inner layers would otherwise take up surface space between components. The rise in popularity of multilayer PCBs with more than two, and especially with more than four, copper planes was concurrent with the adoption of surface mount technology. However, multilayer PCBs make repair, analysis, and field modification of circuits much more difficult and usually impractical.

3.14 DRILLING

Holes through a PCB are typically drilled with drill bits made of solid coated tungsten carbide. Coated tungsten carbide is used because board materials are abrasive. High-speed-steel bits would dull quickly, tearing the copper and ruining the board. Drilling is done by computer-controlled drilling machines, using a *drill file* or excellon file that describes the location and size of each drilled hole. Holes may be made conductive, by electroplating or inserting hollow metal eyelets, to connect board layers. Some conductive holes are intended for the insertion of through-hole-component leads. Others used to connect board layers, are called vias.

When very small vias are required, drilling with mechanical bits is costly because of high rates of wear and breakage. In this case, the vias may be laser drilled—evaporated by lasers. Laser-drilled vias typically have an inferior surface finish inside the hole. These holes are called *micro vias*. It is also possible with *controlled-depth* drilling, laser drilling, or by pre-drilling the individual sheets of the PCB before lamination, to produce holes that connect only some of the copper layers, rather than passing through the entire board. These holes are called *blind vias* when they connect an internal copper layer to an outer layer, or *buried vias* when they connect two or more internal copper layers and no outer layers.

The hole walls for boards with two or more layers can be made conductive and then electroplated with copper to form *plated-through holes*. These holes electrically connect the conducting layers of the PCB. For multi-layer boards, those with three layers or more, drilling typically produces a *smear* of the high temperature decomposition products of bonding agent in the laminate system. Before the holes can be plated through, this smear must be removed by a chemical *de-smear* process, or by *plasma-etch*. The de-smear process ensures that a good connection is made to the copper layers when the hole is plated through. On high reliability boards a process called etch-back is performed chemically with a potassium permanganate-based etchant or plasma. The etch-back removes resin and the glass fibre so that the copper layers extend into the hole and as the hole is plated become integral with the deposited copper.

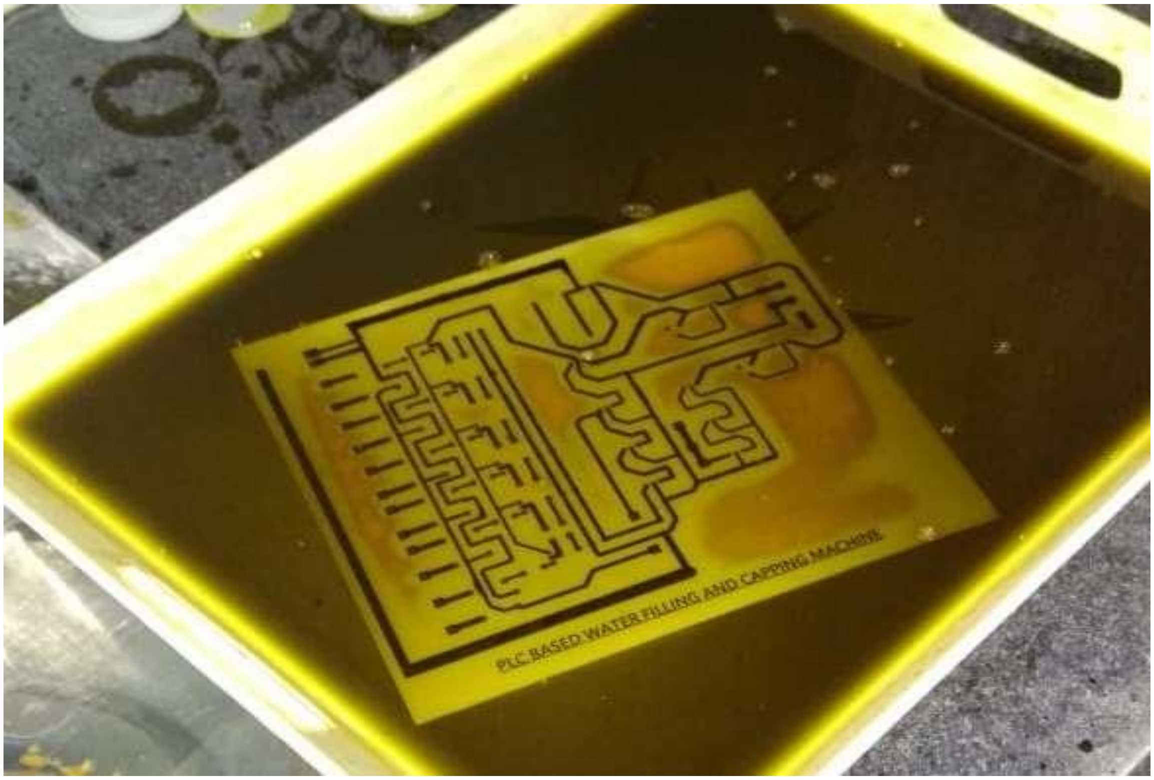


Fig 3.7: INPUT PCB ETCHING

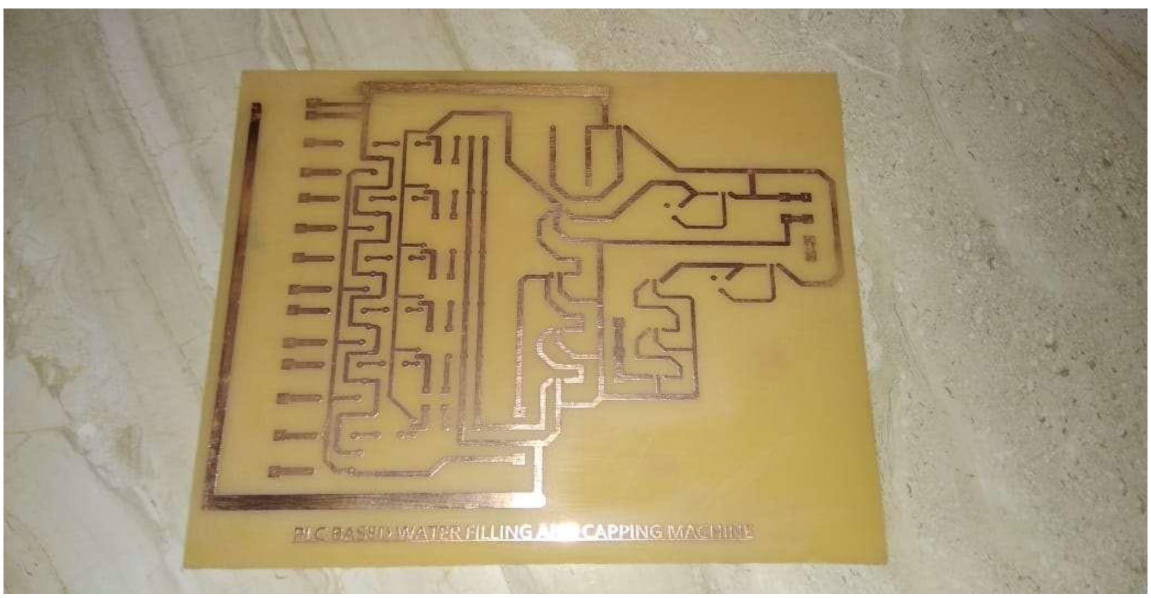


Fig 3.8: INPUT ETCHED PCB

Fig 3.9: OUPUT PCB ETCHING

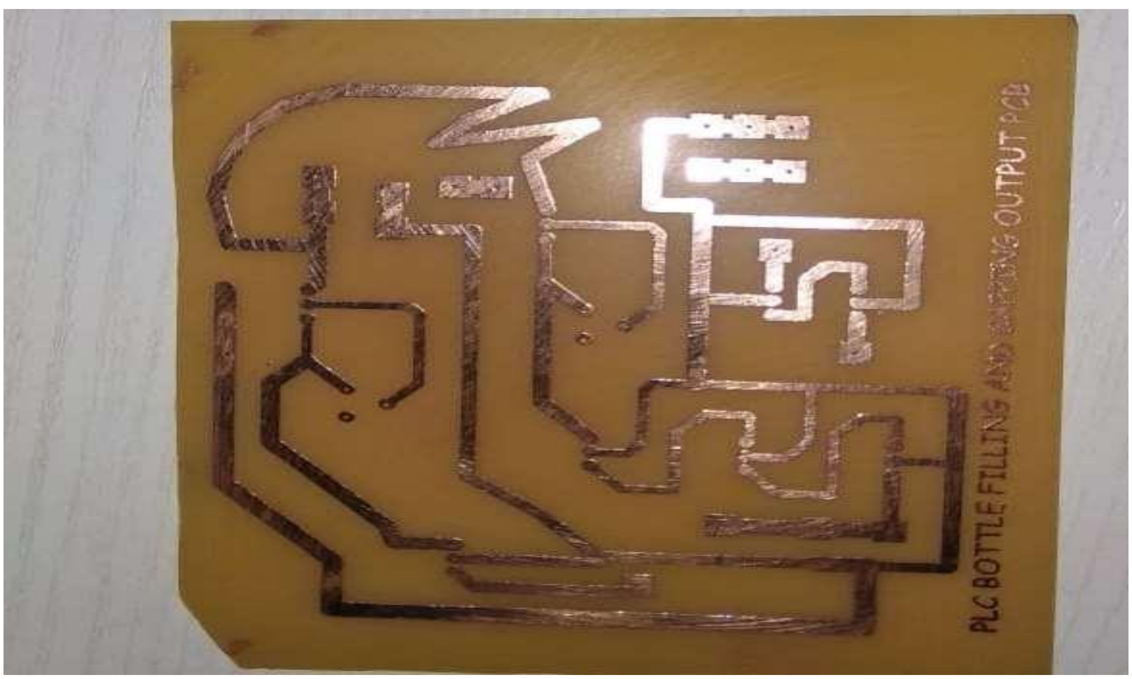


Fig 3.10: OUPUT ETCHED PCB

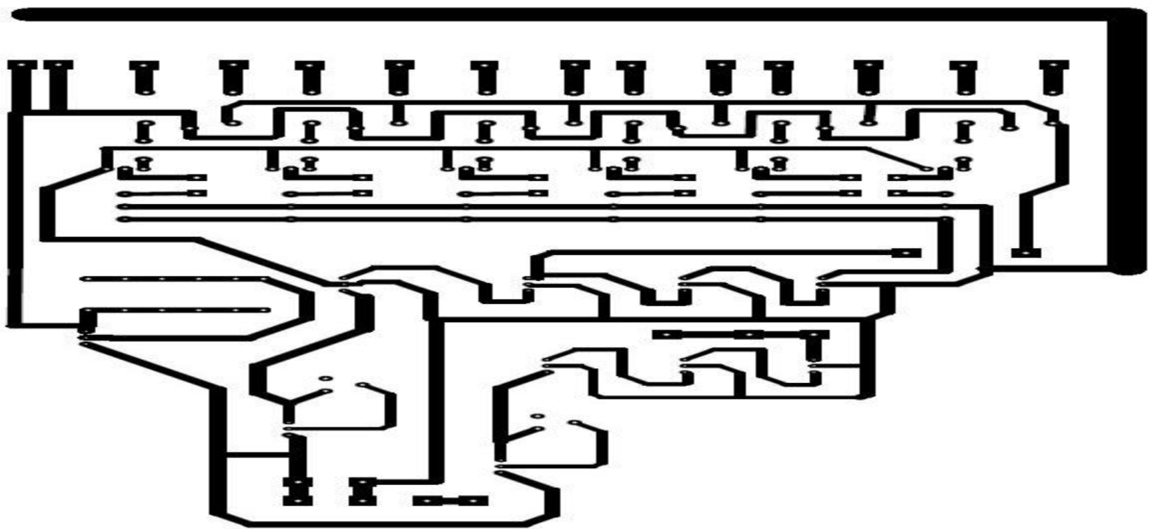


Fig 3.11: INPUT PCB PRINT LAYOUT

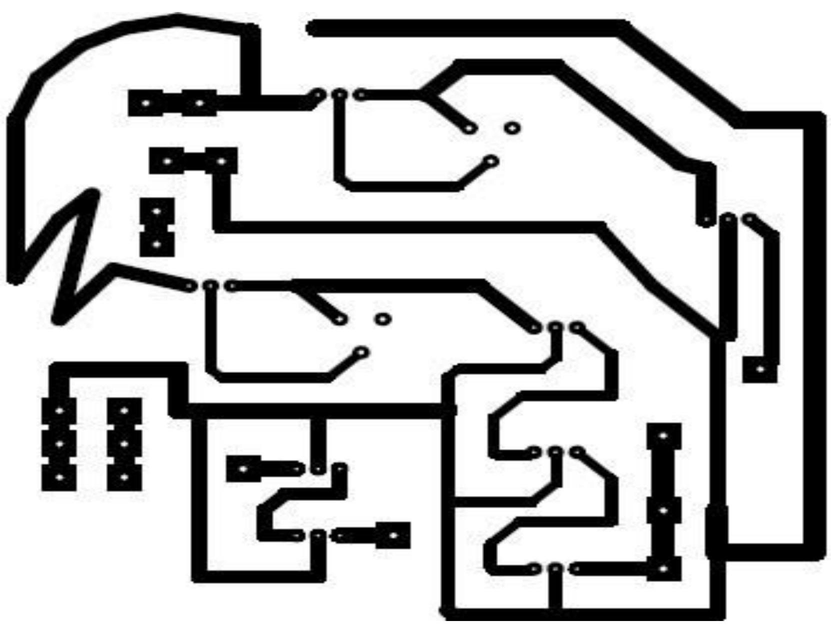


Fig 3.12: OUPUT PCB PRINT LAYOUT

3.15 LM317 3-TERMINAL ADJUSTABLE REGULATOR

3.15.1 Feature Description

The LM317 device is an adjustable three-terminal positive-voltage regulator capable of supplying more than 1.5 A over an output-voltage range of 1.25 V to 37 V. It requires only two external resistors to set the output voltage. The device features a typical line regulation of 0.01% and typical load regulation of 0.1%. It includes current limiting, thermal overload protection, and safe operating area protection. Overload protection remains functional even if the ADJUST terminal is disconnected.

The LM317 device is an adjustable three-terminal positive-voltage regulator capable of supplying up to 1.5 A over an output-voltage range of 1.25 V to 37 V. It requires only two external resistors to set the output voltage.

The device features a typical line regulation of 0.01% and typical load regulation of 0.1%. It includes current limiting, thermal overload protection, and safe operating area protection. Overload protection remains functional even if the ADJUST terminal is disconnected. The LM317 device is versatile in its applications, including uses in programmable output regulation and local onward regulation. Or, by connecting a fixed resistor between the ADJUST and OUTPUT terminals, the LM317 device can function as a precision current regulator.

An optional output capacitor can be added to improve transient response. The ADJUST terminal can be bypassed to achieve very high ripple-rejection ratios, which are difficult to achieve with standard three-terminal regulators.

3.15.2 NPN Darlington Output Drive

NPN Darlington output topology provides naturally low output impedance and an output capacitor is optional. 3-V headroom is recommended (VI – VO) to support maximum current and lowest temperature.

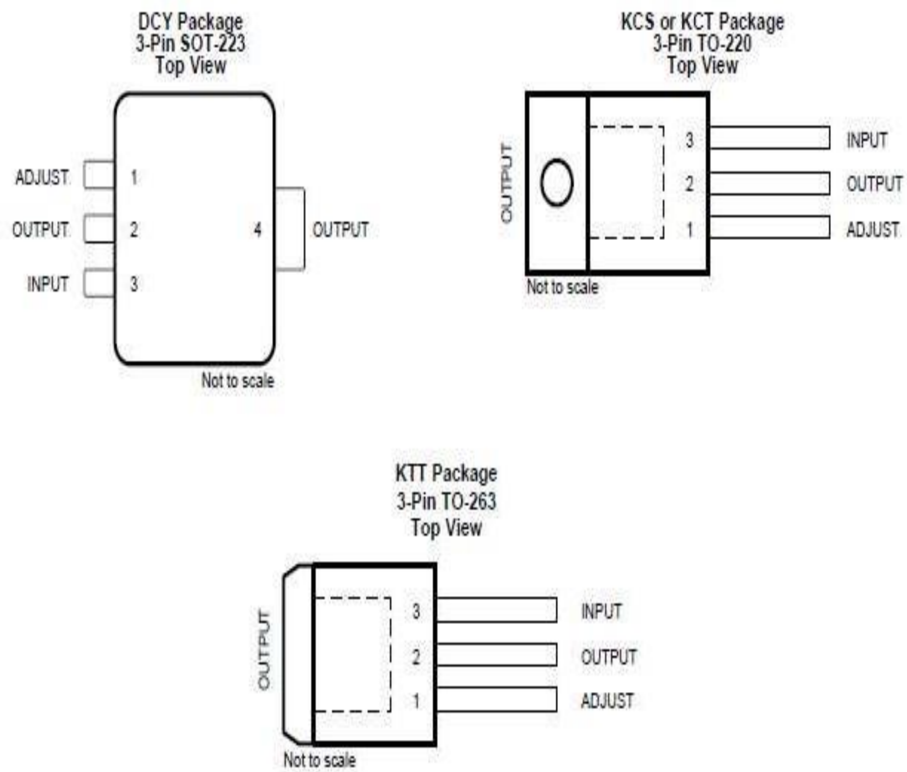
3.15.3 Overload Block

Over-current and over-temperature shutdown protects the device against overload or damage from operating in excessive heat.

3.15.4 Programmable Feedback

Op amp with 1.25-V offset input at the ADJUST terminal provides easy output voltage or current (not both) programming. For current regulation applications, a single resistor whose resistance value is 1.25 V/IO and power rating is greater than (1.25 V)2/R should be used.

5 Pin Configuration and Functions



Pin Functions

PIN			I/O	DESCRIPTION
NAME	TO-263, TO-220	SOT-223		
ADJUST	1	1	I	Output voltage adjustment pin. Connect to a resistor divider to set V_O
INPUT	3	3	I	Supply input pin
OUTPUT	2	2, 4	O	Voltage output pin

Fig 3.13: LM317 PIN CONFIGURATION

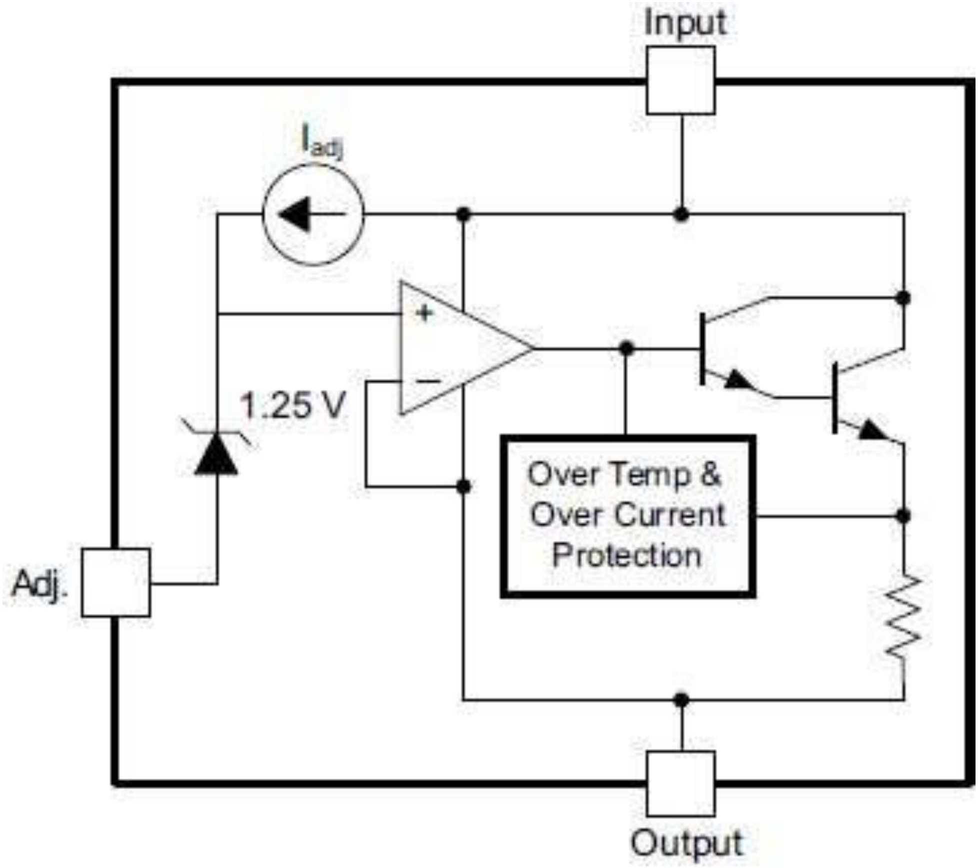


Fig 3.14: LM317 CIRCUIT DIAGRAM

3.16 1A STANDARD POSITIVE VOLTAGE REGULATOR

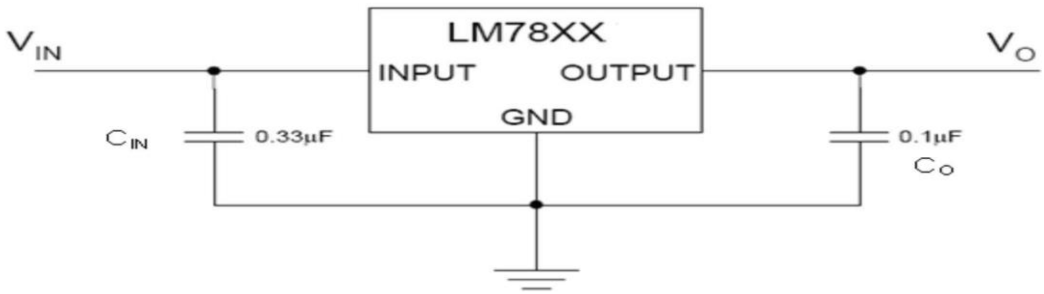
General Description

• The LM78xx series is three terminal standard positive voltage regulators designed for a wide range of applications that required supply current up to 1A.

• The LM78xx series is available in 10 fixed output voltage:4.7V,5V,6V,7V,8V,9V,10V, 12V,15V,18V and 24V.

• The LM78xx series provides internal current limiting, thermal shutdown protection and Safe-area operation compensation which make them virtually immune from output load, and the output current could up to 1A if adequate heat sinking provide

• The LM78xx is available in TO-220, TO-220F, DPAK (TO-252), D2PAK(TO-263) packages.



. Fig 3.15: BLOCK REPRESENTATION OF LM78XX

Features

- Output Current up to 1A
- Maximum Input voltage up to 36V
- Output Voltage Accuracy of ±4% at 25°C
- Thermal Overload Protection
- Short Circuit Current Limiting
- Output Transistor safe operation area (SOA) Protection
- RoHS Compliance and Halogen Free

Applications

- High Efficiency Linear Regulator
- Post Regulation for Switching Supply
- Microprocessor Power Supply
- Mother Board

Absolute Maximum Ratings (Note 1)

Symbol	Description		Ratings	Unit
V_{IN}	Input Voltage	V_O=4.7~18V	35	V
		V_O=20~24V	40	
I_O	Output Current		1	A
P_D	Power Dissipation		Internally Limited	W
T_{LEAD}	Lead Temperature (Soldering 10sec)		260	°C
T_J	Operating Junction Temperature	D^2PAK	0 to 125	
		others	-20 to 150	
T_{STG}	Storage Temperature Range	D^2PAK	-40 to 150	
		others	-55 to 150	
θ_{JA}	Thermal Resistance (Junction to Ambient)	TO-220	65	°C/ W
		TO-220F		
		DPAK (TO-252)	61.54	
θ_{JC}	Thermal Resistance (Junction to Case)	TO-220	5	
		TO-220F		
		DPAK (TO-252)	7.48	

TABLE 3.2: ABSOLUTE MAXIMUM RATING

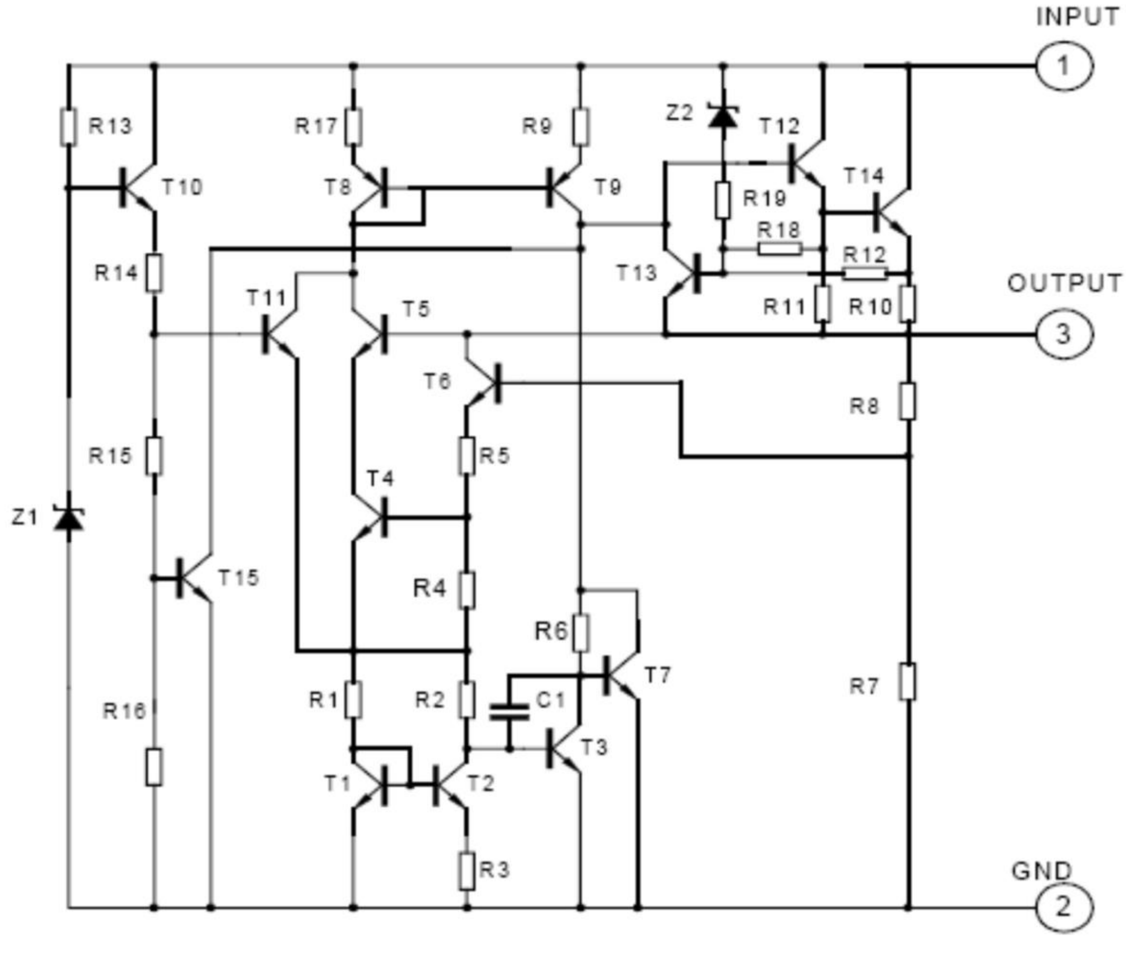
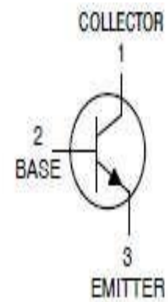


Fig 3.16: LM78XX CIRCUIT DIAGRAM

3.17 AMPLIFIER TRANSISTORS



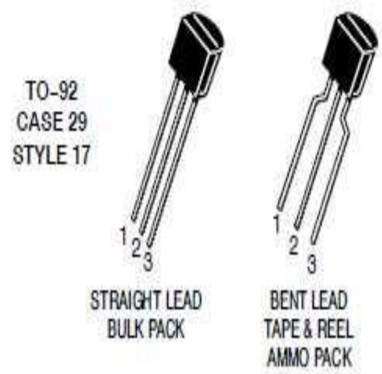
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector – Emitter Voltage	V_{CEO}	45	Vdc
Collector – Base Voltage	V_{CBO}	50	Vdc
Emitter – Base Voltage	V_{EBO}	5.0	Vdc
Collector Current – Continuous	I_C	800	mAdc
Total Device Dissipation @ $T_A = 25°C$ Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ $T_C = 25°C$ Derate above 25°C	P_D	1.5 12	W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	–55 to +150	°C

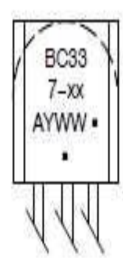
THERMAL CHARACTERISTICS

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction–to–Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction–to–Case	$R_{\theta JC}$	83.3	°C/W

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.



MARKING DIAGRAM



BC337–xx = Device Code
(Refer to page 4)
A = Assembly Location
Y = Year
WW = Work Week
▪ = Pb–Free Package
(Note: Microdot may be in either location)

3.18 RELAY

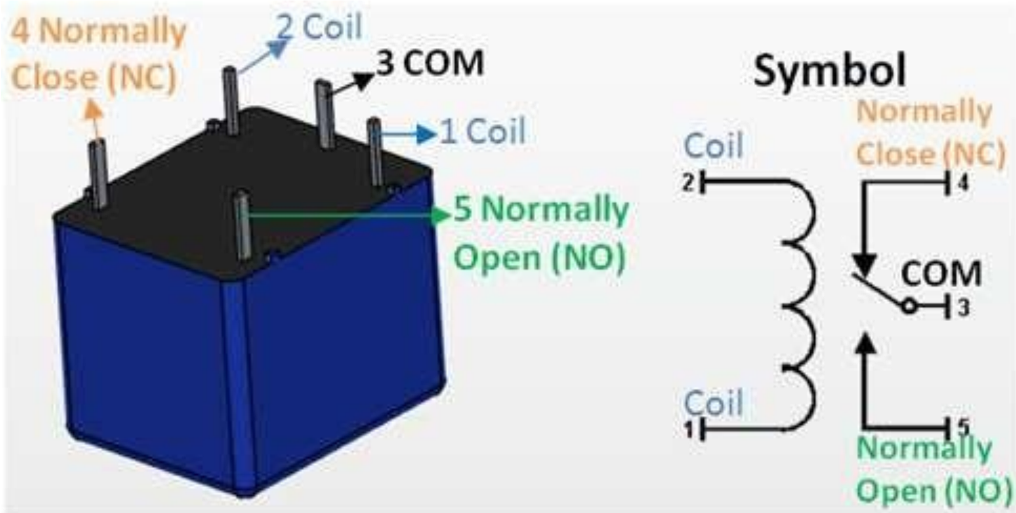


Fig 3.17: RELAY

Pin Number	Pin Name	Description
1	Coil End 1	Used to trigger (On/Off) the Relay, Normally one end is connected to 5V and the other end to ground
2	Coil End 2	Used to trigger (On/Off) the Relay, Normally one end is connected to 5V and the other end to ground
3	Common (COM)	Common is connected to one End of the Load that is to be controlled
4	Normally Close (NC)	The other end of the load is either connected to NO or NC. If connected to NC, the load remains connected before trigger
5	Normally Open (NO)	The other end of the load is either connected to NO or NC. If connected to NO, the load remains disconnected before trigger

TABLE 3.3 REALY PIN CONFIGURATIONS

Features of 5-Pin 5V Relay

- Trigger Voltage (Voltage across coil) : 55V DC

- Trigger Current (Nominal current) : 70mA
- Maximum AC load current: 10A @ 250/125V AC
- Maximum dc load current: 10a @ 30/28v dc
- Compact 5-pin configuration with plastic molding
- Operating time: 10msec Release time: 5msec
- Maximum switching: 300 operating/minute (mechanically)
- 3V Relay, 12V Relay, 1-channel Relay module, 4-channel Relay Module. Relays are most commonly used switching device in electronics. Let us learn how to use one in our circuits based on the requirement of our project.
- Before we proceed with the circuit to drive the relay, we must consider two important parameters of the relay. Once is the **Trigger Voltage**, this is the voltage required to turn on the relay that is to change the contact from Common->NC to Common->NO. Our relay here has 5V trigger voltage, but you can also find relays of values 3V, 6V and even 12V so select one based on the available voltage in your project. The other parameter is your **Load Voltage & Current**, this is the amount of voltage or current that the NC, NO or Common terminal of the relay could withstand, in our case for DC it is maximum of 30V and 10A. Make sure the load you are using falls into this range.

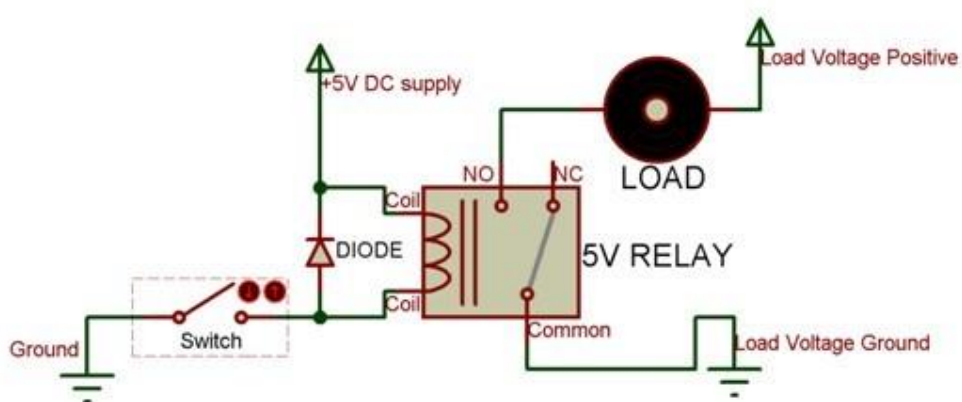


Fig 3.18: RELAY CIRCUIT

The above circuit shows a bare-minimum concept for a relay to operate. Since the relay has 5V trigger voltage we have used a +5V DC supply to one end of the coil and the other end to ground through a switch. This switch can be anything from a small transistor to a microcontroller or a microprocessor which can perform switching operating. You can also notice a diode connected across the coil of the relay, this diode is called the Fly back Diode. The purpose of the diode is to protect the switch from high voltage spike that can produced by the relay coil. As shown one end of the load can be connected to the Common pin and the other end is either connected to NO or NC. If connected to NO, the load remains disconnected before trigger and if connected to NC the load remains connected before trigger.

3.19 POWER ADAPTER

Fig 3.19: POWER ADAPTER

Description:

24V 5A 120W AC/DC Power Supply Adapter for 2.1 & 2.5mm LED Strip Security Camera etc.

Features:

1. Provide consistent power and reliable performance.
2. Replacement 24V 5A Power Supply AC Adapter For many devices with 5.5mm x 2.5mm/2.1mm plug tip (**such as LCD/ LED/ TV Sound Box/ LED Strip/ Security CCTV Camera DVR etc.**)
3. Has ventilation holes in front and back, make sure it will work efficiently and not be over-heat.

Specifications:

1. Output Voltage & Amps: **24V 5A** (120W)
2. Input: AC 100-240V / 50-60Hz (Worldwide Use)
3. Connector: 5.5mm x 2.5mm (Compatible for Both 2.5mm&2.1mm Connector) 4. Dimension: 150*65*38(mm)

3.20 DC MOTOR

Fig 3.20: 30RPM DC MOTOR

A **DC motor** is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor.

DC motors were the first type widely used, since they could be powered from existing direct-current lighting power distribution systems. A DC motor's speed can be controlled over a wide range, using either a variable supply voltage or by changing the strength of current in its field windings. Small DC motors are used in tools, toys, and appliances. The universal motor can operate on direct current but is a lightweight brushed motor used for portable power tools and appliances. Larger DC motors are used in propulsion of electric vehicles, elevator and hoists, or in drives for steel rolling mills. The advent of power electronics has made replacement of DC motors with AC motors possible in many applications.

A coil of wire with a current running through it generates an electromagnetic field aligned with the center of the coil. The direction and magnitude of the magnetic field produced by the coil can be changed with the direction and magnitude of the current flowing through it.

A simple DC motor has a stationary set of magnets in the stator and an armature with one or more windings of insulated wire wrapped around a soft iron core that concentrates the magnetic field. The windings usually have multiple turns around the core, and in large motors there can be several parallel current paths. The ends of the wire winding are connected to a commutator, the commutator allows each armature coil to be energized in turn and connects the rotating coils with the external power supply through brushes. The total amount of current sent to the coil, the coil's size and what it's wrapped around dictate the strength of the electromagnetic field created.

The sequence of turning a coil on or off dictates what direction the effective electromagnetic fields are pointed. By turning on and off coils in sequence a rotating magnetic field can be created. These rotating magnetic fields interact with the magnetic fields of the magnets (permanent or electromagnets) in the stationary part of the motor (stator) to create a torque on the armature which causes it to rotate. In some DC motor designs the stator fields use electromagnets to create their magnetic fields which allow greater control over the motor. At high power levels, DC motors are almost always cooled using forced air. Different number of stator and armature fields as well as how they are connected provide different inherent speed/torque regulation characteristics. The speed of a DC motor can be controlled by changing the voltage applied to the armature. The introduction of variable resistance in the armature circuit or field circuit allowed speed control. Modern DC motors are often controlled by power electronics systems which adjust the voltage by "chopping" the DC current into on and off cycles which have an effective lower voltage.

Since the series-wound DC motor develops its highest torque at low speed, it is often used in traction applications such as electric locomotives, and trams. The DC motor was the mainstay of electric traction drives on both electric and diesel-electric locomotives, street-cars/trams and diesel electric drilling rigs for many years. The introduction of DC motors and an electrical grid system to run machinery starting in the 1870s started a new second Industrial Revolution. DC motors can operate directly from rechargeable batteries, providing the motive power for the first electric vehicles and today's hybrid cars and electric cars as well as driving a host of cordless tools. Today DC motors are still found in applications as small as toys and disk drives, or in large sizes to operate steel rolling mills and paper machines. Large DC motors with separately excited fields were generally used with winder drives for mine hoists, for high torque as well as smooth speed control using thyristor drives. These are now replaced with large AC motors with variable frequency drives.

If external mechanical power is applied to a DC motor it acts as a DC generator, a dynamo. This feature is used to slow down and recharge batteries on hybrid car and electric cars or to return electricity back to the electric grid used on a street car or electric powered train line when they slow down. This process is called regenerative braking on hybrid and electric cars. In diesel electric locomotives they also use their DC motors as generators to slow down but dissipate the energy in resistor stacks. Newer designs are adding large battery packs to recapture some of this energy.

3.21 CONVEYOR BELT

A **conveyor belt** is the carrying medium of a **belt conveyor system** (often shortened to belt conveyor). A belt conveyor system is one of many types of conveyor systems. A belt conveyor system consists of two or more pulleys (sometimes referred to as drums), with an endless loop of carrying medium—the conveyor belt—that rotates about them. One or both pulleys are powered, moving the belt and the material on the belt forward. The powered pulley is called the drive pulley while the unpowered pulley is called the idler pulley. There are two main industrial classes of belt conveyors; Those in general material handling such as those moving boxes along inside a factory and bulk material handling such as those used to transport large volumes of resources and agricultural materials, such as grain, salt, coal, ore, sand, overburden and more.

Conveyor systems are used widespread across a range of industries due to the numerous benefits they provide.

- Conveyors can safely transport materials from one level to another, which when done by human labor would be strenuous and expensive.
- They can be installed almost anywhere and are much safer than using a forklift or other machine to move materials.

- They can move loads of all shapes, sizes and weights. Also, many have advanced safety features that help prevent accidents.
- There are a variety of options available for running conveying systems, including the hydraulic, mechanical and fully automated systems, which are equipped to fit individual needs.

Conveyor systems are commonly used in many industries, including the Mining, automotive, agricultural, computer, electronic, food processing, aerospace, pharmaceutical, chemical, bottling and canning, print finishing and packaging. Although a wide variety of materials can be conveyed, some of the most common include food items such as beans and nuts, bottles and cans, automotive components, scrap metal, pills and powders, wood and furniture and grain and animal feed. Many factors are important in the accurate selection of a conveyor system. It is important to know how the conveyor system will be used beforehand. Some individual areas that are helpful to consider are the required conveyor operations, such as transportation, accumulation and sorting, the material sizes, weights and shapes and where the loading and pickup points need to be.

3.22 LIMIT SWITCH

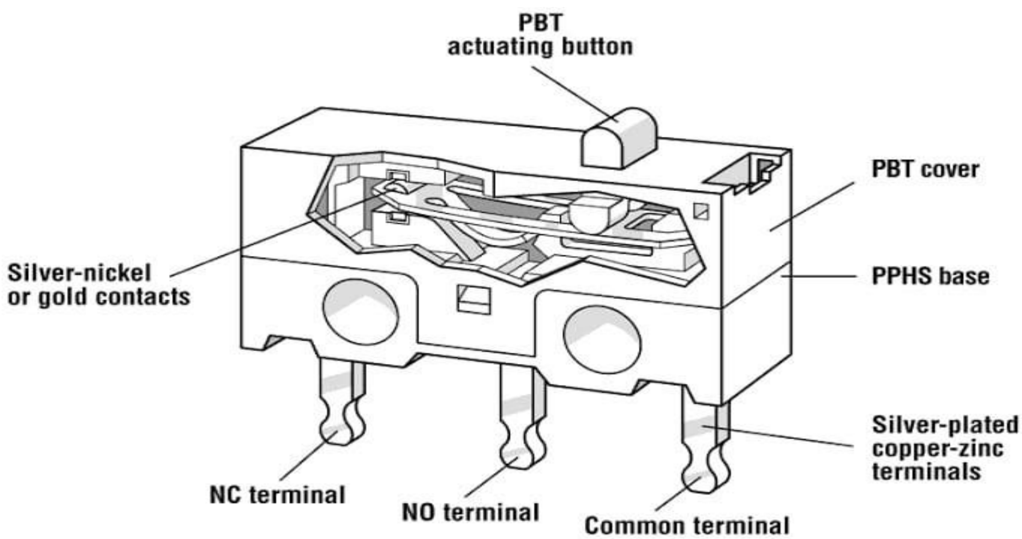


Fig 3.21: LIMIT SWITCH

A **limit switch** is a switch operated by the motion of a machine part or presence of an object.

Limit Switch detects the presence of water in the tank as the water is finished, the normally open terminal will give 24V ,5mA input to the plc and the whole operation will stop.

They are used for controlling machinery as part of a control system, as a safety interlocks, or to count objects passing a point.[1] A limit switch is an electromechanical device that consists of an actuator mechanically linked to a set of contacts. When an object encounters the actuator, the device operates the contacts to make or break an electrical connection. Limit switches are used in a variety of applications and environments because of their ruggedness, ease of installation, and reliability of operation. They can determine the presence or absence, passing, positioning, and end of travel of an object. They were first used to define the limit of travel of an object; hence the name "Limit Switch". Standardized limit switches are industrial control components manufactured with a variety of operator types, including lever, roller plunger, and whisker type. Limit switches may be directly mechanically operated by the motion of the operating lever. A reed switch may be used to indicate proximity of a magnet mounted on some moving part. Proximity switches operate by the disturbance of an electromagnetic field, by capacitance, or by sensing a magnetic field.

Rarely, a final operating device such as a lamp or solenoid valve will be directly controlled by the contacts of an industrial limit switch, but more typically the limit switch will be wired through a control relay, a motor contactor control circuit, or as an input to a programmable logic controller.

Miniature snap-action switch may be used for example as components of such devices as photocopiers, computer printers, convertible tops or microwave ovens to ensure internal components are in the correct position for operation and to prevent operation when access doors are opened. A set of adjustable limit switches are installed on a garage door opener to shut off the motor when the door has reached the fully raised or fully lowered position. A numerical control machine such as a lathe will have limit switches to identify maximum limits for machine parts or to provide a known reference point for incremental motions.

3.23 BC547 TRANSISTOR

BC546/547/548/549/550

Switching and Applications

- High Voltage: BC546, V_{CEO}=65V
- Low Noise: BC549, BC550
- Complement to BC556 ... BC560

NPN Epitaxial Silicon Transistor

Absolute Maximum Ratings T_a=25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CBO}	Collector-Base Voltage : BC546 : BC547/550 : BC548/549	80 50 30	V V V
V_{CEO}	Collector-Emitter Voltage : BC546 : BC547/550 : BC548/549	65 45 30	V V V
V_{EBO}	Emitter-Base Voltage : BC546/547 : BC548/549/550	6 5	V V
I_C	Collector Current (DC)	100	mA
P_C	Collector Power Dissipation	500	mW
T_J	Junction Temperature	150	°C
T_{STG}	Storage Temperature	-65 ~ 150	°C

Electrical Characteristics T_a=25°C unless otherwise noted

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Units
I_{CBO}	Collector Cut-off Current	V_{CB}=30V, I_E=0			15	nA
h_{FE}	DC Current Gain	V_{CE}=5V, I_C=2mA	110		800	
V_{CE} (sat)	Collector-Emitter Saturation Voltage	I_C=10mA, I_B=0.5mA I_C=100mA, I_B=5mA		90 200	250 600	mV mV
V_{BE} (sat)	Base-Emitter Saturation Voltage	I_C=10mA, I_B=0.5mA I_C=100mA, I_B=5mA		700 900		mV mV
V_{BE} (on)	Base-Emitter On Voltage	V_{CE}=5V, I_C=2mA V_{CE}=5V, I_C=10mA	580	660	700 720	mV mV
f_T	Current Gain Bandwidth Product	V_{CE}=5V, I_C=10mA, f=100MHz		300		MHz
C_{ob}	Output Capacitance	V_{CB}=10V, I_E=0, f=1MHz		3.5	6	pF
C_{ib}	Input Capacitance	V_{EB}=0.5V, I_C=0, f=1MHz		9		pF
NF	Noise Figure : BC546/547/548 : BC549/550 : BC549 : BC550	V_{CE}=5V, I_C=200μA f=1KHz, R_G=2KΩ V_{CE}=5V, I_C=200μA R_G=2KΩ, f=30~15000MHz		2 1.2 1.4 1.4	10 4 4 3	dB dB dB dB

3.24 1N4148 DIODE

Fig 3.22: DIODE

The **1N4148** is a standard silicon switching signal diode. It is one of the most popular and long-lived switching diodes because of its dependable specifications and low cost. Its name follows the JEDEC nomenclature. The 1N4148 is useful in switching applications up to about 100 MHz with a reverse-recovery time of no more than 4 ns.

As the most common mass-produced switching diode, the 1N4148 replaced the older **1N914**. They differed mainly in their leakage current specification, however, today most manufacturers list common specifications. 25 nA at -20 V, 25°C

- 5 µA at -75 V, 25°C
- 50 µA at -20 V, 150°C

Today manufacturers produce the 1N4148 and sell it as either part number.[3] It was second-sourced by many manufacturers; Texas Instruments listed their version of the device in an October 1966 data sheet.[4] These device types have an enduring popularity in low-current applications.[5][6]

The JEDEC registered part numbers 1N4148 and 1N914 are diodes in an axial package. Diodes with similar properties are available in surface-mount packages.

Through-hole package 1N4148 in DO-35 glass axial package.

Surface-mount packages

- LL4148 in MiniMELF package.

- 1N4148W in SOD-123 package.
- 1N4148WS in SOD-323 package.
- 1N4148WT in SOD-523 package.

Specifications

- V_{RRM} = 100 V (maximum repetitive reverse voltage)
- I_O = 200 mA (average rectified forward current)
- I_F = 300 mA (DC forward current)
- I_f = 400 mA (recurring peak forward current)
- I_{FSM} = 1 A at 1 s pulse width; 4 A at 1 µs pulse width (non-repetitive peak forward surge current)

Electrical and thermal characteristics

- V_F = 1 V at 10 mA (maximum forward voltage)
- V_R = 75 V at 5 µA; 100 V at 100 µA (minimum breakdown voltage and reverse leakage current)
- t_{rr} = 4 ns (maximum reverse-recovery time)
- P_D = 500 mW (maximum power dissipation)

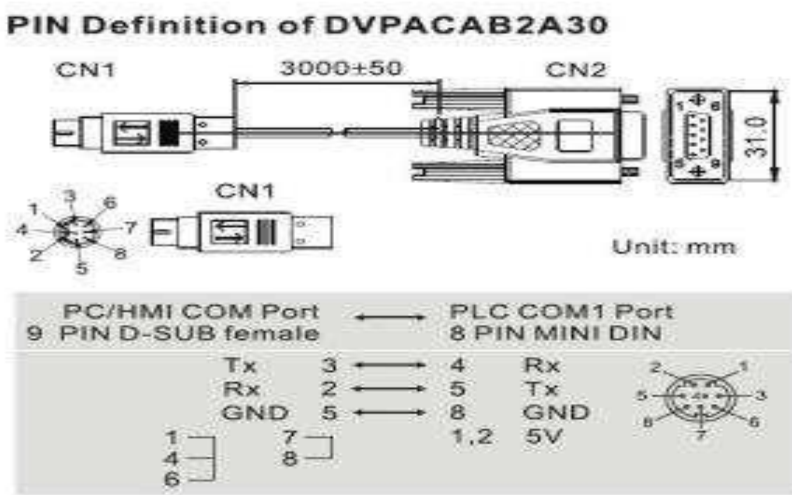
3.25 PROGRAMMING CABLE

We have several methods to communicate our PC with the Delta PLC's, and many users don't know some of them.

On the other side, every time is more difficult to found RS232 serial ports in the computers, and the USB to RS232 converters are not as much trustable as they must, because of that I would like to list our alternatives to that problem

Direct communication PC to PLC:

1. PC RS232 port to PLC RS232 port using the wiring DVPACAB2A30



2. PC USB port to PLC RS485 port using the device IFD6500 (Delta USB-RS485 converter).

3. PC Ethernet port to PLC DVPEN01-SL module (need compatibility with high speed bus)

Communication PC to PLC trough Delta HMI (Direct Link):

The direct link capability in Delta HMI is used to communicate with the PLC and HMI with one only wire. Furthermore, this capability has been improved lately and now is possible monitor both at the same time using only one wire. (direct Link function updated)

1. Direct Link function trough Standard USB wire (WPLsoft and iSOFT)

2. Direct Link function trough Ethernet (WPLsoft and iSOFT) Exactly the same feature is available with the new DOP-B HMI's with Ethernet embedded, helpful for remote support.

3. Direct Link function trough USB host (WPLsoft only).

All systems are Win XP / Win 7 compatibles, so now there's no reason to do not communicate with Delta PLC.

3.26 IR SENSOR

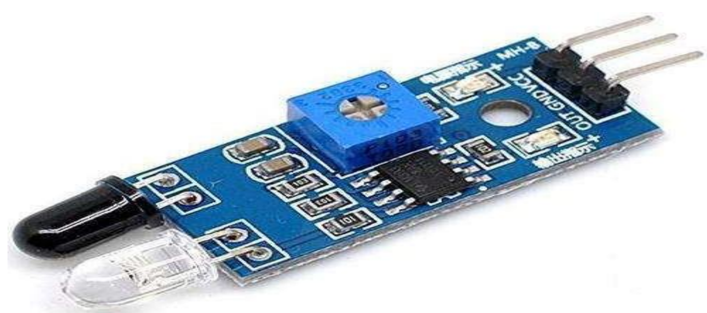


Fig 3.23: IR SENSOR

An infrared sensor is an electronic device, that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. These types of sensors measures only infrared radiation, rather than emitting it that is called as a passive IR sensor. Usually in the infrared spectrum, all the objects radiate some form of thermal radiations. These types of radiations are invisible to our eyes, that can be detected by an infrared sensor. The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode which is sensitive to IR light of the same wavelength as that emitted by the IR LED. When IR light falls on the photodiode, the resistances and these output voltages, change in proportion to the magnitude of the IR light received.

IR Sensor Circuit Diagram and Working Principle

An infrared sensor circuit is one of the basic and popular sensor module in an electronic device. This sensor is analogous to human's visionary senses, which can be used to detect obstacles and it is one of the common applications in real time. This circuit comprises of the following components

- LM358 IC 2 IR transmitter and receiver pair
- Resistors of the range of kilo ohms.
- Variable resistors.
- LED (Light Emitting Diode).

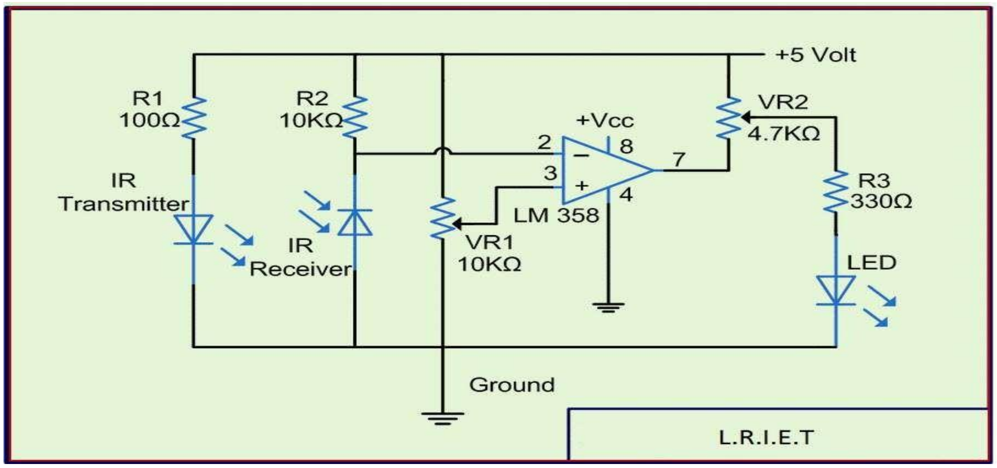


Fig 3.24: IR SENSOR CIRCUIT

In this project, the transmitter section includes an IR sensor, which transmits continuous IR rays to be received by an IR receiver module. An IR output terminal of the receiver varies depending upon its receiving of IR rays. Since this variation cannot be analysed as such, therefore this output can be fed to a comparator circuit. Here an operational amplifier (op-amp) of LM 339 is used as comparator circuit

3.27 PISTON

Fig 3.25: PISTON

A piston is a component of reciprocating engines, reciprocating pumps, gas compressors and pneumatic cylinders, among other similar mechanisms. It is the moving component that is contained by a cylinder and is made gas-tight by piston rings. In an engine, its purpose is to transfer force from expanding gas in the cylinder to the crankshaft via a piston rod and/or connecting rod. In a pump, the function is reversed and force is transferred from the crankshaft to the piston for the purpose of compressing or ejecting the fluid in the cylinder. In some engines, the piston also acts as a valve by covering and uncovering ports in the cylinder.

3.28 WATER PUMP

FIG 3.26 WATER PUMP

A pump is a device that moves fluids (liquids or gases), or sometimes slurries, 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.[1]

Pumps operate by some mechanism (typically reciprocating or rotary), and consume energy to perform work moving the fluid. Pumps operate via many energy sources, including manual operation, electricity, engines, or wind power, come in many sizes, from microscopic for use in medical applications to large industrial pumps. Mechanical pumps serve in a wide range of applications such as pumping water from wells, aquarium filtering, pond filtering and aeration, in the car industry for water-cooling and fuel injection, in the energy industry for pumping oil and natural gas or for operating cooling towers. In the medical industry, pumps are used for biochemical processes in developing and manufacturing medicine, and as artificial replacements for body parts, in particular the artificial heart and penile prosthesis.

When a casing contains only one revolving impeller, it is called a single-stage pump. When a casing contains two or more revolving impellers, it is called a double- or multi-stage pump. In biology, many different types of chemical and biomechanical pumps have evolved; bio mimicry is sometimes used in developing new types of mechanical pumps. Pump efficiency is defined as the ratio of the power imparted on the fluid by the pump in relation to the power supplied to drive the pump. Its value is not fixed for a given pump, efficiency is a function of the discharge and therefore also operating head. For centrifugal pumps, the efficiency tends to increase with flow rate up to a point midway through the operating range (peak efficiency or Best Efficiency Point (BEP)) and then declines as flow rates rise further. Pump performance data such as this is usually supplied by the manufacturer before pump selection. Pump efficiencies tend to decline over time due to wear (e.g. increasing clearances as impellers reduce in size).

When a system includes a centrifugal pump, an important design issue is matching the head loss- flow characteristic with the pump so that it operates at or close to the point of its maximum efficiency.

3.29 WPL SOFTWARE FOR LADDER DIAGRAM

The Working Principles of Ladder Diagram The ladder diagram was a diagram language for automation developed in the WWII period, which is the oldest and most widely adopted language in automation. In the initial stage, there were only A (normally open) contact, B (normally closed) contact, output coil, timer and counter…the sort of basic devices on the ladder diagram (see the power panel that is still used today). After the invention of programmable logic controllers (PLC), the devices displayable on the ladder diagram are added with differential contact, latched coil and the application commands which were not in a traditional power panel, for example the addition, subtraction, multiplication and division operations.

Combination Logic Examples of traditional ladder diagram and PLC ladder diagram for combination logic: Traditional Ladder Diagram PLC Ladder Diagram X4 X0 X2 X3 X1 Y0 Y2 Y1 X0 Y0 X1 Y1 Y2 X2 X3 X4 Row 1: Using a normally open (NO) switch X0 ("A" switch or "A" contact). When X0 is not pressed, the contact DVP-PLC will be open loop (Off), so Y0 will be Off. When X0 is pressed, the contact will be on, so Y0 will be on. Row 2: Using a normally closed (NC) switch X1 ("B" switch or "B" contact). When X1 is not pressed, the contact will be On, so Y1 will be On. When X1 is pressed, the contact will be open loop (Off), so Y1 will be Off. Row 3: The combination logic of more than one input devices. Output Y2 will be on when X2 is not pressed or X3 and X4 are pressed.

Sequential Logic Sequential logic is a circuit with "draw back" structure, i.e. the output result of the circuit will be drawn back as an input criterion. Therefore, under the same input criteria, different previous status or action sequence will follow by different output results. Examples of traditional ladder diagram and PLC ladder diagram for sequential logic: Traditional Ladder Diagram PLC Ladder Diagram X5 Y3 X6 Y3 X5 Y3 X6 When the circuit is first connected to the power, though X6 is On, X5 is Off, so Y3 will be Off. After X5 is pressed, Y3 will be On. Once Y3 is On, even X5 is released (Off), Y3 can keep its action because of the draw back (i.e. the self-retained circuit).

The actions are illustrated in the table below. Device status Action sequence X5 X6 Y3 1 No action No action Off 2 Action No action on 3 No action No action on 4 No action Off 5 No action No action Off From the table above, we can see that in different sequence, the same input status can result in different output results. For example, switch X5 and X6 of action sequence 1 and 3 do not act, but Y3 is Off in sequence 1 and on in sequence 3. Y3 output status will then be drawn back as input (the so-called "draw back"), making the circuit being able to perform sequential control, which is the main feature of the ladder diagram circuit. Here we only explain contact A, contact B and the output coil. Other devices are applicable to the same method.

Differences Between Traditional Ladder Diagram and PLC Ladder Diagram Though the principles of traditional ladder diagram and PLC ladder diagram are the same, in fact, PLC adopts microcomputer to simulate the motions of the traditional ladder diagram, i.e. scan-check status of all the input devices and output coil and calculate to generate the same output results as those from the traditional ladder diagram based on the logics of the ladder diagram. Due to that there is only one microcomputer, we can only check the program of the ladder diagram one by one and calculate the output results according to the program and the I/O status before the 1-2 DVP-PLC Basic Principles of PLC Ladder Diagram cyclic process of sending the results to the output interface ◊ re-reading of the input status ◊ calculation ◊ output. The time spent in the cyclic process is called the "scan time" and the time can be longer with the expansion of the program. The scan time can cause delay from the input detection to output response of the PLC.

The longer the delay, the bigger the error is to the control. The control may even be out of control. In this case, you must choose a PLC with faster scan speed. Therefore, the scan speed is an important specification requirement in a PLC. Owing to the advancement in microcomputer and ASIC (IC for special purpose), there has been great improvement in the scan speed of PLC nowadays. See the figure below for the scan of the PLC ladder diagram program. The output result is calculated based on the ladder diagram. (The result has not yet sent to the external output point, but the internal device will perform an immediate output.) Y0 X0 X1 Start Y0 M100 X3 Y1 X10 : : X100 M505 Y126 End Send the result to the output point Read input status from outside Executing in cycles Besides the difference in the scan time, PLC ladder and traditional ladder diagram also differ in "reverse current". For example, in the traditional ladder diagram illustrated below, when X0, X1, X4 and X6 are on and others are Off, Y0 output on the circuit will be on as the dotted line goes.

However, the PLC ladder diagram program is scanned from up to down and left to right. Under the same input circumstances, the PLC ladder diagram editing tool WPLsoft will be able to detect the errors occurring in the ladder diagram. Reverse current of traditional ladder diagram X6 X0 X1 X2 X3 X4 X5 a b Y0 Reverse current of PLC ladder diagram X6 X0 Y0 X1 X2 Y0 X3 a X4 X5 b Error detected in the third row 1.3 How to Edit Ladder Diagram Ladder diagram is a diagram language frequently applied in automation. The ladder diagram is composed of the symbols of electric control circuit. The completion of the ladder diagram by the ladder diagram editor is the completion DVP-PLC Application Manual

The control flow illustrated by diagram makes the flow more straightforward and acceptable for the technicians of who are familiar with the electric control circuit. Many basic symbols and actions in the ladder diagram come from the frequently-seen electromechanical devices, e.g. buttons, switches, relay, timer and counter, etc. in the traditional power panel for automation control. Internal devices in the PLC: The types and quantity of the devices in the PLC vary in different brand names. Though the internal devices in the PLC adopt the names, e.g. transistor, coil, contact and so on, in the traditional electric control circuit, these physical devices do not actually exist inside the PLC. There are only the corresponding basic units (1 bit) inside the memory of the PLC. When the bit is “1”, the coil will be On, and when the bit is “0”, the coil will be Off. The normally open contact (NO or contact A) directly reads the value of the corresponding bit. The normally close contact (NC or contact B) reads the opposite state of the value of the corresponding bit. Many relays will occupy many bits. 8 bits equal a “byte”. 2 bytes construct a “word” and 2 words combined is “double word”. Byte, word or double words are used when many relays are processed (e.g. addition/subtraction, displacement) at the same time. The other two devices, timer and counter, in the PLC have coil, timer value and counter value and they must process some values in byte, word or double word.

All kinds of internal devices in the value storage area in the PLC occupy their fixed amount of storage units. When you use these devices, you are read the contents stored in the form of bit, byte or word. Introductions on the basic internal devices in the PLC (See Ch 2. Functions of Devices in DVP-PLC for more details.) Device Functions Input Relay The input relay is an internal memory (storage) unit in the PLC corresponding to an external input point and is used for connecting to the external input switches and receiving external input signals. The input relay will be driven by the external input signals which make it “0” or “1". Program designing cannot modify the status of the relay, i.e. it cannot re-write the basic unit of a relay, nor can it force on/Off the relay by HPP/WPLsoft. SA/SX/SC/EH2/SV/EH3/SV2 series MPU can simulate input relay X and force on/Off the relay.

But the status of the external input points will be updated and disabled, i.e. the external input signals will not be read into their corresponding memories inside PLC, but only the input points on the MPU. The input points on the extension modules will still operate normally. There are no limitations on the times of using contact A and contact B of the input relay. The input relays without corresponding input signals can only be left unused and cannot be used for other purposes.

4. RESULT AND CONCLUSION

4.1 RESULTS

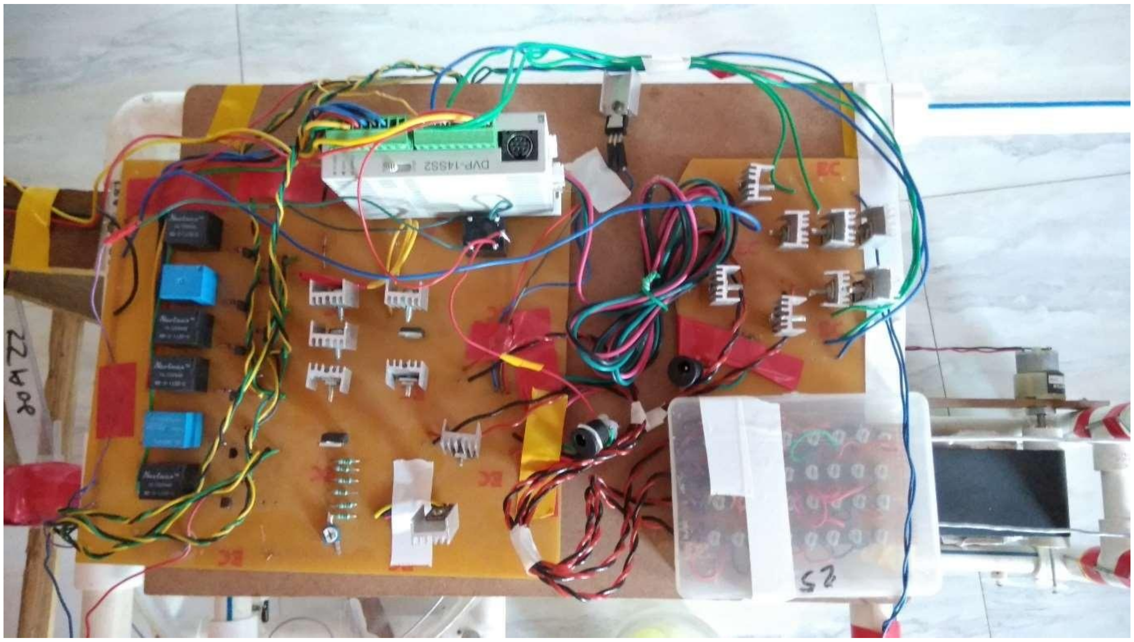


Fig 4.1: RESULT PCB

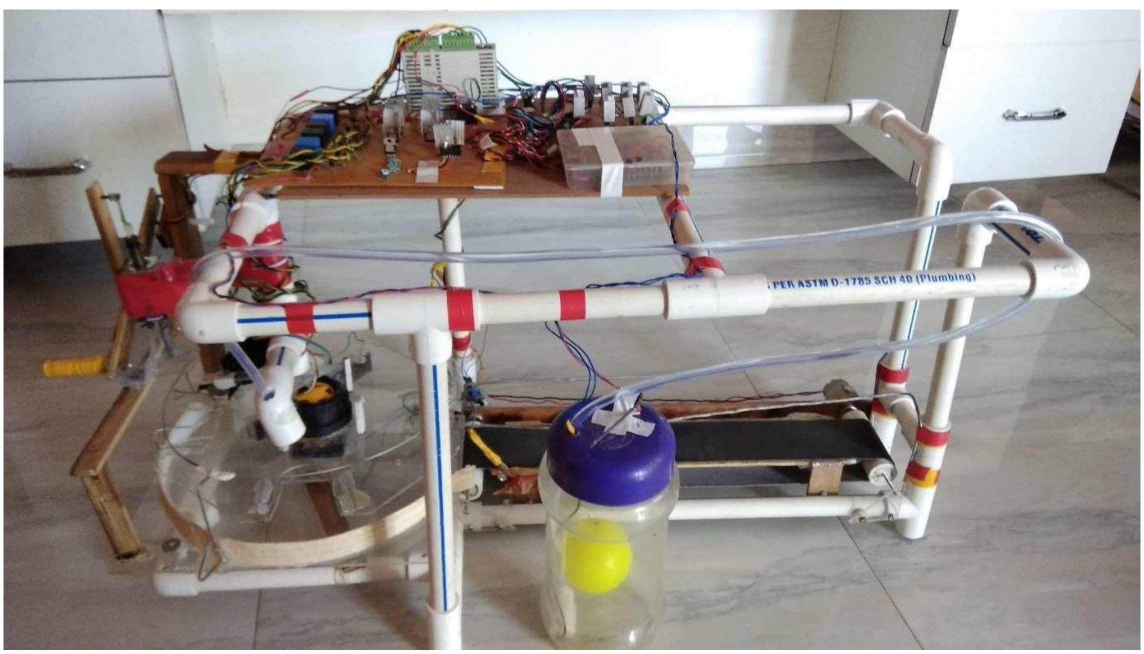


Fig 4.2: RESULT STRUCTURE

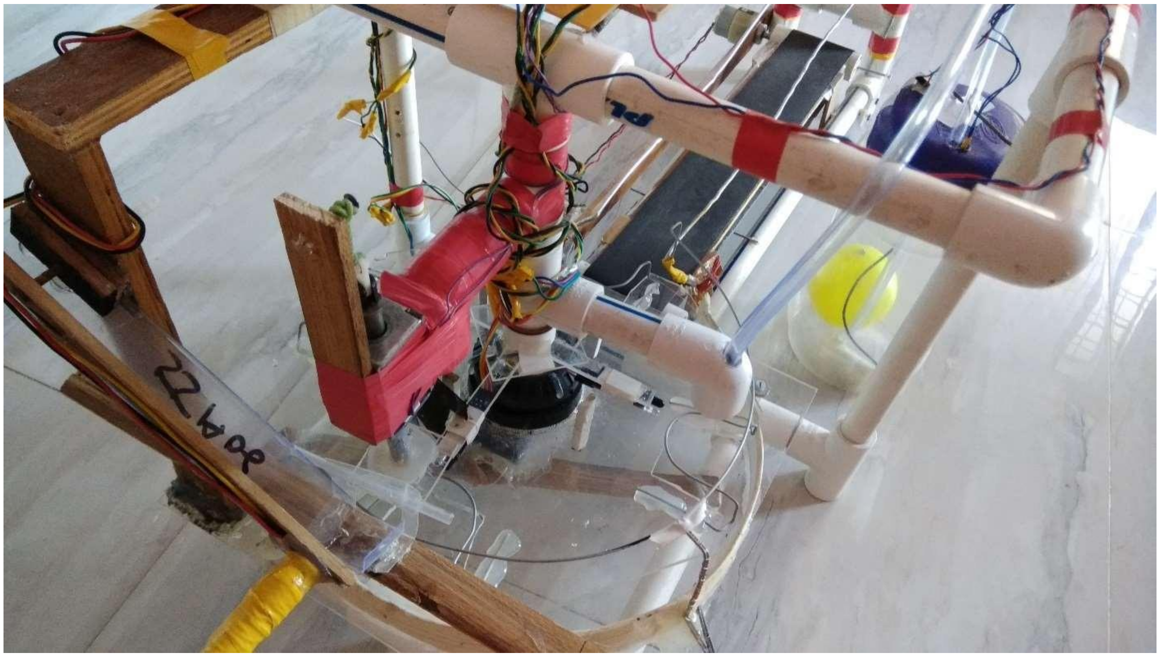


Fig 4.3: FILLING AND CAPPING

Fig 4.4: CONVEYOR BELT

The purpose of this project is to develop a system which requires less man power and more machine power. We gained knowledge about the industrial functions that are used for our liquid bottles that are filled and capped. We learnt WPLsoft for PLC ladder logic.

Software Test:

According to the working process of the system PLC programming, Ladder logic (LAD) simulation software WPLSOFT is used. PLC programming in the form of Ladder diagram.

Pump Control:

Control of pump to start and stop to fill the liquid tank to run complete system.

Filling process:

As the empty bottle sent in to filling area the position INFRARED sensor confirmed the perfect position of bottle for filling it open for time to fill required amount of liquid in bottle. After filling the bottle sent for next operation

4.2 FUTURE USE:

With the help of High-end technologies PLC systems are increasing day by day the drawback of productivity can be overcome. Here we are using normal pump for the purpose of filling of bottles which can be replaced by peristaltic pump which sucks definite amount of liquid and throws the same amount of liquid, which is controlled by changing the RPM of the machine, this means more bottles can be filled in lesser amount of time. Also, levels sensors can be used for level detection of liquid filled. For future use we can also monitor the whole system using the SCADA software.

5. CONCLUSION

The main objective of this project was to develop a bottle filling system based on certain specifications. The project presents an automatic filling system controlled by PLC as per the filling requirement which has simple operation. The system has the advantages as simple structure and reliable operation. The system is controlled by PLC. This was successfully implemented. We consider this project as a journey where we acquired knowledge and gained some insights into the subject which we have shared in this report. By the installation of jet nozzle and strong solenoid valve can reduce the time to fill bottles and can efficiently increase productivity. A guide way could be used in case of vibration. A capping section could also be introduced. The nozzle positioning must be given more care and concentration. The system could be redesigned for increased bottle size and productivity.

REFERENCES:

1. User manual DVP14SS211R Delta Electronics
2. Dunning Gray - ‘Introduction to Programmable Logic Controllers’ - Delmar publishers, pp.421-428.
3. Petruzella, Frank D. (2010) - ‘Programmable logic Controllers’ - Tata McGraw Hill Education, pp.6-12.
4. Gray dunning, ‘Introduction to programmable logic controllers’, -Delmar Thomson Learning (1998)
5. www.deltaww.com
6. T. Kalaiselvi, R. Praveena, Aakansha .R, Dhanya, ‘‘PLC Based Automatic Water Bottle Filling Capping System with User Defined Volume Selection’’, IJETAE, vol. 2, Issue8, (August 2012).
7. Komal Manhas, Meenakshi Dogra, Rajinder Tiwari, Jamini Sharma, ‘Design and Implementation of Bottle Filling Automation System for Food Processing Industries using PLC’, IJPECC (2019) 1–9 © JournalsPub 2019.
8. Zar Kyi Win, Tin Tin New, "PLC Based Automatic Bottle Filling and Capping System" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456- 6470, Volume-3, Issue-6, October 2019

Publication Partner:

International Journal of Scientific and Research Publications (ISSN: 2250-3153)

Appendix A

List of Publications

Sr. No.	Authors	Title of Paper	Name of International Conference	Place and date of Publication with Citation Index
1	1. Rahul Kamdi 2. Manthan Nachankar 3. Abhiram Ringangaonkar 4. Mithilesh Kumbhare 5. Nilesh Sayalwar	PLC Based Bottle Filling and Capping System	International Conference on Robotics, Communication Technology, Electronics and Electrical Engineering.	Pune 24,March 2019 IR-TEEE-PUNE-17039-2377