# Contents

# Chapter 1

# Introduction to PLC

## 1.0 Introduction

Programmable logic controllers (PLCs) have become the most predominant control elements for the discrete event control of a mechatronics system. Simplification of engineering and precise control of manufacturing process can result in significant cost savings. The most cost-effective way which can pay big dividends in the long run is flexible automation; a planned approach towards integrated control systems. It requires a conscious effort on the part of plant managers and engineers to identify areas where automation can result in better deployment and/or utilization of human resources and savings in man-hours or down time. Controls automation need not be high ended and extremely sophisticated; it is the phased, step-by-step effort to automate, employing control systems tailored to one's specific requirements that achieves the most attractive results. This is where programmable logic controls have been a breakthrough in the field of automation and control techniques. This report looks at the role PLCs play in these techniques.

A constant demand for better and more efficient manufacturing and process machinery has led to the requirement for higher quality and reliability in control techniques. With the availability of intelligent, compact solid state electronic devices, it has been possible to provide control systems that can reduce maintenance, down time and improve productivity to a great extend. By installing an efficient and user friendly Electronics systems for manufacturing machinery or processors, one can obtain a precise and reliable means for producing quality products . One of the latest techniques in solid state controls that offers flexible and efficient operation to the user is programmable controllers. The basic idea behind these programmable controllers was to provide means to eliminate high cost associated with inflexible, conventional relay controlled systems. Programmable controllers offer a system with computer flexibility that is suited to withstand the harsh industrial environment, has simplicity of operation/read ability, can reduce machine down time and provide expandability for future and is able to be maintained by plant technicians.

## 1.1 Purpose

This report is an informative overview of the purpose of programmable logic controllers and ladder logic. Due to the complexity of programmable logic controllers and ladder logic, only the basic operationand programming will be discussed. Prior knowledge of basic electrical circuitry, controls and computer programming is suggested before reading this report. In order for the reader to better understand this report, the following questions will be explained:

1. What is a PLC?
2. What is ladder logic?
3. What are the different PLC components?
4. How does ladder logic work?
5. How does a PLC system work in conjunction with everything else?
6. How do you program a ladder logic program?

## 1.2 Plan of Development

To answer these questions, the report will include the followingsections :

**1. Programmable Logic History**: This section will discuss the history and advancement of controls technology, with a comparison of programmable logic controllers and hard-wired relays. It will also discuss PLC operation.

**2. PLC components**: This section will define what programmable logic is and describe all hardware associated with it.

**3. Ladder Logic**: This section will cover ladder logic and its general progressionfrom relay logic.

**4. Ladder Logic Programming**: This section will cover basic programming techniques and their implementation.

### 1.2.1 Project objectives

This project is about develop a new practical traffic light control system which the system will solve the traffic congestion issue. To develop the project, there are two objectives that must be accomplished which are:-

i. Develop a new traffic light control system controlled by programmable logic controller (PLC).
ii. Implement the system on a model of a traffic light.

### 1.2.2 Project scope

i. Construct a model of four way junction of a traffic light model.
ii. Programmed a ladder logic diagram to control the traffic light. iii. Combine the software part and the hardware part to simulate a traffic light system.

## 1.3 Programmable Logic History

PLCs were first introduced in the 1960’s. The primary reason for designing such a device was eliminating the large cost involved in replacing the complicated relay based machine control systems. Bedford Associates (Bedford, MA) proposed something called a Modular Digital Controller (MODICON) to a major US car manufacturer. The MODICON 084 brought the world's first PLC into commercial production.

When production requirements changed so did the control system. This becomes very expensive when the change is frequent. Since relays are mechanical devices they also have a limited lifetime because of the multitude of moving parts. This also required strict adhesion to maintenance schedules. Troubleshooting was also quite tedious when so many relays are involved. Now picture a machine control panel that included many, possibly hundreds or thousands, of individual relays. The size could be mind boggling not to mention the complicated initial wiring of so many individual devices. These relays would be individually wired together in a manner that would yield the desired outcome. The problems for maintenance and installation were horrendous.

These new controllers also had to be easily programmed by maintenance and plant engineers. The lifetime had to be long and programming changes easily performed. They also had to survive the harsh industrial environment. The answers were to use a programming technique most people were already familiar with and replace mechanical parts with solid-state ones which have no moving parts.

Communications abilities began to appear in approximately 1973. The first such system was Modicum’s Mudbugs. The PLC could now talk to other PLCs and they could be far away from the actual machine they were controlling. They could also now be used to send and receive varying voltages to allow them to use analog signals, meaning that they were now applicable to many more controlsystems in the world. Unfortunately, the lack of standardization coupled with continually changing technology has made PLC communications a nightmare of incompatible protocols and physical networks.

The 1980’s saw an attempt to standardize communications with General Motor's manufacturing automation protocol (MAP).It was also a time for reducing the size of the PLC and making them software programmable through symbolic programming on personal Computers instead of dedicated programming terminals or handheldProgrammers.

The 1990’s saw a gradual reduction in the introduction of new protocols, and the modernization of the physical layers of some of the more popular protocols that survived the

1980's. PLCs can now be programmable in function block diagrams, instruction lists, C and structured text all at the same time. PC's are also being used to replace PLCs in some applications. The original company who commissioned the MODICON 084 has now switched to a PC based control system.

## 1.4 Hard Wired Relay Comparison

At the outset of industrial revolution, especially during sixtiesandseventies, relays were used to operate automated machines, and these were interconnected using wires inside the control panel. In some cases a control panel covered an entire wall. To discover an error in the system much time was needed, especially with more complex process control systems. On top of everything, a lifetime of relay contacts was limited, so some relays had to be replaced. If replacement was required, machine had to be stopped and production as well. Also, it could happen that there was not enough room for necessary changes. A control panel was used only for one particular process, and it wasn't easy to adapt to the requirements of a new system. As far as maintenance, electricians had to be very skilful in finding errors. In short, conventional control panels proved to be very inflexible. Typical example of conventional control panel is given in the following picture.

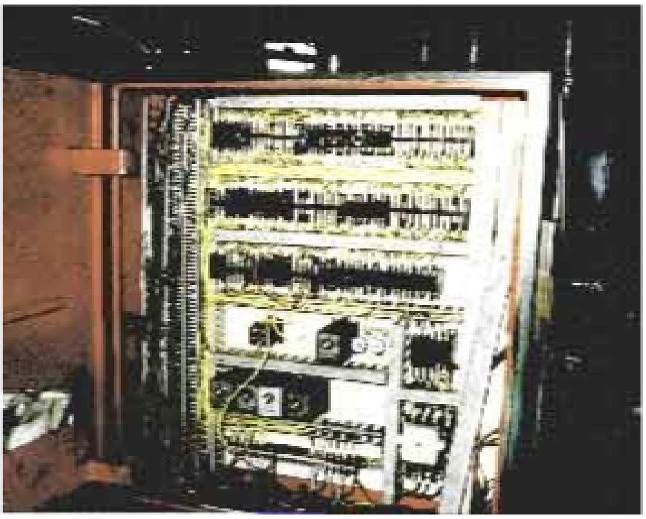


*Figure 1: Typical Small Scale Control Panel*

In Figure.1 you can see a large number of electrical wires, relays, timers and other elements of automation typical for that period.

The pictured control panel is not one of the more complicated ones, so you can imagine what complex ones looked like.

The most frequently mentioned disadvantages of a classic control panel are:

1. Large amount of work required connecting wires
2. Difficulty with changes or replacements
3. Difficulty in finding errors; requiring skilful/experienced workforce
4. When a problem occurs, hold-up time is indefinite, usually long.

With invention of programmable controllers, much has changed in how a process control system is designed. Many advantages appeared. Typical example of control panel with a PLC controller is given in the following picture

*Figure 2: Typical PLC Control Panel*

**Advantages of control panel that is based on a PLC controller can be presented in few basic points:**

1. Compared to a conventional process control system, number of wires needed for connections is reduced by approximately 80%.
2. Diagnostic functions of a PLC controller allow for fast and easy error detection.
3. Change in operating sequence or application of a PLC controllerto a different operating processcan easily be accomplished by replacing a program through a console or using PC software (not requiring changes in wiring, unless addition of some input or output device is required).
4. Needs fewer spare parts.
5. It is much cheaper compared to a conventional system, especially in cases where a large number of Input /Output instruments are needed and when operational functions are complex.

6. Reliability of a PLC is greater than that of an electro-mechanical relay or a timer, because of less moving parts
7. They are compact and occupy less space
8. Use of PLC results in appreciable savings in Hardware and wiring cost.

## 1.5 Programmable Logic Controller Components

A Programmable controller is a solid state user programmable control system with functions to control logic, sequencing, timing, arithmetic data manipulation and counting capabilities. It can be viewed as an industrial computer that has a central processor unit, memory, input output interface and a programming device. The central processing unit provides the intelligence of the controller. It accepts data, status information from various sensing devices like limit switches, proximity switches, executes the user control program stored in the memory and gives appropriate output commands to devices such as Solenoid valves, switches etc.

Input output interface is the communication link between field devices and the controllers. Through these interfaces the processorcan sense and measure physical quantities regarding a machine or process, such as, proximity, position, motion, level, temperature, pressure, etc. Based on status sensed, the CPU issues command to output devices such as valves, motors, alarms, etc. The programmer unit provides the man machine interface. It is used to enter the application program, which often uses a simple user-friendly logic.

## 1.6 Components:

The PLC mainly consists of a CPU, memory areas, and appropriate circuits to receive input/output data. We can actually consider the PLC to be a box full of hundreds or thousands of separate relays, counters, timers and data storage locations. They don't physically exist but rather they are simulated and can be considered softwareCounters, timers, etc.

Each component of a PLC has a specific function:

•**Input Relays (contacts)** - These are connected to the outside world. They physically exist and receive signals from switches, sensors, etc. Typically they are not relays but rather they are transistors.

•**Internal Utility Relays**- These do not receive signals from the outside world nor do they physically exist. They are simulated relays and are what enables a PLC to eliminate external relays. There are also some special relays that are dedicated to performing only one task.

Some are always on while some are always off. Some are on only once during power-on and are typically used for initializing data that was stored.

•**Timers-** These come in many varieties and increments. The most common type is an on-delay type. Others include off-delay and both retentive and non-retentive types. Increments vary from 1 millisecond through 1 second. •Timers- These come in many varieties and increments. The most common type is an on-delay type. Others include off-delay and both retentive and non-retentive types. Increments vary from 1 millisecond through 1 second.

•**Counters-** These are simulated counters and they can be programmed to count pulses. Typically these counters can count up, down or both up and down. Since they are simulated they are limited in their counting speed. Some manufacturers also include high-speed counters that are hardware based. We can think of these as physically existing.

•**Timers-** These come in many varieties and increments. The most common type is an on-delay type. Others include off-delay and both retentive and non-retentive types. Increments vary from 1 millisecond through 1 second.

•**Data Storage-** Typically there are registers assigned to simply store data. They are usually used as temporary storage for math or data manipulation. They can also typically be used to store data when power is removed from the PLC. Upon power-up they will still have the same contents as before power was removed.

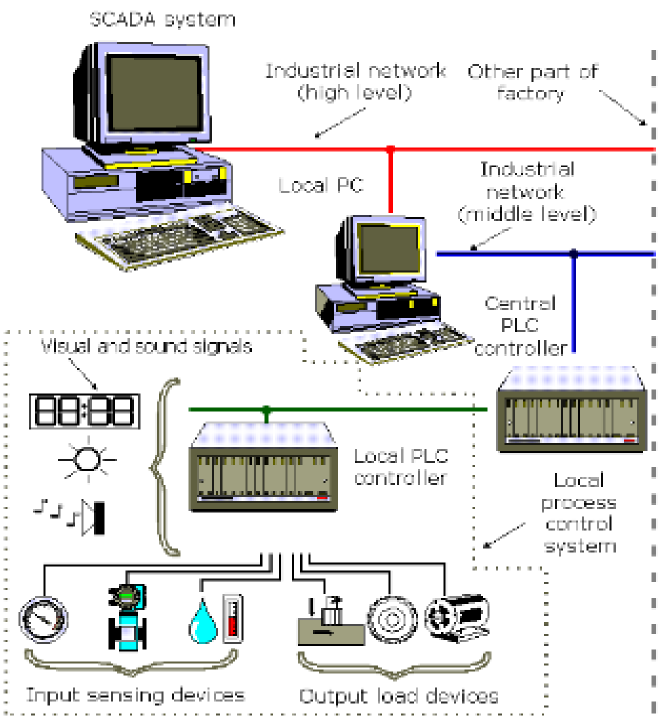



*Figure 3: PLC Components Diagram*

A counter is a simple device intended to do one simple thing - count. Using them can sometimes be a challenge however because every manufacturer seems to use them a different way. There are several different types of counters. There are up-counters called CTU CNT, or CTR that only count up, such as 1, 2, and 3. There are also down counters called CTD that only count down, such as 9, 8, 7, etc. In addition to these two, there are up-down counters, typically called UDC (up-down counter).

These count up and/or down (1,2,3,4,3,2,3,4,5,...).

A timer is an instruction that waits a set amount of time before doing something. As usual in industry, different types of timers are available with different manufacturers. The most common type of timer is an On-Delay Timer. This type of timer simply delays turning on its respective output. In other words, after our sensor (input) turns on we wait "x" number of seconds before activating a solenoid valve (output). This is the most common timer. It is often called TON (timer on-delay), TIM (timer) or TMR (timer). Another type of timer is an Off-Delay Timer. This type of timer is the opposite of the on-delay timer listed above. This timer delays turning off its respective output. After a sensor (input) sees a target we turn on a solenoid (output).When the sensor no longer sees the target we hold the solenoid on for x number of seconds before turning it off. It is called a TOF (timer off-delay) and is less common than the on-delay type listed above. Very few manufacturers include this type of timer, although it can be quite useful. The last type of timer is a Retentive or Accumulating timer. This type of timer needs 2 inputs. One input starts the timing event (i.e. the clock starts ticking) and the other resets it. The on/off delay timers above would be reset if the input sensor wasn't on/off for the complete timer duration. This timer however holds or retains the current elapsed time when the sensor turns off in mid-stream. For example, we want to know how long a sensor is on for during a 1 hour period. If we use one of the above timers they will keep resetting when the sensor turns off/on. This timer however, will give us a total or accumulated time. It is often called an RTO (retentive timer) or TMRA (accumulating timer).

## 1.7PLC Operation

A PLC works by continually scanning a program. We can think of this scan cycle as consisting of 3 important steps. There are typically more than 3 but we can focus on the important parts and not worry about the others. Typically the others are checking the system and updating the current internal counter and timer values. The first type of scanning, as shown in the diagram below, is not as common as the type that will be discussed second.

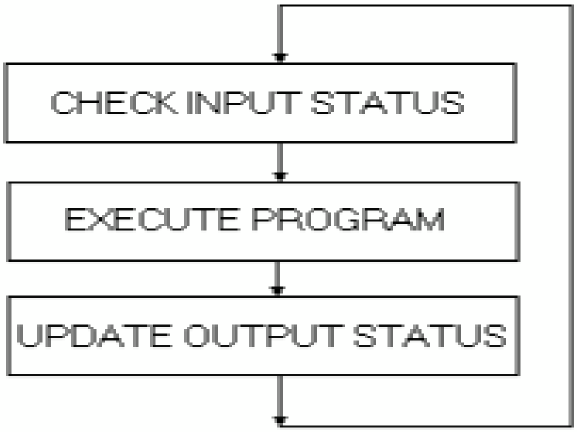



*Figure 4: PLC Scan Diagram*

The first step is to check the input status. This step is therefore generally referred to as the "Check Input Status" stage. First the PLC takes a look at each input to determine if it is on or off. In other words, is the sensor connected to the first input on? How about the second input? How about the third? This goes on and on through the entire program. It records this data into its memory to be used during the next step.

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

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

A new style of scanning has been implemented in the more recent years, called "rung scanning". This type basically scans each ladder rung individually in the entire ladder logic program, updating the outputs on that rung after scanning through the inputs. This changes the type of programming that will be used as well. If an output is in a rung above the inputs it depends on, you will not get the output updated until the next scan, as the program will keep scanning down until the last rung, then start over. This style is very advantageous in certain situations. If you want your outputs updated at the soonest possible moment, this is the style of scanning that you want to use.

## 1.8.The Structure of PLC

Programmable logic controllers (PLCs) have been used in industry in one form or another for the past twenty over years. The PLC is designed as a replacement for the hard-wired relay and timer logic to be found in traditional control panels, where PLC provides ease and flexibility of control based on programming and executing logic instructions. The internal functions such as timers, counters and shift registers making sophisticated control possible using even the smallest PLC. The structure of a PLC can be divided into four parts. They are input/output modules, central processing unit (CPU),memory and programming terminal.

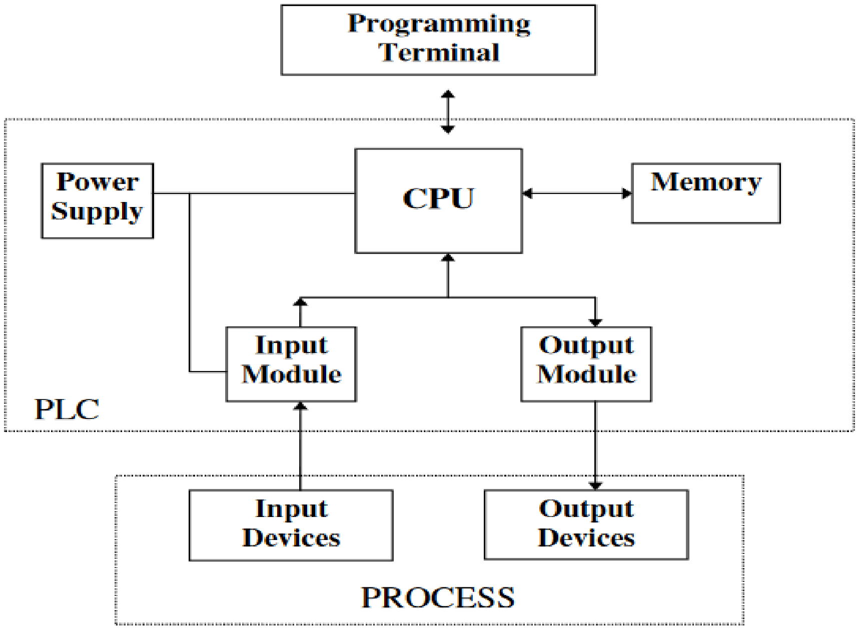



Fig. 1 : **Programmable logic controller (PLC) structure** *

A programmable controller operates by examining the input signals from a process and carrying out logic instructions (which have been programmed into its memory) on these input signals, producing output signals to drive process equipment or machinery. Standard interfaces built-in to PLC allow them to be directly connected to process actuators and transducers without the need for intermediate circuitry or relays.

PLCs require shorter installation and commissioning times than do hard-wired systems. Although PLCs are similar to 'conventional' computers in term of hardware technology.

**Specific features suited for industrial control:**

(a) Rugged, noise immune equipment;

(b) Modular plug-in construction, allowing easy replacement or addition of units (e.g. input/output);

(c) Standard input/output connections and signal levels;

(d) Easily understood programming language;

(e) Ease of programming and reprogramming in-plant;

(f) Capable of communicating with other PLCs, computers and intelligent devices;

(g) Competitive in both cost and space occupied with relay and solid-state logic systems;

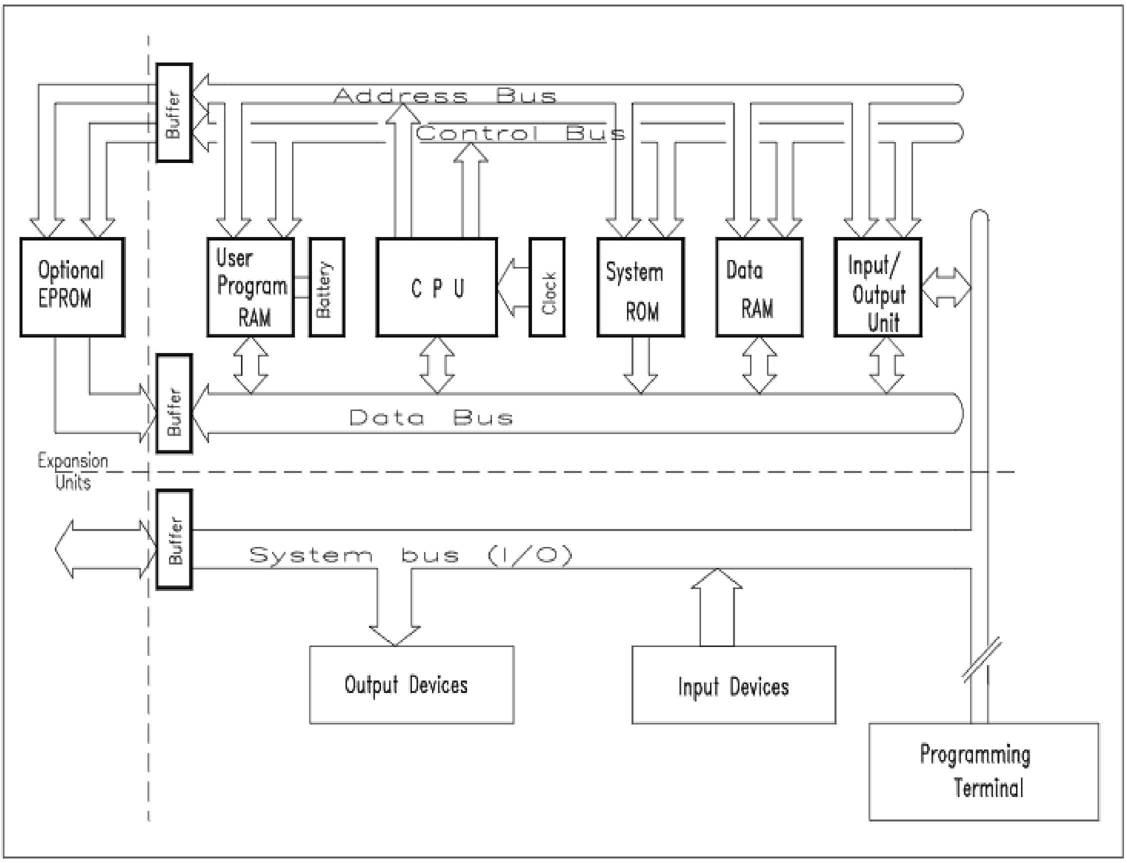
These features make programmable controllers highly desirable in a wide variety of industrial-plant and process-control situations.

## 1.9 PLC - Hardware

Programmable logic controllers are purpose-built computers consisting of three functional areas: processing, memory and input/output. Input conditions to the PLC are sensed and then stored in memory, where the PLC performs the programmed logic instructions on these input states. Output conditions are then generated to drive associated equipment. The action taken depends totally on the control program held in memory.

### 1.10.Central Processing Unit (CPU)

The CPU controls and supervises all operations within the PLC, carrying out programmed instructions stored in the memory. An internal communications highway, or bus system, carries information to and from the CPU, memory and I/O units, under control of the CPU.

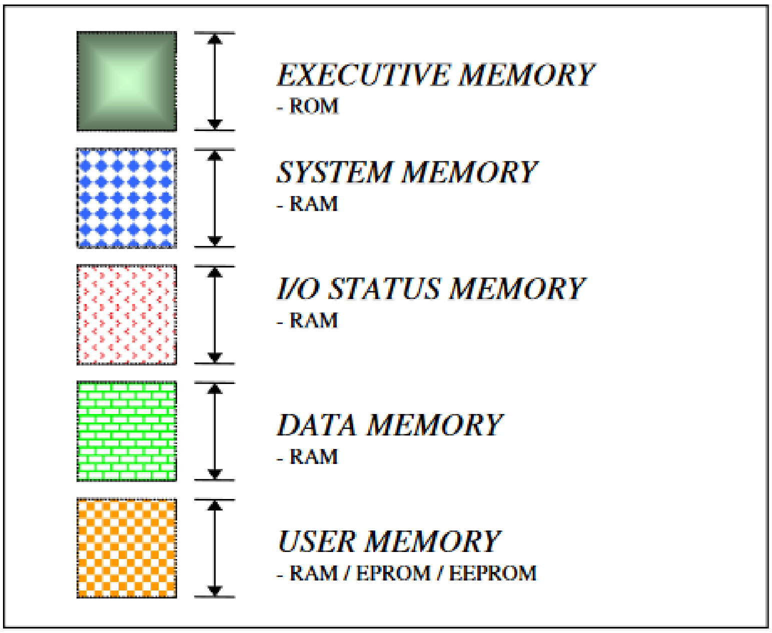



**Block diagram of PLC CPU architecture**

Virtually all modern PLCs are microprocessor-based, using a 'micro' as the system CPU. Some larger PLCs also employ additional microprocessors to control complex, time-consuming functions such as mathematical processing, three-term PID control, etc.

## 1.11. Memory

All PLCs contain both RAM and ROM in varying amounts depending upon the design of the PLC. The use of a PLC's memory is determined again by the design of the unit. However, all PLC memories can be subdivided into at least five major areas. A typical memory utilizationmap for a PLC is depicted in the following figure.




Typical PLC memory utilization map

**a. Executive Memory**

The operating system or executive memory for the PLC is always in ROM since, once programmed and developed by the manufacturer , it rarely needs changing. It is the one that actually does the scanning in a PLC. The operating system is a special machine language program that runs the PLC. It instructs the microprocessor to read each user instruction, helps the microprocessor to interpret user programmed symbols and instructions, keeps track of all the I/O status , and is responsible for maintaining/monitoring the current status of the health of the system and all its components.

**b. System memory**

In order for the operating system to function, a section of the memory is allotted for system administration. As the executive program performs its duties, it often requires a place to store intermediate results and information. A section of RAM is installed for this purpose. Normally this area is allotted for use of the operating system only and is not available to the user for programming. It might be thought of as a scratch pad for the operating system to doodle on as necessary. Some PLCs use this area for storing the information which passes between programmer and operating system, e.g. the operating system generates certain error codes store in the specific address in this area during the execution of user program which can be read by user program; or the user may also give additional information to the operating system before execution of user program by writing some codes in the specific address in this area, etc.

### c.I/O Status Memory - I/O Image Table

Another portion of RAM is allocated for the storage of current I/O status. Every single input/output module has been assigned to it a particular location within the input/output image table.

The location within the input and output image tables are identified by addresses, each location has its own unique address. During the execution of user program, the microprocessor scans the user program and interpret the user commands, the status of input modules used are read from the input image table (not directly from the input module itself). Various output device status generated during the execution of user program are stored in the output image table (not directly to output modules). (Find out about input scan and output scan.)

### d. Data Memory

Whenever timers, counters, mathematics and process parameters are required, an area of memory must be set aside for data storage. The data storage portion of memory is allocated for the storage of such items as timers or counter preset/accumulated values, mathematics instruction data and results, and other miscellaneous data and information which will be used by any data manipulation functions in the user program.

Some manufacturers subdivide the data memory area into two sub-memories, one for fixed data and other for variable data. The fixed data portion can only be programmed via the programming device. The CPU is not permitted to place data values in this area. The variable portion of the data memory is available to the CPU for data storage.

### e. User Program Memory

The final area of memory in a PLC is allocated to the storage of the user program. It is this memory area that the executive program instructs the microprocessor to examine or 'scan' to find the user instructions. The user program area may be subdivided if the CPU allocates a portion of this memory area for the storage of ASCII messages, subroutine programs, or other special programming functions or routines. In the majority PLCs, the internal data storage and user program areas are located in RAM. Several systems do offer an option that places both the user program and the fixed data storage areas in EPROM type memory. The user can develop program in RAM and run the system to ensure correct operation. Once the user is satisfied that the programming is correct, a set of EPROMs is then duplicated from the RAM. Then the user can shut down the CPU and replaces the RAM with the newly programmed EPROM. Any future change would require that the EPROMs be reprogrammed.

### 1.12.Input/Output Module Units

The input/output unit of PLCs handles the job of interfacing high power industrial devices to the low-power electronic circuitry that stores and executes the control program. MostPLCs operate internally at between 5 and 15V d.c. (common TTL and CMOS voltages), whilst signal from input devices can be much greater, typically 24V d.c. to 240V a.c. at several amperes.

The I/O module units form the interface between the microelectronics of the programmable controller and the real world outside , and must therefore provide all necessary signal conditioning and isolation functions. This often allows a PLC to be directly connected to process actuators and input deviceswithout the need for intermediate circuitry or relays.

It is standard practice for all I/O channels to be electrically isolated from the controlled process, using opto isolator circuitson the I/O modules. An opto -isolator allows small signal to pass through, but will clamp any high-voltage spikes or surges down to the same small level. This provides protection against switching transients and power-supply surges, normally up to 1500 V.

In small self-contained PLCs in which all I/O points are physically located on one casing, all inputs will be of one type (e.g. 24V) and the same for outputs (e.g. 240V triac). This is because manufacturers supply only standard function boards for economic reasons. On the other hand, modular PLCs have greater flexibility of I/O, since the user can select from several different types and combinations of input and output modules.

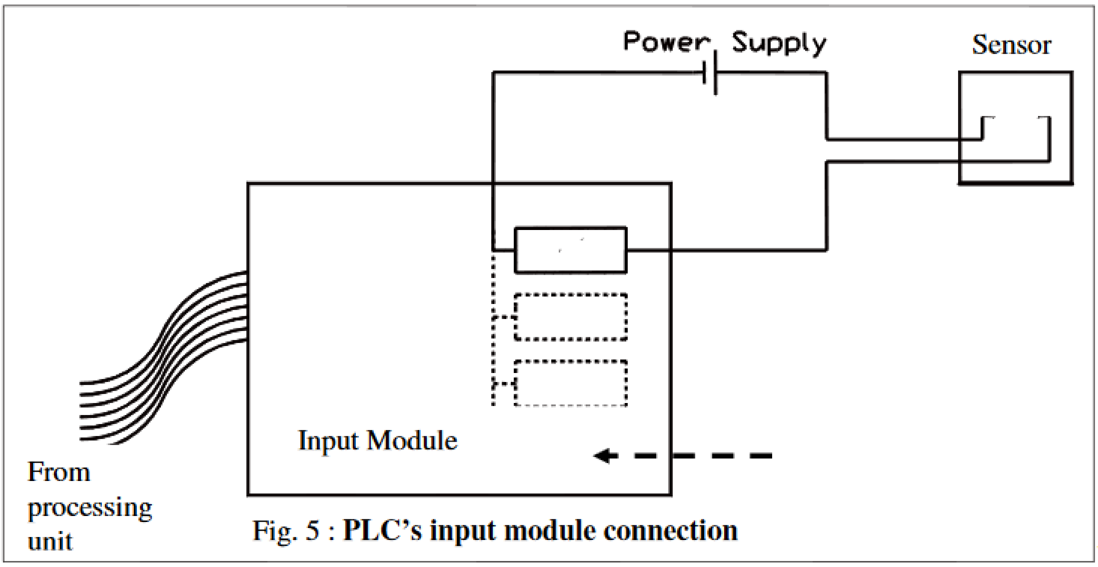



Fig. 5 : **PLC's input module connection**

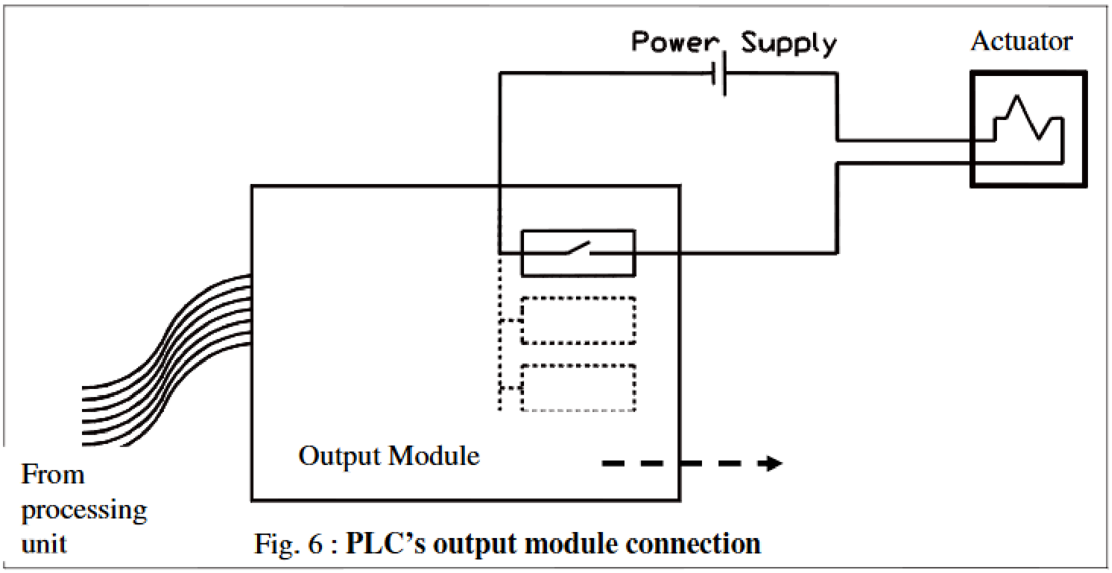



Fig. 6 : **PLC's output module connection**

In all cases the input/output module units are designed with the aim of simplifying the connection of input devices and actuators to the PLC . For this purpose, all PLCs are equipped with standard screw terminals or plugs on every I/O point, allowing the rapid and simple removal and replacement of a faulty I/O card. Every input/output module point has a unique address or channel number which is used during program development to specify the monitoring of an input or the activating of a particular output within the program. Indication of the status of input/output channels is provided by light-emitting diodes (LEDs ) on the PLC or I/O unit, making it simple to check the operation of processed inputs and outputs from the PLC itself.

## Chapter 2

# Ladder Logic

### 2.0 Definition

Ladder logic is one form of drawing electrical logic schematics, and is a graphical language very popular for programming Programmable Logic Controllers. Ladder logic was originally invented to describeLogic made from relays. The name is based on the observation that programs in this language resemble ladders, with two vertical "rails" and a series of horizontal "rungs" between them. Figure 5 below is a very basic example of ladder logic used in a programmable logic controls program.

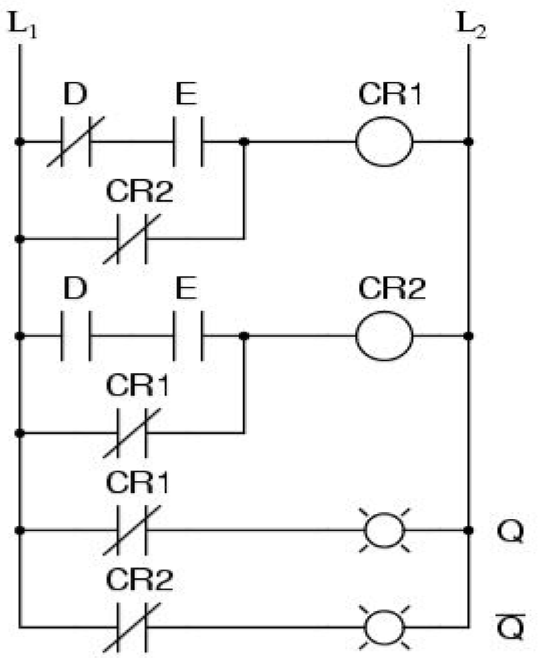


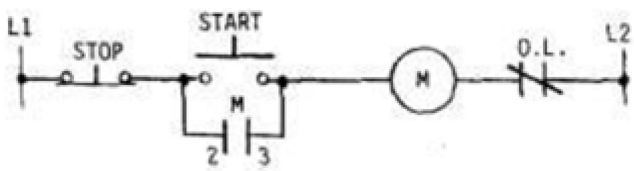

*Figure 5: Basic Ladder Logic Program*

### 2.1. Comparison to Relay Logic

The program used in a controls schematic, called a ladder diagram, is similar to a schematic for a set of relay circuits. An argument that aided the initial adoption of ladder logic was that a wide variety of engineers and technicians would be able to understand and use it without much additional training, because of the resemblance to familiar hardware systems. This argument has become less relevant lately given that most ladder logic programmers have a software background in more conventional programming languages, and in practice implementations of ladder logic have characteristics such as sequential execution that make the analogy to hardware somewhat imperfect. Electricians and data cabling or control technicians still argue that this is the best graphical interface as they generally do not have any computer science or digital systems background, and are therefore taught with this interface in sequence with relay logic.

Electromagnetic relay

Relay logic is the precursor to ladder logic, and is a method of controlling industrial electronic circuits by using relays and contacts. Above shows an average mechanical relay used in older relay logic systems. The schematic diagrams for relay logic circuits are often called line diagrams, because the inputs and outputs are essentially drawn in a series of lines, with the lines representing actual wires run in the circuit. A relay logic circuit is an electrical network consisting of lines, in which each input/output group must have electrical continuity with all components in that group of devices to enable the output device .The Relay logic diagrams represent the physical interconnection of devices, while the relay logic circuit forms an electrical schematic diagram for the control of input and output devices. This is why electricians and control technicians can easily understand and interpret relay logic and ladder logic diagrams. Figure7 below shows a basic relay logic circuit. Notice how it differs from the ladder logic circuit in Figure 5 in that the “virtual” inputs and outputs in the ladder logic circuit have replaced the actual relays and coils in the relay logic circuit.




It is a small, basic relay logic circuit. You can see how in relay logic circuits the pushbuttons are represented with graphical drawings of a normally closed pushbutton for the stop button, and a normally open pushbutton for the start button. The coil that is marked “M” is a motor coil, and is a physical piece of equipment in the same location as the motor, which is represented by a circle with the letter M in the middle. The over current or overload device is representted by a normally closed coil symbol with "O.L." over it. There would only be seven wires to connect in this circuit, so this would not be very difficult to wire, but when more inputs andoutputs are added ,the difficulty grows exponentially. Figure8 shows an expanded relay circuit of Figure7 in that a double pole single throw pushbutton is added into the diagram to be used as a "jog function". As the diagram shows, a jog switch is used to run the output (motor). Only one component is added, but three wires need to be installed in the circuit for the component to be utilized in the intended manner.

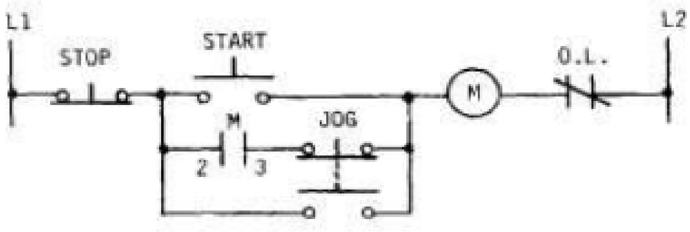



*Figure 8: Relay Logic Circuit with Jog function added*

Figure 9 below adds four more components to the system. Two of them are just coils from the motor apparatus that are used as inputs and the other two are a red and green light to be utilized as output/motor status indicators for the user.

# Chapter-3

# TRAFFIC LIGHT CONTOL

A traffic light is a collection of two or more coloured lights found at some junctions and pedestrian crossings which indicates whether it is safe and/or legal to continue across the path of other road users. In the United Kingdom, traffic lights are widely used both on major roads and in built-up areas. Their numbers have increased exponentially since they were first invented in 1868.The operation of standard traffic lights which are currently deployed in many junctions are based on predetermined timing schemes, which are fixed during the installation and remain until further resetting. The timing is no more than a default setup to control what may be considered as normal traffic. Although every road junction by necessity requires different traffic light timing setup, many existing systems operate with an over-simplified sequence. This has instigated various ideas and scenarios to solve the traffic problem. To design an intelligent and efficient traffic control system, a number of parameters that represent the status of the road conditions must be identified and taken into consideration.

### 3.1 Background History

The first traffic lights actually had their roots in the railway signals used at the time, where two gas lamps, one red and one green, would be alternately hidden by asemaphore arm depending on whether the arm was in a horizontal position or at a 30°angle. The first lights were installed outside the Houses of Parliament in London on 10December, 1868 to control the increasing number of vehicles there. However, according to some sources, they later exploded and injured the policeman operating them. The first electric lights were developed in the USA in the early 20th Century. Various people lay claim to the invention of the modern traffic light.

These include:

(i)**Lester Wire** , a Salt Lake City policeman who set up the first red-green electric traffic lights in 1912.

(ii)**James Hoge** , from Cleveland, who in 1914 designed some red-green electric lights with a buzzer which sounded when the lights changed.

(iii)**William Potts** from Detroit, who designed the first three-colour electric traffic lights in1920.

(iv) **John Harriss**, a Police Commissioner from New York who developed the first interconnected three-colour electric traffic lights in 1922.

(v) **Garrett Morgan**, from Cleveland, who in 1923 designed a cross-shaped signalling device which is often mistakenly referred to as the first traffic light. Once the USA had finished reinventing the traffic light, it was adopted in the UK. The first automatic lights were installed in Princes Square in Wolverhampton. Nowadays, traffic lights are often operated by complex computer software designed to optimise traffic flow [1]. This optimization is done using the Programmable Logic Controller (PLC).

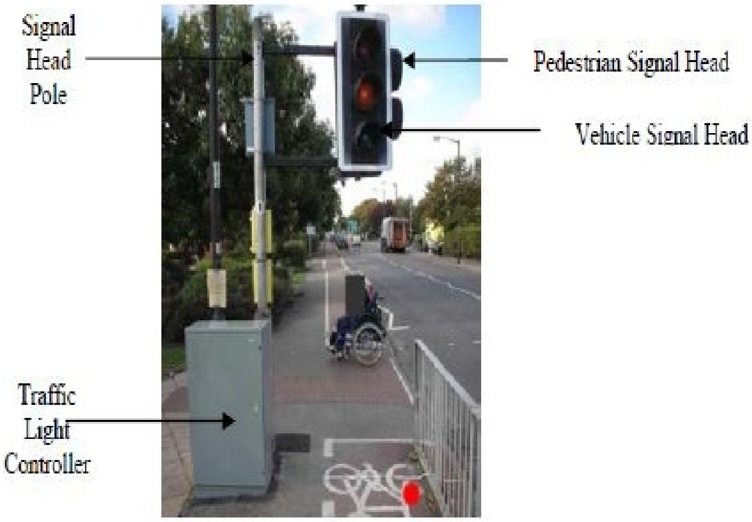



Figure-1. A modern traffic light.

Traffic Control Systems are used at a point where there are more than two paths for passage of vehicles or wherever passage is to be given to pedestrians to cross a road. It is also used wherever two paths cross each other thus creating a four-way lane. These systems are also put in place at points where there are by-lanes attached to the main road. The main aim of a traffic control system is to control the flow of vehicles through a lane and prevent accidents or road blockage. These systems are also used at points wherever a vehicle needs to be stopped for any purpose.

In our country the traffic control system is mostly based on sequential logic. There are three lights red for stop, yellow for get ready and green for go. Each light operates for a given period one after the other. The programming is so done that two lanes won't have the green light at the same time.

The traffic control system at a certain places is even controlled manually by traffic personnel but human error calls for automation to prevent undesirable incidents on road.

The traffic signals control the vehicle movements. They are connected to electronics system which controls the signals. They mainly work on logics which can be classified as

a) Signal phase and cycle length which is dependent on the traffic flow on the desired tracks.
b) System responds to interrupts or timing based system and opens the desired signal as required.

### 3.2. Advantages of a good Traffic Control System

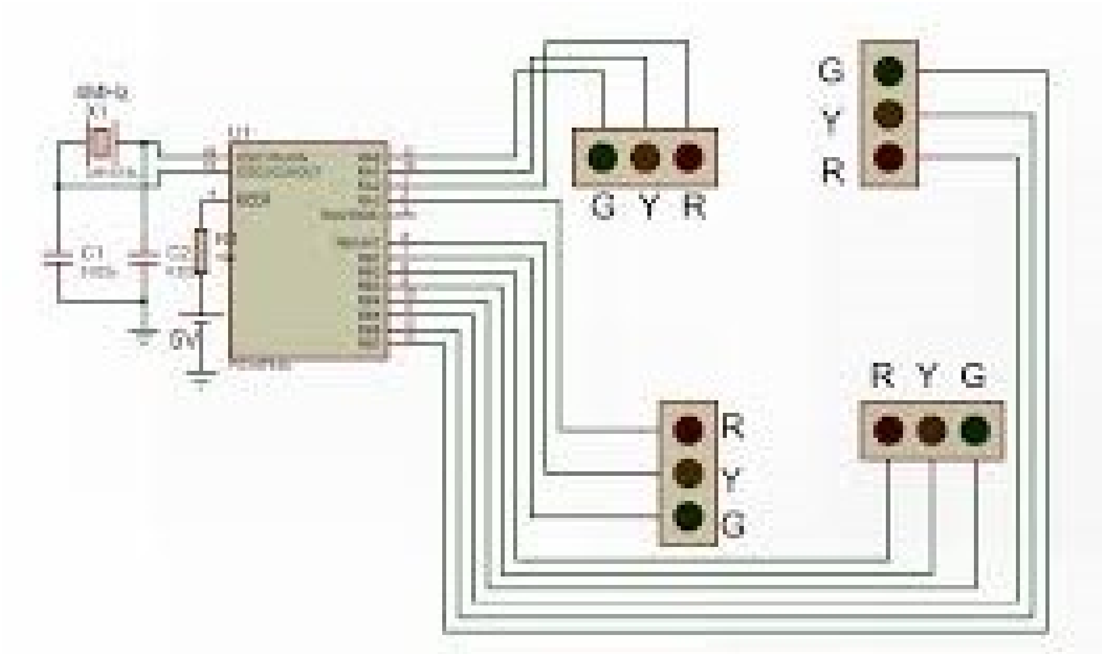
A properly ordered traffic control system can

1. Provide for orderly movement of traffic
2. Increase capacity at intersection
3. Reduce frequency and severity of certain kind of clashes
4. Provide continuous movement of traffic at a desired speed
5. Interrupt heavy traffic to allow pedestrians to pass
6. Effectively perform traffic management

But using a generalized traffic control system fails to detect high priority situations or emergency conditions. Hence the need for a Smart Traffic Control System arises which would work on certain conditions and be able to take decisions automatically.

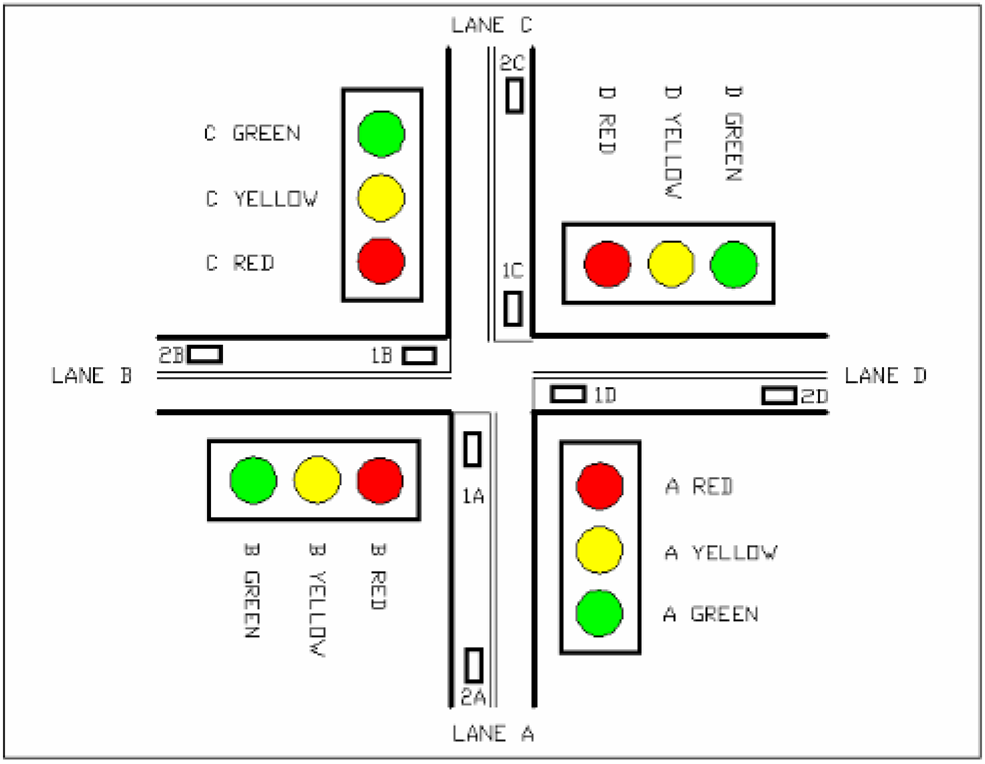
### 3.3 Traffic light model

The four ways junction is developed to display the simulation the development of the new traffic light control system. Figures shown below the design of traffic light model. Every lane and traffic light signals have been labelled with alphabet A, B, C and D to separate each lane and traffic light. Each traffic light lane has their set of traffic light signal “Red, Yellow, and Green”. This traffic light signal operates similar like common traffic light signal. It changes from red to green and then yellow and after that back to red signal.




Four way traffic signal light plc

Each lane also has two limit switches represent asa sensor on the road. The suitable sensor for design a real traffic light system is type of linear sensor or electromagnetic sensor. The first sensor placed in front of lane to detect the presence car at the junction and the second sensor placed at certain length from first sensor to determine the volume of the car at that lane. From this combination of sensor, we will know the expected time for green signal on when each lane change to the green signal.




**Traffic light**

## Need for Traffic Control

- Increasing number of vehicles and lower phase of highways developments have led to traffic congestion problem.
- Time of travel, environment quality, quality of life and road safety are all adversely affected as a result of traffic congestions.
- Delays caused due to traffic congestions indirectly affect productivity, efficiency, and energy losses.
- Human error can cause mismanagement.
- Emergency situations like medical emergencies,costructionwork,accidents,etc

## 3.4 Ladder Logic concept

It is a PLC based concept used for programming. It is developed to create relay logic by selecting ladder programming method the amount of training needed is very less. Relays are normally drawn in a schematic to represent the input coil. It is a simple device using magnetic field to control a switch. The contact which closed when input coil is energized is called normally open and those which close when not energized are called normally closed. In this logic we often use an output status as an input to another. The ladders are arranged in rungs. All rungs in a ladder receive same voltage supply.

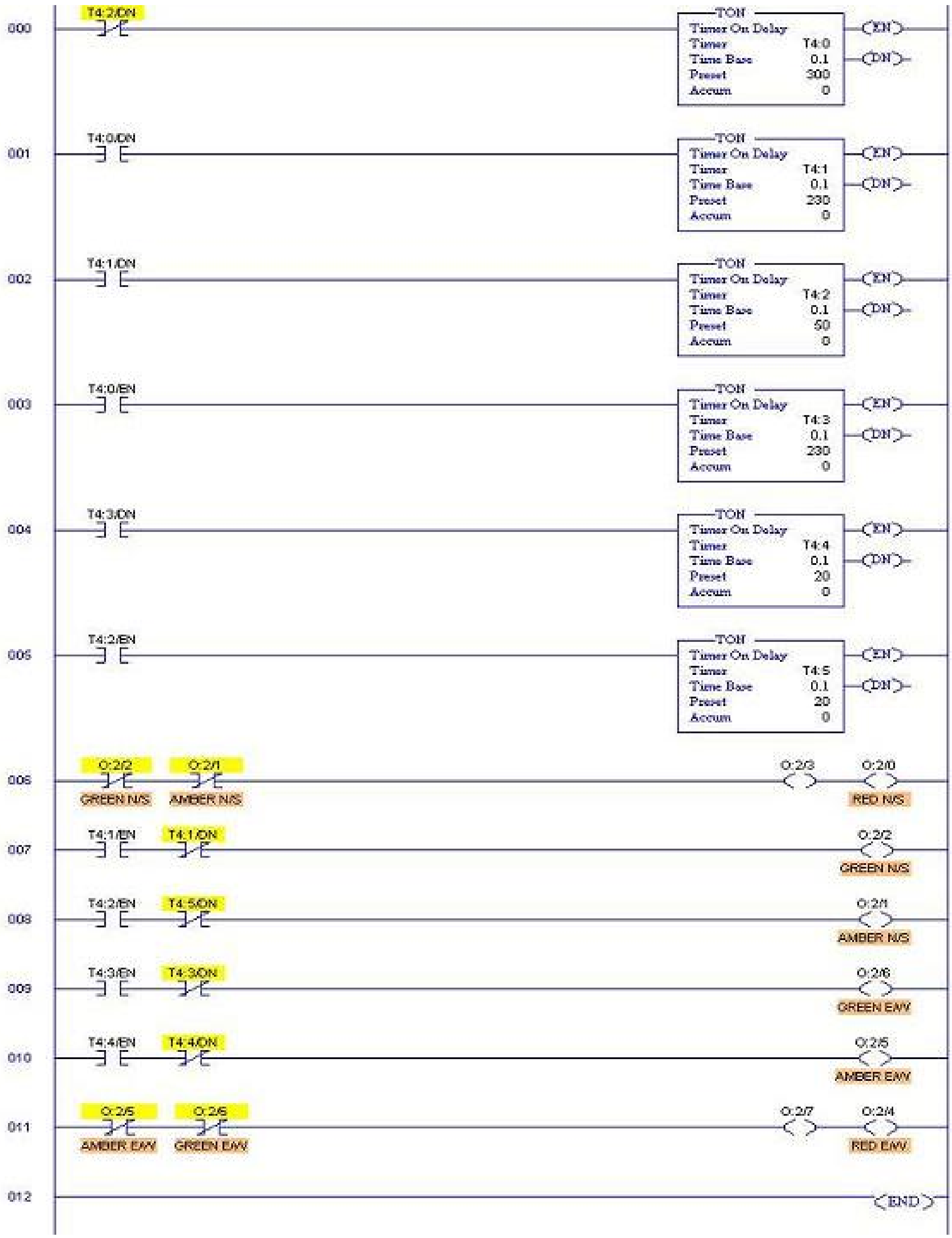
## Mnemonics

LG (1, 2,3,4)-Green light of respective lanes

LR (1,2,3,4)-Red light of respective lanes

T(1,2,3,4)-On timers for respective lanes to allow traffic flow

S(1,2,3,4)- switches representing whether density of a lane is high or not




LADDER DIAGRAM

Hardware model

# CONCLUSION

In this paper, the proposed of a new development of a traffic light control system controlled by PLC. This system will decreased the traffic congestion at traffic light by extend the time for the green signal if traffic density at that lane are high and give the priority to who first arrive at the junction to get a green signal. This project is divided into two parts which are hardware and software. The hardware part for this project is a model of four way junction of a traffic light. Each lane has two limits switch (input) function as a sensor. Three indicator lamps with different colours (Red, Yellow and Green) are installed at each lane for represents as traffic light signal. This limit switches and indicator lamps are connected to PLC. The PLC controls every signal which is coming from the inputs (Limit switch) to software and display to the outputs (Indicator lamps). The software part operates with Omron PLC is CXProgrammer. With using this software, the ladder logic diagram is programmed to control the traffic light. At the end of this project, the traffic light successfully control by PLC.

## REFERENCES


1. Monica Voinescu, AndreeaUdrea, SimonaCaramihal "On Urban Traffic Modelling and Control" (http://www.ceai.srait.ro/index.php/ceai/article/view/307)
2. C. M. Mwangi, S. M. Kang'ethe and G. N. Nyakoe "Design and simulation of a fuzzy logic traffic signal controller for a signalized intersection" (elearning.jkuat.ac.ke/journals/ojs/index.php/jscp/article/view/699)
3. sananas.G.Sayyed, Poonam.V.Pawar, Vishakha.S.Thakare,Snehal.R.Jadhav Design of smart traffic controller using embedded system(www.iosrjournals.org)
4. www.wikipedia.com (https://en.wikipedia.org/wiki/Traffic_light_control_and_coordination)
5. www.atmel.com
6. www.scribd.com
7. www.bookrags.com
8. www.ijater.com