

# Development of PLC and Software Tools using Renesas Controller with Real-Time Application

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**Abstract** - Throughout a development process of control system, control engineers deal with the challenges like shorter development time, higher quality & flexibility requirements & reusability of the control code. It has been integral part of the factory automation & industrial process control for decennium they control a wide part of applications from simple lighting functions to chemical processing plants. Programmable Logic Controller (PLC) is a digital computer which is used for the automation of various electro-mechanical processes in industries.. PLCs are demanded to work perfectly for years in industrial environments that are hazardous for the electronic components that modern PLCs are made from. The aim of the application is to develop RENESAS controller with serial port & to increase I/O in the PLC. RL78 microcontrollers (MCUs) from the Renesas Electronics are an advanced family of general-purpose and application-specific MCUs, combining true low power consumption and high performance operation. This paper discusses about the development of the PLC and software tools using digital logic gates with real time application i.e. smart railway platform.

**Key Words:** Programmable logic controller, Renesas controller, Low cost, Low power consumption.

## 1. INTRODUCTION

During the past decades, number of industrial automations has been developed based on Electro-pneumatics. The conventional method was to test a machine with pneumatic setup automated with the electro pneumatic system and PLC based automation system. The automation is testing a machine with the help of various sensors and control devices with high accuracy modules which decreases the errors in the results. Industrial automation is now becoming the global trend in manufacturing. Industries without automation do not even able to withstand in the global market. In the recent years, the automation market is prospering as compared to earlier because of competition. The recent survey found that the industrial automation projected to reach USD 153.30 Billion by 2022, at a CAGR of 4.88% during the forecast period. Most of the industries have initiated a switch to industrial automation to make the products cost effective and reach the demand of the customers. The product validation and reliability is also one of the important processes in the industry. In this process cycle time is more and accuracy of test results are less due to manual method of product validation. By implementation of

automation in this process provides the benefits as compared to manual method of product validation.[1] Programmable Logic Controller (PLC) is a digital computer which is used for the automation of various electro-mechanical processes in industries. These controllers are specially designed to survive in severe situations and protected from heat, cold, dust, and moisture etc. PLC consists of a microprocessor programmed using the computer language. The program is written in a computer software and is downloaded to the PLC via cable or USB. These loaded programs are stored in the non - volatile memory of the PLC. During the transition of relay control panels to PLC, the hard wired relay logic get exchanged for the program which is fed by the user. A visual computer programming language known as the Ladder Logic was then created to program the PLC.[2]

Automation is a need of time. In today's modern era automation helps us to save time, cost as well as manpower. Vehicles are used considerably for transportation. To have easy and effective system for maintaining the vehicles cleanliness is also important. So we can use car washing system using PLC and SCADA. 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. The car washing system consists of 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 will be further controlled by PLC & SCADA.[3] Throughout a development process of control system, control engineers deal with challenges like shorter development time, higher quality & flexibility requirements & reusability of the control code. It has been integral part of the factory automation & industrial process control for decennium they control a wide part of applications from simple lighting functions to chemical processing plants. [4]

Implementation of the model Industry 4.0 will be successful when the ubiquitous automation of the industrial processes and equipment becomes a reality. For this purpose, the training to future engineers must give them a theoretical knowledge as well as practical skills in the PLC software development. It needs to describe the possibilities of a PLC training simulator and some software examples which are intended for learning the basics of the PLC programming. [5] Automation is the key to innovation and has been

hypothetically understood as a way such as to increase efficiently and to improve productivity. [6]

In this paper, we have developed a software tool using IO Flow 1.0 software in which logic gates such AND, OR, NOR, NOT, etc., Timers, Flip-flops, and some other electronic components are available for programming. Also, by considering the real time application as Smart Railway platform, we designed the hardware.

## 2. OVERVIEW

### 1. Programmable logic control

A programmable logic controller is basically a digitally operating electronic device which uses a programmable memory to store the set of instructions for implementing specific functions, such as logic, sequencing, timing, counting and arithmetic, to control through digital or analog input and output, various types of machines or process. PLC is also referred to as programmable controllers that are used in commercial and industrial applications. It consists of input modules, a Central Processing Unit (CPU), and output modules as shown in Fig.1. The PLC accepts inputs from switches and sensors that is measured or sensed from the system. An input module accepts a variety of digital or analog signals from various old devices (sensors) and converts them into a logic signal that can be used by the CPU. The Central Processing Unit (CPU) evaluates, makes decisions and executes these signals based on a program instructions or logic sequence. Output module converts control instructions from the CPU into a digital or analog signal that can be used to control various devices such as a machine or process.

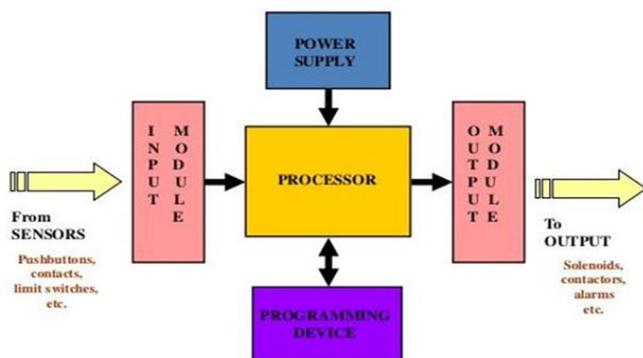


Fig.1- Overview of PLC

### 2. Renesas Controller

RL78 Family is a 16- and 8-bit CPU core for embedded microcontrollers of Renesas Electronics introduced in 2010. It works on Ultra-Low Power Technology 1.6V to 5.5 V operation from a single supply 16-bit RL-78 CPU Core. It has Main Flash Memory 16KB to 512 KB and Data Flash Memory 4 KB to 8 KB size. RL78 has in-built High-Speed On-chip

oscillator 32 MHz, etc. Fig.2 shows on-board Renesas RL 78 controller.



Fig 2- Renesas RL 78 Board

### 3. SYSTEM DESIGN-APPLICATION BASED

Looking forward to the safety of people at railway station while crossing the platform, we have developed sliding railway platform which will be used conveniently by the pedestrians so to avoid climbing the stairs of the bridge and risk to cross the platform directly by the railway path, and thus the smart platform will avoid accidents and provides security. The Fig.3 shows the Block diagram of PLC using Renesas controller for the application of Smart Railway Platform.

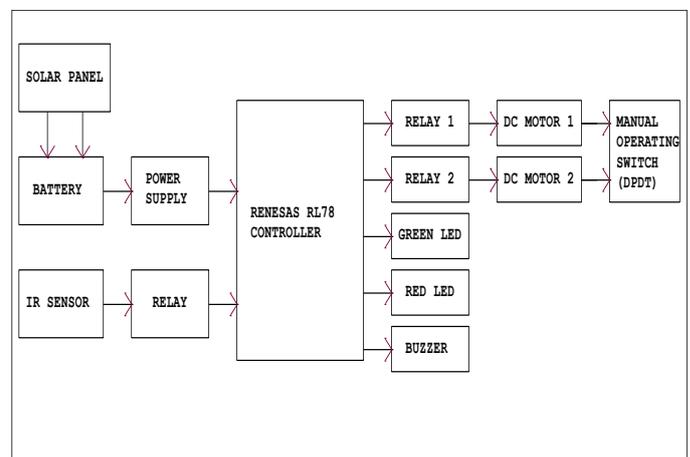


Fig.3 - Block Diagram of PLC using Renesas for Smart Railway Platform

The main components used for the applications are battery connected to solar panel to provide supply voltage on which the application runs IR sensor to detect the presence of train on the path, Power supply from MSEB is also provided for the days in rainy seasons when solar energy is not available continuously. Relays are the most important part which are used to control the system and to give command to the PLC to open or close the platform. LEDs and Buzzer are used for Indication purpose.

**WORKING:** The RL78 Renesas Controller will sense the presence of trains by using Infrared sensor. So on sensing the train on one path, the PLC will give pulses to relays which in turn rotate the motor in forward direction and thus close the sliding mobile platform automatically. Just before the platform starts to get close, Buzzer will ON so that pedestrians get audio alert indication not to cross the bridge. After some provided time delay, motor will rotate in reverse direction and there will be reopening of the sliding mobile platform. The mobile platform has a red or green Signal indication so that the pedestrians can know whether they can use the bridge or not. Manual switching is also provided for the backup purpose. The signal automatically turns to red when the train comes and becomes green after predefined delayed period. Rocker switch is used to manually operate the sliding platform. All the system is based on Battery. This battery is charged by solar panel.

### 3. DEVELOPMENT OF SOFTWARE USING JAVA PLATFORM FOR REAL TIME APPLICATION

#### 3.1 Logic gate programming

Implementation of various Logic Gates AND, OR, NOT, NOR, NAND, EX-OR and EX-NOR in PLC using Ladder Diagram programming language. Assuming that all the gates comprise two inputs and NOT Gate has only one input, Logic Gates can be well implemented in PLC using Ladder Diagram programming language as shown in Program section. To implement Examine if closed, Normally Open contact is used and to implement Examine if open, Normally Closed contact is used. These contacts is said to work as relay contacts.

In Normally Open / XIC contact, when logic 1, or in other words, when logic high is provided, the contact closes allowing current to pass through the circuit. And in Normally Closed / XIO contact, when logic 1 is not present, or in other words, when logic 0 is present, it allows current to pass through the circuit. But when logic 1 is present in case of XIO, the contact opens inhibiting current to pass through the circuit. By simply using these logics, all Logic Gates can be well implemented using Ladder Diagram programming language.

#### 3.2 IO Flow Software 1.0

IO flow configuration tool is specially designed to configure the PLC. This configure tool is designed in JAVA to run on Windows platform. This tool having different gates like AND, OR, AND, NAND, different types of timers. Using USB, we can easily live simulate the program in the PLC and run the program. While running the program, Green line shows the ON part of the system where the system is working and Red line shows the non-working part of the system. It is very easy to edit or learn the program in IO Flow 1.0 software.

The Fig.4 shows the the program written and the execution of the same program is shown in Red or Green lines.

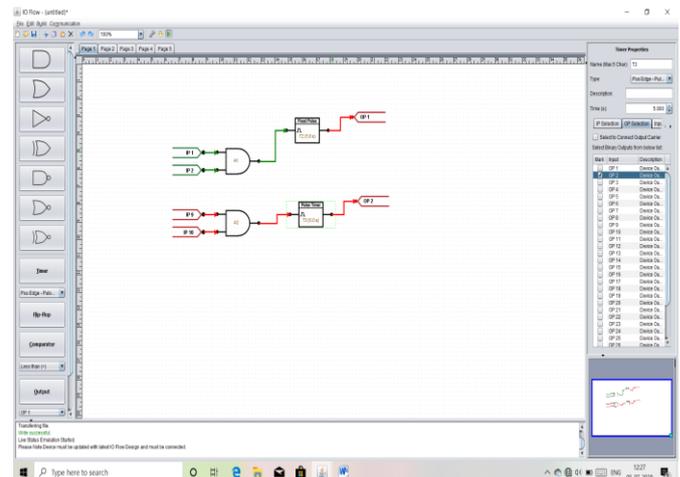
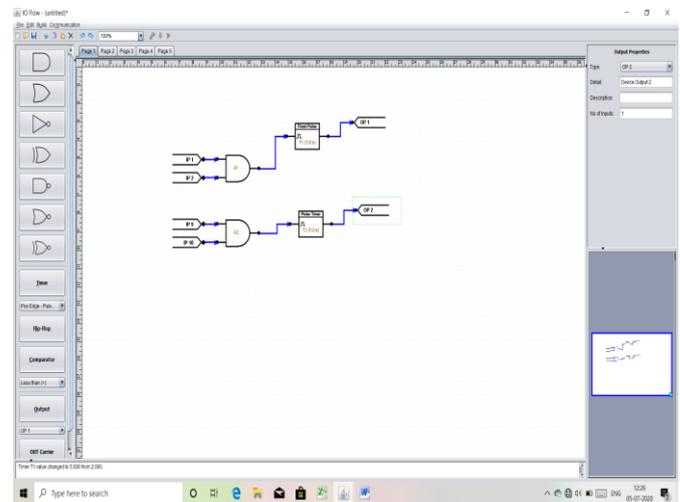


Fig.4 - Boolean Operations performed on IO Flow Software

### 4. RESULTS

The result shows the Boolean operations performed in software for the real-time application. Input provided here is IR Sensor and the Outputs are Motor, Red signal, Green signal and Buzzer. The time delay is provided for each output to get ON or OFF after some delay provided. So as to avoid the consequences of motor to rotate in forward and reverse direction, NOT gates are used for conversion.

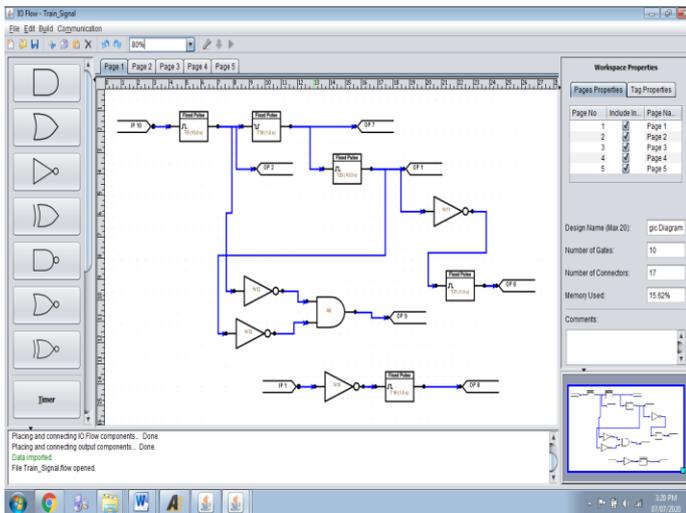


Fig.5 - Boolean Operations performed on IO Flow Software for smart railway platform

### 5. ADVANTAGES

- I. Saves the time of the passengers.
- II. Reduces the Accidents: Slider foot-bridge reduces the accidents.
- III. Good for safety of people.
- IV. Transportation: Slider foot-bridge can easily transfer goods from one platform to another platform.

### 6. CONCLUSION

The conclusion of this project is we have successfully studied the PLC using Renesas controller and developed software using Java platform. The software is user friendly and very easy to operate. Symbolic presentation is easily available in Java software so user can easily develop digital gate logics. Using gates, timers, flip-flops, etc., user just needs to select required gate and mention the inputs and outputs. Results will be achieved as per required for any application. Here in this paper, we have developed a programming for smart railway platform. The online simulation tools are available in Java software so that we can easily understand that Green line indicates the output is high and Red line indicates the output is low.

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