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PLC-Based Smart Car Washing Machine

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CONTENTS

Abstract

Designning and implementation of smart car washing machine model.The project consists of the following Items :

- Programmable logic controller (PLC).
- DC motors .
- Mechanical frame.
- 3-phase induction motor.
- Compressor.
- Inverter.
- Valve.
- Sensor.
- Limit switches.

Simulation, Modelling of the project are presented.

Experimental set-up of the project is presented.

Finally, smart car washing machine model project is tested.

Chapter 1

Survey About Car Washing Machine

Chapter (1)

1-Survey of car washing machine

1.1 In year 1930, Called Automated Laundry, the car wash was not actually automated.

Automated Laundry involved a traditional "Pail-and-sponge" method that was similar to the common fundraising activity which can be found in parking lots across the country today. The cars were manually pushed through a tunnel in which three men provided a service of soaping, rinsing, and drying the vehicle.[1]

1.2 In year 1950, the first automatic conveyor car wash opened in Hollywood.This car wash system involved a winch system that automatically pulled the vehicle through a tunnel, but the washing of the vehicle was still provided through manual labor. Like Automated Laundry, this involved men soaping, rinsing, and drying the vehicle as it moved down the line.[1]

1.3 In year 1970, a gentleman by the name of Thomas Simpson invented the first semiautomatic car wash system. A majority of the manual labor was removed through Simpson's invention, but not entirely. This car wash system involved hooking a conveyor belt to the bumper of the vehicle which pulled it through a tunnel. An overhead water sprinkler was then used to wet the vehicle down, which was followed by three sets of manually operated brushes for cleaning, and an air blower for drying.[2]

1.4 In year 1990, the first fully automatic car wash system came to fruition in Seattle, WA. Opened by three brothers – Archie, Dean, and Eldon Anderson – this revolutionized the way people washed their vehicles and led to incredible investment opportunities for many businessmen. The automated car wash system involved pulling the vehicle through the tunnel, soap being sprayed on the vehicle by large machinery, automatedbrushes scrubbing down the vehicle, nozzles being used to rinse the vehicle off, and large air blowers to dry the vehicle.[2]

1.5 In year 2015, Technology is best interconnecting channel in each part of world with the means of transportation or communication or business which led to a highly increase in the number of cars. So how to maintain or clean those? using automated washing system? All peoples face big issue called as time consumption essential for cleaning these vehicles or cars etc .Time management is directly proportional to reduction of cost for maintenance.[3]

In the project, programmable logic controller (PLC), using which they have controlled all the parameters of this project. Software & Automated tools (equipments) used in current project do washing car automatically using conveyor assembly in it. The conveyor assembly that they have used is for moving the car. In this process the car is on conveyor belt of developed system, when conveyor assembly starts the car moves. There is the IR sensor is placed from this sensor the car is get sensed all process is ready for further use. Sensing the availability of car, first process is to detergent water applies. The belt i.e. conveyor assembly stops so as to the car get full shampooing effectively.

When it's done of this process conveyor moves and halts at next step for cleaning purpose which is done by brushes carried forward by sprinkling clean water. Conveyor again at drying section where car is dried using exhaust fan. This is how process gets completed and car is get fully washed properly.[4]

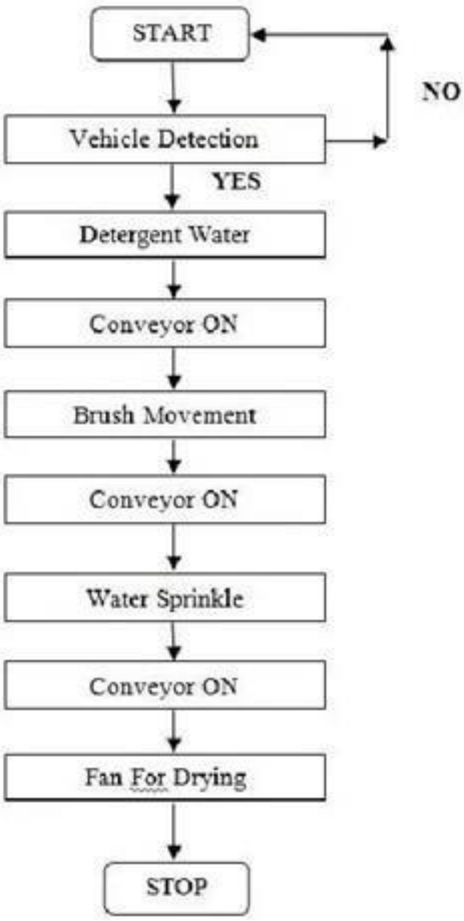


Fig 1.2 flow chart

Fig 1.1: the right angle drive design combines a powerful brush less DC motor with a proprietary small gearbox tool.

1.6 In year 2016, Automatic car washing system using PLC.

Automation is a need of time. Today in this modern era automation helps us to save time, cost as well as manpower.

Vehicles are used extensively for transportation. It is also important to have easy and effective system for maintaining the vehicles cleanliness. Our paper focuses on car washing system using PLC and SCADA.

In developed countries automatic continuous automatic car washing system is already developed and is being used extensively. In developing countries like India it is still uncommon and has lots of potential for development of such system and design. Car washing can be done at spaces where cars can be parked for a long time and washing car can be done easily like fuel filling stations, super markets, hospitals, government buildings, railway stations etc.[5]

car washing system has three main processes namely washing, cleaning and drying, Hence the exterior of the car will be washed by detecting the car on conveyor belt and further controlled by PLC & SCADA.

Fig 1.3.a: Car washing model

Fig 1.3.b: Car washing model

Car washing is simple activity done in order to keep the exterior of the car clean. Mostly it is done manually in automobile garage or service centres of automobile companies. This manual way of cleaning car results in more consumption of water, manpower and time. The automatic car washing system explained in this paper minimises the use of water and also manpower requirement. Our car washing system utilises control using PLC. SCADA system will be installed on the operator panel and hence the operator can monitor and control the whole process.

There are three process involved in our car washing system namely washing, cleaning and drying. Cycles of washing includes washing with water, and then with detergent. Using this automatic car washing system, many cars can be washed and it will save time, energy and manpower. Such systems can be installed anywhere such as malls, airports, railway stations, residential buildings etc.[6]

BLOCK DIAGRAM OF AUTOMATIC CAR WASHING SYSTEM •

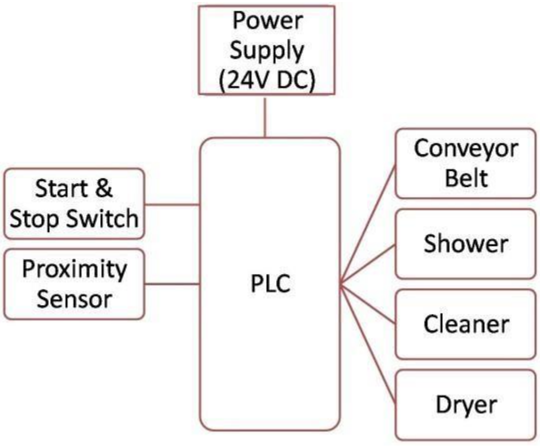


Fig 1.4: Block diagram of Automatic car washing system

As seen in the above figure, all the components like Conveyor Belt, Shower, Cleaner, Dryer are connected to the PLC. These components are getting signals from the PLC. Also a start and stop switch is given as an input to the PLC. A Proximity sensor which senses if the vehicle is in place or not is also connected to the PLC.

Fig 1.5: Car Washing Process Diagram

A. Washing

In a car washing system , washing is a primary stage. In the first stage car is to be washed by water necessarily to remove dust or mud from the outer body and from wheels of car. This process is done manually in service stations. In our automatic system when the car is sensed on the conveyor belt by the proximity sensor, the conveyor belt stops the solenoid valve is opened and hence water is sprayed on the car.

There are two solenoid valves used for:

A. washing with Water

Washing with Foam After washing with foam, the car has to be washed with water to remove the excess soap and water. When this stage is completed the conveyor belt starts again and the car is moved ahead.

B. Cleaning

After washing the next process is called Cleaning. In cleaning, car is sensed by the sensor and the mechanism of motor with curtain is use for cleaning. A set of horizontal brushes wash the top, front and rear of the vehicles. Two sets of side brush wash the area around the vehicles, and another set of wheels brush cleans the wheel. The water rinses away.

C. Drying

After cleaning the further process is called drying. In drying, car is sensed by the proximity sensor and so the conveyor belt stop and dryer/fans starts. A compressed air dryer is used for removing water vapor from compressed air which are commonly found in a wide range of industrial and commercial facilities. Hence the car will be dried using the dryers. After this stage the car is cleaned and hence the conveyor belt starts and the car is removed from the conveyor belt.

Fig 1.6: Car Drying Model

FLOW CHART •

Fig 1.7: Process Flow Chart

In car washing system, the car is moved to the conveyor belt and the presence of the car is detected by aproximity sensor. As seen in the flow chart when the car is detected the sensor gives signal to the PLC and hence the conveyor belt stops. After this stage the car has to be washed with water and hence the solenoid valve is opened and water is sprayed on the car. After washing the car with water the car is to be washed with foam to remove all the dirt and dust so for this another solenoid valve is to be opened. Once the car is washed with foam the car is again washed with water to remove the foam and so water solenoid valve is opened. After the washing stage the car is moved ahead for cleaning using curtains. The proximity sensor detects that the car is in place and hence the car is cleaned using the brushes. The last stage of car washing system is drying the car for which the car is again moved ahead and when the proximity sensor detects the car in place the dryer turns on and the car is dried. The conveyor is moved on again and the car is removed from the conveyor belt as shown in the flow chart. Thus all the three stages are completed after which the car is cleaned automatically.

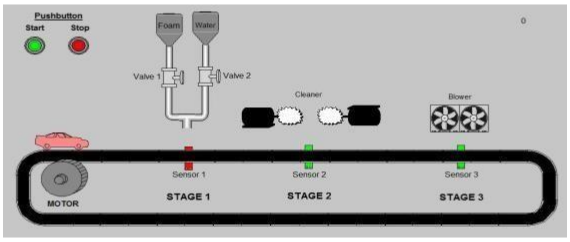


Fig 1.8: SCADA Model

As seen in the above figure the SCADA for the car washing system was designed. A start and a stop switch is seen in the SCADA which will work The car is seen on the conveyor belt. Three sensors are placed on the conveyor belt for position detection of car. Also two solenoid valves are placed one for water and one for foam. Brushes for cleaning as well as fan for drying can be seen in the SCADA.

In Automatic Car Washing System, we performed all the operation needed to clean the car successfully by using PLC and hybrid compact logic L43 DCS, also developed mimic of the whole system on SCADARS VIEW 32 Works and checked the overall process step by step by visualization.

This prototype will help to perform car washing automatically and results in high quality end product. Thus it will be User-friendly and capable to wash multiple cars at a time. Also require less man power,time and no pollution.[7]

1.7 In year 2017, Water recycling automation of car wash with cleaningchannel and changeable adsorptive plate holders

Almaty car service recycling water supply is an important component of environmental safety and of reducing potable water consumption by industry. The project proposes the installation of recycling water supply, the principle of which is based on the purification of oily water effluents in the adsorption changeable cassettes. The pilot installation and algorithm of calculation engineering method allow determining the height and thickness of the adsorbent bed in a removable cassette. Computer experiments and the three-dimensional model confirm calculations and visualize the process of hydrocarbons overflow through the adsorbent bed. This provides automation of water purification process using modern microcontrollers and SCADA-system.[8]

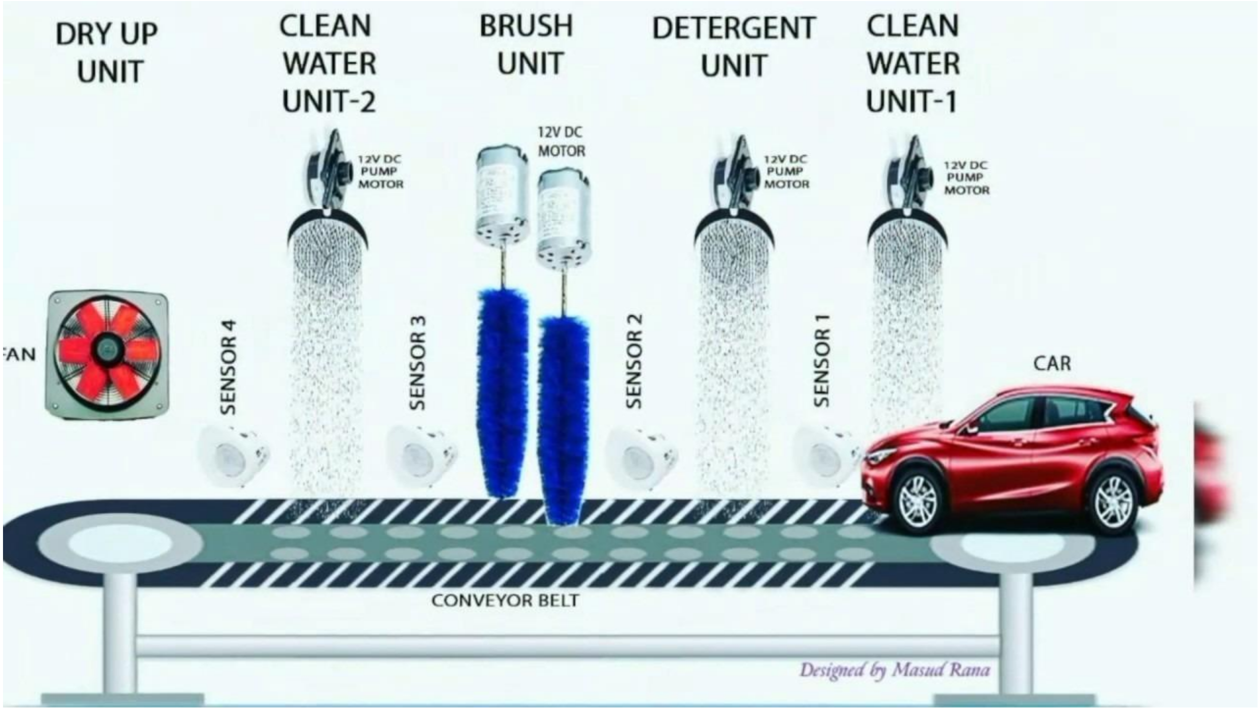


Fig 1.9: Stages of car washing model

1.8 In year 2018, Automatic Car Washing System with microcontroller purchasing power of people are increasing. Hence there is a need of High end Technology that fast, quick & efficient. People nowadays are more concern about the looks of car & a car lover won't like his car dirty. So this project would be smart solution to the problem. It also has to be eco-friendly & should not harm environment. As a dirt on car can cause many problems ranging from spoiling of paint job to even causing hindrance in working of suspensions. The machine is fully contained in its own structure, no drawbacks & easily transportable. The machine simply needs a flat surface for installation which can be created in case not available. Owners of service centre can make use of this project so that to reduce manpower. As this is fast, mall owner can make this car washing model available to the customer, so that they will receive their car clean.[9]

Automatic Car Washing System explained about the use of micro controller to process to process

Fig 1.10: car washing process with brushes

1.9 In year 2019, Automatic Car Washing System Using Plc & SCADA The automatic car washing system explained in this project minimizes the use of water and also manpower requirement. Our car washing system utilises control using PLC. SCADA system will be installed on the operator panel and hence the operator can monitor and control the whole process. Car washing system has three main processes namely washing, cleaning and drying; hence the exterior of the car will be washed by detecting the car on conveyor belt and further controlled by PLC & SCADA.[10]

The first automatic car washes appeared in the late 1930s. Automatic car washes consist of tunnel-like buildings into which customers (or attendants) drive. Some car washes have their customers pay through a computerized POS (point of sale unit), also known as an "automatic cashier". The mechanism inputs the wash PLU into a master computer ora tunnel controller automatically. When the sale is automated, after paying the car is put into a line-up often called the stack or queue. The stack moves sequentially, so the wash knows what each car purchased. After pulling up to the tunnel entrance, an attendant usually guides the customer onto the track or conveyor. At some washes, both tires will pass over a tire sensor, and the system will send several rollers. The tire sensor lets the wash know where the wheels are and how far apart they are. On other systems the employee may guide the customer on and hit a 'Send Car' button on the tunnel controller, to manually send the rollers which push the car through. When the customer is on the conveyor, the attendantwill instruct the customer to put the vehicle into neutral, release all brakes, and refrain from steering. Failure to do so can cause an accident on the conveyor. The rollers come up behind the tires, pushing the car through a detector, which measures vehicle length, allowing the controller to tailor the wash to each individual vehicle. The equipment frame, or arches, vary in number and type. A good car wash makes use of many different pieces of equipment and stages of chemical applicationto thoroughly clean the vehicle.[11]

Fig 1.11: A vehicle in the high pressure

Also visible is the conveyor. The carwash will generally start cleaning with pre-soaks
applied through special arches. They may apply a lower pH (mild acid) followed by a higher pH (mild alkali), or the order may be reversed depending on chemical suppliers and formula used. Chemical formulas and concentrations will also vary based upon seasonal dirt and film on vehicles, as well as exterior temperature, and other factors.
Chemical dilution and application works in combination with removal systems based on either high pressure water, friction, or a combination of both. Chemical substances, while they are industrial strength, are not used in harmful concentrations since car washes are designed not to

harm a vehicle's components or finish. The customer next encounters tire and wheel nozzles, which the industry calls CTAs (Chemical Tire Applicators). These will apply specialized formulations, which remove brake dust and build up from the surface of the wheels and tires. The next arch will often be wraparounds, usually made of a soft cloth, or closed cell foam material. These wraparounds should rub the front bumper and, after washing the sides, will follow across the rear of the vehicle cleaning the rear including the license plate area. Past the first wraps or entrance wraps may be a tire brush that will scrub the tires and wheels. This low piece is often located beneath a matter (the hanging ribbon- like curtains of cloth that move front to back or side to side) or top wheels. There may also be rocker panel washers which are shorter in size (ranging in size from 18 inches [45 cm] up to 63 inches [160 cm] tall) that clean the lower parts of the vehicle. Most rocker brushes house the motor below the brush hub so they don't inhibit cloth movement and allow the brush to be mounted under a support frame or below a matter. Some car washes have multiple mitters, or a combination of mitters and top brushes.[12]

Fig 1.12: vehicle in the high-pressure rinse stage of the wash.

1.10 In year 2020, Manufacturing of Full Automatic Car wash Using withIntelligent Control Algorithms.

the intelligent control of full automatic car wash using a programmable logic controller (PLC) has been investigated and designed to do all steps of car washing. The Intelligent control of full automatic car wash has the ability to identify and profile the geometrical dimensions of the vehicle chassis. Vehicle dimension identification is an important point in this control system to adjust the washing brushes position and time duration. The study also tries to design a control set for simulating and building the automatic car wash. The main purpose of the simulation is to develop criteria for designing and building this type of car wash in actual size to overcome challenges ofautomation. The results of this research indicate that the proposed method in process control not only increases productivity, speed, accuracy and safety but also reduce the time and cost of washing basedon dynamic model of the vehicle. A laboratory prototype based on an advanced intelligent control has been built to study the validity of the design and simulation which it’s appropriate performance confirms thevalidity of this study.[13]

modern industries, industrial automation was inevitable, which means if it doesn't move quickly enough in competition with others it will lose. Many factories use programmable logic controls (PLCs) in automation processes to diminish production cost and to increase quality and reliability. Now a days in competitive world, high rate of production, the possibility of rapid changes in the production line, dealing with marketing needs with high quality is essential for success and survival of any industry which is not achievable except by advanced automation. Hence, this research tries to design and build a laboratory prototype with advanced algorithms, so automatic carwash is a smart move. advances of science and technology done extensive researches can be done as yang and his colleagues noted in 2003 in the field of PLC automation .[14]

PLC is a specialized computer used for the control and operation of manufacturing process and machinery.

It uses a programmable memory to store instructions and execute functions including on/off control, timing, counting, sequencing, arithmetic, and data handling .

in a conventional automatic car wash, a limited number of washing steps, such as the moisture and drying is done automatically, and even in most set of existing carwash extensive restrictions on the optimization of these categories exists which is not compatible with all types of cars. In order to save time, energy, cost and create competitive automatic carwash system, this study is trying to use PLC, and the project is designed so that it can perform all the steps needed to wash all types of cars. This feature is intended for the following:

The duration of washing for each vehicle will be different to the five cycles vary

provided to implement a specific cycle depending on the host or client to be repeated or

it's possible to put different washing cycle in the menu choice that individuals order their own preferable washing process, which is the unique feature of this type of car wash.

• Ability to wash at least 3 cars simultaneously.

• Manual control facilitates can also be added.

• Possibility to increase additional cycle on the system in the future.

Conditions of the existing car wash systems and urgent need to increase systems performance, attracts researches to work on this project.

1.11 In year 2021, Control Design of Automatic
Intelligent CarWashing Machine Based on PLC

With the development of auto industry in recent years, car washing has become more and more important. In view of the high cost, low efficiency, low cleanliness, low automation and low water utilization rate of the current car wash industry.

fully automatic car washing model based on S7-200 SMART PLC control system, which is intelligently cleaned. The system can realize all-round high-efficiency cleaning of the vehicle, and the sewage treatment system can realize the recycling and reuse of the car wash water. The project not only improves the efficiency, cleanliness and water resource utilization of the car washing , but also has the advantages of stable system, convenient use and simple maintenance, and has broad market prospect.

The control process are: opening the entrance machine at the beginning to slow the vehicle into the washing shop. Open the bottom spray system to clean the wheel and the bottom of the vehicle during the vehicle's entry, and close the bottom spray system after the vehicle has completely crossed the bottom spray system. At the same time, the sensor is used to collect the vehicle parameters and the vehicle abnormality detection. After the detection is correct, the user is prompted to select the automatic car wash mode. During the car wash, the user can observe whether the washing, foam, water wax and air drying are completed through the touch screen, so that the vehicle time is completed. Knowing the current process, the user can also pause or cancel the process under abnormal conditions. When the car washing is finished, the system will remind the user to complete the car wash through the display and voice. After the vehicle leaves the washing Workshop, the car washing sewage recovery and purification system will be started to realize the reuse of water resources, and finally the system will be shut down.[15]

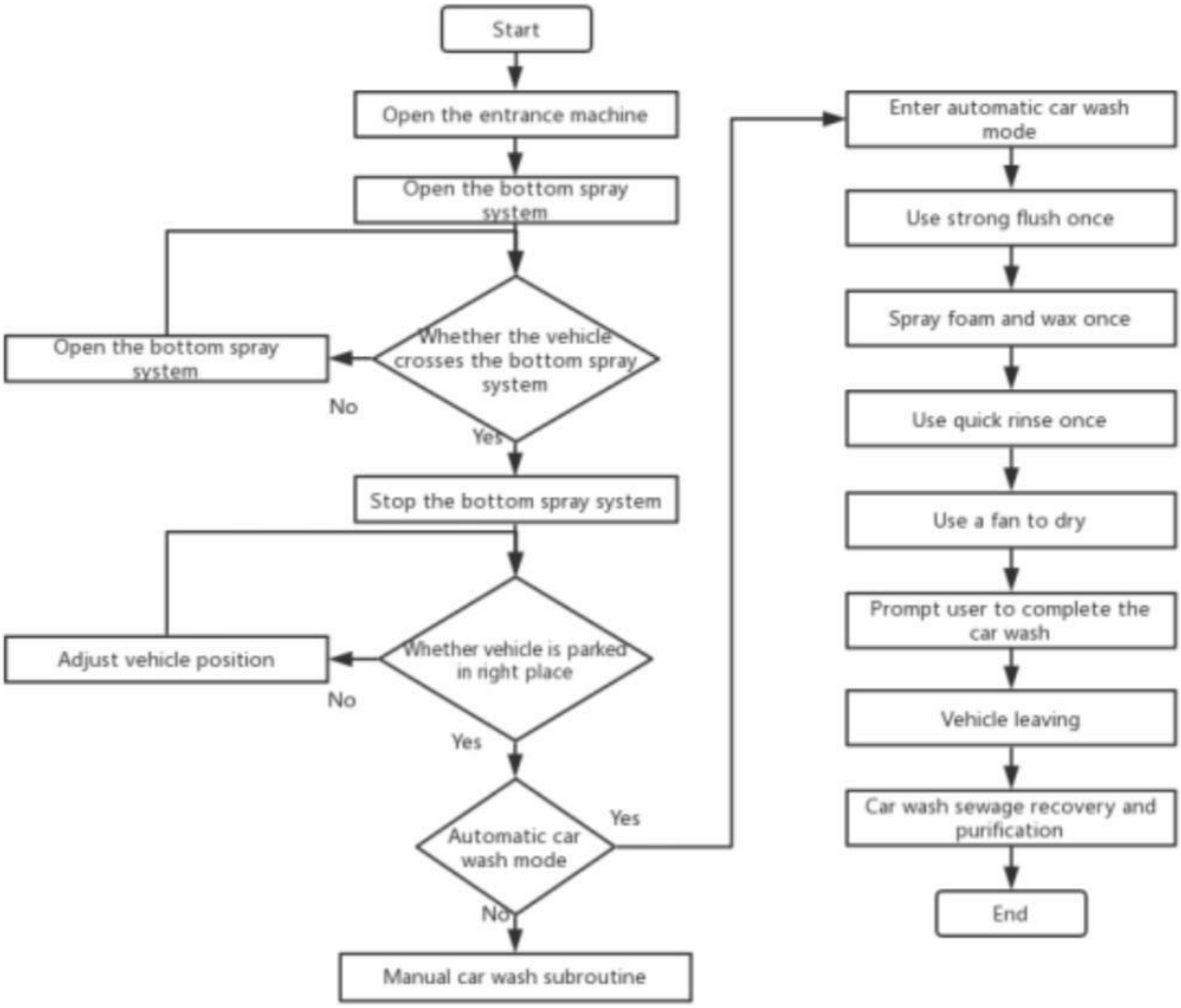


Fig 1.13: Car wash work flow chart

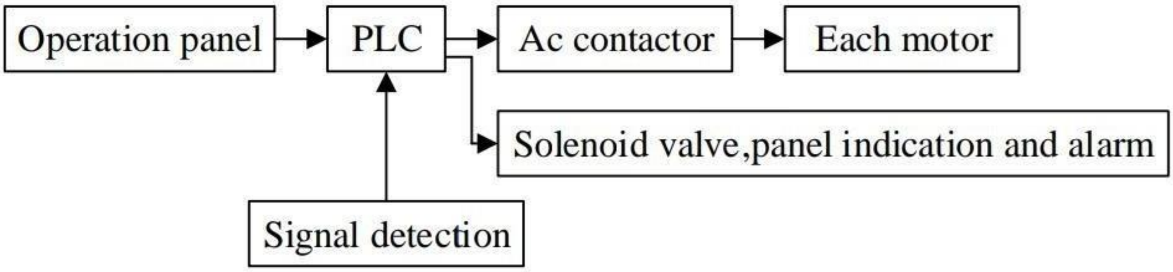


Fig 1.14: Control system structure

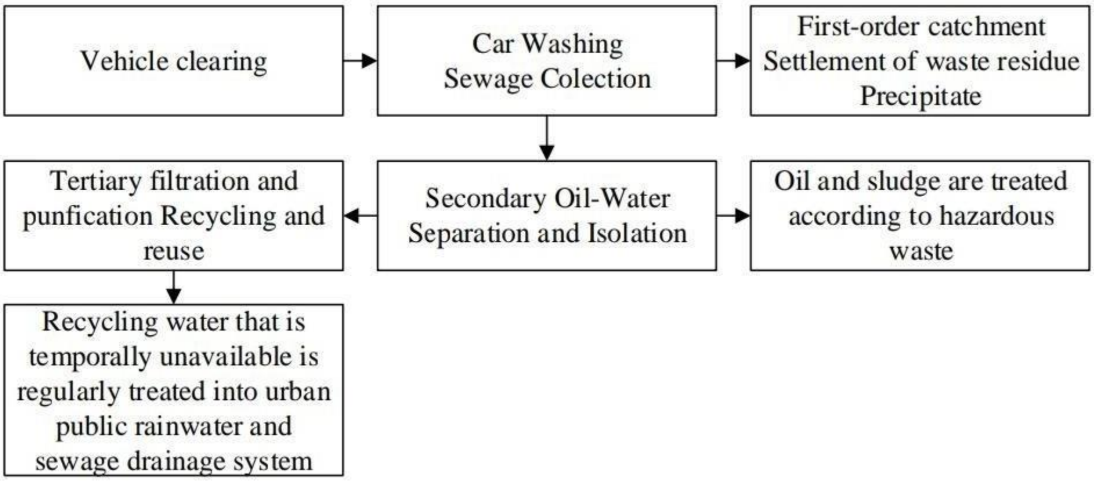


Fig 1.15: Car wash sewage reuse process

Chapter 2

Programmable logic control (PLC)

Chapter (2)

2- Programmable logic control (PLC)

2.1 Definition of PLC

PLCs are often defined as miniature industrial computers that contain hardware and software that is used to perform control functions. A PLC consists of two basic sections: the central processing unit (CPU) and the input/output interface system. The CPU, which controls all PLC activity, can further be broken down into the processor and memory system. The input/output system is physically connected to field devices (e.g., switches, sensors, etc.) and provides the interface between the CPU and the information providers (inputs) and controllable devices (outputs).

To operate, the CPU "reads" input data from connected field devices through the use of its input interfaces, and then "executes", or performs the control program that has been stored in its memory system. Programs are typically created in ladder logic, a language that closely resembles a relay-based wiring schematic, and are entered into the CPU's memory prior to operation. Finally, based on the program, the PLC "writes", or updates output devices via the output interfaces.

This process, also known as scanning, continues in the same sequence without interruption, and changes only when a change is made to the control program.

Inputs: Tell the PLC about its environment. They connect to temperature sensors, position detectors, limit switches etc.

Outputs: Tell things what to do. Outputs may instruct motors to go to a position, a valve to open or a door to lock.

2.2 Types of PLC

Programmable Logic Controllers (PLCs) are integrated as either single or modular units.

2.2.1 An integrated or Compact PLC shown in figure 2.1 is built by several modules within a single case. Therefore, the I/O capabilities are decided by the manufacturer, but not by the user. Some of the integrated PLCs allow to connect additional I/Os to make them somewhat modular.

Fig 2.1: Compact PLC

2.2.2A modular PLC shown in the figure 2.2 is built with several components that are plugged into a common rack or bus with extendable I/O capabilities. It contains power supply module, CPU and other I/O modules that are plugged together in the same rack, which are from same manufacturers or from other manufacturers. These modular PLCs come in different sizes with variable power supply, computing capabilities, I/O connectivity, etc.

Modular PLCs are further divided into small, medium and large PLCs based on the program memory size and the number of I/O features as shown in figure 2.3 .

Fig 2.3: Memory Size of PLC **Fig 2.2: Modular PLC**

1-Small PLC is a mini-sized PLC that is designed as compact and robust unit mounted or placed beside the equipment to be controlled. This type of PLC is used for replacing hard-wired relay logics,counters, timers, etc. This PLC I/O module expandability is limited for one or two modules and it uses logic instruction list or relay ladder language as programming language.

2-Medium-sized PLC is mostly used PLC in industries which allows many plug- in modules that are mounted on backplane of the system. Some hundreds of input/ output points are provided by adding additional I/O cards – and, in addition to these – communication module facilities are provided by this PLC.

3-Large PLCs are used wherein complex process control functions are required. These PLCs' capacities are quite higher than the medium PLCs in terms of memory, programming languages, I/O points, and communication modules, and so on. Mostly, these PLCs are used in supervisory control and data acquisition (SCADA) systems, larger plants, distributed control systems, etc.

Some of the manufacturers or types of PLCs are given below in figure 2.4:

Fig 2.4: Manufacturers of PLCs

Allen Bradley PLCs (AB), ABB PLCs (Asea Brown Boveri), Siemens PLCs, Omron PLCs, Mitsubishi PLCs, Hitachi PLCs, Delta PLCs, General Electric (GE) PLCs, Honeywell PLCs,. Modicon PLCs, Schneider Electric PLCs and Bosch PLCs

2.3 Applications of PLC

Proper application of a PLC begins with an economic justification analysis. The batch process in chemical, cement, food and paper industries are sequential in nature, requiring time or event based. decisions. PLCs are being used more and more as total solutions to a batch problem in these industries rather than just a tool. In batch process savings are developed principally from reduced cycle time and scheduling. Cycle automation provides rigid control enforcement to eliminate human errors and to minimize manual interventions. Increased efficiency in scheduling is to be expected with maximum utilization of equipment and reduction of fluctuating demands on critical equipment. In large process plants PLCs are being increasingly used for automatic start up and shutdown of critical equipment. A PLC ensures that an equipment cannot be started unless all the permissive conditionsfor safe start have been established. It also monitors the conditions necessary for safe running of the equipment and trip the equipment whenever any abnormality in the system is detected. The PLC can be programmed to function as an energy management system for boiler control for maximum efficiency and safety. In the burner management system it can be used to control the process of purging, pilot light off, flame safety checks, main burner light off and valve switching for change over of fuels

All advantages of programmable controller are:

1- Very fast.

2- Easy to change logic i.e. Flexibility.

3- Reliable due to absence of moving parts.

4- Low power consumption.

5- Easy maintenance due to modular assembly.

6- Facilities in fault finding and diagnostic .

7- Capable of handling of very complicated logic operations.

8- Good documentation facilities.

9- Easy to couple with the process computers.

10- Analog signal handling and close loop control programming.

11-. Counter, timer and comparator can be programmed.

2.4 Programming of PLC

PLCs are programmed using application software on personal computers, which now represent the logic in graphic form instead of character symbols. The computer is connected to the PLC through Ethernet, RS-232, RS-485, or RS-422 cabling. The programming software allows entry and editing of the ladder-style logic. Generally the software provides functions for debugging and troubleshooting the PLC software, for example, by highlighting portions of the logic to show current status during operation or via simulation. The software will upload and download the PLC program, for backup and restoration purposes.

There are some languages to program PLC:

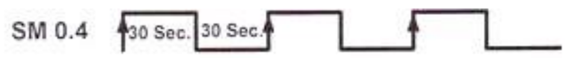
2.4.1 Instruction List (IL): A low-level language very similar to assembly language. The code is compact and suitable for small projects. It’s not very powerful. The other languages are easier to use and document.

Example: Make a program to increase the counter by one with each pulse from the pulse generator SM0.4 (on rising edge) , and decrease another counter by the same pulse.

Solution:

steps of solution would be like this:

1. put zero in memory location vw100.
2. put (10) in the memory location vw110.
3. with each rising edge from SM0.4 (every 30 sec), we increase memory location vw100 by one. and at the same time decrease vw110 by one. The program will continue like that without any instruction to stop.



instruction list

LD	SM 0.1	On for One Scan
MOVW	# 0 , VW100	Put 0 in address VW100
MOVW	# 10 , VW110	Put 10 in address VW110
LD	SM 0.4	Pulse generator
EU		Raising edge
INCW	VW100	Increment VW100
DECW	VW110	Decrement VW110
		End programming
MEND		

Fig 2.5: Example of Instruction List

Notes :

Load (LD) instruction

MOVW => move word

INCW => increment word

DECW => decrement word

2.4.2 Structured Text (ST): A high level language structured like Pascal. Users trained in high level text languages would be comfortable with ST.

Example: Figure 2.6 shows an example of this language.

```
// PLC configuration
CONFIGURATION DefaultCfg
    VAR_GLOBAL
        b_Start_Stop  : BOOL;         // Global variable to represent a boolean.
        b_ON_OFF      : BOOL;         // Global variable to represent a boolean.
        Start_Stop AT %IX0.0:BOOL;    // Digital  input of the PLC (Address 0.0)
        ON_OFF     AT %QX0.0:BOOL;    // Digital output of the PLC (Address 0.0). (Coil)
    END_VAR

    // Schedule the main program to be executed every 20 ms
    TASK Tick(INTERVAL := t#20ms);

    PROGRAM Main WITH Tick : Monitor_Start_Stop;
END_CONFIGURATION

PROGRAM Monitor_Start_Stop          // Actual Program
    VAR_EXTERNAL
        Start_Stop  : BOOL;
        ON_OFF      : BOOL;
    END_VAR
    VAR                             // Temporary variables for logic handling
        ONS_Trig    : BOOL;
        Rising_ONS  : BOOL;
    END_VAR

    // Start of Logic
    // Catch the Rising Edge One Shot of the Start_Stop input
    ONS_Trig    := Start_Stop AND NOT Rising_ONS;

    // Main Logic for Run_Contact -- Toggle ON / Toggle OFF ---
    ON_OFF := (ONS_Trig AND NOT ON_OFF) OR (ON_OFF AND NOT ONS_Trig);

    // Rising One Shot Logic
    Rising_ONS := Start_Stop;
END_PROGRAM
```

Fig 2.6 : Example of Structured Text Language

2.4.3Ladder Diagrams (LD): The most common PLC programming language is Ladder Logic. They consist of a series of electrical drawings that control how the PLC functions. We’ll go through the basics of Ladder Logic starting with Coils and Contacts. An example of Ladder Diagram is shown in figure 2.7 .

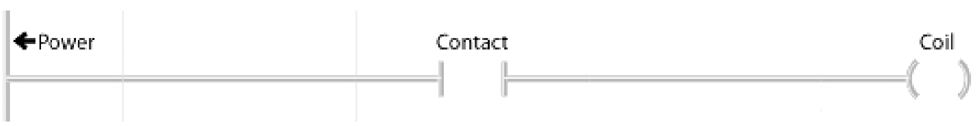


Fig 2.7 : Example of Ladder Diagram

Contacts :

Contacts stand between power and **Coils,** asking questions. If the answer to the question is true, then power is allowed to flow through the contact, if not the path is blocked.

List of typical Contacts:

⊣ ⊢ Normally Open asks if a bit is = 1

⊣/⊢ Normally Closed asks if a bit is = 0

⊣<⊢ Less Than asks if Value A is less than Value B.

⊣>⊢ Greater Than asks if Value A is greater than Value B

⊣≤⊢ Less Than or Equal asks if Value A is less than or equal to Value B.

⊣≥⊢ Greater Than or Equal asks if Value A is greater than or equal to Value B.

⊣=⊢ Equal asks if Value A is equal to Value B.

⊣≠⊢ Not Equal asks if Value A is not equal to Value B.

Coils

```
// PLC configuration
CONFIGURATION DefaultCfg
    VAR_GLOBAL
        b_Start_Stop  : BOOL;          // Global variable to represent a boolean.
        b_ON_OFF      : BOOL;          // Global variable to represent a boolean.
        Start_Stop AT %IX0.0:BOOL;     // Digital  input of the PLC (Address 0.0)
        ON_OFF     AT %QX0.0:BOOL;     // Digital output of the PLC (Address 0.0). (Coil)
    END_VAR

    // Schedule the main program to be executed every 20 ms
    TASK Tick(INTERVAL := t#20ms);

    PROGRAM Main WITH Tick : Monitor_Start_Stop;
END_CONFIGURATION

PROGRAM Monitor_Start_Stop          // Actual Program
    VAR_EXTERNAL
        Start_Stop  : BOOL;
        ON_OFF      : BOOL;
    END_VAR
    VAR                             // Temporary variables for logic handling
        ONS_Trig    : BOOL;
        Rising_ONS  : BOOL;
    END_VAR

    // Start of Logic
    // Catch the Rising Edge One Shot of the Start_Stop input
    ONS_Trig    := Start_Stop AND NOT Rising_ONS;

    // Main Logic for Run_Contact -- Toggle ON / Toggle OFF ---
    ON_OFF := (ONS_Trig AND NOT ON_OFF) OR (ON_OFF AND NOT ONS_Trig);

    // Rising One Shot Logic
    Rising_ONS := Start_Stop;
END_PROGRAM
```

Each Coil is tied to a specific Bit of data. Here are the standard Coil Types and what they to the specified Bit.

- Out: If the Coil is powered, the bit is assigned a 1. If not it's assigned a 0.
- Set: If the Coil is powered, the bit is assigned a 1. If not, the value remains whatever it was.
- Reset: If a Coil is powered, the bit is assigned a 0. If not, the value remains whatever it was.

Contacts and coils are often associated with the physical **Inputs & Outputs** on the PLC**.**

<u>**Example:**</u>

IA+IB*IC=Q

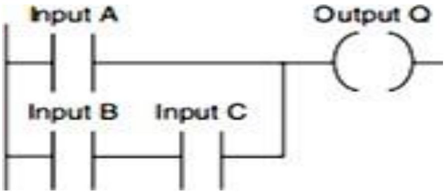


Fig 2.8 : Example of Using the & (AND) and | (OR) symbol in Ladder Logic

2.4.4 Function Block Diagram (FBD): The blocks contain procedures or functions to act on the input "wires" and output the result. It lends itself readily to standardizing, modulating, and maintaining programs.

Example:

IA+IB*IC=Q

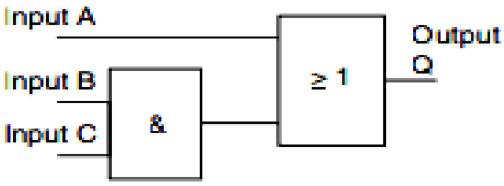


Fig 2.9 : Example of Using the & (AND) and |(OR) symbol in Function Block Diagram

2.4.5 Sequential Function Chart (SFC): This graphic language is great for concurrent parallel sequential operations. It very useful pulling together in a flow chart form the other PLC programming elements such as function blocks (FB) or structured text (ST).

Example: Moving a Wagon

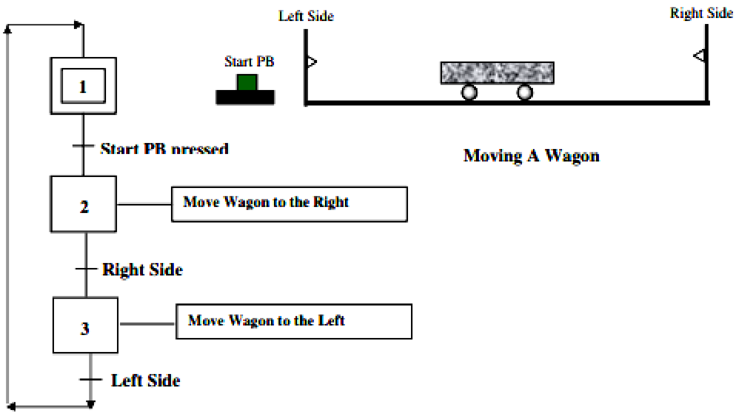


Fig 2.10 : Example of Sequential Function Chart

2.5 Data in PLC

PLC memory is like a cabinet with drawers called Registers. Data is held in these Registers. These Registers come in different sizes, and hold different kinds of data.

Bits: Can have values 1 or 0. 1 typically represents On while 0 represents Off. Bits are the building block For all other types of data.

Integers: Whole numbers (no decimal points). Called: Characters (char), Integers (int), long Integers (long int) or Words. Look for the bit size and whether they are signed or unsigned. Unsigned are positive numbers, while signed are positive or negative.

Floating point numbers: Numbers with decimal points, and can be positive or negative. They are called floating point numbers (Float), with their larger variety called double floats.

Addresses/Tags: The Registers are all stacked side by side in the PLC's memory. Each location has an Address that lets the PLC know what data you're talking about. Older PLC software requires the user to refer to data by this Address (example "x1023" could mean the 1023'd register). Some newer software makes the Addresses transparent. The user gives a piece of data a name (example "Oven2Temperature"), and the PLC keeps track of where the register is located. If the software uses Addresses to refer to data it's called "Address Based", if it uses named data it's called "Tag Based". Some programming packages are Address Based, but allow Addresses to have "Nicknames" or something similar. Their benefits over standard Address Based systems tend to be limited. Advantages to Tag based systems become evident as programs grow, and remembering what's stored in x1023 becomes difficult. If your program is going to have any complexity at all using a Tag Based System simplifies the design.

Inside the Data Types: As stated earlier, all Data Types are made of Bits (1′s and 0′s). An 8 bit number is written like bbbbbbbb (where "b" can represent a 0 or 1), so you may have 00000000, 11111111 or 01011110…. any combo will do. What these Bits mean is determined by the Data Type.

Unsigned Integers: The least valuable bit is the rightmost bit and double in value each position you move left.

The right-most bit is 1 it's worth 1 next bit to the left

2 4 8 16 32 64 128 256 ……

(this goes on for as many bits as the Data Type calls for). Here's what is looks like for an Unsigned 8-bit Integer: If all 8 bits are 0 (00000000) then we get 0 + 0 + 0 + 0 + 0 + 0 + 0 + 0 = 0 If all 8 bits are 1 (11111111) then we get 128 + 64 + 32 + 16 + 8 + 4 + 2 + 1 = 255.

So the range of an 8 bit unsigned Integer is 0 – 255. An example of something in between (00110101): 0 + 0 + 32 + 16 + 0 + 4 + 0 + 1 = 53.

Hexadecimal Format (Hex): Instead of writing every bit out, it is common to group sets of 4 bits together. Each group can have a value of 0 – 15, which causes a problem since our number system goes from 0 – 9, so we also use A, B, C, D, E and F to get a total of 16 values. (0, 1, 2, 3, 4, 5, 6, 7, 8, 9 , A, B, C, D, E, F).

Example 1001 0011 1111 0010 in Hex would be 93F2 0010

2.6 PLC Output Units

A digital output typically consists of a switch (either mechanical as in a relay, or electronic as in a transistor or triac) that either opens or closes the circuit between two terminals depending on the binary state of the output.

PLC Output units can be:

- Relay,
- Transistor, or
- Triac.

Note: Each user of PLC should be:

- Check the specifications of load before connecting it to the PLC output.
- Make sure that the maximum current it will consume is within the specifications of the plc output.

2.6.1. Relay

Relays in General

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays.

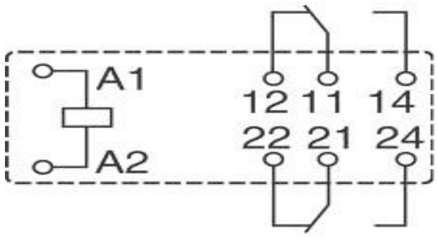


Fig 2.11 : Relay

Since relays are switches, the terminology applied to switches is also applied to relays; a relay switches one or more *poles*.

Normally open (NO) contacts connect the circuit when the relay is activated; the circuit is disconnected when the relay is inactive.

Normally closed (NC) contacts disconnect the circuit when the relay is activated; the circuit is connected when the relay is inactive.

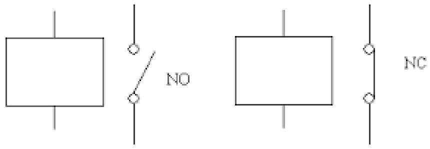


Fig 2.12 : Normally Open and Normally Closed Contacts

Relay Outputs

One of the most common types of outputs available is the relay output. Existence of relays as outputs makes it easier to connect with external devices. A relay is non- polarized and typically it can switch either AC or DC.

2.6.2 Transistor

Transistor in General

A transistor is a semiconductor device used to amplify and switch electronic signals and electrical power. It is composed of semiconductor material with at least three terminals for connection to an external circuit as shown in figure 2.13 and 2.14 .

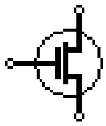


Fig 2.13 :N-Channel MOSFET Transistor

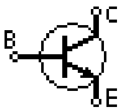


Fig 2.14 : NPN Bipolar Transistor

Transistor Outputs

Transistor type outputs can only switch a dc current. The PLC applies a small current to the transistor base and the transistor output "closes". When it's closed, the device connected to the PLC output will be turned on.

A transistor typically cannot switch as large a load as a relay. If the load current you need to switch exceeds the specification of the output, you can connect the plc output to an external relay, then connect the relay to the large load.

Typically a PLC will have either NPN or PNP transistor type outputs. Some of the common types available are BJT and MOSFET. A BJT type often has less switching capacity than a MOSFET type. The BJT also has a slightly faster switching time.

A transistor is fast, switches a small current, has a long lifetime and works with dc only. A relay is slow, can switch a large current, has a shorter lifetime and works with AC or DC.

2.6.3 Triac

Triac in General :

TRIAC, from triode for alternating current, is a generalized trade name for an electronic component that can conduct current in either direction when it is triggered (turned on), and is formally called a bidirectional triode thyristor or bilateral triode thyristor.

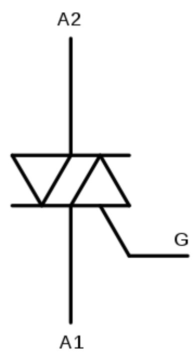


Fig 2.15: Triac

Triac outputs:

Triac output can be used to control AC loads only. Triac output is faster in operation and has longer life than relay output.

Inductive loads have a tendency to deliver a "back current" when they turn on. This back current is like a voltage spike coming through the system. This could be dangerous to output relays. Typically a diode, thyristor, or other "snubber" circuit should be used to protect the PLC output from any damage

2.7 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. PLCs contain input and output devices compatible with industrial pilot devices and controls; little electrical design is required, and the design problem centers on expressing the desired sequence of operations. PLC applications are typically highly customized systems, so the cost of a packaged 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 economical. This is due to the lower cost of the components, which can be optimally chosen instead of a "generic" solution, and where the non- recurring engineering charges are spread over thousands or millions of units.

For high volume or very simple fixed automation tasks, different techniques are used. For example, a consumer dishwasher would be controlled by an electromechanical cam timer costing only a few dollars in production quantities.

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. Automotive applications are an example; millions of units are built each year, and very few end- users alter the programming of these controllers. However, some specialty vehicles such as transit buses economically use PLCs instead of custom-designed controls, because the volumes are low and the development cost would be uneconomical.

Very complex process control, such as used in the chemical industry, may require algorithms and performance beyond the capability of even high-performance PLCs. Very high-speed or precision controls may also require customized solutions; for example, aircraft flight controls.

Single-board computers using semi-customized or fully proprietary hardware may be chosen for very demanding control applications where the high development and maintenance cost can be supported. "Soft PLCs" running on desktop-type computers can interface with industrial I/O hardware while executing programs within a version of commercial operating systems adapted for process control needs.

Programmable controllers are widely used in motion control, positioning control, and torque control. Some manufacturers produce motion control units to be integrated with PLC so that

G-code (involving a CNC machine) can be used to instruct machine movements.

PLCs may include logic for single-variable feedback analog control loop, a proportional, integral, derivative (PID) controller. A PID loop could be used to control the temperature of a manufacturing process, for example. Historically PLCs were usually configured with only a few analog control loops; where processes required hundreds or thousands of loops, a distributed control system (DCS) would instead be used. As PLCs have become more powerful, the boundary between DCS and PLC applications has become less distinct.

PLCs have similar functionality as remote terminal units (RTU). An RTU, however, usually does not support control algorithms or control loops. As hardware rapidly becomes more powerful and

cheaper, RTUs, PLCs, and DCSs are increasingly beginning to overlap in responsibilities, and many vendors sell RTUs with PLC-like features, and vice versa. The industry has standardized on the IEC 61131-3 functional block language for creating programs to run on RTUs and PLCs, although nearly all vendors also offer proprietary alternatives and associated development environments.

In recent years "safety" PLCs have started to become popular, either as standalone models or as functionality and safety-rated hardware added to existing controller architectures (Allen Bradley Guardlogix, Siemens F-series etc).

These differ from conventional PLC types as being suitable for use in safety-critical applications for which PLCs have traditionally been supplemented with hard-wired safety relays. For example, a safety PLC might be used to control access to a robot cell with trapped- key access, or perhaps to manage the shutdown response to an emergency stop on a conveyor production line. Such PLCs typically have a restricted regular instruction set augmented with safety-specific instructions designed to interface with emergency stops, light screens, and so forth. The flexibility that such systems offer has resulted inrapid growth of demand for these controllers.

2.8 S7-300 CPUs "Step 7- 300 Central Processing Units

A graded CPU range with a wide performance range is available for configuring the controller.

In the first instance SIMATIC S7-300 is used for innovative system solutions in manufacturing technology, especially for automobile industry, mechanical engineering in general and especially for special machine building and serial production of machines (OEM), at plastics processing, packaging industry, food and beverage industry and process engineering

As an all-purpose automation system is S7-300 the ideal solution for applications, which need a flexible concept for central as well as local configuration

Particularly in the finishing technique the S7-300 is used in the following industries:

- Automobile industry
- General mechanical engineering
- Building of special machines
- Series mechanical engineering, OEM
- Plastics processing
- Packaging industry
- Food and Beverage industry
- Process engineering
- Fast counting/fairs with direct access on the hardware counter

- Simply positioning with direct control the MICROMASTER frequency static frequency changers
- PID-Regulation with integrated functional module.

Benefits of The S7-300:-

- Thanks to their high processing speed, the CPUs enable short machine cycle times.
- The S7-300's range of CPUs provides the right solution for every application, and the users can only pick for the performance actually required for a specific task.
- The S7-300 can be set up in a modular configuration without the need for slot rules for I/O modules
- The narrow module width results in a compact controller design or a small control cabinet.
- The ability to integrate powerful CPUs with Industrial Ethernet/PROFINET interface, integrated technological functions, or fail-safe designs make additional investments unnecessary.

2.9 " CPU 313C "Project PLC :-

Fig 2.16 : SEMINS CPU313

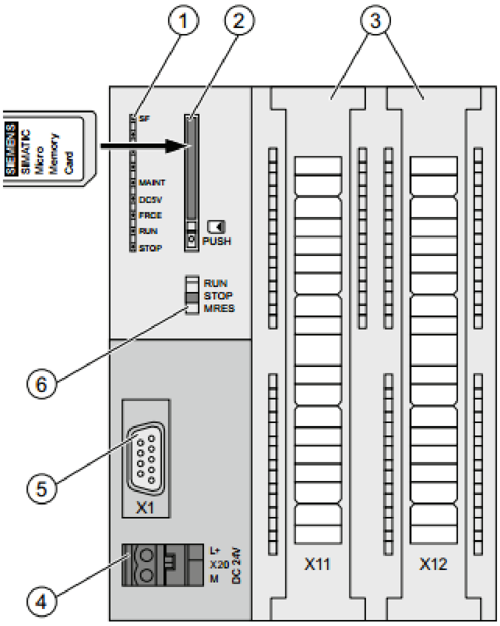
2.9.1.General Information :-

CPU for installations with high requirements interms of processing power and response time

- MPI interface onboard
- Technological functions:
  1- Counting
  2- CPU313Closed loop control
  3- Frequency measurement
  4- Pulse width modulation
  5- Pulse generator
- 24 digital inputs
- 16 digital outputs
- 4 analog inputs
- 2 analog outputs

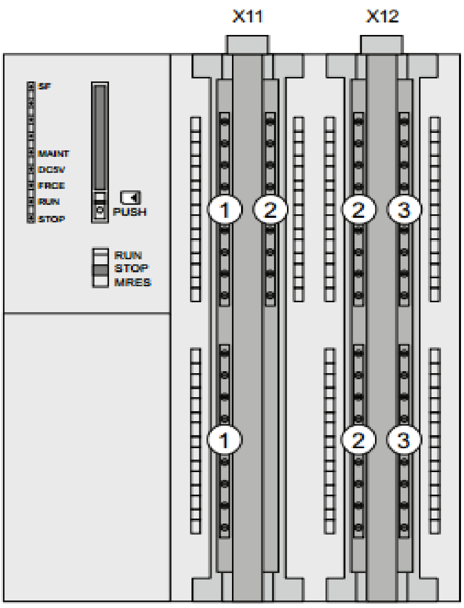
2.9.2 CPU 313C Contents:-

CPU parts have shown in the figures 2.17 and figure 2.18 .



1. **Status and error indicators.**
2. **Slot for the SIMATIC Micro Memory Card .**
3. **Terminals of the integrated inputs and outputs.**
4. **Power supply connection.**
5. **Interface .**
6. **Mode selector.**

Fig 2.17 : Operator Controls and Indicators of the CPU 313C



1. **Analog inputs and analog outputs.**
2. **Digital inputs.**
3. **Digital outputs**

Fig 2.18 : Integrated Digital and Analog Inputs/Outputs of the CPU

2.9.3 CPU Memory Areas

The three memory areas of CPU 313C :-

1. System Memory.
2. Main Memory.
3. Load Memory

System Memory :

- The system memory is integrated in the CPU and cannot be expanded.
- The system memory of the S7-CPUs is divided into address areas.
- By using corresponding instructions in your program, you can address the
- data directly in the relevant address area.
- Address areas of the system memory shown in table2.1 below :-

Table 2.1 : Address Area of the system memory

Address areas	Description
Process input image	At every start of an OB 1 cycle, the CPU reads the input values from the input modules and saves them in the process input image.
Process output image	During the cycle, the program calculates the values for the outputs and stores them in the process output image. At the end of the OB 1 cycle, the CPU writes the calculated output values to the output modules
Bit memory	This area provides memory for saving the intermediate results of a program calculation.
Timers	Timers are available in this area.
Counters	Counters are available in this area.
Local data	Temporary data of a code block (OB, FB, FC) is saved to this memory area while the block is being processed.

Main Memory :-

- The main memory is integrated in the CPU with 64 KB and cannot be extended. It is used to execute the code and process user program data. Programs only run in the main memory and system memory.

Load Memory :-

- The load memory is located on a Micro Memory Card (MMC). The amount of load memory corresponds exactly to the MMC. It serves to store code and data blocks as well as system data (configuration, connection, module parameters, etc.). Blocks that are identified as non runtime-related are stored exclusively in load memory.
- You can also store all the configuration data for your project on the MMC.
- Your program in the load memory is always retentive; It is saved upon loading on the MMC to protect against network failure and resets.
- Size of Micro Memory Card as shown in table 2.2:
- Figure 2.19 shows that download of the user to Micro Memory Card.

Table 2.2 : Size of Micro Memory Card

Size of Micro Memory Card128KB	1024
512KB	2560
2MB	The maximum number of blocks that can be loaded on a specific CPU is less than the number of blocks that can be stored on the SIMATIC Micro Memory Card. For information about the maximum number of blocks that can be loaded on a specific CPU, refer to the corresponding technical specification
4MB	
8MB	

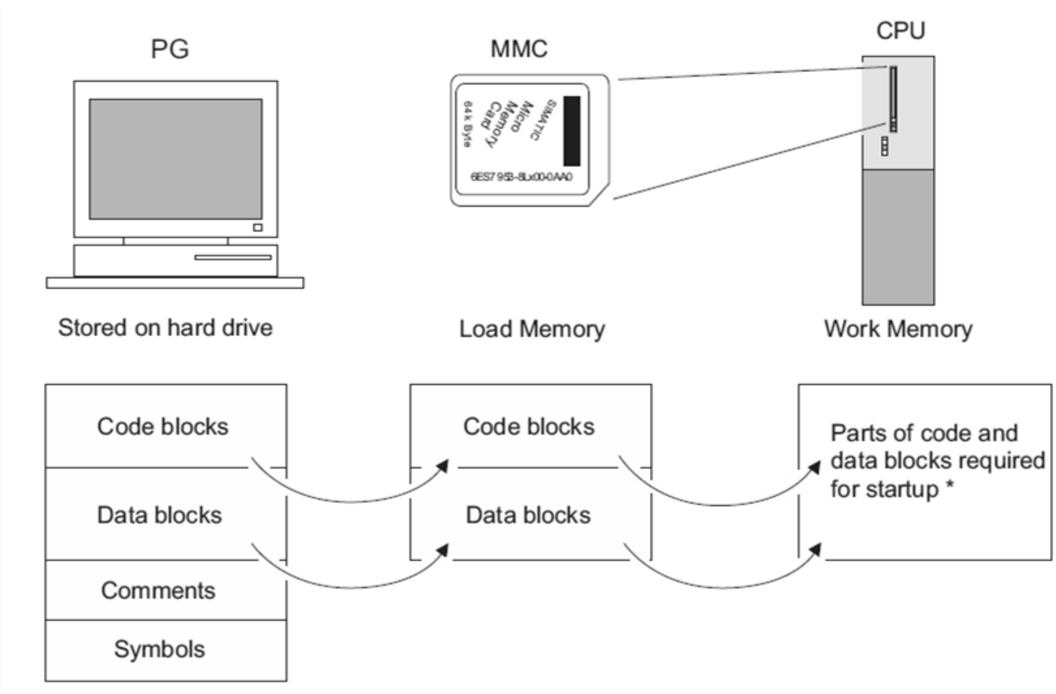


Fig 2.19: Download of the User Program to the Load Memory Card

Chapter 3

Simulation and modeling of car washing machine

Chapter (3)

3- Simulation and modeling of car washing machine

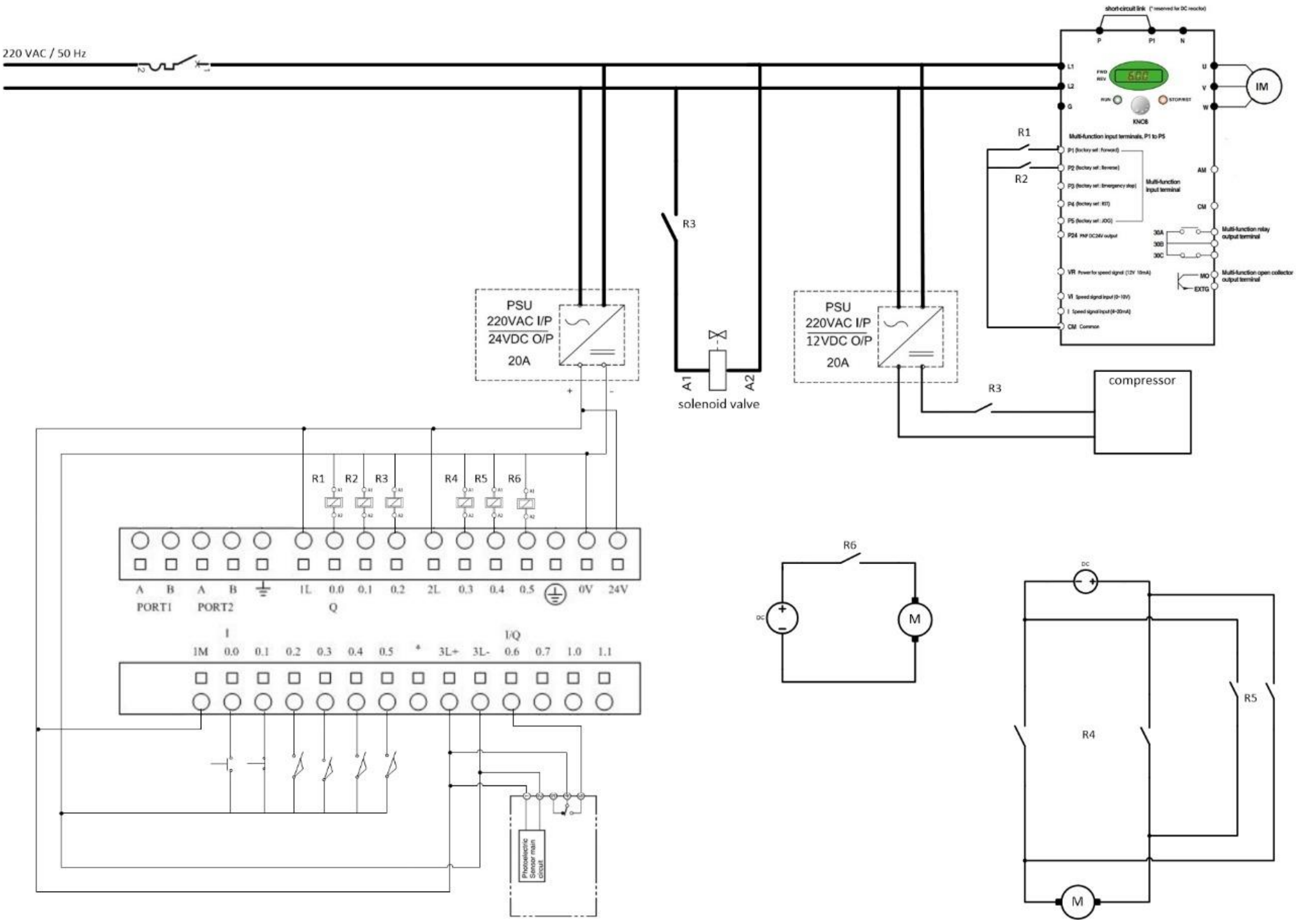


Fig 3.1: simulation and modeling of car washing machine

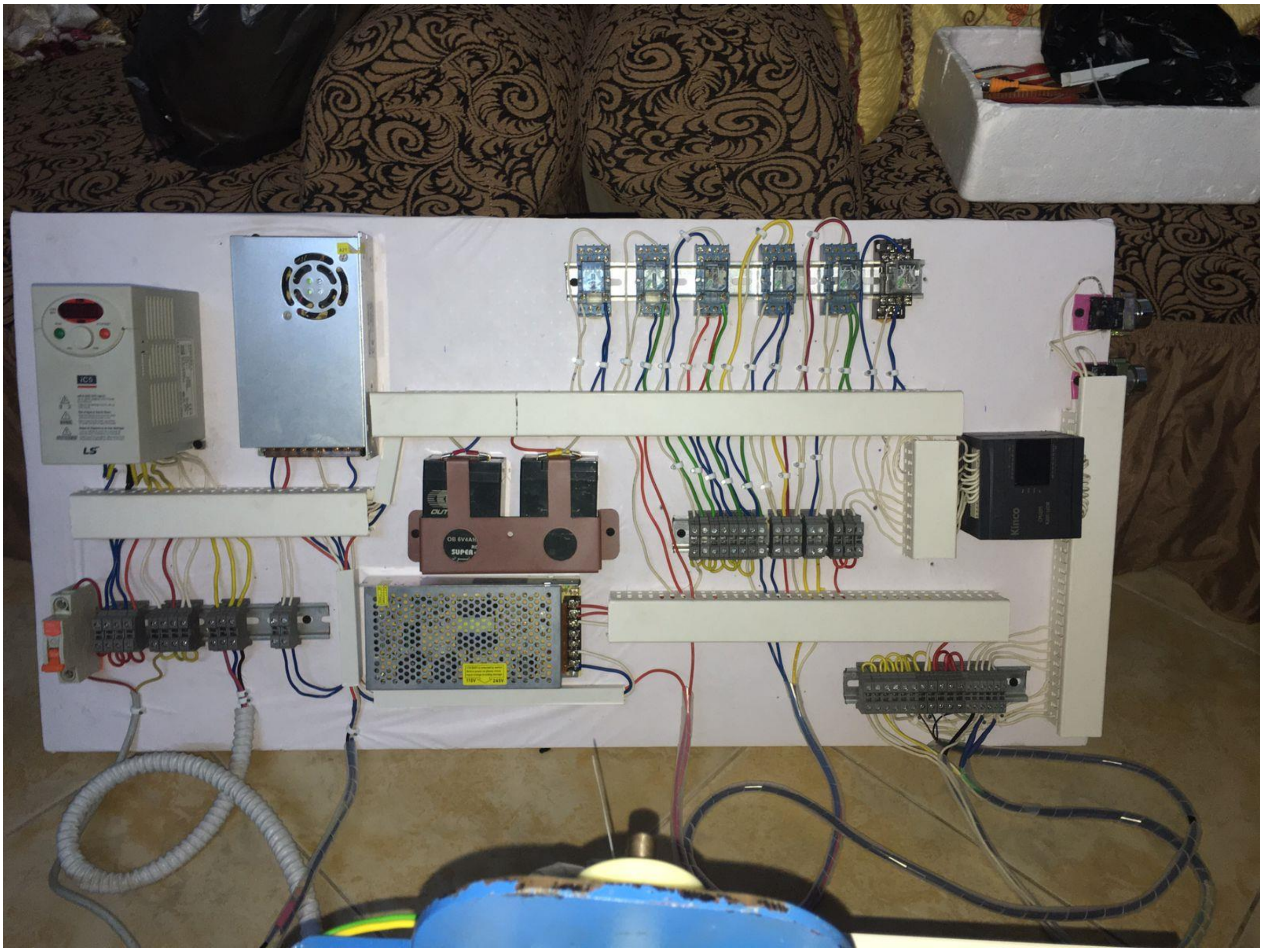


Fig 3.2: control panel of car washing machine

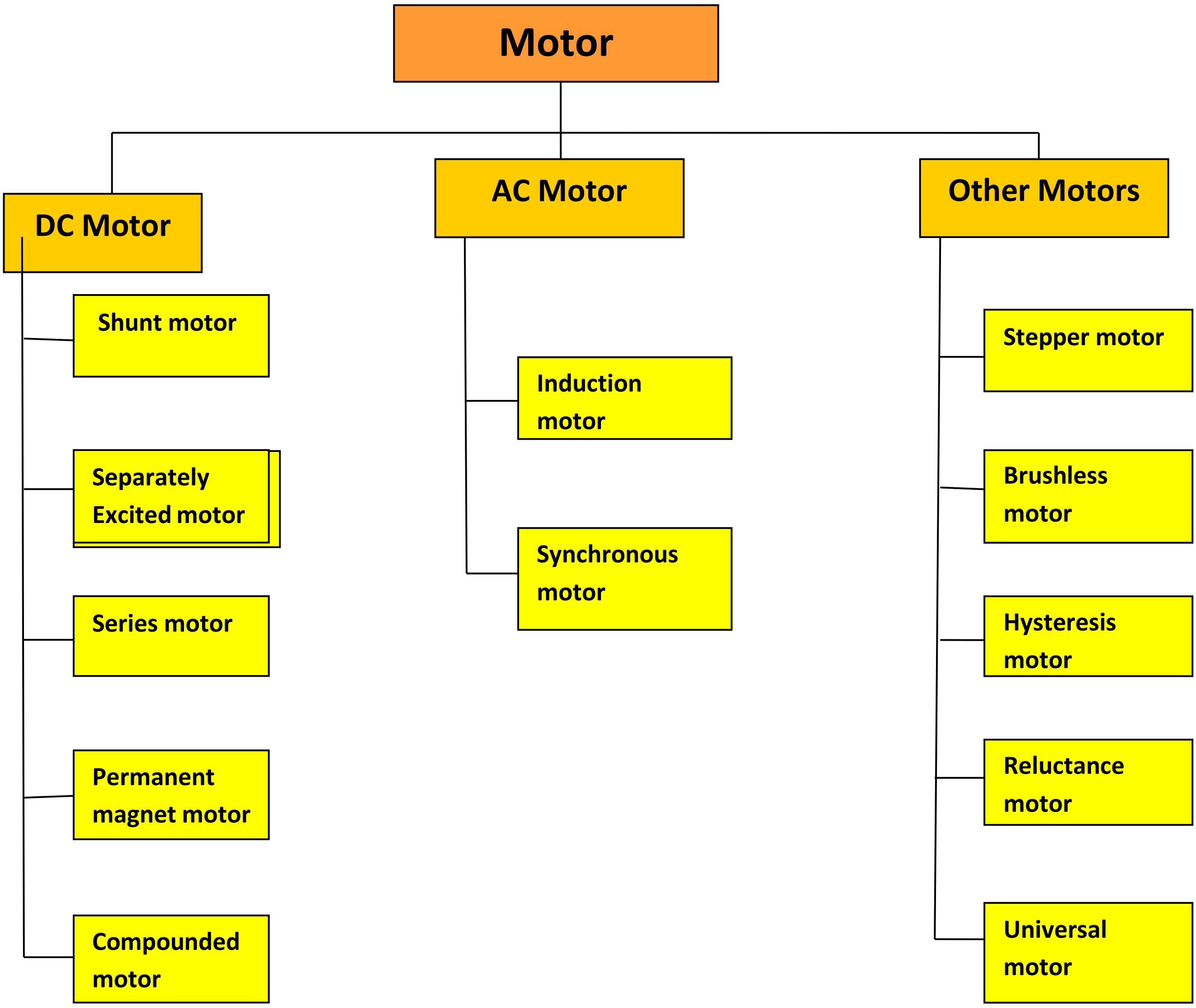
3.1 Motors :

An electric motor is an electrical machine that converts electrical energy into mechanical energy. In normal motoring mode, most electric motors operate through the interaction between an electric motor's magnetic field and winding currents to generate force within the motor. In certain applications, such as in the transportation industry with traction motors, electric motors can operate in both motoring and generating or braking modes to also produce electrical energy from mechanical energy.

Electric motors are used to produce linear or rotary force (torque), and should be distinguished from devices such as magnetic solenoids and loudspeakers that convert electricity into motion but do not generate usable mechanical powers, which are respectively referred to as actuators and transducers.

- Advantages of motor :
  - Low Initial Cost - $/Hp
  - Simple & Efficient Operation
  - Compact Size – cubic inches/Hp
  - Long Life – 30,000 to 50,000 hours
  - Low Noise
  - No Exhaust Emissions
  - Withstand high temporary overloads
  - Automatic/Remote Start & Control.
- Disadvantages of motor :
  - Portability
  - Speed Control
  - No Demand Charge

3.1.1.Types of motor :



3.1.2.DC Motors

A DC motor is any of a class of electrical machines that converts direct current electrical power into mechanical power. 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. Most types produce rotary motion; a linear motor directly produces force and motion in a straight line.

1. **Shunt DC motor:** The rotor and stator windings are connected in parallel.

2. **Separately Excited motor:** The rotor and stator are each connected from a different power supply, this gives another degree of freedom for controlling the motor over the shunt.

3. **Series motor:** The stator and rotor windings are connected in series.

4. **Permanent Magnet motors:** The stator is a permanent magnet, so the motoris smaller in size.

5. **Compounded motor:** The stator is connected to the rotor through a compound of shunt and series windings, if the shunt and series windings add up together, the motor is called cumulatively compounded. If they subtract from each other, then a differentially compounded motor results, which is unsuitable for any application.

3.1.3.AC Motor :

1. **Induction Motor:** So called because voltage is induced in the rotor (thus no need for brushes), but for this to happen, the rotor must rotate at a lower speed than the magnetic field to allow for the existence of an induced voltage. Therefore a new term is needed to describe the induction motor.

2. **Synchronous Motor:** So called because rotor tries to line up with the rotating magnetic field in the stator. It has the stator of an induction motor, and the rotor of a DC motor.

3.1.4.Other Motors :

1. **Reluctance motor:** A synchronous-induction motor. The rotor has salient poles and a cage so that it starts like an induction motor, and runs like a synchronous motor.
2. **Hysteresis motor:** hysteresis produces the torque, can be very tiny, used as the driver for electric clocks.
3. **Stepper motor:** a special type of synchronous motors that rotates a number of degrees with each electric pulse.
4. **Brushless DC motor:** a close cousin of a permanent magnet stepper motor with electronic controllers.
5. **Universal motor:** If a series DC motor has a laminated stator frame, it can run effectively from an AC supply as well as DC, this is the universal motor.

3.2 Timer :

There are a number of different forms of timers that can be found with PLCs. With small PLCs there is likely to be just one form, the on-delay timers. These are timers which come on after a particular time delay. Off-delay timers are on for a fixed period of time before turning off. Another type of timer that occurs is the pulse timer. This timer switches on or off for a fixed period of time the IEC 1131-3 standard symbols for timers. TON issued to denote on-delay, TOF off-delay, and TP pulse timers. On- delay is also represented by T–0 and off-delay by 0–T. they are shown in figure 3.2 :

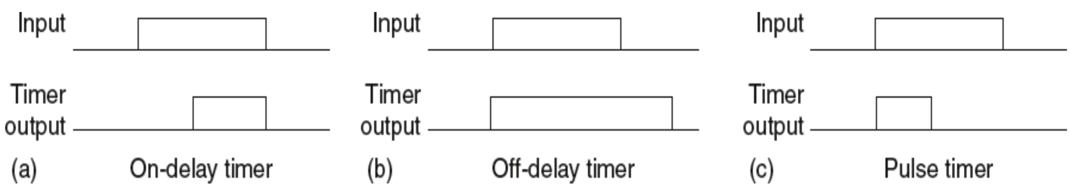


Fig 3.3: Delay Timer

3.2.1.On-Off Cycle Timer :

Example :

- On-delay timers can be used to produce an on-off cycle timer
- The timer is designed to switch on an output for 5 s, then off for 5 s, then on for 5s, then off for 5 s, and so
- on.
- When there is an input to In 1 and its contacts close, timer starts.
- Timer 1 is set for a delay of 5 s. After 5 s, it switches on timer 2 and the output Out 1.
- Timer 2 has a delay of 5 s. After 5 s, the contacts for timer 2, which are normally closed, open.
- This results in timer 1, in the first rung, being switched off.
- This then causes its contacts in the second rung to open and switch off timer 2.
- This results in the timer 2 contacts resuming their normally closed state and so the input to In 1 causes the cycle to start all over again.

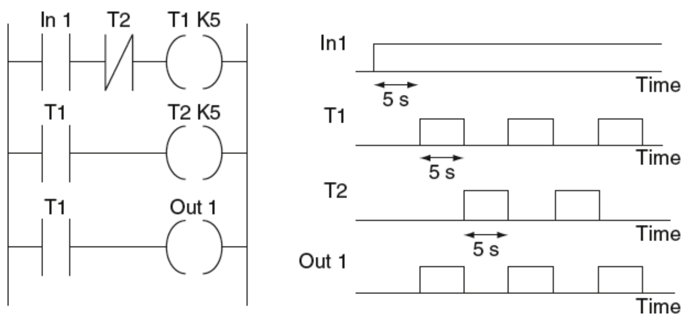


Fig 3.4 :On-Off Cycle Timer

3.2.2.Off-Delay Timer :

Example :

- An on-delay timer can be used to produce an off-delay timer
- With such an arrangement, when there is a momentary input to In l, both the output Out 1 and the timer are switched on.
- Because the input is latched by the Out 1 contacts, the output remains on. Afterthe preset timer time delay, the timer contacts, which are normally closed, open and switch off the output. Thus the output starts as on and remains on until the time delay has elapsed.

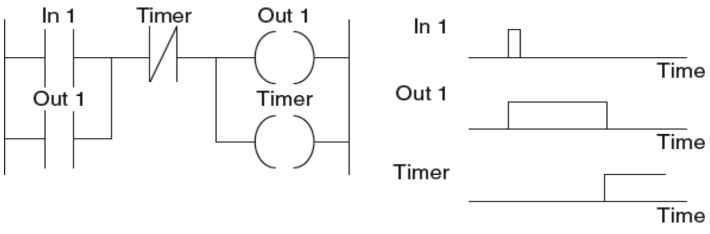


Fig 3.5 :Off Delay Timer

3.2.3.Pulse Timer :

Example:

- Pulse timers are used to produce a fixed duration output from some initiating input.
- ladder diagram for a system that will give an output from
- Out 1 for a predetermined fixed length of time when there is an input to In 1, the timer being one involving a coil.
- There are two outputs for the input In 1. When there is an input to In 1, there is an output from Out 1 and the timer starts.
- When the predetermined time has elapsed, the timer contacts open. This switches off the output.
- Thus, the output remains on for just the time specified by the timer.

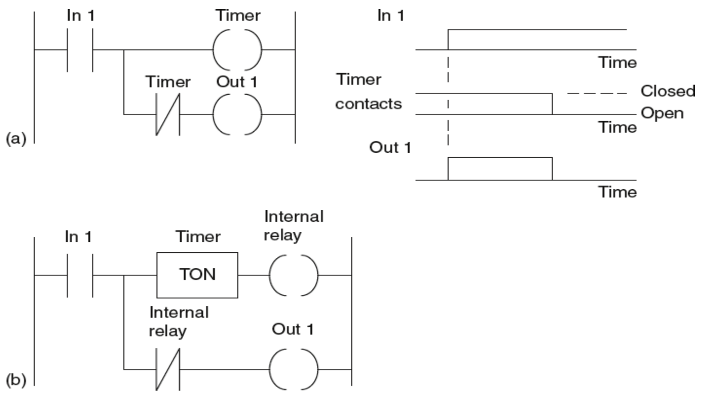


Fig 3.6: Pulse Timer

3.3 Valve :-

A valve is a device that regulates, directs or controls the flow of a fluid (gases, liquids, fluidized solids, or slurries) by opening, closing, or partially obstructing various passageways. Valves are technically valves fittings, but are usually discussed as a separate category. In an open valve, fluid flows in a direction from higher pressure to lower pressure.

- **Types of valves :**

The many different types of valves all have different names as shown in Figure 3.6 . The most common ones are the butterfly, plug, gate, globe, needle, poppet, and spool :

A- Butterfly: A butterfly valve is a disk that sits in the middle of a pipe and swivels sideways (to admit fluid) or upright (to block the flow completely).

B- plug: In a plug valve, the flow is blocked by a cone-shaped plug that moves aside when you turn a wheel or handle.

C- Gate or sluice: Gate valves open and close pipes by lowering metal gates across them. Most valves of this kind are designed to be either fully open or fully closed and may not function properly when they are only part-way open. Water supply pipes use valves like this.

D- Globe: Water faucets (taps) are examples of globe valves. When you turn the handle, you screw a valve upward and this allows pressurized water to flow up through a pipe and out through the spout below. Unlike a gate or sluice, a valve like this can be set to allow more or less fluid through it.

E- Needle: A needle valve uses a long, sliding needle to regulate fluid flow precisely in machines like car engine carburetors and central-heating systems.

F- Poppet: The valves in car engine cylinders are poppets. This type of valve is like a lid sitting on top of a pipe. Every so often, the lid lifts up to release or admit liquid or gas.

G- Spool: Spool valves regulate the flow of fluid in hydraulic systems. Valves like this slide back and forward to make fluid flow in either one direction or another around a circuit of pipes

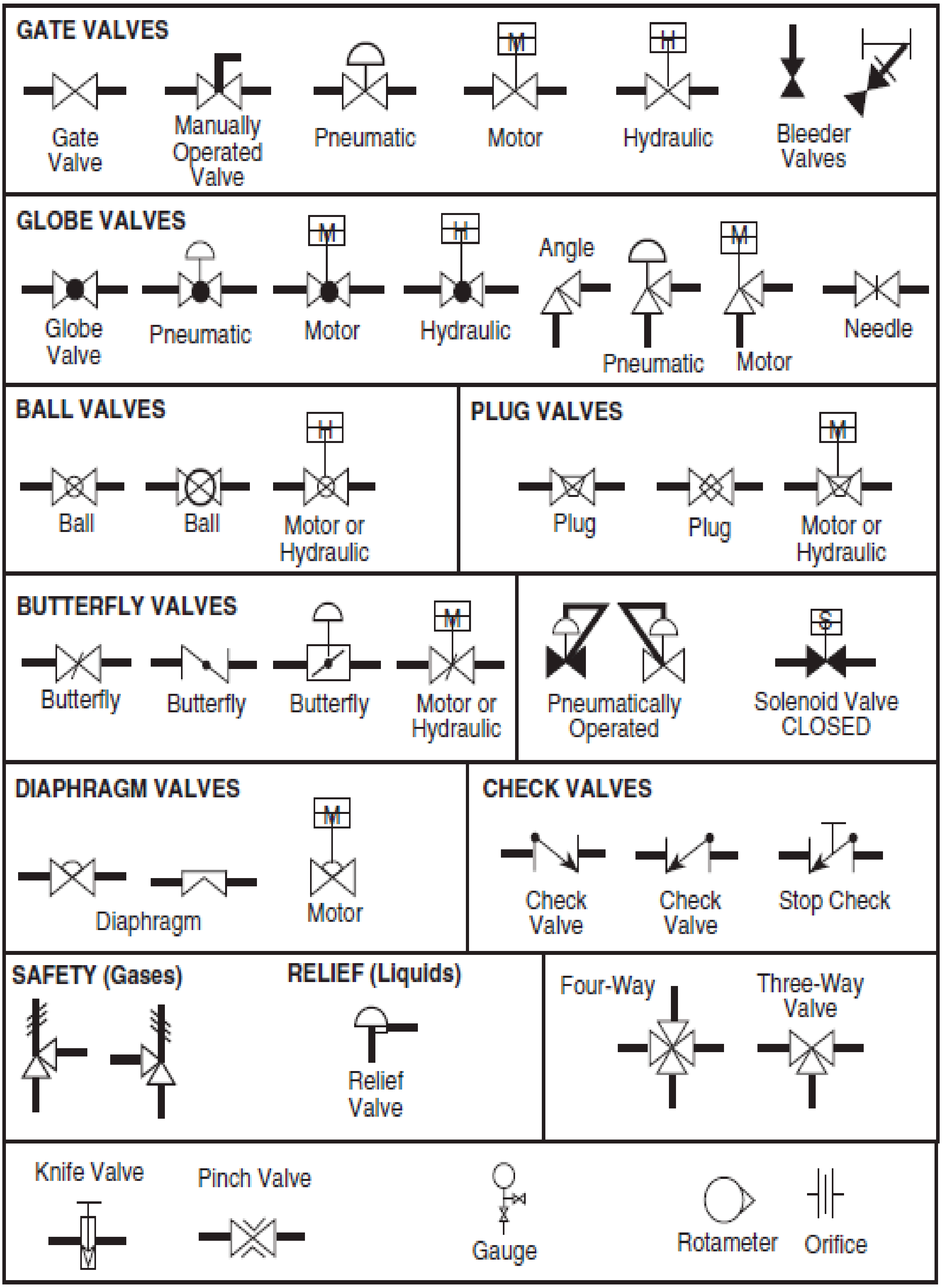


Fig 3.7 :Types of Valves

3.4 Sensors :-

A sensor is an object whose purpose is to detect events or changes in its environment, and then provide a corresponding output. A sensor is a type of transducer

- **Types of Sensors :**

3.4.1.Contact Sensors (Limit Switch):

Our Limit Switches are electro-mechanical devices that consist of an actuator mechanically linked to a set of contacts. When an object comes into contact with the actuator, the device operates the contacts to make or break an electrical connection. Our limit switches work in a variety of applications and environments because of their ruggedness, simple visible operation, easy installation and reliable operation

Fig 3.8 : Example of Contact Sensor

3.4.2.Proximity Sensors:

The proximity sensor is a sensor able to detect the presence of nearby objects without any physical contact. It often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors. For example, a capacitive or photoelectric sensor might be suitable for a plastic target; an inductive proximity sensor always requires a metal target. Proximity sensors can have a high reliability and long functional life because of the absence of mechanical parts and lack of physical contact between sensor and the sensed object.

The maximum distance that this sensor can detect is defined "nominal range". Some sensors have adjustments of the nominal range or means to report a graduated detection distance.

❖ Types of Proximity Sensors:

1. Inductive Sensors:

An inductive proximity sensor is a type of non-contact electronic proximity that is used to detect the position of metal objects. The sensing range of an inductive switch is dependent on the type of metal being detected. Ferrous metals, such as iron and steel, allow for a longer sensing range, while nonferrous metals, such as aluminum and copper, can reduce the sensing range by up to 60 percent. Since the output of an inductive sensor has two possible states, an inductive sensor is sometimes referred to as an inductive proximity switch.

Fig 3.9: Example of Inductive Sensor

2. Capacitive Sensors

Capacitive sensors detect anything that is conductive or has a dielectric different from that of air. Many types of sensors use capacitive sensing, including sensors to detect and measure proximity, position or displacement, humidity, fluid level, and acceleration. Human interface devices based on capacitive sensing, such as track pads.can replace the computer mouse. Digital audio players, mobile phones, and tablet computers use capacitive sensing touch screens as input devices.

Fig 3.10: Example of Capacitive Sensors

3. Photoelectric Sensors

Photoelectric sensors consist of a few of basic components: each has an emitter light source (Light Emitting Diode, laser diode), a photodiode or phototransistor receiver to detect emitted light.

Fig 3.11: Example of Photoelectric Sensors

4. Ultrasonic Sensors

Ultrasonic transducers are transducers that convert ultrasound waves to electrical signals or vice versa. Those that both transmit and receive may also be called ultrasound transceivers; many ultrasound sensors besides being sensors are indeed transceivers because they can both sense and transmit. These devices work on a principle similar to that of transducers used in radar and sonar systems, which evaluate attributes of a target by interpreting the echoes from radio or sound waves, respectively. Ultrasonic proximity sensors are used in many automated production processes. They employ sound waves to detect objects, so color and transparency do not affect them.

Fig 3.12: Example of Ultrasonic Sensors

3.5 Solenoid

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

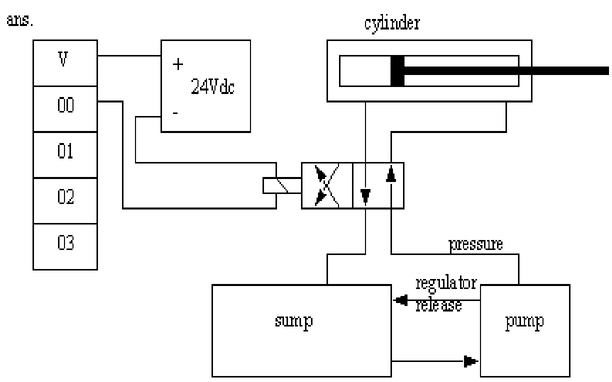


Fig 3.13: Solenoid Wiring Connection with PLC

3.6 cylinders

Mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion. Like hydraulic cylinders, something forces a piston to move in the desired direction. The piston is a disc or cylinder, and the piston rod transfers the force it develops to the object to be moved. Engineers sometimes prefer to use pneumatics because they are quieter, cleaner, and do not require large amounts of space for fluid storage.

Fig 3.14: Examples of Cylinders

❖ **Type of cylinders:**

3.6.1.Double-Acting Cylinder:

Power stroke is in both directions and is used in the majority of applications. The cylinder in which the working fluid acts alternately on both sides of the piston. In order to connect the piston in a double-acting cylinder to an external mechanism

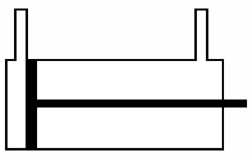


Fig 3.15: Double Acting Cylinder

3.6.2.Single-Acting Return Spring Cylinder :

When thrust is needed in only direction, a single-acting cylinder may be used. The inactive end is vented into the atmosphere through a breather filter for pneumatic applications, or vented to a reservoir below the oil level in hydraulic applications. A single-acting cylinder relies on the load, springs, other cylinders, or the momentum of a flywheel, to push the piston back in the other direction

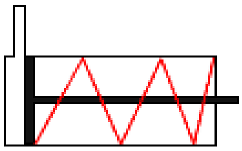


Fig 3.16: Single-Acting Return Spring Cylinder

3.7 inverter

- A variable-frequency drive (VFD) is a type of motor drive used in electro-mechanical drive systems to control AC motor speed and torque by varying motor input frequency and, depending on topology, to control associated voltage or current variation VFDs may also be known as inverter drives.
- Over the last four decades, power electronics technology has reduced VFD cost and size and has improved performance through advances in semiconductor switching devices, simulation and control techniques, and control hardware and software.

Fig 3.17: inverter

Chapter 4

Experimental work of car washing machine

Chapter (4)

4- Experimental work of car washing machine

Components of the PLC based car washing machine

The components are presented as following:

1) Mechanical parts

2) Photoelectric Sensor

3) Valve with solenoid

4) Compressor

5) dc motors

6) 3- phase indction motors

7) Inverter to control 3 phase induction motor

8) PLC

9) Power Sources (ac and dc)

10) Relays

1) Figure 4.1 represent the experimental work of the project

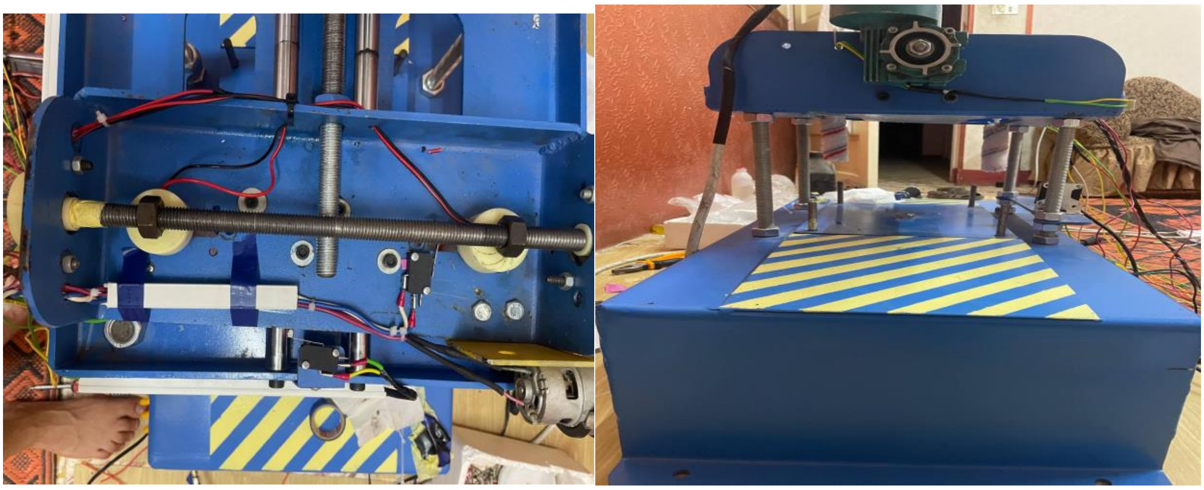


Fig 4.1.a: mechanical part represent DC motors

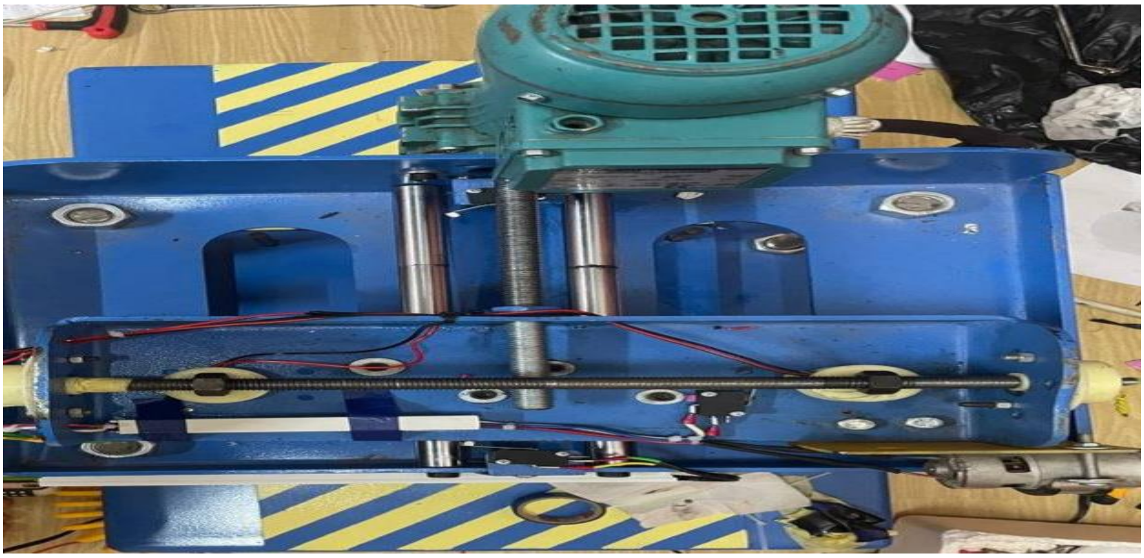


Fig 4.1.b: mechanical frame represent 3- phase induction motor

2) Sensor

Sensor (as shown in fig 4.2) is used to sense the car and give signal to start the process

Fig 4.2: photoelectric sensor

3) Valve with solenoid

The valve (as shown in fig 4.3) operate with solenoid and give signal for piston to rise to rise the car

Fig 4.3: valve with solenoid

4) Compressor

The compressor (as shown in fig 4.4) is used to pump the air in the piston to rise it .

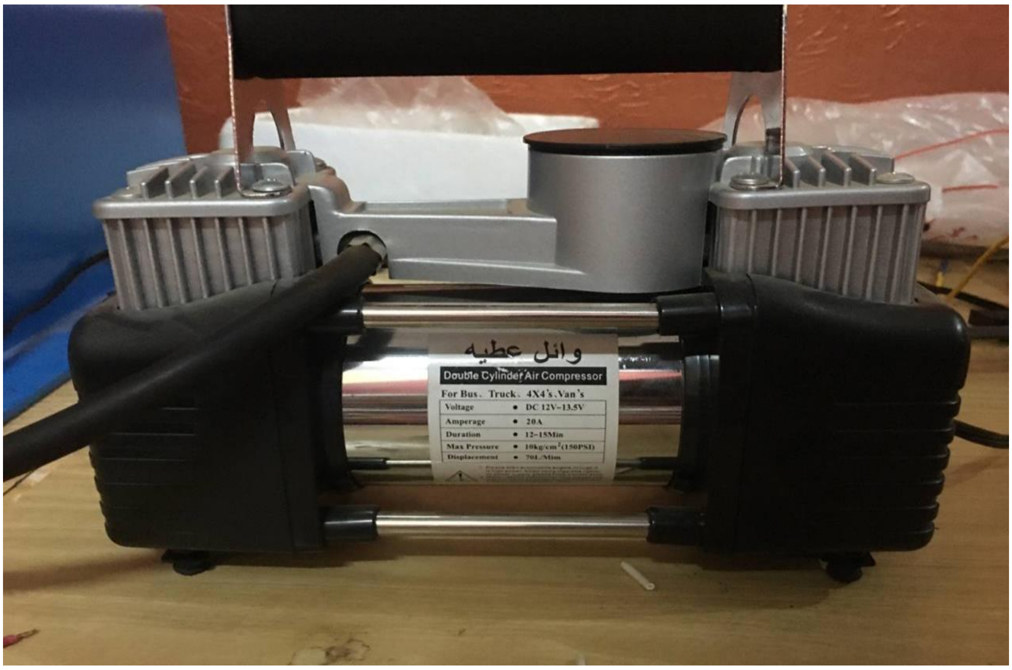


Fig 4.4: compressor

5) Dc motor (12 volt)

The dc motor (as shown in fig 4.5) is used to close and open the brushes.

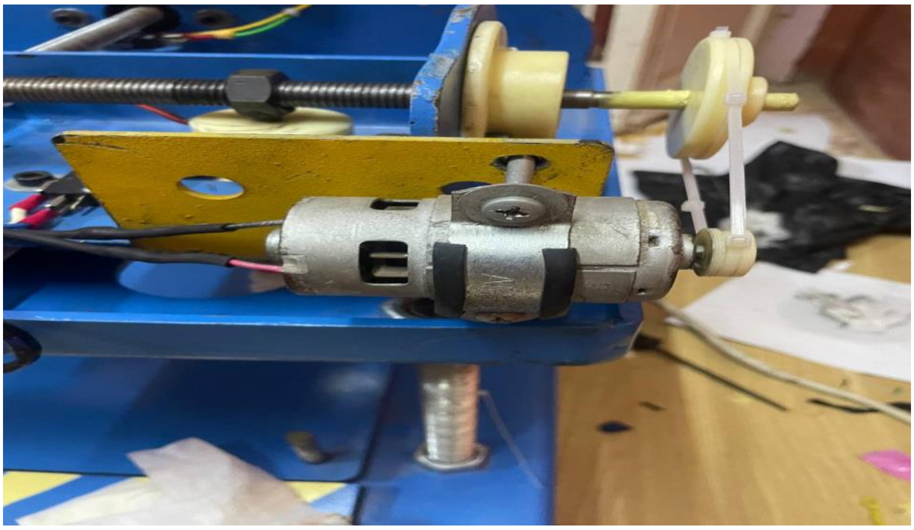


Fig 4.5 : Dc motor (12 volt)

5.1) Tow motors (6 volt)

Two motors are used to rotate the two brushes (as shown in fig4.6.a)

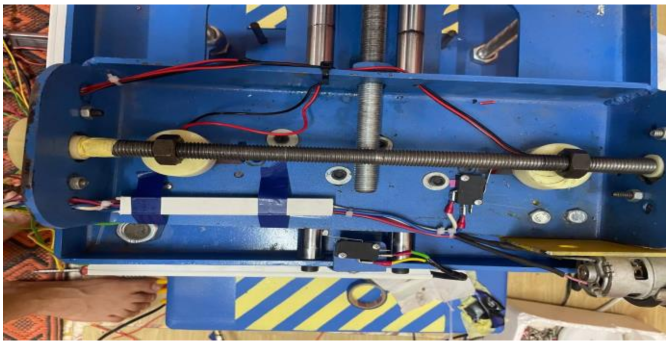


Fig 4.6.a: Two Dc motor to rotate the brushes

Fig 4.6.b: Dc motor (6 volt)

6) 3- phase induction motor

The 3- phase induction motor (as shown in fig 4.7) is used to move the mechanical group (the brushes and Dc motors) in forward and reverse.

Fig 4.7: 3- phase induction motor

7) inverter

The inverter (as shown in fig 4.8) is used to convert from single phase ac source to three phase ac source to feet the 3- phase induction motor , control in speed of 3- phase induction motor and move the 3- phase induction motor in forward and reverse.

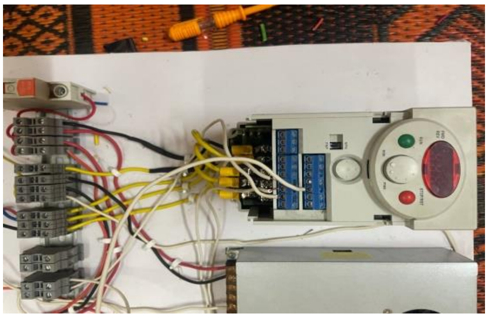
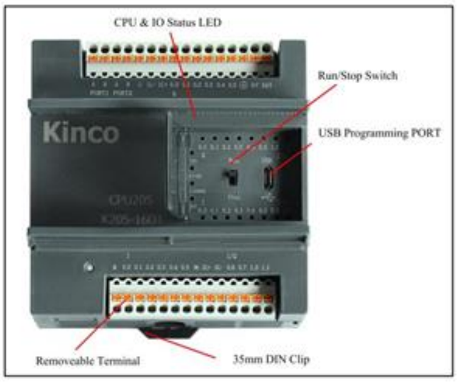


Fig 4.8: inverter

8) Programmable logic control (PLC)

PLC (as shown in fig 4.9) is used for control the output automatically .



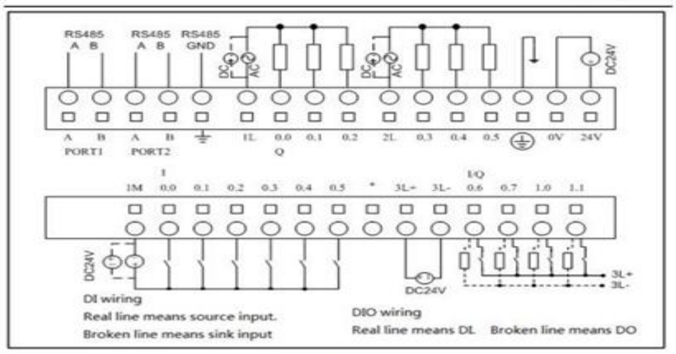
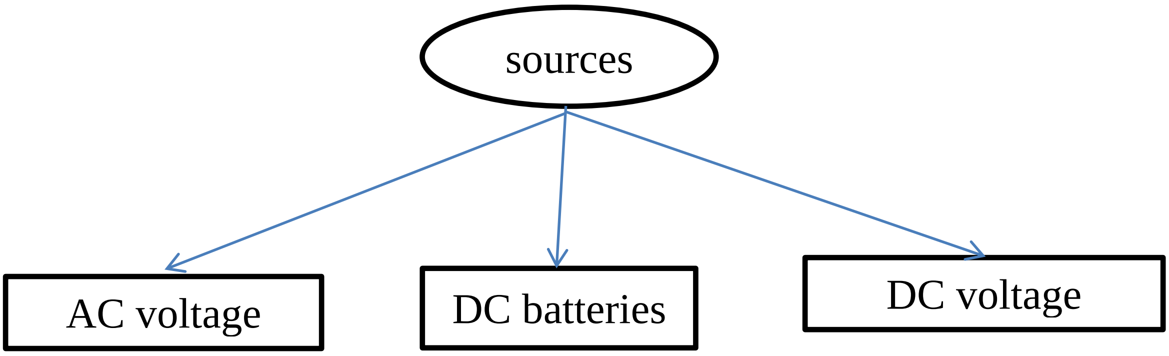


Fig 4.9.a: Programmable Logic control (PLC)

Fig 4.9.b: K205-DR wiring diagram

9) power sources



9.1) Ac voltage (220v phase voltage) is used to feed the inverter for 3- phase induction motor.

9.2) Dc batteries (as shown in fig 4.10) are used to feed the dc motors.

Fig 4.10: Dc battery

9.3) Two Dc voltage (12 volt and 24 volt)

9.3.1) the Dc voltage (12 volt)

The Dc voltage (12 volt) (as shown in fig 4.11) is used to feet the compressor.

Fig 4.11:Dc voltage (12 volt)

9.3.2) the Dc voltage (24 volt)

The Dc voltage (24volt) (as shown in fig 4.12) is used to feet the PLC (CPU , input and output of PLC).

Fig 4.12: Dc voltage (24 volt)

10) Relays

Relays as shown in fig (4.13) are used as output of PLC to protect the PLC unit.

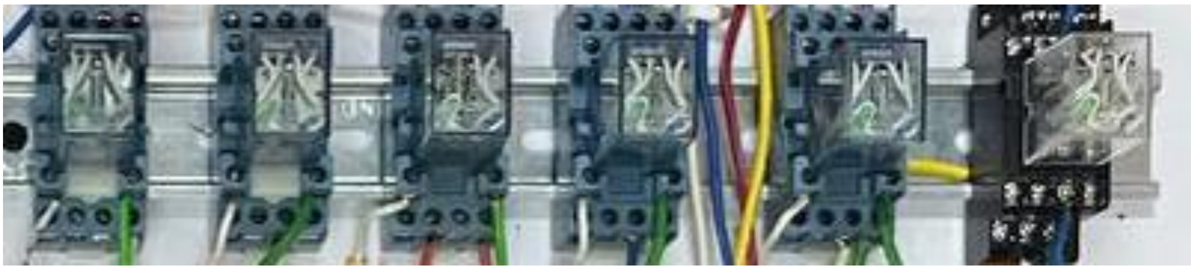


Fig 4.13: Dc Relays (24 volt)

Conclusion

In this project we have designed and built car wash using plc.

we have tested the project and we have noticed different errors are a mechanical frame design, programming , noisy sound at finishing the project and the operation of the relay.

We fixed theses errors

First testing contacts of relay

Second replace the relay which its contact is burnt with new relay

For noisy sound problem we fixed it by using valve in the opposite side

Future work

The system that we have built is a working on (micro controller) Arduino controller, which should be compact, fast and accurate.

This system may not have the features and reliability of the original design. It is only being developed to ensure that the design is feasible, not impractical and can be implemented on a much larger scale in a more efficient way.

(1) Interior wash

(2) Under chases wash Overcome limitations

(3)Coin & token system

(4)Also we can implement a counter which will be allowing the number of cars washed to be counted

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