PLC-SCADA BASED MODEL DESIGN OF A TRAIN COLLISION AVOIDANCE SYSTEM

A PROJECT REPORT

Submitted by

SHAH DIPALI V. (100670111042)

PATEL KHUSHBU B. (100670111105)

MALIK SAJEDA I. (100670111007)

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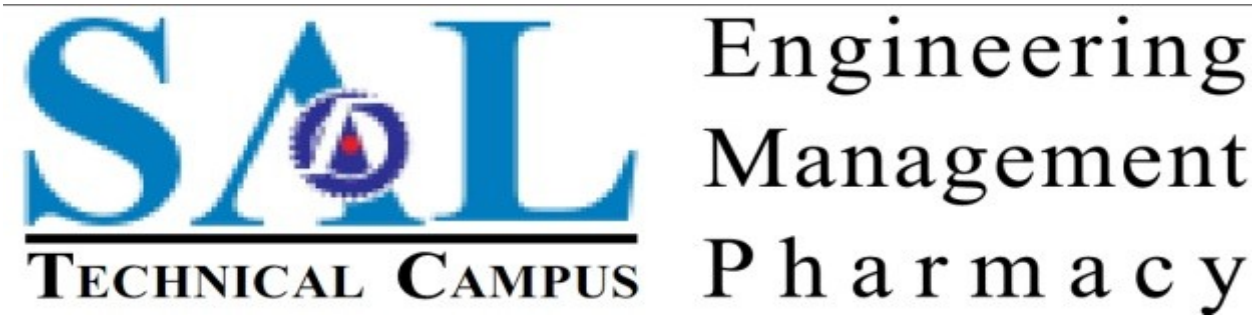

SAL-ITER, AHMEDABAD-380060

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We have a great pleasure in presenting this project report on "**PLC-SCADA Based Model Design of a Train Collision Avoidance System**" & to express our deep regard to towards those who have offered their valuable time & guidance in my hour of need.

To complete any type of seminar work is teamwork. It involves all the technical/ non-technical expertise from various sources. The contribution from the experts in the form of knows-how and other technical supports is of vital importance. I am indebted to our inspiring guide ***Miss.Sonal patel*** and our H.O.D. ***Mrs. Nidhi Bhatt*** who has extended valuable guidelines, help and constant encouragement through the various different stages for the onslaught of the project.

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DIPALI V.SHAH/ 100670111042

KHUSHBU B.PATEL/100670111105

SAJEDA I.MALIK/100670111007

ABSTRACT

This article introduces a design concept to curb the rail accidents such as collisions and derailment as obtaining in the Southern African Region. The design comprises apparatus for detecting the presence of an approaching locomotive within a specified limited area, while being insensitive to the presence of objects outside the specified region and triggering braking circuits which will stop the train. The system is integrated with the braking system of the train and is capable of detecting the possibility of collisions in real time.

The design is intended to automate fully the communication system between locomotives so that rail traffic accidents can be minimized or eliminated. For authentication purposes the design incorporates addresses of encoder and decoder that are matched, this way the detection unit will never respond to stray signals or other signals within the spectrum. The main advantage of this electronically controlled braking system would be reduced braking distance and increased railway traffic under safe conditions.

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CHAPTER 1

INTRODUCTION

1. INTRODUCTION

Our project comprise of PLC-a controller used for industrial automation, SCADA-software used for supervisory & monitoring processes or tasks & sensors to automate the process.

The objective of our project is to avoid human & monetary loss due to train collision – a deadly mishap which could bring havoc in terms of its acute senerity.

Though our project, we intend to avoid the heavy human & monetary loss by avoid train collision on the tracks. Our project comprise of sensors, which would sense the proximity of the train coming from the other side and provides the signal to PLC, which would then automatically apply the brakes to avoid the train mishap, thereby saving a whole of economy which could be used elsewhere to support the nation-upliftment.

1.1 BASIC MODEL OF THE SYSTEM

1.1.1 PARTS OF THE SYSTEM

- PLC (Micrologix 1000)
- Simulation Boar
- Train & Track
- Light Emitting Diode (LED)
- Resistor
- Computer System
- Battery
- IR sensor
- IR Sensor Triggering
    - DC Jack
    - Relay(6V)
    - Voltage Regulator(7805)
    - ULN 2803APG
    - Socket
    - Adapter(12V,2Amp)

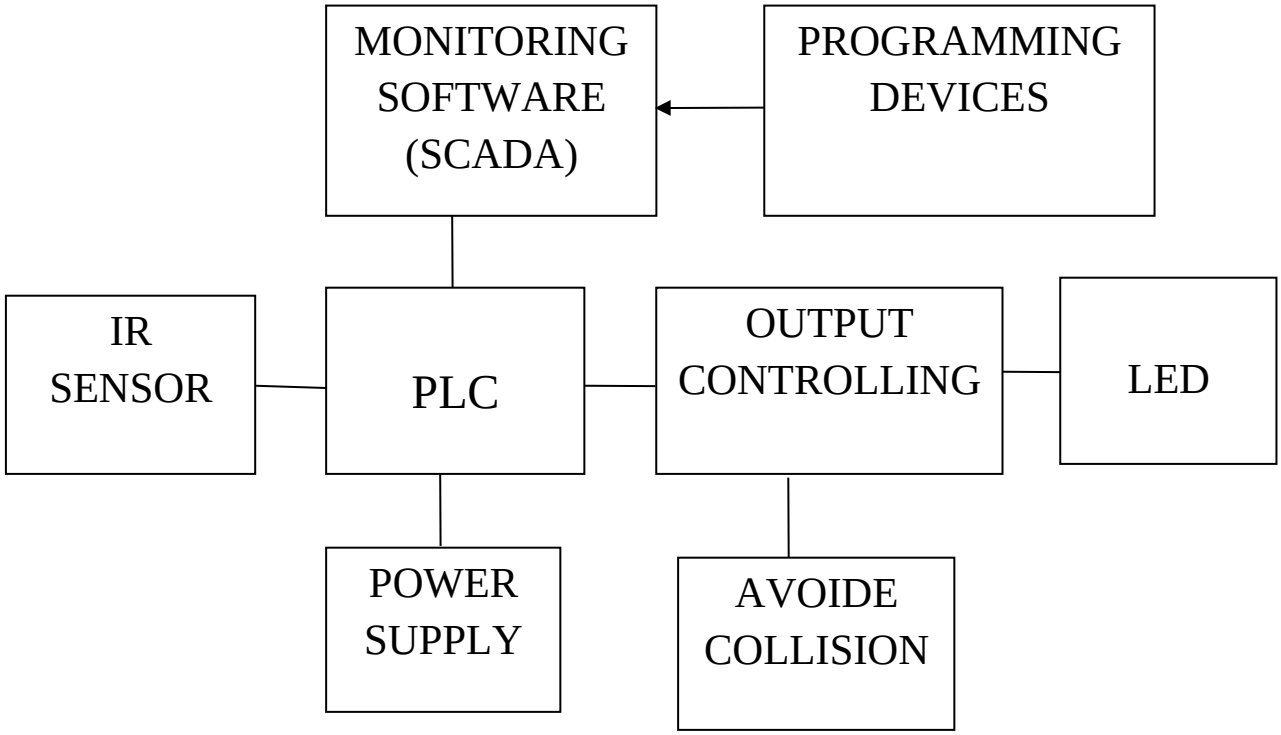


Fig.1.1 Basic Block Diagram Of The System

1.1.1.1 IR SENSOR

IR Sensors work by using a specific light sensor to detect a select light wavelength in the Infra-Red (IR) spectrum and send the signal to PLC (16-pin controller).

1.1.1.2 PLC

A PLC is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures.

1.1.1.3 SCADA

SCADA (supervisory control and data acquisition) is a system operating with coded signals over communication channels so as to provide control of remote equipment

1.1.1.4 LED

A LED is a semiconductor light source. It used as indicator lamps in many devices and are increasingly used for other lighting.

1.2 CIRCUIT DIAGRAM

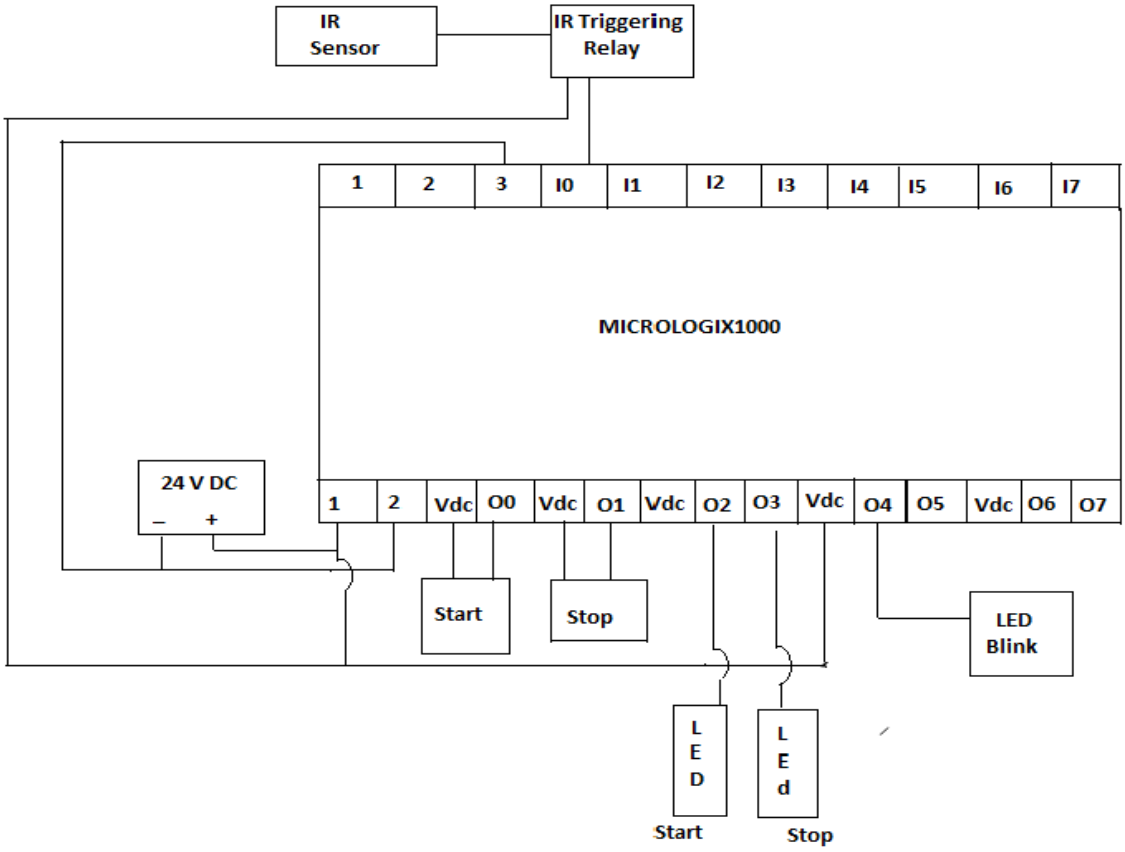


Fig.1.2 Circuit diagram of the System

CHAPTER 2

THEORATICAL BACKGROUND & FLOWCHART

2.1 WORKING MODEL & WORKING PRINCIPLE

The working of our project is when train will start then LED will on and when train will come in red alert then LED will be start blinking and then IR sensor sensing the train coming from the other side

and then passing on signal to the PLC (16-pin controller). The program coded PLC segment will then actuates its process & automatically apply the brakes to avoid the train collision mishap. After avoid the collision LED will be on.

2.2 FLOWCHART REPRESENTING THE WORKING OF A SYSTEM

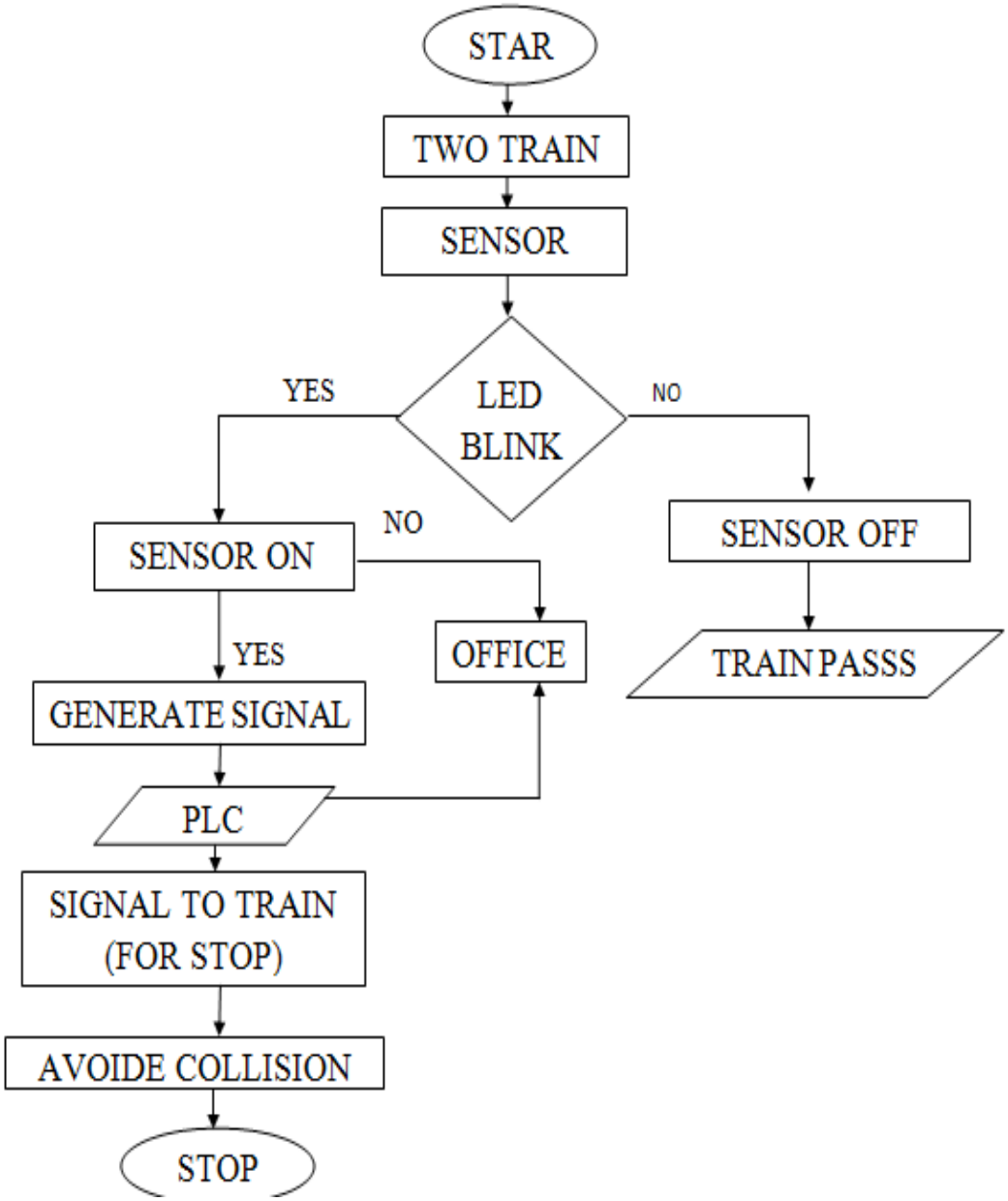


Fig.2.1 Flow Chart of the system

CHAPTER 3

HARDWARE DESCRIPTION

3.1 PLC (Programmable logic controller)

3.1.1 INTRODUCTION TO PLC

Fig.3.1 Programmable Logic Controller

A **PLC** is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. The abbreviation "PLC" and the term "Programmable Logic Controller" are registered trademarks of the Allen-Bradley Company (Rockwell Automation).

PLCs are used in many industries and machines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory.

A PLC is an example of a *hard* real time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result.

3.1.2 BASICS ARCHITECTURE OF PLC SYSTEM

The PLC is basically a programmed interface between the field input elements like limit switches, sensors, transducers, push buttons etc. and the final control elements like actuators, solenoid valves, dampers, drives, LED's, hooters etc.

This interface called as PLC consists of following:

- CPU with processor and program memory
- Input / Output modules
- Bus system
- Power supply
- The user program directs and controls the CPU's working.

3.1.2.1 CENTRAL PROCESSING UNIT

The central processing unit or CPU consists of the following blocks:

- Program Memory
- Arithmetic Logic Unit (ALU)
- Process image memory (Internal memory of CPU)
- Internal timers and counters
- Flags

The heart of CPU is its microprocessor / microcontroller chip. The working of CPU is fully controlled by the instructions / program stored in "user program memory".

The user program directs and controls the CPU's working. This program is prepared by the user based on control logic required for the control and automation task.

3.1.2.2 Power Supply

The power supply generates the voltage required for the electronic modules of the PLC from the mains supply.

3.1.2.3 Input modules

The input module acts as an interface between the field control inputs and the CPU. The voltage or current signals generated by the sensors, transducers, limit switches, push buttons etc. are applied to the terminals of the input module.

3.1.2.4 The Input Modules helps in the following way

It converts the field signal into a standard control signal for processing by PLC. The standard control signal delivered by input module could be 6v or 9v. Where as the field signal received by it could be 64V DC, 110V AC or 650V AC.

- If required, it isolates the field signal from CPU.
- It sends one input at a time to CPU by multiplexing action.
- Depending upon the nature of input signal coming from field, the input module could be
    - Analog Input Module
    - Digital Input Module

3.1.3 WORKING OF PLC SYSTEM

Bringing input single status to the internal memory of CPU

A field signals are connected to input module. At the output of input modules the field status converted into the voltage level required by the CPU is always available. At the beginning of each cycle the CPU brings in the field input signals from in/out module and stores into its internal memory as process image of input signal. This internal memory of CPU is called as PII means process image input. The programmable controller operates cyclically meaning when complete program has been scanned, it starts again at the beginning of program.

Processing of signals using program

Once the field input status is brought into the internal memory of CPU i.e. in PII, the execution of performs logical and arithmetic operation on the data from PII. It also processes times and counts as well as flag states.

Storing the result of processing in the internal memory

The results of the user program scan are then stored in the internal memory of CPU. This internal memory is called process output image.

Sending process output image to output module

At the end of the program run i.e. at the end of scanning cycle, the CPU transfers the signal states in process image output to the output module and further to field controls.

3.1.4 The hardware features of the PLC

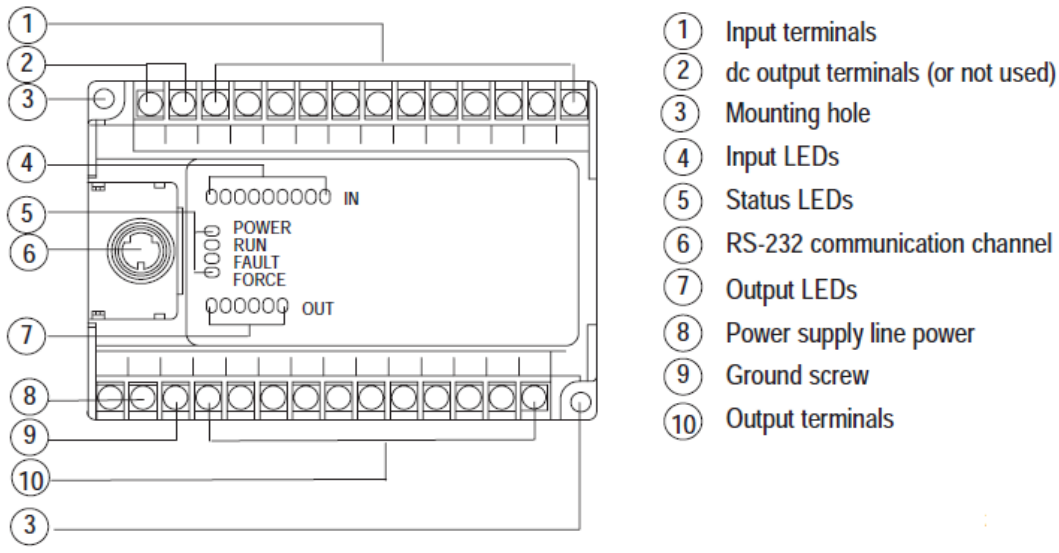


Fig.3.2 Pin Diagram of PLC

3.1.5 ADVANTAGES OF PLC

- Reduced Space

- Energy Saving
- Easy of maintenance
- Economical
- Greater life and reliability
- Tremendous Flexibility
- Advanced Computation Supported
- Programming Mode
- Speed and Flexibility
- Closed loop control supported
- Shorter Project Time
- Easier Storage Archiving and Documentation

3.1.1 DISADVANTAGE OF PLC

- PLC was designed for Relay Logic Ladder and has difficulty with some smart devices.
- To maximize PLC performance and flexibility, a number of optional modules must be added.
- The biggest problem with PLC is that it is an open loop system. It does not know what the exact requirement is & how to adjust automatically in accordance with the requirement.
- PLCs will run a pre programmed process, but monitoring each of them individually can be difficult, usually because they are spread out over the system.
- PLCs historically had no standardized method to display or present data to an operator.

3.1.2 APPLICATION

- Machine controls Packaging, Palletizing, Material handling, similar Sequential task as well as Process control.
- It is used in sequential logic control system in chemical food, cement and paper industries in which the processes are sequential in nature requiring time or event based decision.
- PLC is also used to control the batch process. In this a stored program is used to execute production cycle.
- PLC is used in energy management system of boiler control for maximum efficiency and safety.

3.2 IR SENSOR

-

3.2.1 INTRODUCTION OF IR SENSOR

Fig.3.3 IR SENSOR

IR Sensors work by using a specific light sensor to detect a select light wavelength in the Infra-Red (IR) spectrum. By using an LED which produces light at the same wavelength as what the sensor is looking for, you can look at the intensity of the received light. When an object is close to the sensor, the light from the LED bounces off the object and into the light sensor. This results in a large jump in the intensity, which we already know can be detected using a threshold.

3.2.2 BLOCK DIAGRAM OF IR SENSOR

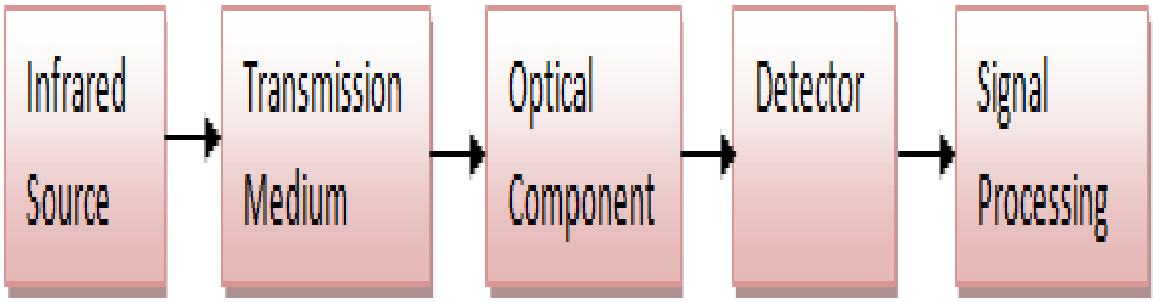


Fig.3.4 Block Diagram of IR Sensor

3.2.3 CIRCUIT DIAGRAM OF IR SENSOR

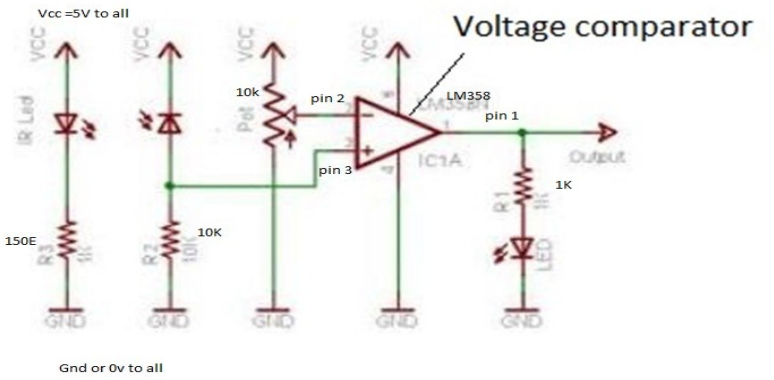


Fig.3.5 Circuit Diagram OF IR Sensor

1. Infrared Source

All objects above 0 K radiate infrared energy and hence are infrared sources. For active IR sensors, infrared Lasers and LEDs of specific IR wavelengths are used as IR sources.

2. Transmission Medium

Three main types of transmission medium used for Infrared transmission are vacuum, the atmosphere, and optical fibers

3. Optical Components.

Often optical components are required to converge or focus infrared radiations, to limit spectral response, etc.

4. Infrared detectors.

Various types of detectors are used in IR sensors. Important specifications of detectors are

• Photosensitivity or Responsivity

• Noise Equivalent Power (NEP)

• Detectivity

5. Signal Processing

ince detector outputs are typically very small, preamplifiers with associated circuitry are used to further process the received signals.

3.2.4 Triggering IR sensor

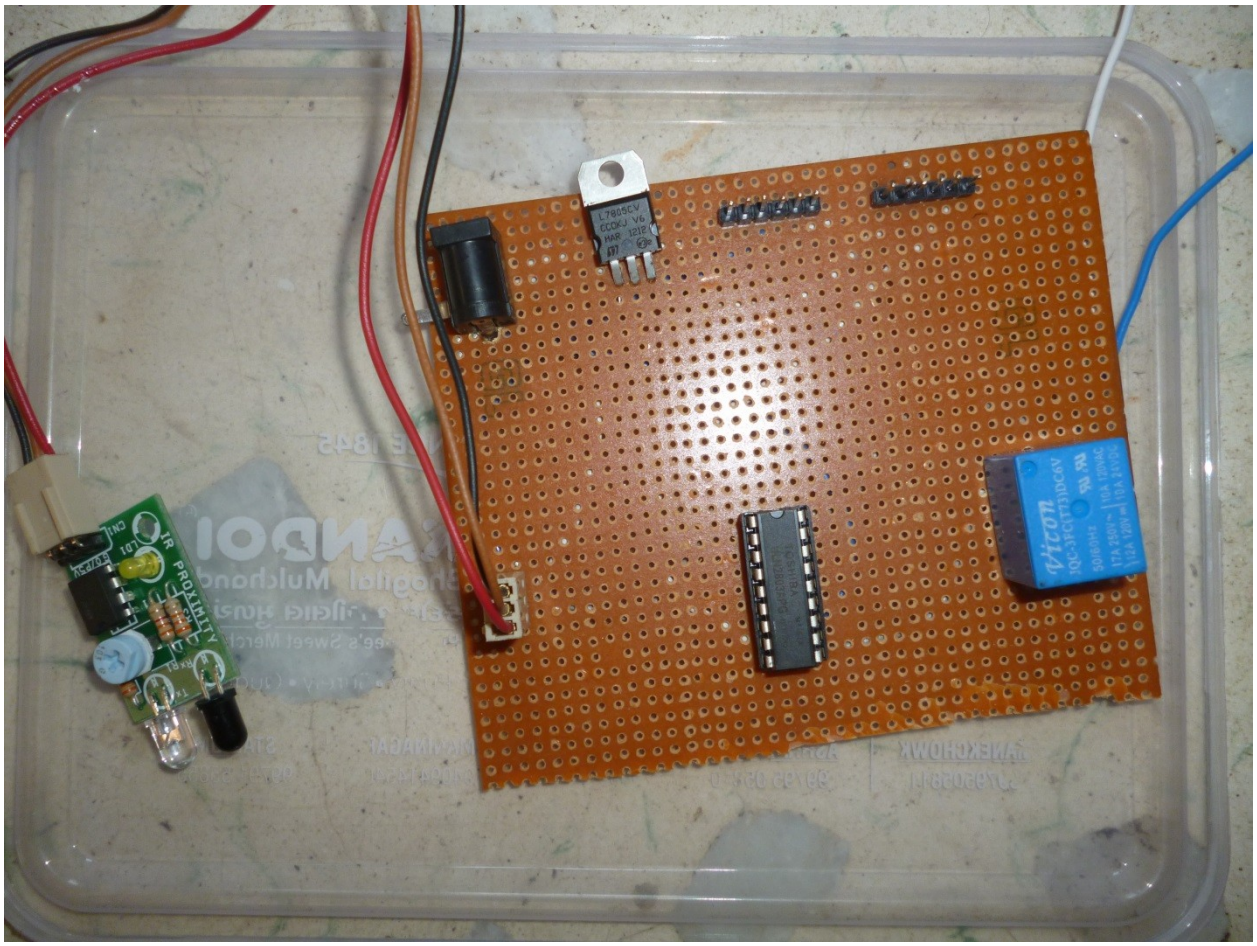


Fig.3.7 Triggering of IR Sensor

3.3 ULN2803 IC

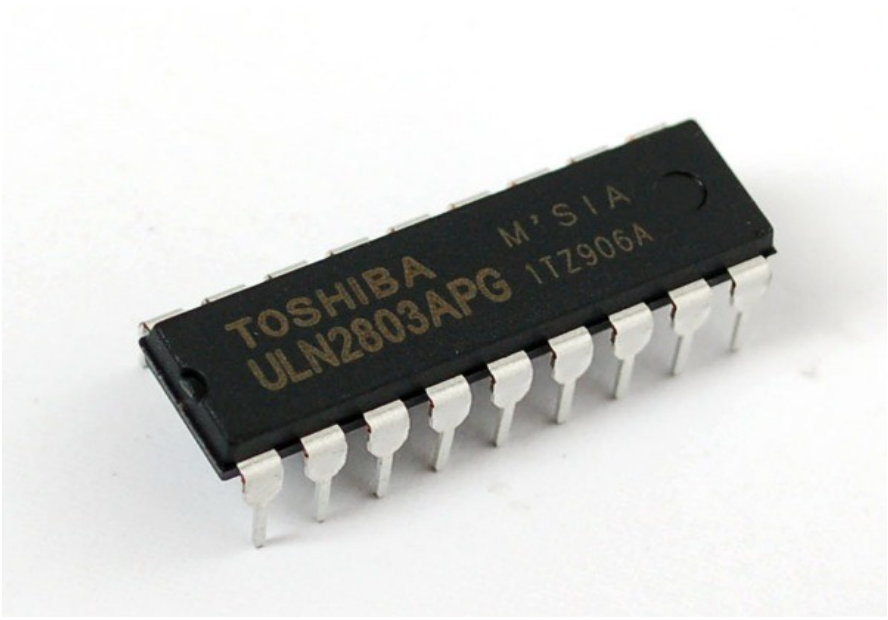


Fig.3.7 ULN2803IC

3.3.1 Introduction

IC ULN2803 consists of octal high voltage, high current darlington transistor arrays. The eight NPN Darlington connected transistors in this family of arrays are ideally suited for interfacing between low logic level digital circuitry (such as TTL, CMOS or PMOS/NMOS) and the higher current/voltage requirements of lamps, relays, printer hammers or other similar loads for a broad range of computer, industrial, and consumer applications.

3.3.1 Features

- Eight Darlingtons with Common Emitter.
- Open–collector outputs.
- Free wheeling clamp diodes for transient suppression.
- Output Current to 500 mA.
- Output Voltage to 50 V.
- Inputs pinned opposite outputs to simplify board layout.

3.3.3 Working

The ULN 2803 IC consists of eight NPN Darlington connected transistors (often called a Darlington pair). Darlington pair consists of two bipolar transistors such that the current amplified by the first is amplified further by the second to get a

high current gain β or h_{FE}. The figure shown below is one of the eight Darlington pairs of ULN 2803 IC.

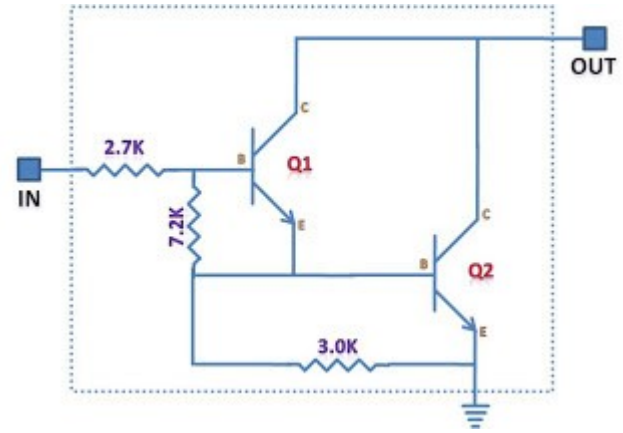


Fig.3.8 Working of ULN2803 IC

Now 2 cases arise:-

Case 1: When IN is 0 volts.

Q1 and Q2 both will not conduct as there is no base current provided to them. Thus, nothing will appear at the output (OUT).

Case 2: When IN is 5 volts.

Input current will increase and both transistors Q1 and Q2 will begin to conduct. Now, input current of Q2 is combination of input current and emitter current of Q1, so Q2 will conduct more than Q1 resulting in higher current gain which is very much required to meet the higher current requirements of devices like motors, relays etc. Output current flows through Q2 providing a path (sink) to ground for the external circuit that the output is applied to. Thus, when a 5V input is applied to any of the input pins (1 to 8), output voltage at corresponding output pin (11 to 18) drops down to zero providing GND for the external circuit. Thus, the external circuit gets grounded at one end while it is provided $+V_{cc}$ at its other end. So, the circuit gets completed and starts operating.

3.4 RELAY

3.4.1 INTRODUCTION

Fig 3.9 Sugar Cube Relay

A relay is similar to a switch; it is either open or closed. When the switch is open no current passes through the relay, the circuit is open, and the load that is connected to the relay receives no power. When a relay is closed, the circuit is completed and current passes through the relay and delivers power to the load.

3.4.2 WORKING OF RELAY

Relay is an **electrically operated switch**. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and they are **double throw** (**changeover**) switches.

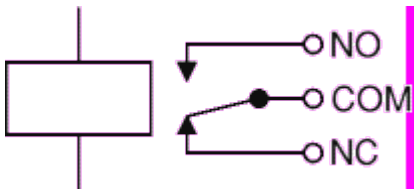


Fig.3.10 Working of Relay

Relays allow one circuit to switch a second circuit which can be completely separate from the first. For example a low voltage battery circuit can use a relay to switch a 230V AC mains circuit. There is no electrical connection inside the relay between the two circuits; the link is magnetic and mechanical.

The coil of a relay passes a relatively large current, typically 30mA for a 12V relay, but it can be as much as 100mA for relays designed to operate from lower voltages. Most ICs (chips) cannot provide this current and a transistor is usually used to amplify the small IC current to the larger value required for the relay coil.

The maximum output current for the popular 555 timer IC is 200mA so these devices can supply relay coils directly without amplification. Relays are usually SPDT or DPDT but they can have many more sets of switch contacts, for example relays with 4 sets of changeover contacts are readily available.

3.4.3 ADVANTAGE OF RELAY

- Relays can switch AC and DC
- Relays can switch higher voltages.
- Relays are often a better choice for switching large currents.
- Relays can switch many contacts at once.

3.4.4 DISADVANTAGE OF RELAY

- Relays are bulkier than transistors for switching small currents.
- Relays cannot switch rapidly (except reed relays), transistors can switch many times per second.
- Relays use more power due to the current flowing through their coil.

3.4.1 APPLICATION

- Domestic Appliances
- Office Machines
- Audio Equipment
- Coffee-Pots
- Control unit

3.5 VOLTAGE REGULATOR IC(7805)

3.5.1 INTRODUCTION

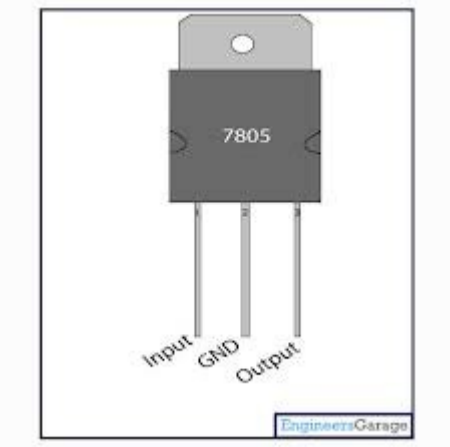


Fig.3.11 7805 IC

7805 is a voltage regulator integrated circuit. It is a member of 78xx series of fixed linear voltage regulator ICs. The voltage source in a circuit may have fluctuations and would not give the fixed voltage output. The voltage regulator IC maintains the output voltage at a constant value. The xx in 78xx indicates the fixed output voltage it is designed to provide. 7805 provides +5V regulated power supply. Capacitors of suitable values can be connected at input and output pins depending upon the respective voltage levels.

3.5.2 Pin Description

Pin No	Function	Name
1	Input voltage (5V-18V)	Input
2	Ground (0V)	Ground
3	Regulated output; 5V (4.8V-5.2V)	Output

3.6 LIGHT EMITTING DIODE

3.6.1 DESCRIPTION

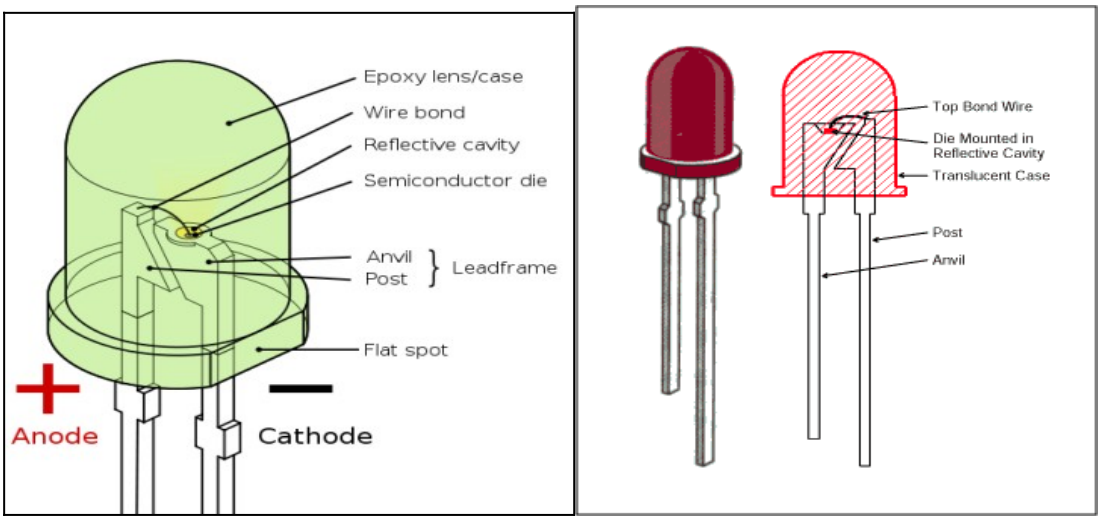


Fig. 3.12 LED configuration

A light-emitting diode (LED) is a semiconductor light source. LEDs are used as indicator lamps in many devices and are increasingly used for other lighting. Early LEDs emitted low-intensity red light, but modern versions are available across the visible, ultraviolet, and infrared wavelengths, with very high brightness.

When a light-emitting diode is forward-biased (switched on), electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence and the color of the light (corresponding to the energy of the photon) is determined by the energy gap of the semiconductor. An LED is often small in area (less than 1 mm^2), and integrated optical components may be used to shape its radiation pattern. LEDs present many advantages over incandescent light sources including lower energy consumption, longer lifetime, improved physical robustness, smaller size, and faster switching. LEDs powerful enough for room lighting are relatively expensive and require more precise current and heat management than compact fluorescent lamp sources of comparable output.

Light-emitting diodes are used in applications as diverse as aviation lighting, automotive lighting, advertising, general lighting, and traffic signals. LEDs have allowed new text, video displays, and sensors to be developed, while their high switching rates are also useful in advanced communications technology. Infrared LEDs are also used in the remote control units of many commercial products including televisions, DVD players, and other domestic appliances.

3.6.2 CIRCUIT DIAGRAM

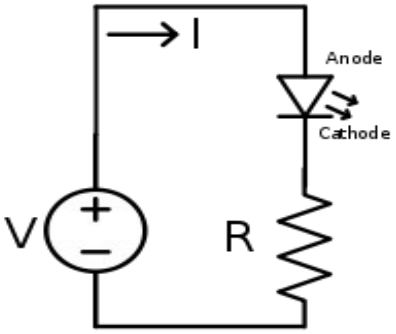


Fig. 3.13 Circuit diagram of the LED

3.6.1 APPLICATIONS

- Light source for machine vision systems, requiring bright, focused, homogeneous and possibly
- Strobed illumination.
- Exit signs
- Motorcycle and Bicycle lights
- Toys and recreational sporting goods, such as the Flashlight
- Railroad crossing signals
- Continuity indicators
- Flashlights, including some mechanically powered models.

3.7 ADAPTER

An adapter or adaptor is a person that adapts or a device that converts attributes of one device or system to those of an otherwise incompatible device or system. Some adapters may only affect physical attributes:

In technical term an electrical adapter may enable connection of a socket used in one region to a plug used in another by offering connections for the disparate contact arrangements, while not changing the voltage. For more, see: Domestic AC power plugs and sockets.

Fig.3.14 Adapter

A transformer adapts household electric current from high voltage (100 to 240 volts AC) to low voltage suitable for consumer electronics. These adapters will warm through converting alternating current to direct current, but are safe to the environment and can withstand months of continuous prolonged activity.

3.8 RESISTOR

Fig.3.15 Resistor

A Resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. Resistors may have fixed resistances or variable resistances, such as those found in thermistors, varistors, trimmers, photoresistors and potentiometers.

The current through a resistor is in direct proportion to the voltage across the resistor's terminals. This relationship is represented by Ohm's law:

$$I = \frac{V}{R}$$

where I is the current through the conductor in units of amperes, V is the potential difference measured across the conductor in units of volts, and R is the resistance of the conductor in units of ohms (symbol: Ω).

The ratio of the voltage applied across a resistor's terminals to the intensity of current in the circuit is called its resistance, and this can be assumed to be a constant (independent of the voltage) for ordinary resistors working within their ratings.

CHAPTER 4

SOFTWARE DESCRIPTION

4.1 INTRODUCTION OF PLC SOFTWARE

4.1.1 PLC COMMUNICATION TO PC

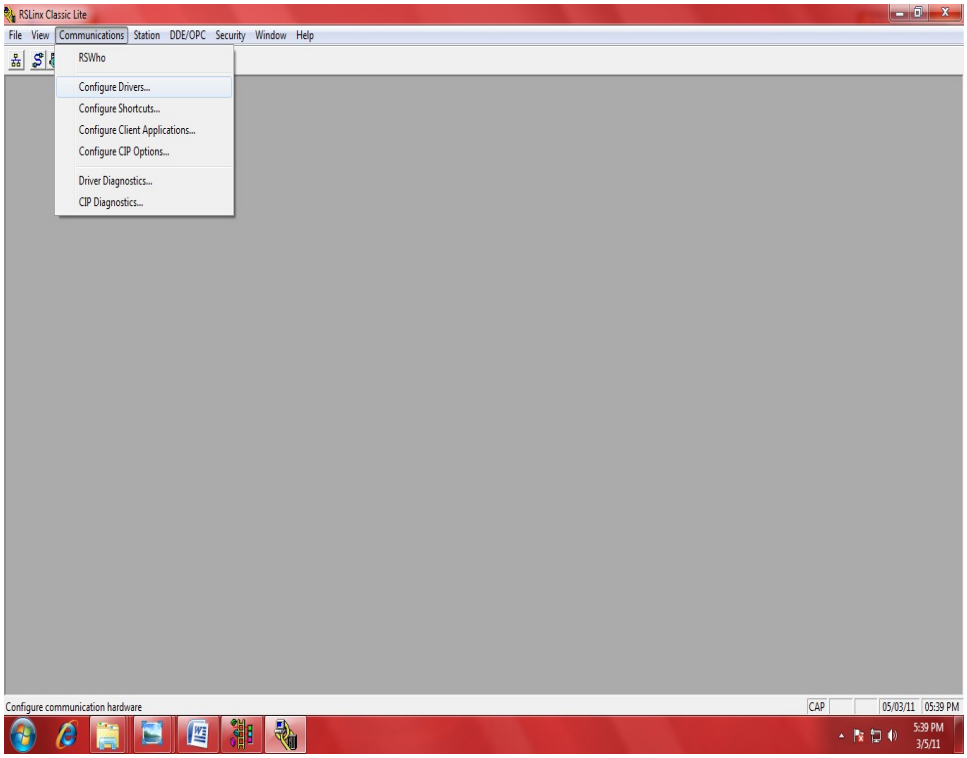


Fig 4.1 PLC to PC communication1

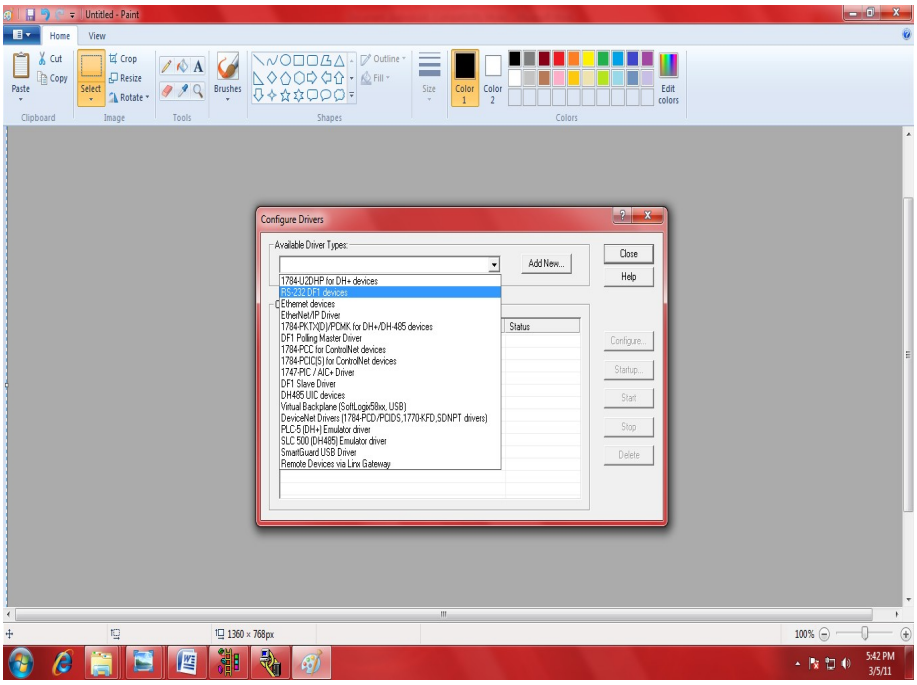


Fig 4.2 PLC to PC communication2

4.1.2 Two types of software

- **Programming software**

Programming software is Rslogix500 while driver software is Rslinx.

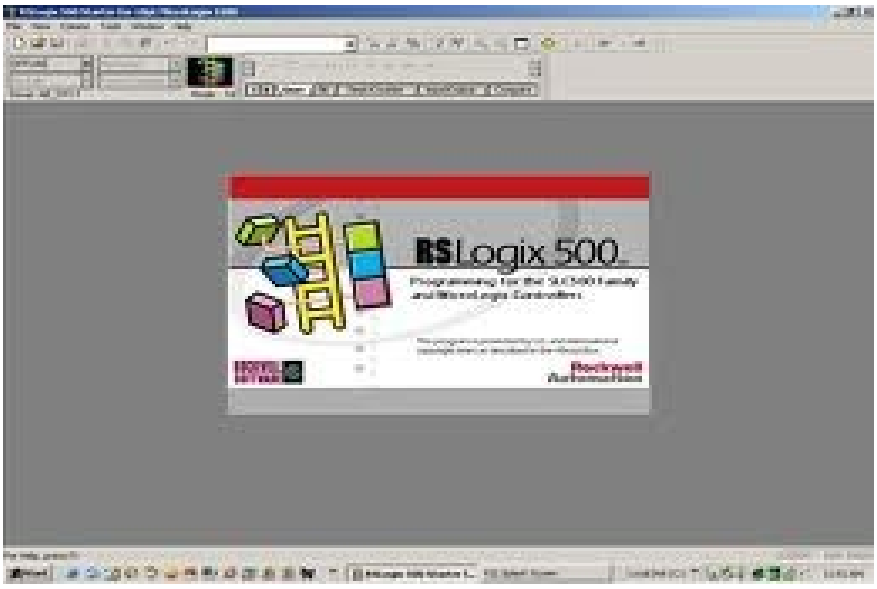


Fig.4.3 RSLOGIX 500

- **Driver software**

Driver software is used for interfacing hardware device that allows Rslinx to communicate with PLC.

Fig.4.4 RSLinx

4.1.3 PROGRAM FILES

In ML1000 there are 17 program files. Programming files contain ladder program and any subroutine programs. The purpose of each program file is discussed below:

1. S/t 0: contains system related information and information you supply such as processor type, I/O configuration, processor file name and password.
2. S/t 1: it is reserved
3. LAD 2: (main ladder program) contains your main ladder logic operating instructions.
4. LAD 3 to LAD 16: these files are called subroutine files.

Data files contain the status information associated with the external I/O and all other instructions you use in your main and subroutine ladder program files. In addition, these files store information concerning controller operation. ML1000 allow eight default data files.

1. O0 (output): this file store the state of i/p terminals for the controller.
2. I1 (input): this file stores the state of the I/P terminals for the controller..
3. S2 (status): this file stores controller operation information useful for troubleshooting controller and program operation.
4. B3(binary): this file stores internal relay logic
5. T4: this file stores the timer accumulator, preset value and status bits.
6. C5(counter): this file stores the counter accumulator, preset value and status bits
7. N7(integer): this file is used to store information of numeric values or bit information
8. R6 (control): this file stores the length, pointer position and status bits for specific instructions such as shift registers and sequencers.

4.1.4 LADDER DIAGRAM

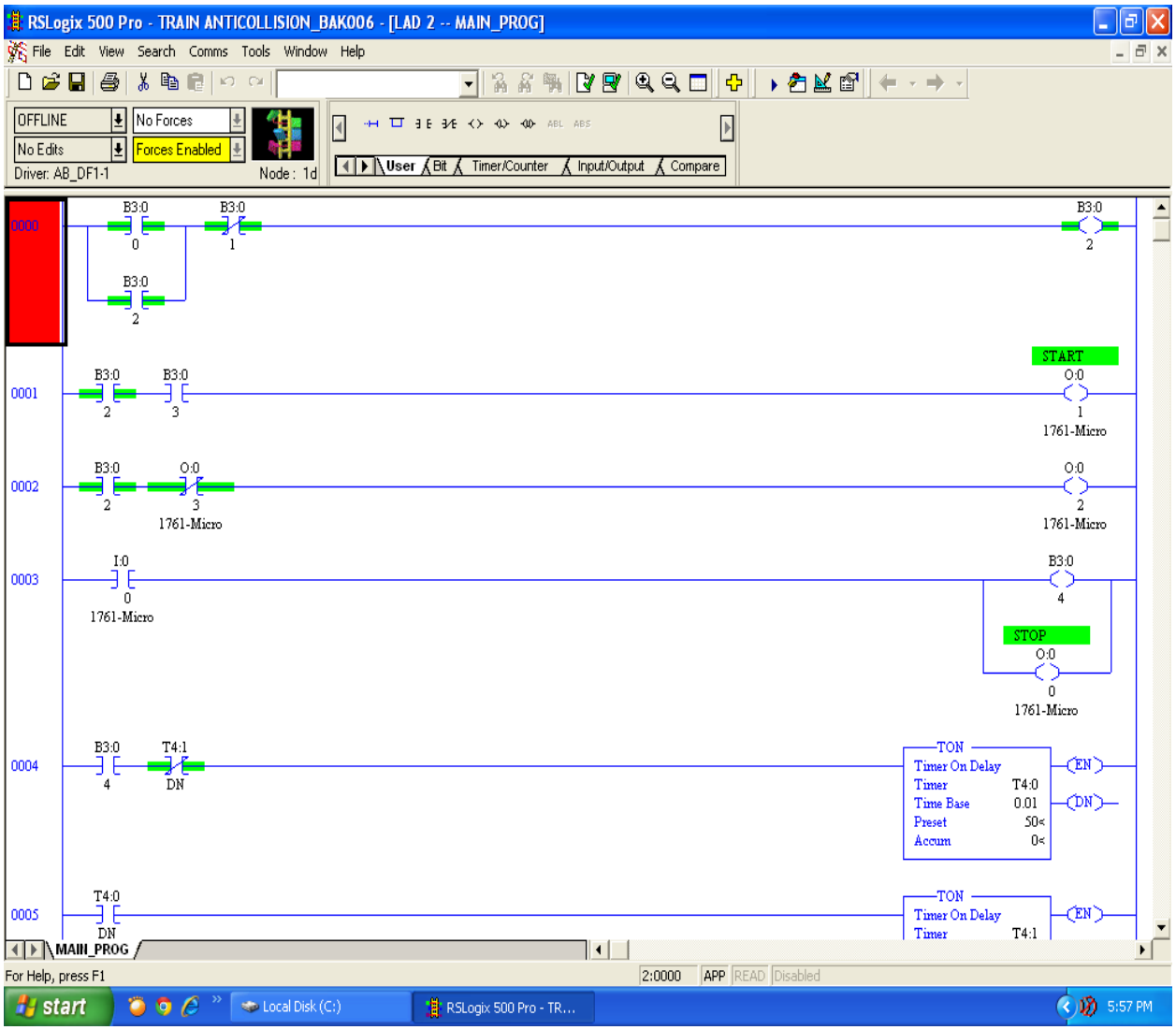


Fig 4.5 coding of plc 1

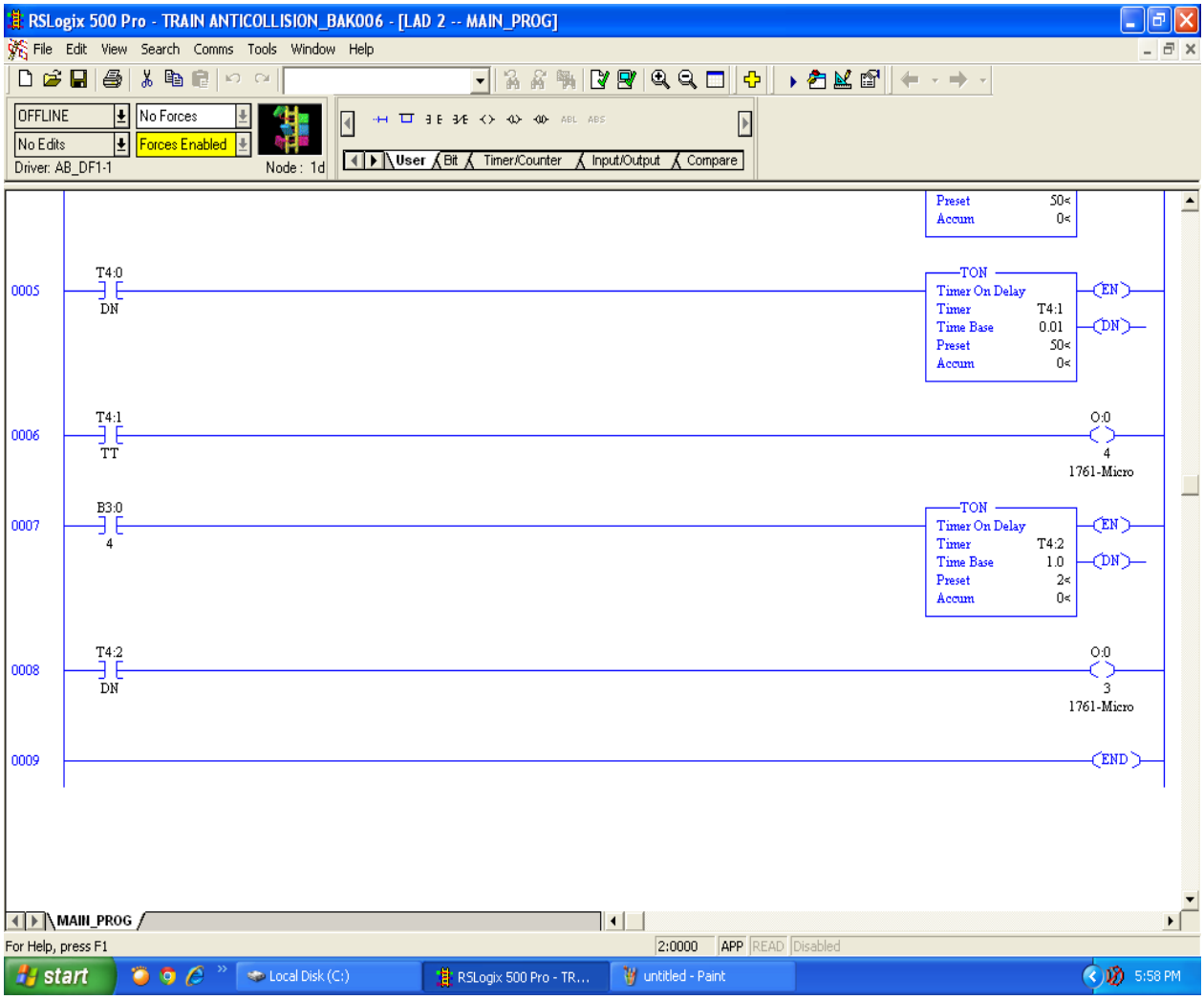


Fig 4.6 coding of PLC 2

4.2 INTRODUCTION OF SCADA SOFTWARE

4.2.1 INTRODUCTION TO SCADA

An industrial SCADA system will be used for the development of the controls of the four LHC experiments. This paper describes the SCADA systems in terms of their architecture, their interface to the process hardware, the functionality and the application development facilities they provide.

Widely used in industry for Supervisory Control and Data Acquisition of industrial processes, SCADA systems are now also penetrating the experimental physics laboratories for the controls of ancillary systems such as cooling, ventilation, power distribution, etc.

SCADA systems have made substantial progress over the recent years in terms of functionality, scalability, performance and openness such that they are an alternative to in house development even for very demanding and complex control systems as those of physics experiments.

4.2.2 TYPES OF SCADA

1. D+R+N (Development +Run + Networking)

2. R+N (Run +Networking)

3. Factory focus

4.2.3 FEATURES OF SCADA

- Dynamic process Graphic
- Alarm summery
- Alarm history
- Real time trend
- Historical time trend
- Security (Application Security)
- Data base connectivity
- Device connectivity
- Scripts

4.2.4 MANUFACTURE OF SCADA

1. Modicon (Telemecanique) Visual look
2. Allen Bradley : RS View
3. Siemens: win cc
4. Kpit: Astra
5. Intelution: Aspic
6. Wonderware: Intouch

4.2.5 SOFTWARE USE FOR SCADA: INTOUCH

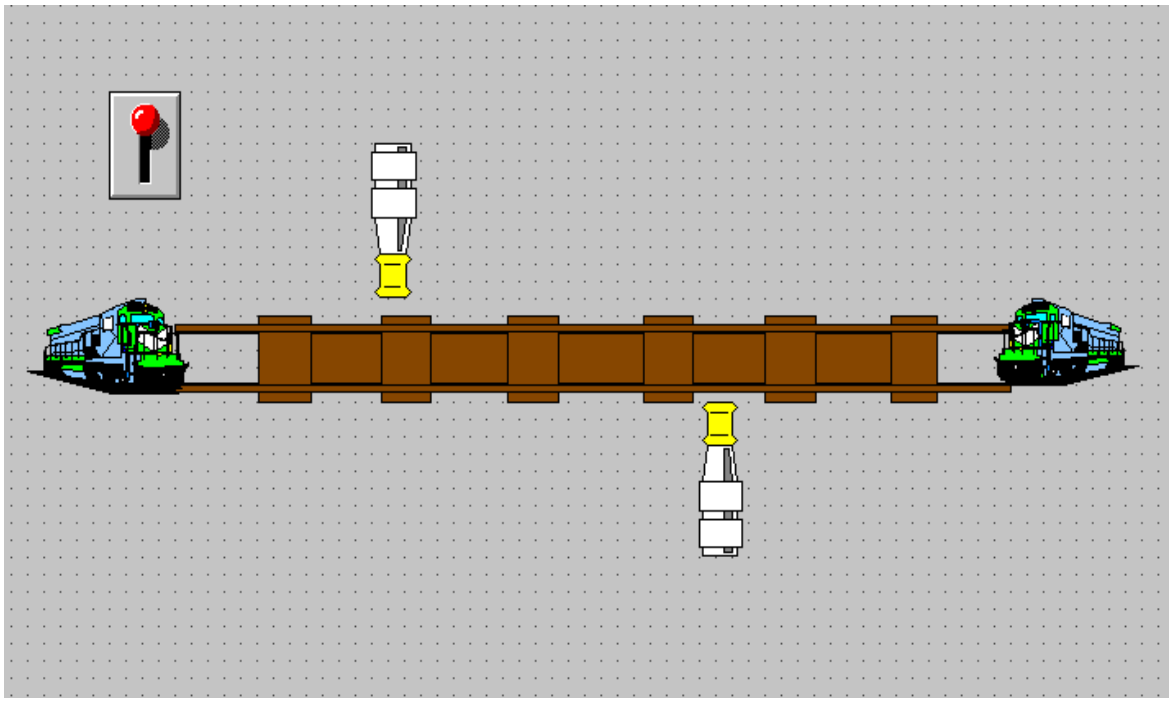


Fig.4.7 Avoid the collision between train using SCADA

4.2.6 SCRIPT

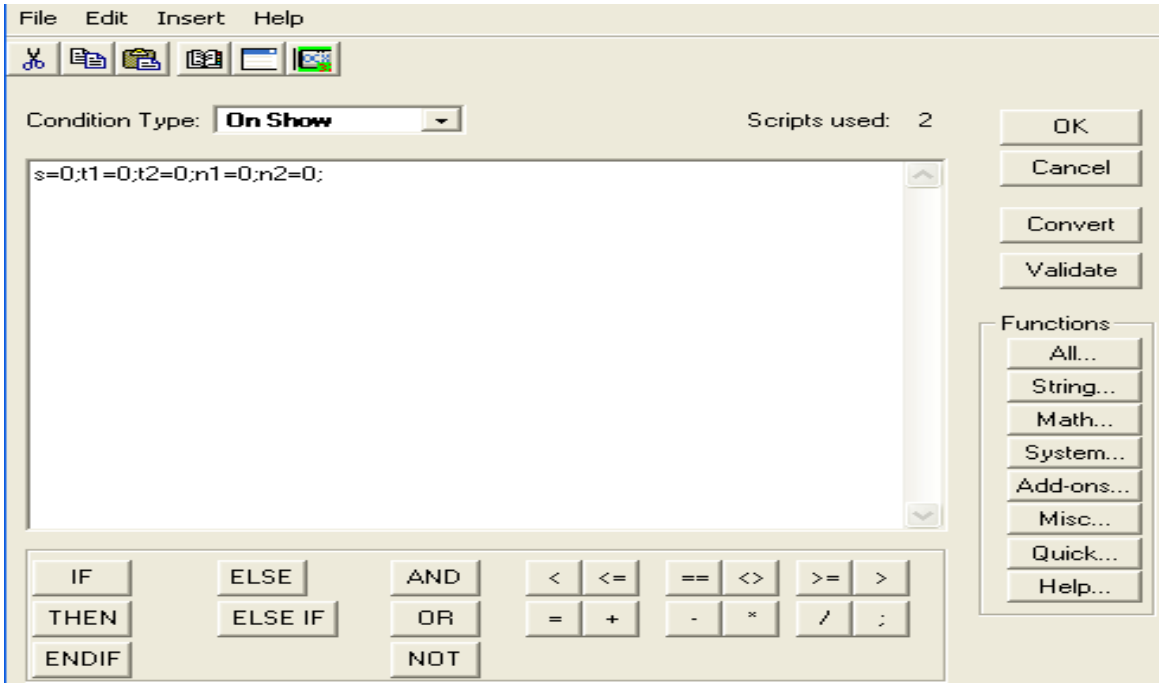


Fig.4.8 Codding in SCADA 1

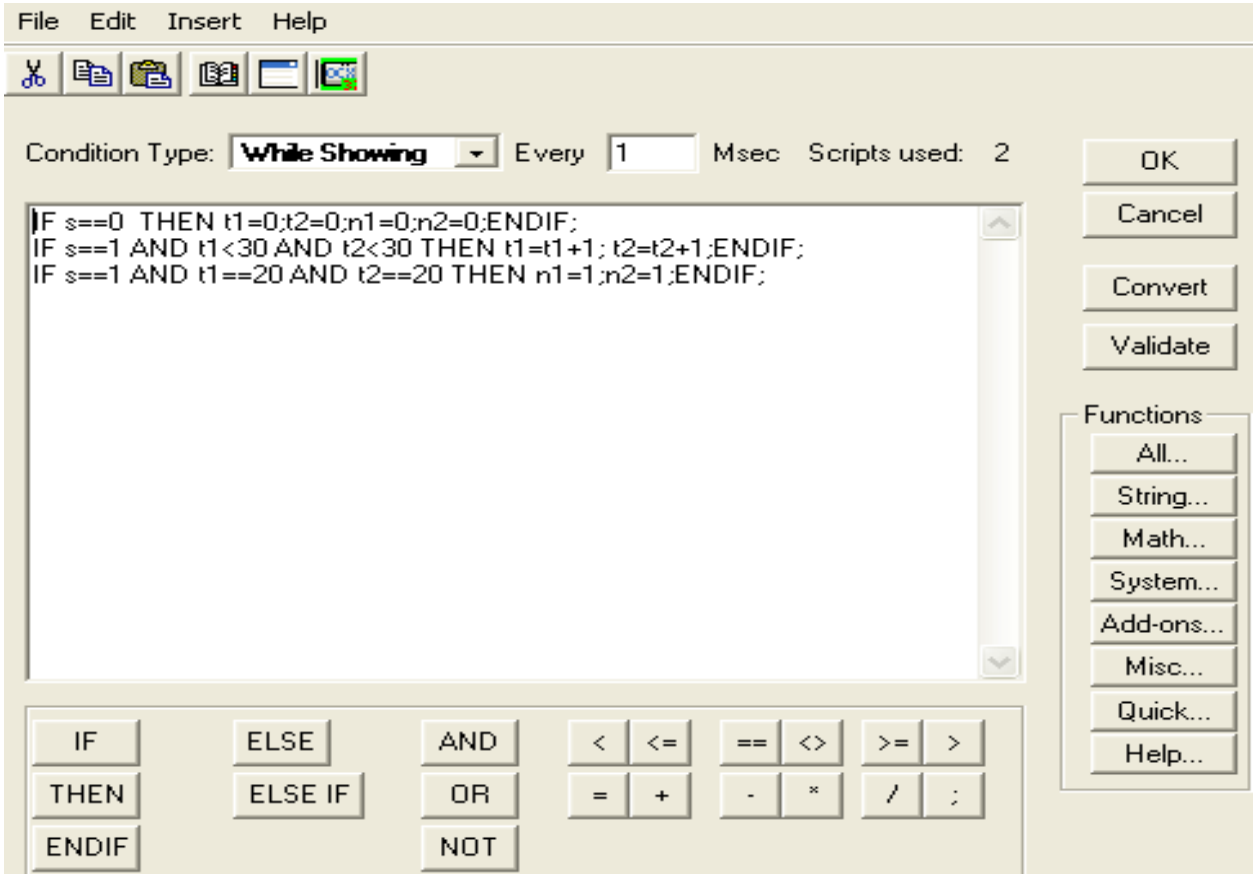
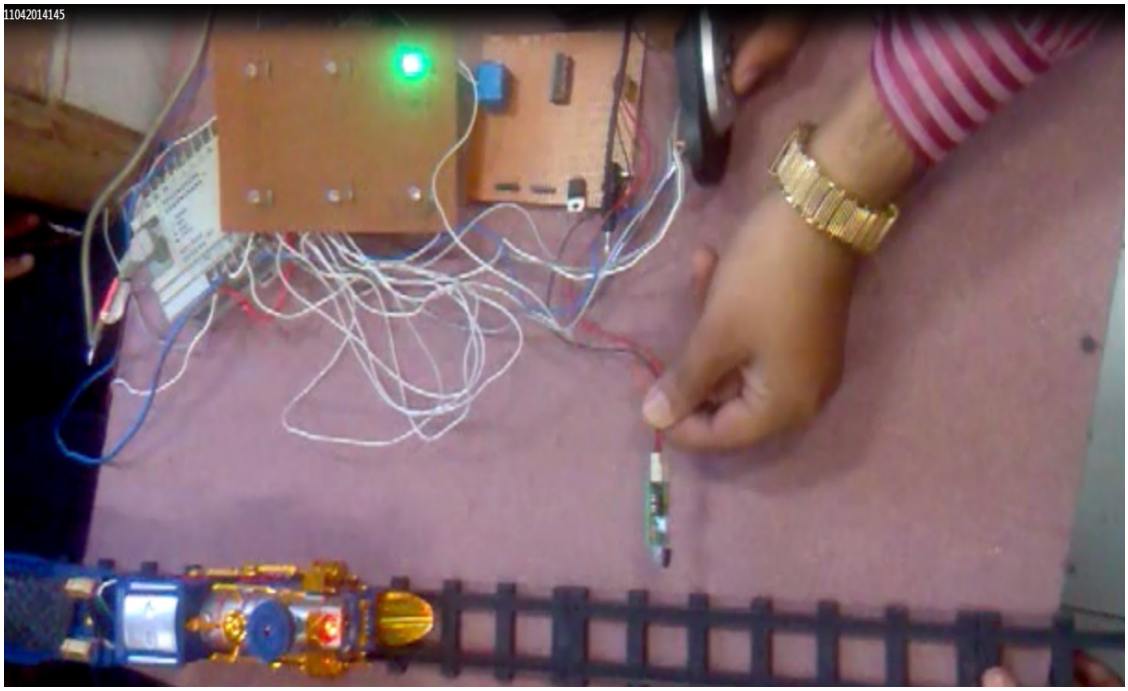
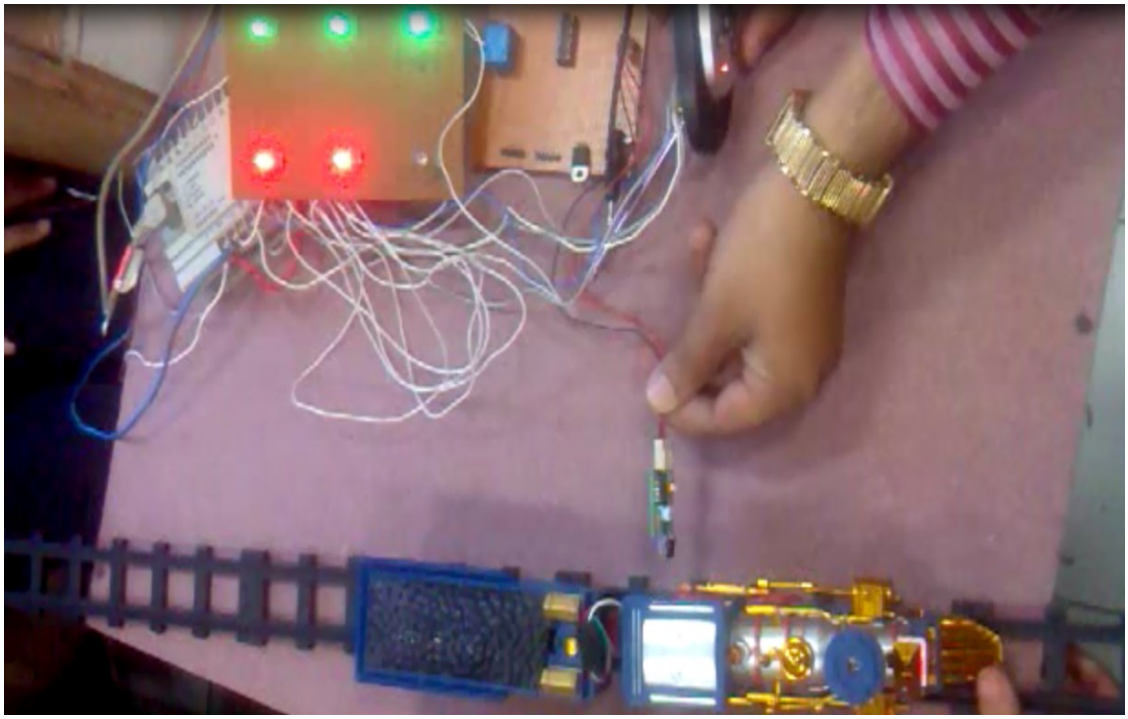


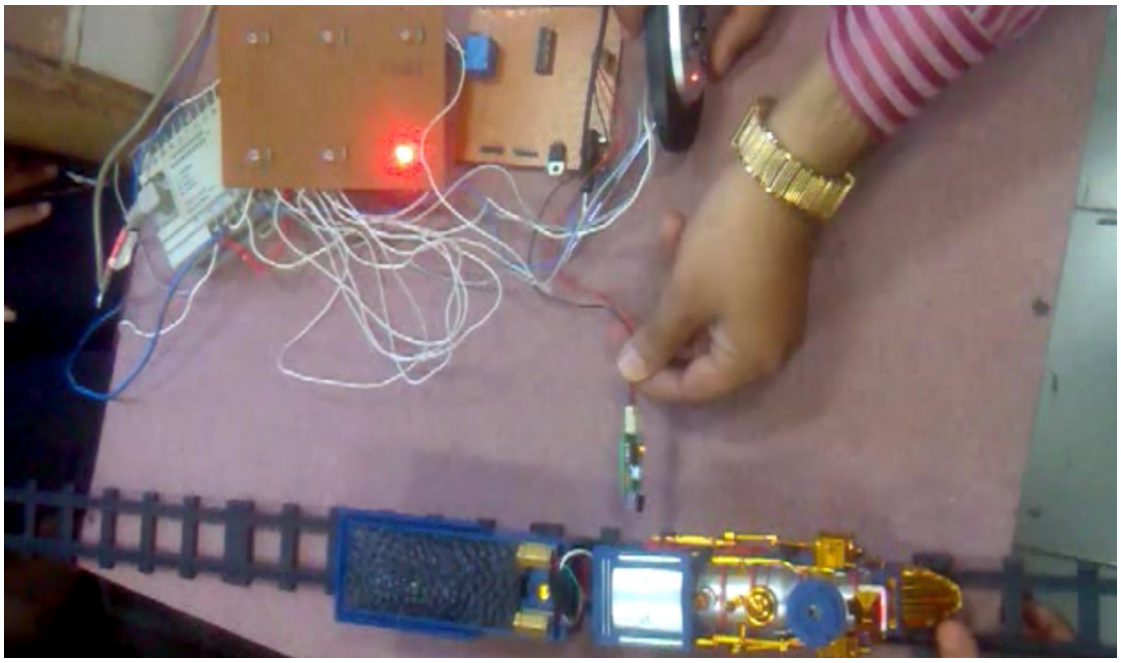
Fig.4.9 Coding in SCADA 2

CHAPTER 5
RESULTS & CONCLUSION

5.1 RESULT







5.2 ADVANTAGES

- Reduces human error
- Less Time consumings
- No human resource is required
- Energy conservation
- Simply Operated through PC
- Reliable Transportation

5.3 FUTURE SCOPE

The future scope of our project find its application in the sense that we can avoid happening of such kind of collisions in future.

5.4 Application

- Railway Gate Controlling
- Railway Track Switching
- Sub Platforms

5.5 Conclusion

- This technology will eliminate the collision between two trains through PLC and SCADA.
- It will provide control over major mishap occurrence.

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