FINAL YEAR PROJECT REPORT

(Automatic Bottle Filling System Using PLC)

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(Automatic Bottle Filling System Using PLC)

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In

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Abstract

A Programmable Logic Controller (PLC) is a specialized computer used for the control and operation of manufacturing process and machinery. A PLC implementation and designing, mainly covers the following topics: PLC hardware components, developing fundamental PLC wiring diagrams, basics of PLC programming, timers, counters, program control instructions, data manipulation instructions, PLC installation, editing and troubleshooting. For practicing, PLC programming we have used RSLogix® from Rockwell Automation. We are able to observe the operation of the program and make necessary modifications. This project aims to solve practical process in industrial environments with the help of PLC. The process consists of conveyor belt which is constantly moving in normal condition. Empty bottles are placed on conveyer belt. When a bottle is exactly in front of the sensor, the object sensors will sense it and after few seconds the conveyor belt will stop. When the bottle is exactly under the solenoid valve, the Solenoid valve will operate after two seconds and the filling of bottle will start. After a constant time, Solenoid valve will stop and after two seconds conveyor belt will start moving again. In this way process completes its one cycle.

Dedication

We would gratefully like to dedicate our Final Year Project Report to our parents and teachers who guided and supported us through our learning and whose love, prayers and encouragement helped us to achieve this goal.

Acknowledgements

All praise and thanks to the Almighty ALLAH, the most gracious, the most merciful who blessed us with wisdom and knowledge to carry out this project.

We are greatly indebted to our project Adviser Mr. Khan M. Nazir whose guidance and enlightening ideas helped us at each level of learning. He was kind, gracious and patient in support of time that we devoted to the project and with his own valuable time.

We offer our regards and blessings to Co-Adviser Mr. Jawadullah who supported us in any respect during the completion of the project. Without his contribution, it was impossible to complete our project. He was a constant source of inspiration and encouragement. He fully contributed his immense intellectual prowess towards originating, shaping and completing this project.

Lastly, we thank everybody who even contributed a little straw to our newly built raft. But special thanks to our project committee members Mr. Rauf Ali, Mr. Asim Butt, Mr. Muhammad Shoib and lab Supervisor Mr. Saleem, who tried to facilitate us in all respects concerned to all technical work on PLC.

Contents

INTRODUCTION

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The project we design is automatic bottle filling system using PLC which consists of conveyor belt (**Refer to figure 1, Figure 2**) which is constantly moving in normal condition, the different sizes of bottles will move on the conveyor belt. When bottle exactly reach under the solenoid valve then bottle stop automatically and valve will be open then filling of bottle will start. After filling the solenoid valve will close and bottle will start moving on conveyor belt again in this way process completes its one cycle.

Taking liquid in proportion using sensors & valves which is controlled by PLC through serial port (RS-232) gives the complete control over the rate of flow of the liquid passing through it. Conveyer belt driven by DC gear motor is used for controlled bottles purposes that provide user defined rotation of belt in either direction.

The process consists of mainly following hardware components.

1- Conveyer belt assembly.

2- Water tank.

3- DC gear motor.

4- IR sensors.

5- Solenoid valve.

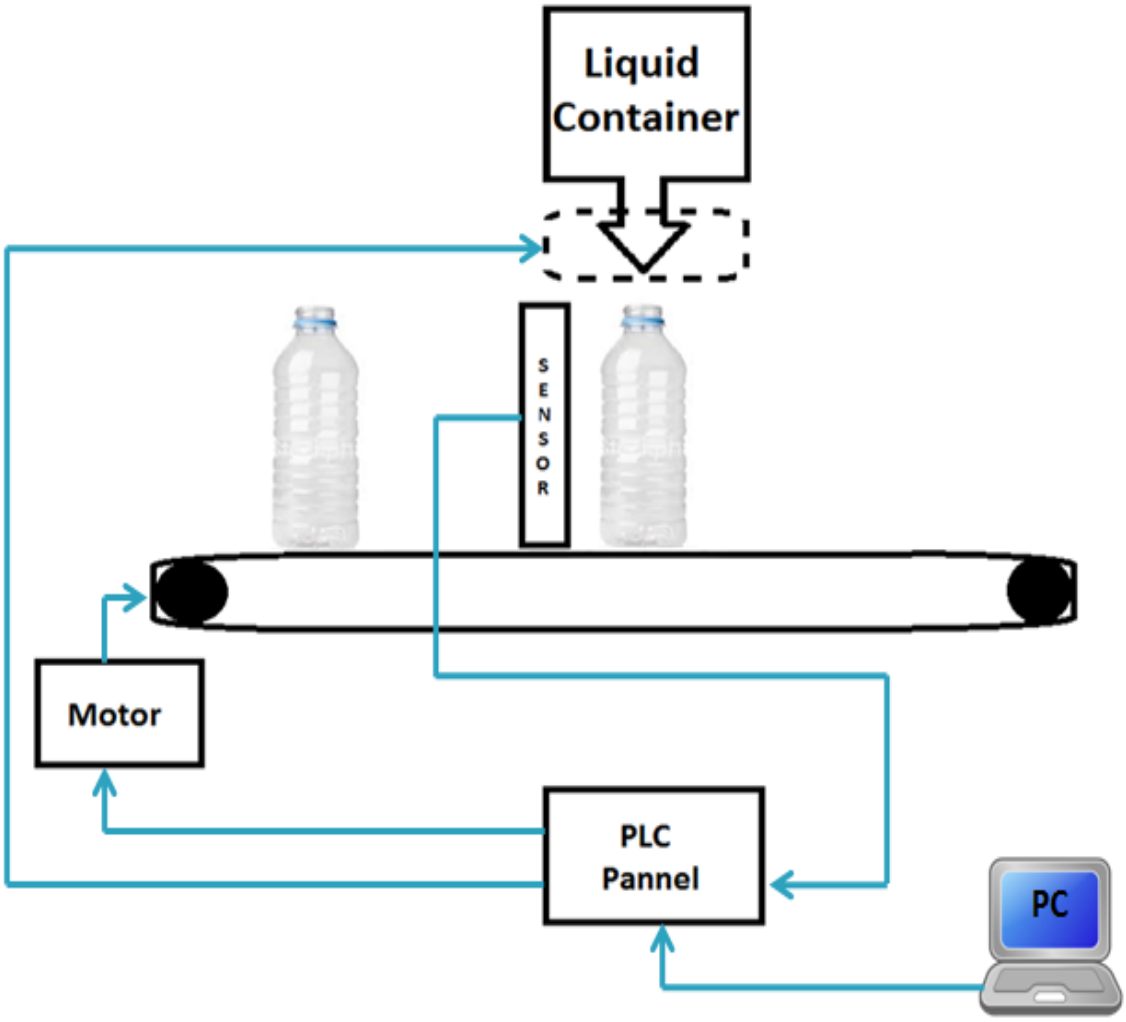


Figure 1: (Block Diagram)

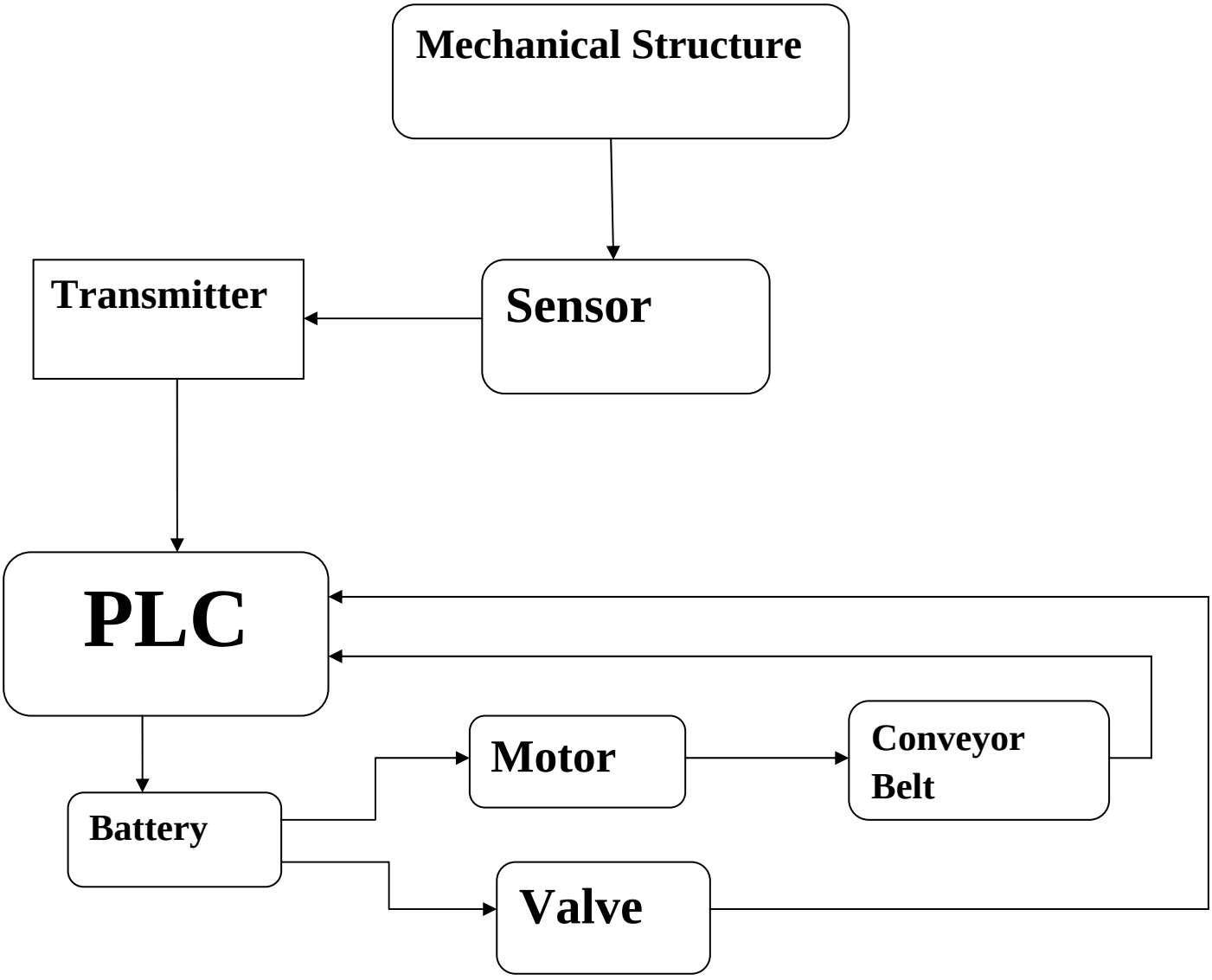


Figure 2: Block Diagram

The process consists of conveyor belt which is constantly moving in normal condition, the bottle will move on the conveyor belt that will have choose to fill, when these bottles are exactly front of sensor, the object sensors will operate and after few seconds the conveyor belt will stop when the bottle exactly under the solenoid vale, then the Solenoid valve will operate after two seconds and filling of bottle will start. After a constant time, Solenoid valve will stop and after two seconds conveyor belt will start moving again. In this way process completes its one cycle.

So we have to control the following parameters for this process.

1- Water Level Control.
2- Conveyor Control.
3- Timing Control.

We are controlling the water level of bottles by using external timer. The timer has different values in milliliters, We can set it value according to over need. We used this process instead of level sensor because Level sensors are too expensive and are not commonly available.

There is a conveyer belt which is moved by a DC geared motor. We are using a geared motor to control the running of conveyer belt because we require a slow and smooth running and also jerk free stopping of conveyer belt.

We are filling the bottles by exact measurement of time required to fill the bottle. We are using this technique because it is too simple and cost free. The only equipment required for this purpose is the Solenoid Valve which will operate for a constant time depending upon size of the bottle which will we choose.

The Object Sensors consist of laser transmitters and receivers which are connected opposite to each other on the conveyer belt assembly .They detect the presence of bottles when an object block the transmitter light and receiver is unable to collect it. We are using IR as a transmitter while the core of receiver circuit is IR which forces the Relay to operate by controlling the Base current of Transistor. The IR has maximum resistance in normal state and contains minimum resistance when it is under the influence of light.

The solenoid valve operates only in two states ON or OFF and it requires a AC supply for its operation.

CHAPTER # 1

HARDWARE

1.1 PROCESS

The complete mechanism is been driven by switching through PLC which gets a signal from IR sensors whenever the bottle arrives at the conveyor belt. The process consists of conveyor belt which is constantly moving in normal condition, the bottle will move on the conveyor belt that will have choose to fill, when these bottles are exactly front of sensor, the object sensors will operate and after few seconds the conveyor belt will stop when the bottle exactly under the solenoid vale, then the Solenoid valve will operate after two seconds and filling of bottle will start. After a constant time, Solenoid valve will stop and after two seconds conveyor belt will start moving again. In this way process completes its one cycle.

The process consists of mainly following hardware components.

1.1.1PLC (PROGRAMMABLE LOGIC CONTROLLER)

A digitally operating electronic system, designed for use in an industrial environment, which uses a programmable memory for the internal storage of user-oriented instructions for implementing specific functions such as logic, sequencing, timing, counting and arithmetic, to control, through digital or analogue inputs and outputs, various types of machines or processes. Both the PC and its associated peripherals are designed so that they can be easily integrated into an industrial control system and easily used in all their intended functions. A programmable logic controller is therefore nothing more than a computer, tailored specifically for certain control tasks. This is shown in fig 1-1.

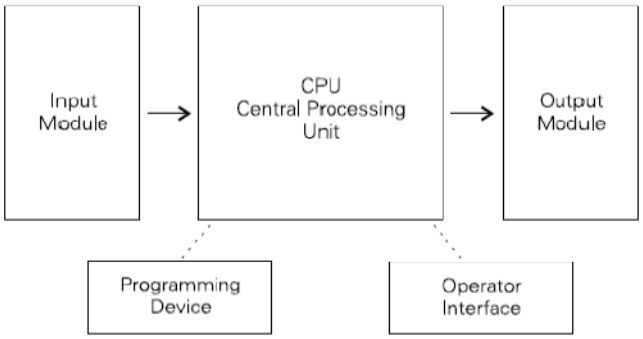


Fig 1-1 (Block diagram of PLC system)

Input module

Output module

Central Processing Unit

The function of an input module is to convert incoming signals into signals, which can be processed by the PLC, and to pass these to the central control unit. The reverse task is performed by an output module. This converts the PLC signal into signals suitable for the actuators. The actual processing of the signals is effected in the central control unit in accordance with the program stored in the memory.

1.1.2 PLC compared with other control systems

PLCs are well-adapted to a range of automation tasks. These are typically industrial processes in manufacturing where the cost of developing and maintaining the automation system is high relative to the total cost of the automation, and where changes to the system would be expected during its operational life.

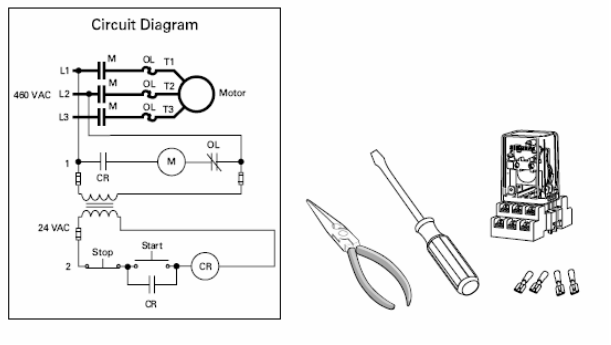


Fig 1-2 (Prior to PLCs, many of hard-wired tasks were solved with contactor or relay controls)

PLC is low compared to the cost of a specific custom-built controller design. On the other hand, in the case of mass-produced goods, customized control systems are economic due to the lower cost of the components, which can be optimally chosen.

A computer is optimized for calculation and display tasks

A computer is programmed by specialists

A PLC is designed for (logic) control and regulation tasks

A PLC is programmed by non-specialists

A PLC is well adapted to industrial environment

A microcontroller-based design would be appropriate where hundreds or thousands of units will be produced and so the development cost (design of power supplies, input/output hardware and necessary testing and certification) can be spread over many sales, and where the end-user would not need to alter the control.

Programmable controllers are widely used in motion control, automotive applications, positioning control and torque control. PLCs may include logic for single-variable feedback analog control loop, a "proportional, integral, derivative" or "PID controller." A PID loop could be used to control the temperature of a manufacturing process, for example.

1.2 Conveyer belt

A **conveyor belt** (or **belt conveyor**) consists of two or more pulleys, with a continuous loop of material - the conveyor belt - that rotates about them. One or both of the 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. 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 industrial and agricultural materials, such as grain, coal, ores, etc. generally in outdoor locations. Generally companies providing general material handling type belt conveyors do not provide the conveyors for bulk material handling. In addition there are a number of commercial applications of belt conveyors such as those in grocery stores.

Conveyors are used as components in automated distribution and warehousing. Belt conveyors are the most commonly used powered conveyors because they are the most versatile and the least expensive. Product is conveyed directly on the belt so both regular and irregular shaped objects, large or small, light and heavy, can be transported successfully. Belt conveyors can be used to transport product in a straight line or through changes in elevation or direction. Belt conveyors are generally fairly similar in construction consisting of a metal frame with rollers at either end of a flat metal bed. The belt is looped around each of the rollers and when one of the rollers is powered by an electric motor, the belting slides across the solid metal frame bed, moving the product. In heavy use applications the beds which the belting is pulled over are replaced with

rollers. The rollers allow weight to be conveyed as they reduce the amount of friction generated from the heavier loading on the belt.

Specification

Length : 3 feet

Width : 3 inches

Two 3.5 inches ROLLERS

Belt 6 feet straight

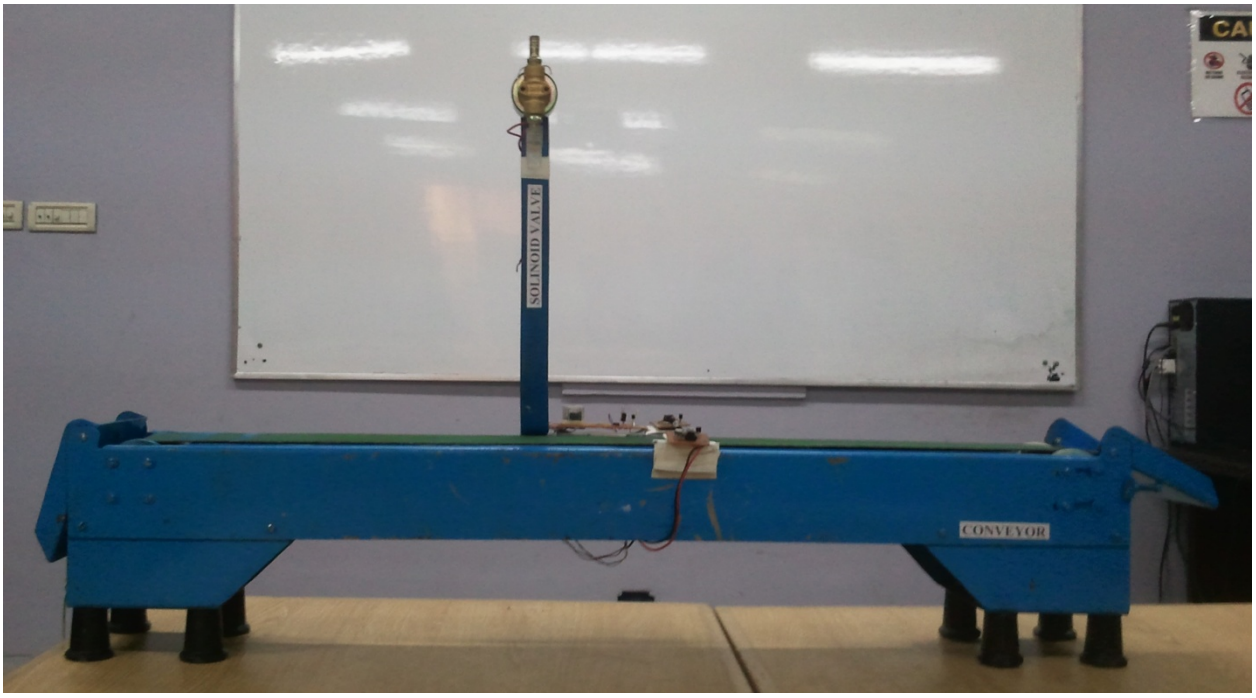


Figure 1-3 (Conveyor Belt)

1.3 Object Sensors (IR SENSORS)

1.3.1 WORKING PRINCIPLE

Infrared radiation enters through the front of the sensor, known as the sensor face. The sensor is often manufactured as part of an integrated circuit and may consist of one (1), two (2) or four (4) 'pixels' of equal areas of the pyroelectric material. Pairs of the sensor pixels may be wired as opposite inputs to a differential amplifier. In such a configuration, the PIR measurements cancel each other so that the average temperature of the field of view is removed from the electrical signal; an increase of IR energy across the entire sensor is self-cancelling and will not trigger the device. This allows the device to resist false indications of change in the event of being exposed to flashes of light or field-wide illumination. (Continuous bright light could still saturate the sensor materials and render the sensor unable to register further information.) At the same time, this differential arrangement minimizes common-mode interference, allowing the device to resist triggering due to nearby electric fields. However, a differential pair of sensors cannot measure temperature in that configuration and therefore this configuration is specialized for motion detectors

1.3.2 Advantages

This sensor can be used for most indoor applications where no important ambient light is present. For simplicity, this sensor doesn't provide ambient light immunity, but a more complicated, ambient light ignoring sensor should be discussed in a coming article. However, this sensor can be used to measure the speed of object moving at a very high speed, like in industry or in tachometers. In such applications, ambient light ignoring sensor, which rely on sending 40 Khz pulsed signals cannot be used because there are time gaps between the pulses where the sensoris 'blind'.

1.3.4 ELECTRONIC CIRCUITRY

Design: Low range, Always ON:-

As the name implies, the sensor is always ON, meaning that the IR led is constantly emitting light. This design of the circuit is suitable for **counting objects**, or **counting revolutions** of a

rotating object, that may be of the order of 15,000 rpm or much more. However this design is more power consuming and is not optimized for high ranges. in this design, range can be from 1 to 10 cm, depending on the ambient light conditions.

- The sender is composed of an IR LED (D2) in series with a 470 Ohm resistor, yielding a forward current of 7.5 mA.
- The receiver part is more complicated, the 2 resistors R5 and R6 form a voltage divider which provides 2.5V at the anode of the IR LED (here, this led will be used as a sensor). When IR light falls on the LED (D1), the voltage drop increases, the cathode's voltage of D1 may go as low as 1.4V or more, depending on the light intensity.
- This voltage drop can be Detected using an Op-Amp (operational Amplifier LM358). You will have to adjust the variable resistor (POT.) R8 so the the voltage at the positive input of the Op-Amp (pin No. 5) would be somewhere near 1.6 Volt. if you understand the functioning of Op-Amps, you will notice that the output will go High when the volt at the cathode of D1 drops under 1.6. So the output will be High when IR light is detected, which is the purpose of the receiver.
- The Object Sensors consist of laser transmitters and receivers which are connected opposite to each other on the conveyer belt assembly .They detect the presence of objects when an object block the transmitter light and receiver is unable to collect it. We are using Laser LED as a transmitter while the core of receiver circuit is LDR which forces the Relay to operate by controlling the Base current of Transistor. The following figure shows the receiver circuit.

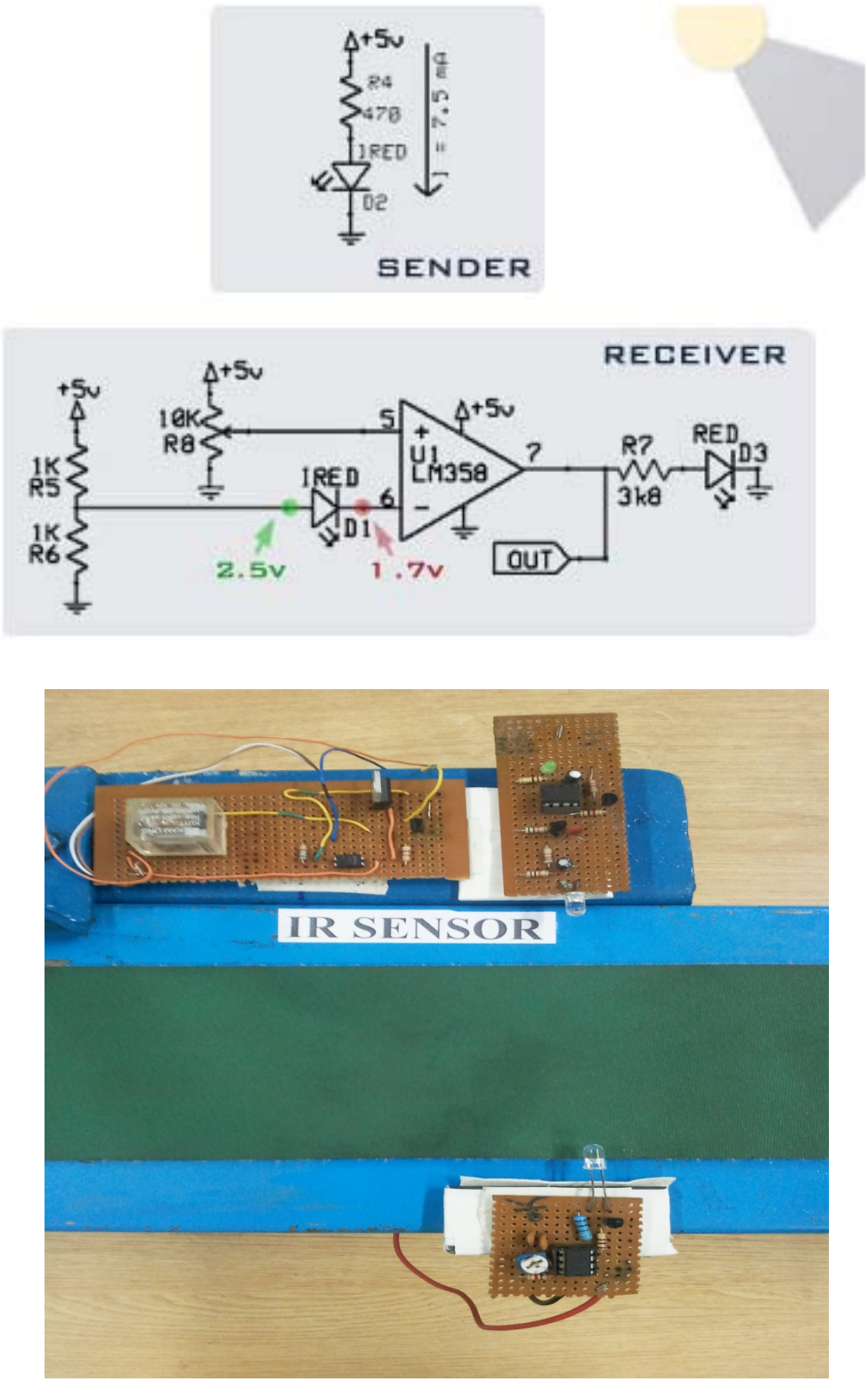


Figure 1-4 IR Object sensor

PIN	DESCRIPTION	PURPOSE
1	Ground	DC Ground
2	Trigger	The trigger pin triggers the beginning of the timing sequence. When it goes LOW, it causes the output pin to go HIGH. The trigger is activated when the voltage falls below 1/3 of +V on pin 8.
3	Output	The output pin is used to drive external circuitry. It has a "totem pole" configuration, which means that it can source or sink current. The HIGH output is usually about 1.7 volts lower than +V when sourcing current. The output pin can sink up to 200mA of current. The output pin is driven HIGH when the trigger pin is taken LOW. The output pin is driven LOW when the threshold pin is taken HIGH, or the reset pin is taken LOW.
4	Reset	The reset pin is used to drive the output LOW, regardless of the state of the circuit. When not used, the reset pin should be tied to +V.
5	Control Voltage	The control voltage pin allows the input of external voltages to affect the timing of the 555 chip. When not used, it should be bypassed to ground through a 0.01uF capacitor.
6	Threshold	The threshold pin causes the output to be driven LOW when its voltage rises above 2/3 of +V.
7	Discharge	The discharge pin shorts to ground when the output pin goes HIGH. This is normally used to discharge the timing capacitor during oscillation.
8	+V	DC Power - Apply +3 to +18VDC here.

555 Timer

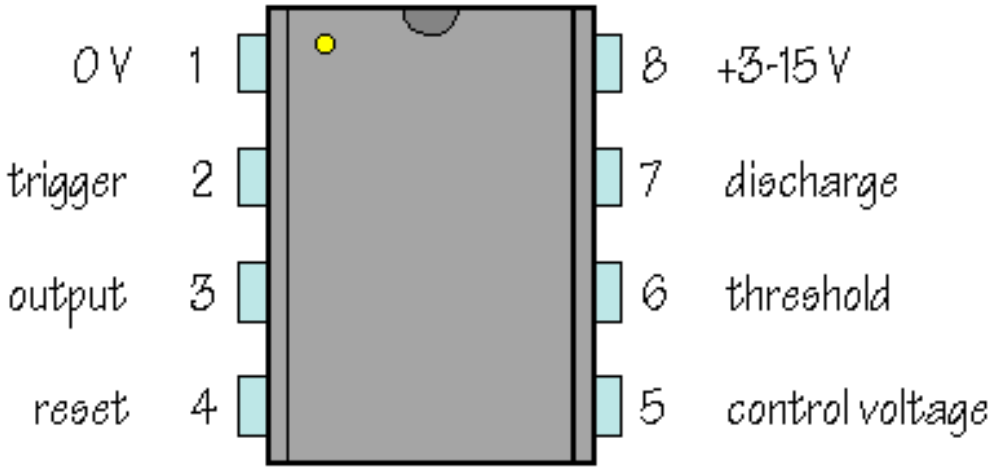


Figure 1-5 (555 timer)

1.4 Relay

A **relay** is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. Because a relay is able to control an output circuit of higher power than the input circuit, it can be considered to be, in a broad sense, a form of an electrical amplifier. When an electric current is passed through the coil, the resulting magnetic field attracts the armature and the consequent movement of the movable contact or contacts either makes or breaks a connection with a fixed contact. If the set of contacts was closed when the relay was de-energized, then the movement opens the contacts and breaks the connection, and vice versa if the contacts were open. Since relays are switches, the terminology applied to switches is also applied to relays. A relay will switch one or more*poles*, each of whose contacts can be *thrown*by energizing the coil in one of three ways:

Normally-open (**NO**) contacts connect the circuit when the relay is activated; the circuit is disconnected when the relay is inactive. It is also called a **Form A** contact or "make" contact. Normally-closed (**NC**) contacts disconnect the circuit when the relay is activated; the circuit is

connected when the relay is inactive. It is also called a **Form B** contact or "break" contact. Change-over (**CO**), or double-throw (**DT**), contacts control two circuits: one normally-open contact and one normally-closed contact with a common terminal. It is also called a **Form C** contact or "transfer" contact ("break before make"). If this type of contact utilizes" make before break" functionality, then it is called a **Form D** contact.

1.5 Solenoid valve

1.5.1 Valve

A valve is a device that regulates the flow of a fluid (gases, liquids, fluidized solids, or slurries) by opening, closing, or partially obstructing various passageways. Valves are technically pipe fittings, but are usually discussed as a separate category. In an open valve, fluid flows in a direction from higher pressure to lower pressure. Valves are also found in the human body. For example, there are several heart valves which control the flow of blood in the chambers of the heart and maintain the correct pumping action. Valves are used in a variety of contexts, including industrial, military, commercial, residential, and transport. The industries in which the majority of valves are used are oil and gas, power generation, mining, water reticulation, sewerage and chemical manufacturing.

Valves may be operated manually, either by a hand wheel, lever or pedal. Valves may also be automatic, driven by changes in pressure, temperature, or flow. These changes may act upon a diaphragm or a piston which in turn activates the valve, examples of this type of valve found commonly are safety valves fitted to hot water systems or boilers.

1.5.2 APPLICATIONS of Valves

Valves vary widely in form and application. Sizestypically range from 0.1 mm 60 cm (2 ft). Special valves can have a diameter exceeding 5 meters. Valve cost ranges from simple inexpensive disposable valves to specialized valves cost thousands of US dollars per inch of

diameter. Disposable valves may be found inside common household items including mini-pump dispensers and aerosol cans.

1.5.3 Types of Valves

Valves are quite diverse and may be classified into a number of basic types. Valves may also be classified by how they are actuated:

Hydraulic

Pneumatic

Manual

Solenoid

Motor

Working Principle

A solenoid valve is an electromagnetic valve for use with liquid or gas controlled by running or stopping an electric current through a solenoid, which is a coil of wire, thus changing the state of the valve. The operation of a solenoid valve is similar to that of a light switch, but typically controls the flow of air or water, whereas a light switch typically controls the flow of electricity. Solenoid valves may have two or more ports: 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. Solenoid valves are the most frequently used control elements in fluidics. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design. A solenoid valve has two main parts: the solenoid and the valve. The solenoid converts electrical energy into mechanical energy which, in turn, opens or closes the valve mechanically.

Figure 1-6(a) Solenoid Valve

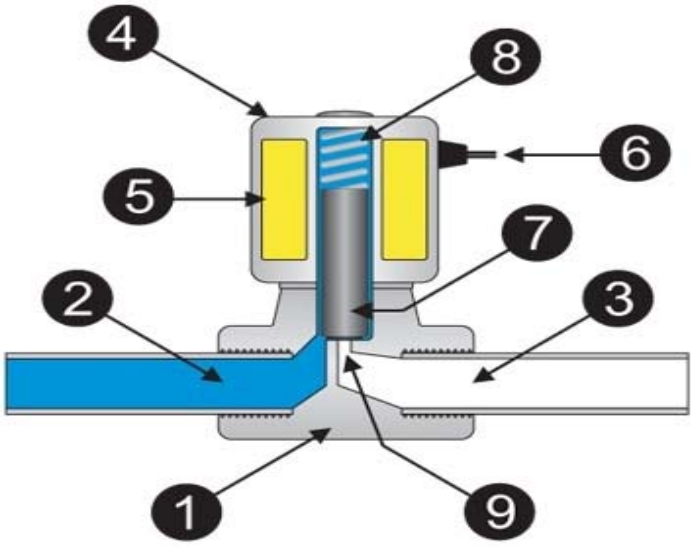
1.5.4 Design Considerations

When the operation of your system or process requires the remotecontrol of liquid, air, gases or vacuum, the proper selection of a solenoid valve can make a significant difference in the final performance of the machine or process. KIP solenoid valves, operators and manifolds have the versatility and design features to fulfill all types of applications. Some consideration should be given to the following design parameters to help you with the selection process:

• Valve Type
• Media
- Temperature
- Lubrication
- Cleanliness
- Isolation
• Flow Rate
• Pressure
• Power Consumption

• Duty Cycle
• Material of Construction
• Electrical Termination
• Porting
• Mounting

A solenoid valve is an electromagnetic valve to use with liquid controlled by running or stopping an electric current through a solenoid, which is a coil of wire, thus changing the state of the valve. Whenever package arrives then Conveyor belt would stop and valve would be given an ON signal through PLC. As this project is size based so every size of the package has its own timer on the constant flow rate, so as soon as the time is completed then valve will close &conveyor belt would again put into the running condition. So the opening and closing of valve depends upon whenever package arrives and its size.



1. Valve Body	4. Coil / Solenoid	7. Plunger
2. Inlet Port	5. Coil Windings	8. Spring
3. Outlet Port	6. Lead Wires	9. Orifice

Figure 1-6 (b) Solenoid valve

1.6Male and female connectors (RS-232)

The terms "slot" and "socket" are often used for "female" connectors, and "plug" and "pin" for "male" connectors while the term “jack” is used for both female and male connectors.

Figure 1-7(a):15 pin female connector

Figure 1-7(b): 48 pin male connector

A connector in a fixed location is a jack, and a moveable connector is a plug. It is common practice to use female connectors for jacks. These connectors are available in different number

1.7 DC Gear motor

(DRIVING CONVEYOR BELT)

1.7.1 ELECTRIC motor

An electric motor converts electrical energy into mechanical energy.Most electric motors operate through the interaction of magnetic fields and current-carrying conductors to generate force. The reverse process, producing electrical energy from mechanical energy, is done by generators such as an alternator or a dynamo; some electric motors can also be used as generators, for example, a traction motor on a vehicle may perform both tasks.

A DC motor is designed to run on DC electric power. By far the most common DC motor types are the brushed and brushless types, which use internal and external commutation respectively to reverse the current in the windings in synchronism with rotation.

Electric motors are everywhere! In your house, almost every mechanical movement that you see around you is caused by an AC (alternating current) or DC (direct current) electric motor.

A simple motor has six parts:

- Armature or rotor
- Commutator
- Brushes
- Axle
- Field magnet
- DC power supply of some sort.

1.7.2 DC Gear Motor

The conveyer belt is moved by a DC gear motor. We are using a DC gear motor to control the running of conveyer belt because we require a powerful, slow and smooth running ,and also jerk free stopping of conveyer belt. A Gear motor has a gearbox that increases torque and decreases speed. DC motors might run in the thousands of RPMs, and if you want to do anything slower and with more torque, you need a gearbox.

Figure 1-8 (DC Gear Motor)

Basic Specification :-

1. 12V DC, 24V DC Input power: 0.1~2.5W
2. 1.1-200 rpm
3. Direction of Rotation: CW, CCW range of reduction ratio: 1:30, 1:60, 1:90, 1:180, 1:270

No Load Specification :-

1. NO Load Current: 75 mA max
2. No Load Speed: 100±10%

ON Load Specification:

1. ON Load Torque: 1.0kg.cm
2. ON Load Current: 450 mA max
3. ON Load Speed: 80±10%

Stall Specification:-

1. Stall Torque: 10kg.cm
2. Stall Current: 900 mA max