Configuration Tool for Commissioning of Automation Products

Submitted By

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16MCEC07

DEPARTMENT OF COMPUTER ENGINEERING

INSTITUTE OF TECHNOLOGY

NIRMA UNIVERSITY

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Configuration Tool for Commissioning of Automation Products

Major Project

Submitted in fulfillment of the requirements

for the degree of

Master of Technology in Computer Science and Engineering

Submitted By

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(16MCEC07)

Guided By

Prof. Jigna Patel

DEPARTMENT OF COMPUTER ENGINEERING

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MAY 2018

Certificate

This is to certify that the major project entitled **"Configuration Tool for Commissioning of Automation Products"** submitted by **Dhara Kakadiya (16MCEC07)**, towards the fulfillment of the requirements for the award of degree of Master of Technology in Computer Science and Engineering of Nirma University, Ahmedabad, is the record of work carried out by him under my supervision and guidance. In my opinion, the submitted work has reached a level required for being accepted for examination. The results embodied in this major project part-II, to the best of my knowledge, haven't been submitted to any other university or institution for award of any degree or diploma.

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Statement of Originality

I, **Dhara Kakadiya**, **16MCEC07.**, give undertaking that the Major Project entitled "**Configuration tool for Commissioning of Automation Products**" submitted by me, towards the fulfillment of the requirements for the degree of Master of Technology in **Computer Science & Engineering** of Institute of Technology, Nirma University, Ahmedabad, contains no material that has been awarded for any degree or diploma in any university or school in any territory to the best of my knowledge. It is the original work carried out by me and I give assurance that no attempt of plagiarism has been made.It contains no material that is previously published or written, except where reference has been made. I understand that in the event of any similarity found subsequently with any published work or any dissertation work elsewhere; it will result in severe disciplinary action.

_____

Signature of Student

Date:

Place:

Endorsed by

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Abstract

The actual goal of this tool is to configured the energy data from substation. This tool is connected with automation product RTU (Remote Terminal Unit). Basically, RTU is communication gateway between field and master location. RTU is connected with different sensors, meter and actuators. This configuration tool is provided customize menu as per user requirement. This tool is easy to handle, reliable and cost efficient. Using proprietary protocol to establish communication with Tool and RTU. This tool configured real time data and store log data in csv and xml file system. If any crisis and fault happened then easy to take care with stored file data.

Abbreviations

AI	Analog Input.
CPC	Central Processing Card.
CSV	Comma Separated Values
CRC	Cyclic Redundant Checksums
DI	Digital Input
DO	Digital Output
IDE	Integrated Development Environment
PCB	Programmable Logic Control
RTU	Remote Terminal Unit.

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Chapter 1

Introduction

In automation era, day by day technology increases and easy to catch up the goal. The basic purpose of this project is to design the tool that handle requirement easily with less effort. Tool is used for configuring the data of substation. This tool is based on hardware and software. This tool is connected with automation product RTU (Remote terminal Unit). This tool provides customized menu then this tool also can be used for nuclear power plant, water wastage, gas refining and transport system.

Basically, this tool communicates with RTU which configure required data. For this tool proprietary protocol has been designed for communication purpose. This tool provides facility to visualize entire communication with controlling, gathering and monitoring. This tool has been designed using Microsoft visual win form and implemented in C#. Device data is stored in DataTable. DataTable is in memory so this data is stored in csv and xml file system for future use. when any fault and damage occurs then it can easily retrieve that data from csv and xml file. Designed proprietary protocol for tool and device communication interface. Protocol designs set of rules for transmitting parameters data between tool and automated product RTU.

1.1 Remote Terminal Unit

This project is discussing about Automation product RTU (Remote Terminal Unit). RTU is located on field and take data from substation. The main function of RTU is to collect all data from substation digitized them and send to configuring Tool through the communication interface. RTU plays crucial role in substation automation. It consists

different types of sections that can handle various types of field parameters. Actual goal of RTU is possessing to monitor electrical data such as voltage, current, temperature from the input line to transmit data to master tool. RTU is communication gateway. We can set logic as per requirement.

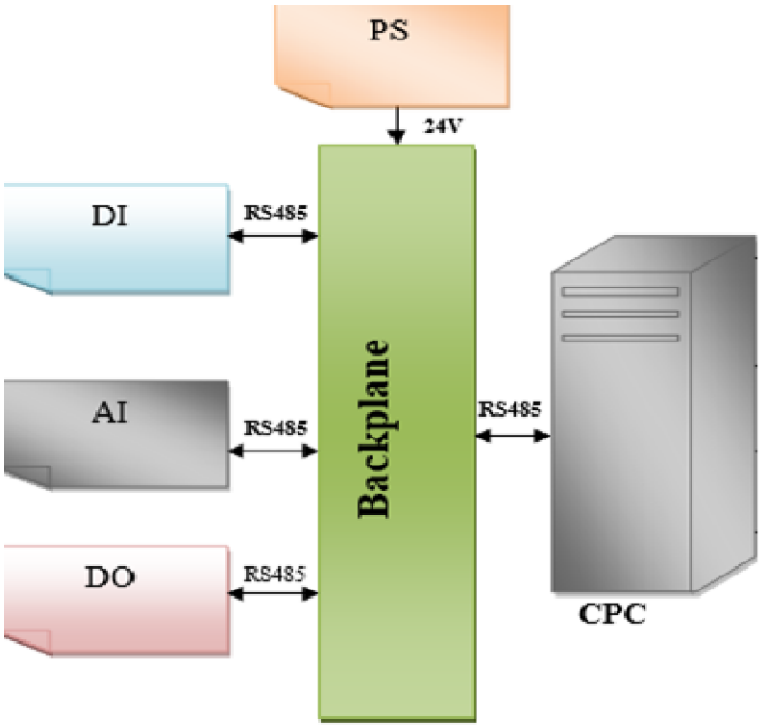


Figure 1.1: RTU

RTU has 9 slots. Each slot has different card i.e., AI (Analog Input), DI (Digital Input), DO (Digital Output), CPC (Central Processing Card) and power supply as shown in Figure 1.1. Power supply card is responsible to generate and provide require power to every card. CPC is the main processing board of this unit. It controls all the cards. It takes data from input cards and sends data to output card. CPC has great communication capability. It has one RS485 communication interface at the backplane connector to communicate with the different cards in the unit.

Master Station is handling data processing and user interface. The software package contains the all information and parameter of RTU. Software package should be designed to fulfil all types of user need and to achieve better functionality.

1.2 Problem Statement

This tool is needed for Configuration purpose. This tool is using direct collecting parameter of RTU and handle the request/response protocol. Configuration tool is made suitable for RTU substation. It is stored real time data in CSV and XML format if any time fails then easily catch the save data. CSV and XML file are storing all event logs. This tool is verifies and filters incoming data.

Chapter 2

Literature Survey

In present state, world is using automated system. Everywhere needs automated system and aware of automation system. Automated System means to eliminate the need of human interference in order and complete a task. Remote Terminal Unit (RTU) is a vital part for getting distribution automation in system.

Remote Terminal Unit was black box(dumb) device that served as an extension of the central computer to the input/output. Traditional RTU had no intelligence but could only read the input and activate the control inputs. RTU developed and use with 8 bit, 16 bit and 32 bit microcontrollers, so now RTU dedicated microcomputer with perpetual capability. RTU managing database with the central computer, the central computer becomes an operator interface tool. The function of RTU is to collects all the data from the plant, digitize them and send to the master station through the communication network. RTU also receives command from control master station and executes it at the substation.

Chen Peijiang and Jiang Xuehua [1] designed and implemented a remote monitoring system based on GSM. The system divide in two parts: monitor Station and remote monitor station. The communication is established between two parts by TC35 communication device of GSM. MSP430F149 MCU is used for monitoring station. The result of demonstration showed that the system can monitor and control the remote communication between the monitoring Centre and the remote monitoring station.

Chang.et.al[2] developed a DNP protocol for better performance RTU which was ap-

plied to the feeder automation system of Power Plant. The Harvard architecture advanced microcontroller using pipeline processing technology would be used as the control core, to improve the system efficiency. The RTU in this project could measure AI, DI, DO parameter of the voltage and current of the feeder, monitor the feeder line branch switch status, digital relay and utilize DNP and feeder automation host machine.

Aamir.et.al [3] has done a comparative study of two different selections of CPU for designing an RTU based on performance measurement in view of energy management applications. The two CPUs are programmable Logic (PLC) and Field Programmable Gate Array(FPGA). The study showed that FPGA based RTU possesses unique features like encryption support, radio support and large memory area while PLC based RTU exhibits limited features. An optimized RTU was proposed based on significant parameter that facilities the optimized design.

Chapter 3

System Requirements

3.1 Non-Functional Requirement

1 **Reliable**

This tool is reliable and easy to use.

2 **Manageability**

This tool is manage the require phase of RTU.

3 **Environment**

This tool is suitable for energy power plant.

4 **Recoverability**

If any fault or damage occurs then data is easily recover. because data is store in file system.

5 **Serviceability**

One time tool commissioning after not need to worry. All the process handle by tool.

3.2 Functional Requirement

Functional requirement is specify behavior of the project. It contains information about how to proceed do with project.

3.2.1 System Requirement

- Connection with RTU

- Configuration of RTU
- Data Store in file
- Data Validation
- Protocol Design
- Serialize and Deserialize

3.2.2 Software Requirement

Table 3.1: Software Tool

Tools Detail	Open Source/ Licensed	Information/Features	Limitations
IDE - MS Visual Studio 2017	Licensed	It is rich IDE. Provide Advance debugger. Write code accurately without losing current file. deliver best quality software. it is use version control. Source: https://msdn.microsoft.com/ en-us/library/ e2h7fzkw.aspx	More Space and Memory requires
.Net Framework 4.1	Open Source	It is rich framework. easily creating apps that run on number of platforms. deploying the software time minimize conflict. provides vast support program, compiler and code libraries. Features: Rich Toolbox Simplicity Automatic Monitioring easy maintenance Object Oriented Source: https://www.microsoft.com/ en-in/download/ details.aspx?id=8515	Object relational support limited Managed Code that you run with this framework can be slower than native code vendor lock-in migration is expensive
Windows Presentation Foundation	Licensed	WPF is a powerful framework for windows application. Features: Graphics charts(2D/3D) Themes Imaging Different Control:Tab Control, List Control Media Service(Audio,Video)	In-box control suite limited not run on old OS i.e. windows 2000 or lower
Serial Port Monitor	Licensed	Powerful system utility for RS232/422/485 port Monitor COM monitor displays, logs and analyzes all activity. Using track problem that occur during driver development, testing Source: https://www.eltima.com/products /serial-port-monitor	

Chapter 4

System Design

4.1 Master-Slave Model

The configuration tool and RTU works as a master- slave architecture. The configuration tool works as a master and RTU works as a slave. Master request for communication using serial port interface to RTU. RTU handle the request give the reply according required frame and set communication between Master and slave.

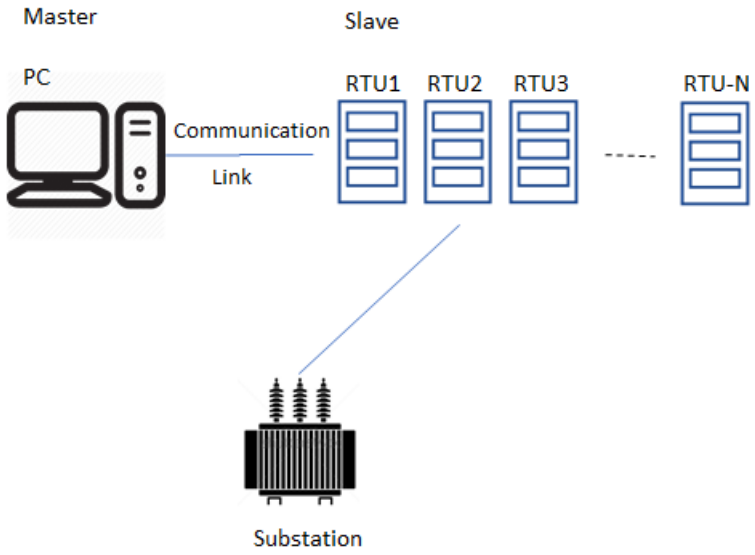


Figure 4.1: Master-Slave Architecture

As per given figure 4.1 Configuration tool is connected with RTU using communication interface such as communication link. Master configured the data and send to RTU. For

this communication some rules are needed. This rule sets by protocol. This system used as proprietary protocol. Implementation of proprietary protocol for the architecture of message/data request/response to /from master and RTU. RTU and Master with operation perform as per given figure 4.2.

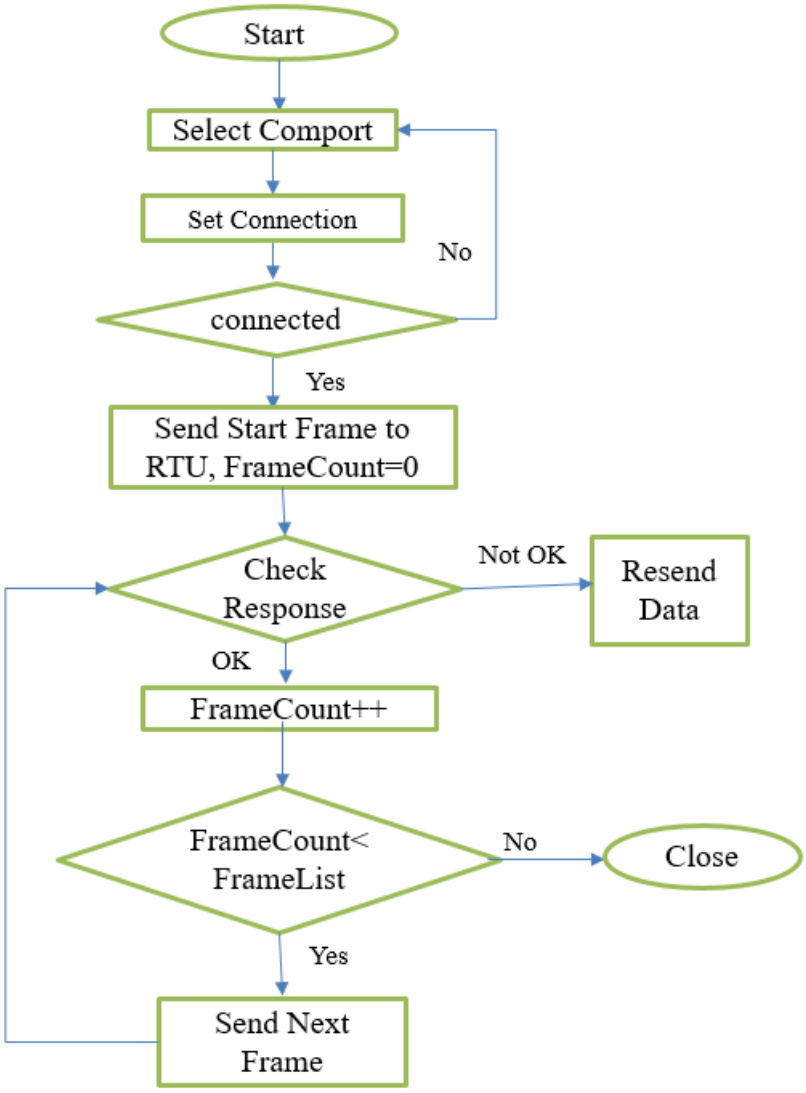


Figure 4.2: RTU Operation

For RTU, there is need of intelligent device such as computer, pc to handle all communication. Here master has the capability to manage all the communication of Slave. Information is transfer between master and slave.

Chapter 5

Communication Model

The Request/ Response relation between master-slave is called Protocol. This protocol is a serial communication protocol. This proprietary protocol set data transfer rules between tool and RTU. This protocol is suitable for this project because ease of use and reliable. This protocol is design by some relevant parameter i.e. header, operation, GroupId and SubgroupID and CRCProtocol messages are a simple 2 byte CRC(Cyclic Redundant Checksum). Protocol structure can be used floating point and ASCII text. CRC is process of checking errors in data that has been transmitted on a communication link. CRC apply on 16 bit, 32 bit , 64 bit data and so on. Figure 5.1

5.1 Protocol Design

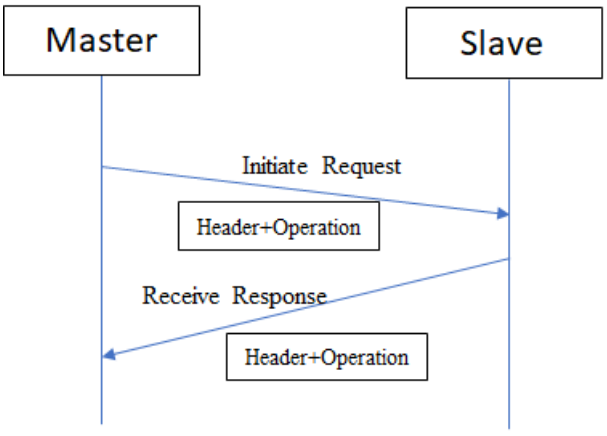


Figure 5.1: Initiate Protocol

For this protocol some parameter need to set. The parameter set as per below table

Table 5.1: Protocol Setting Field

Field Name	Set Value
Baud Rate	9600 - 115200
Data Bit	8-10
Parity	Even/Odd/None
Stop Bit	One/Two

Operation status set for communication start, stop, read and write. This data is stored in list. The list wise user selected parameter send to device. Given figure 5.2 is the frame structure of project. This frame using send and receive the data from tool to RTU.

Frame has appropriate operation status. If communication initiate then Header(function code i.e. 2 byte 0xF0F0) with operation start(any hex number define for start i.e. 0x01) frame send to RTU. If frame Header, Operation and CRC match then RTU send the response frame with Operation OK(i.e. 0xa0) otherwise send operation Not OK(i.e. 0xb0).

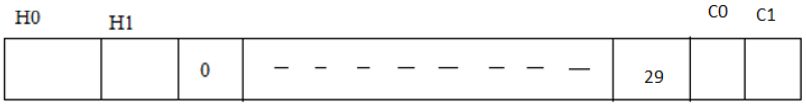
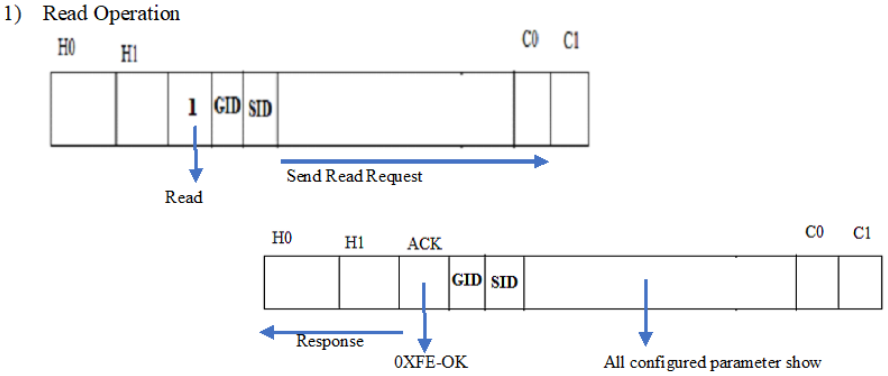


Figure 5.2: Frame structure

Below figure 5.3 give the information about the operation.

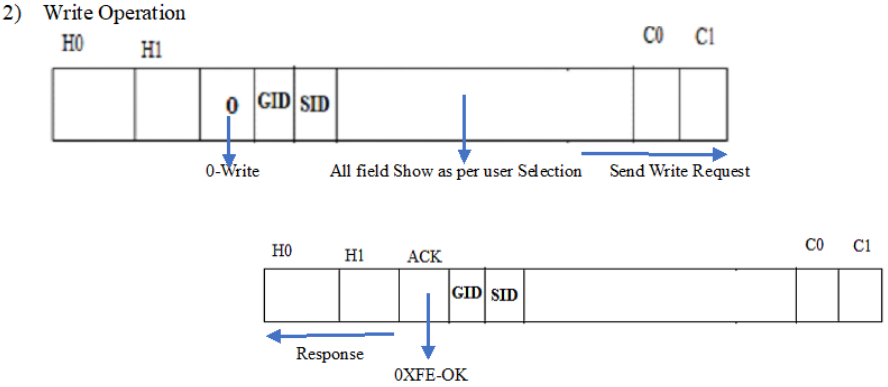
Here if frame wrong then number of operation status possible. For operation termination, tool send last frame with appropriate operation status STOP(i.e. 0xC0) to RTU and process terminate. Last frame structure show in below figure 5.4

1) Read Operation



At Read operation time all configured parameter show.

2) Write Operation



At Write operation time all fields show as per user selection and user can change and modify.

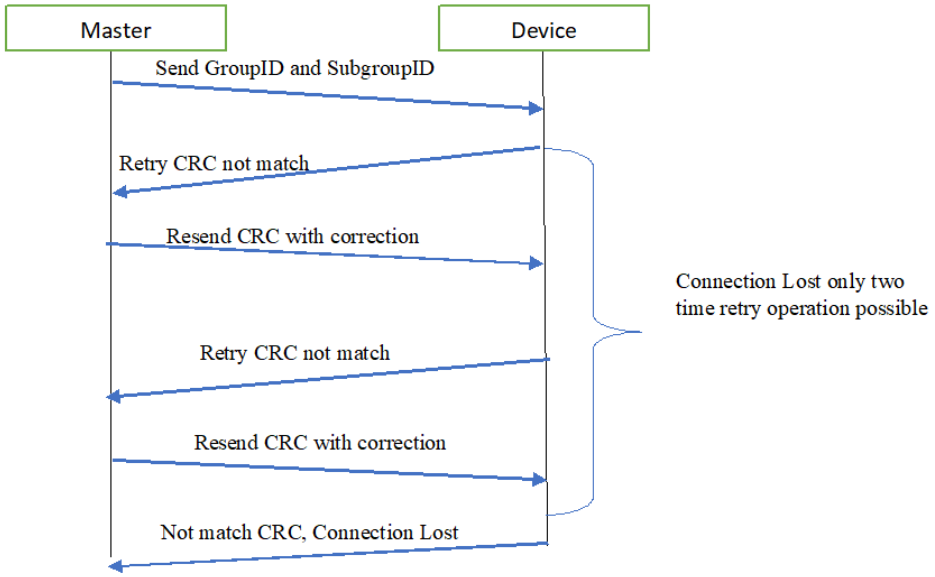


Figure 5.3: Protocol Structure

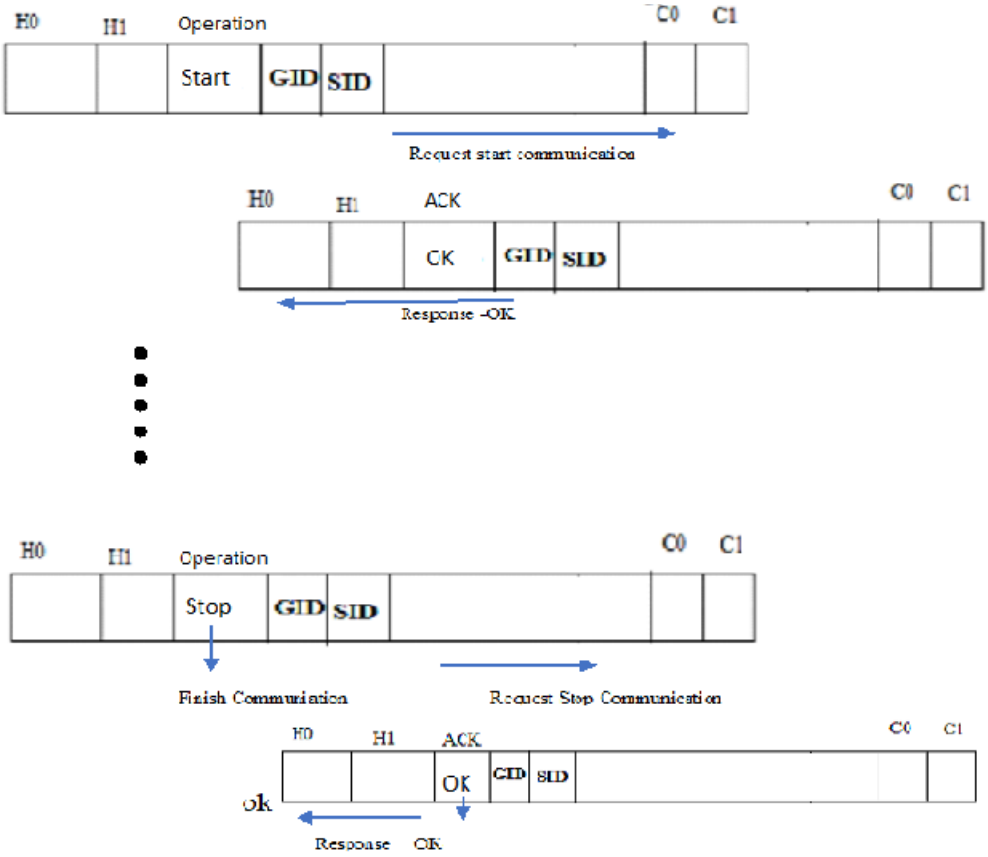


Figure 5.4: Terminate Frame

Chapter 6

Implementation

6.1 Pseudo Code

This tool is designed in Microsoft win form and implemented in c♯. RTU has different card and card has number of channel. These RTU, card AI, DI DO and Point AI, DI, DO implemented their class and structure as per parameter requirement and size of frame. Structure is marshal the size of parameter data, store in particular byte. One by one data marshaling and store in frame. In this project every data store in list. List is set the frame.

For Tool and RTU need to performed littel Endian and Big Endian operation. Send Parameter to RTU then perform Big Endian Operation and Receive data from RTU that time perform Little Endian. Big Endian is store most significant byte first where as Little Endian is store least significant byte first as shown in figure 6.1. This Operation is used Logical Operation. you have to convert all the parameter data type in this form.

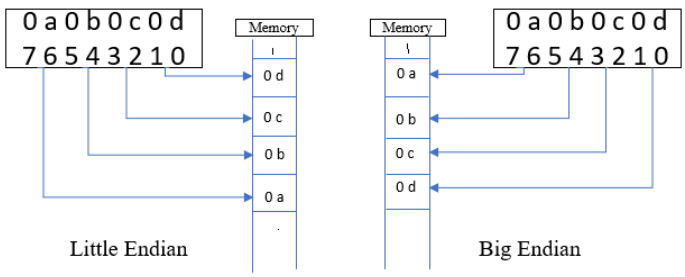


Figure 6.1: Little Endian and Big Endian

This frame is send or receive with correct data or not that test by CRC. The CRC is used to detect error at transmission on data frame. If frame size is 30 byte then 2 byte

data append for CRC. Now, 32 byte reserved for every single frame. CRC is very popular because it is easy to implement for binary hardware.CRC is calculated by using logical operation shift and XOR.CRC can be calculated by using Big Endian and Little Endian.

1 Take two variable that define 1 byte for CRC1 and CRC2. CRC is 2 byte possible.

2 Perform XOR logical operation of total frame.

3 This XOR logical operation result is equal to last 2 byte of CRC then your frame is with correct data otherwise check data and recalculate the CRC.

function crc(bit list[1 to length], int polynomial) {
shiftdata := initial data // basically one or zero possible
for i from 1 to length {
if MSB of shiftdata ∧ (XOR) list[i] = 1 {
shiftdata := (shiftdata left shift 1) XOR polynomial
} else {
shiftdata := (shiftdata left shift 1)
}

if LSB of shiftdata ∧ (XOR) list[i] = 1 {
shiftdata := (shiftdata right shift 1) XOR polynomial
} else {
shiftdata := (shiftdata right shift 1)
}
}
return shiftdata
}

6.2 Graphical User Interface

The GUI(graphical user interface) is follow the hierarchical structure Treeview and right hand side propertgrid.

6.2.1 Add Customer

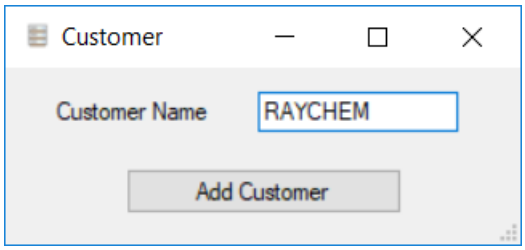


Figure 6.2: Add Customer Node

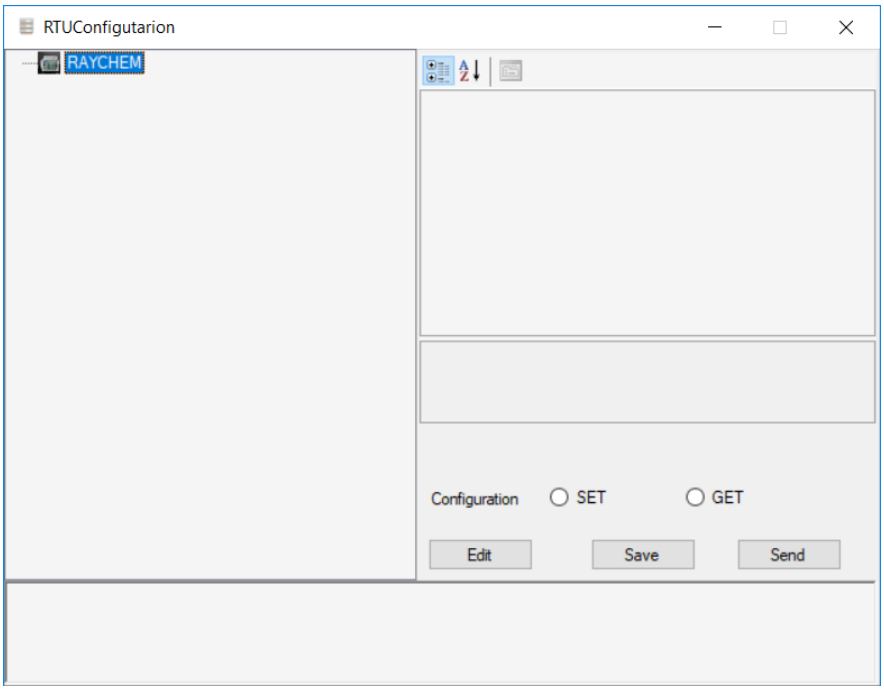


Figure 6.3: Customer Node

6.2.2 Add RTU

Add RTU node in Treeview. When click on RTU node then property show in property-Grid.

6.2.3 Add Card

Click on RTU node and add Card Node in Treeview.

Click on Card and their property show in propertyGrid.

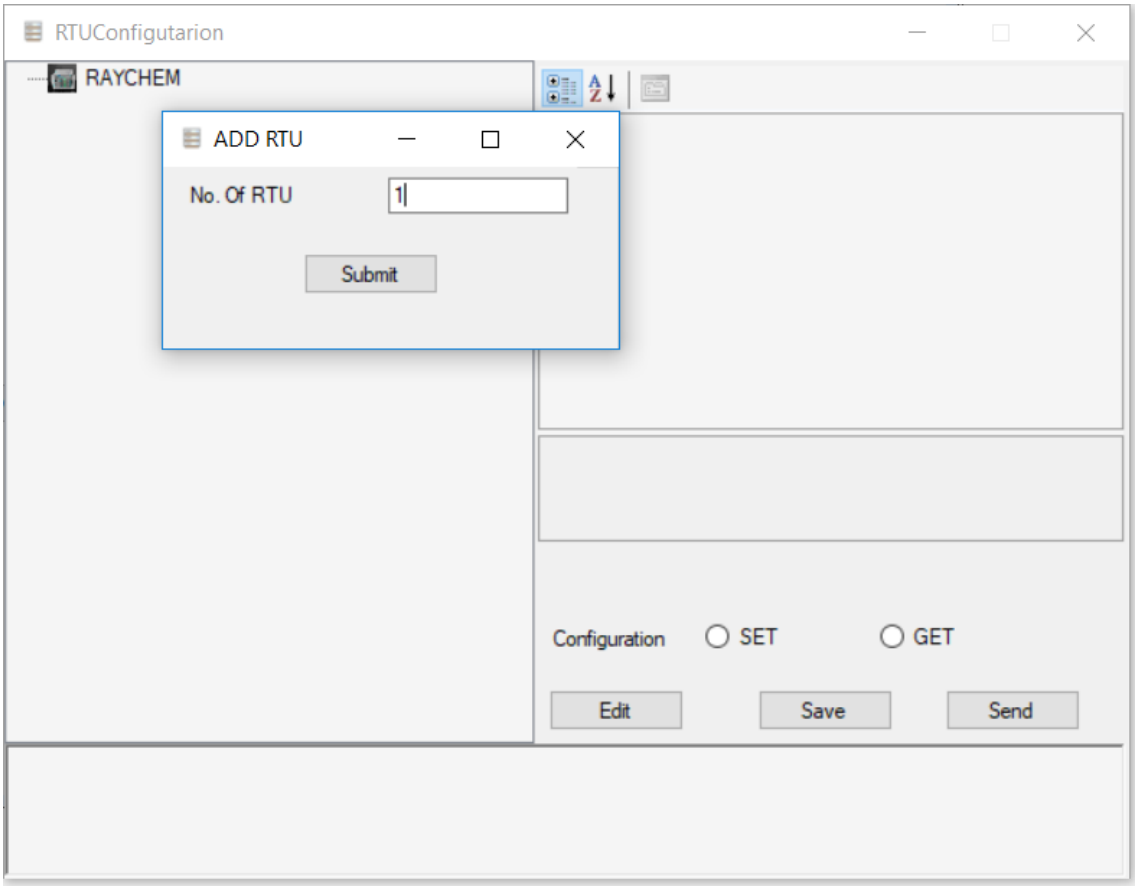


Figure 6.4: Add RTU

6.2.4 Add Point

Click on Analog Card node and add Point of Analog node in Treeview. Click on Analog Point and their property show in propertyGrid

In this tool different card selection possible. Here AI, DI, and DO card require. Every Card has functionality different.

For this tool Serialized and Deserialized the given data. Serialization is the process of converting given object into a stream of byte in order to store the object into particular format i.e. database, file and memory. This application data is storing in .xml so Serialization and Deserialisation acquire.

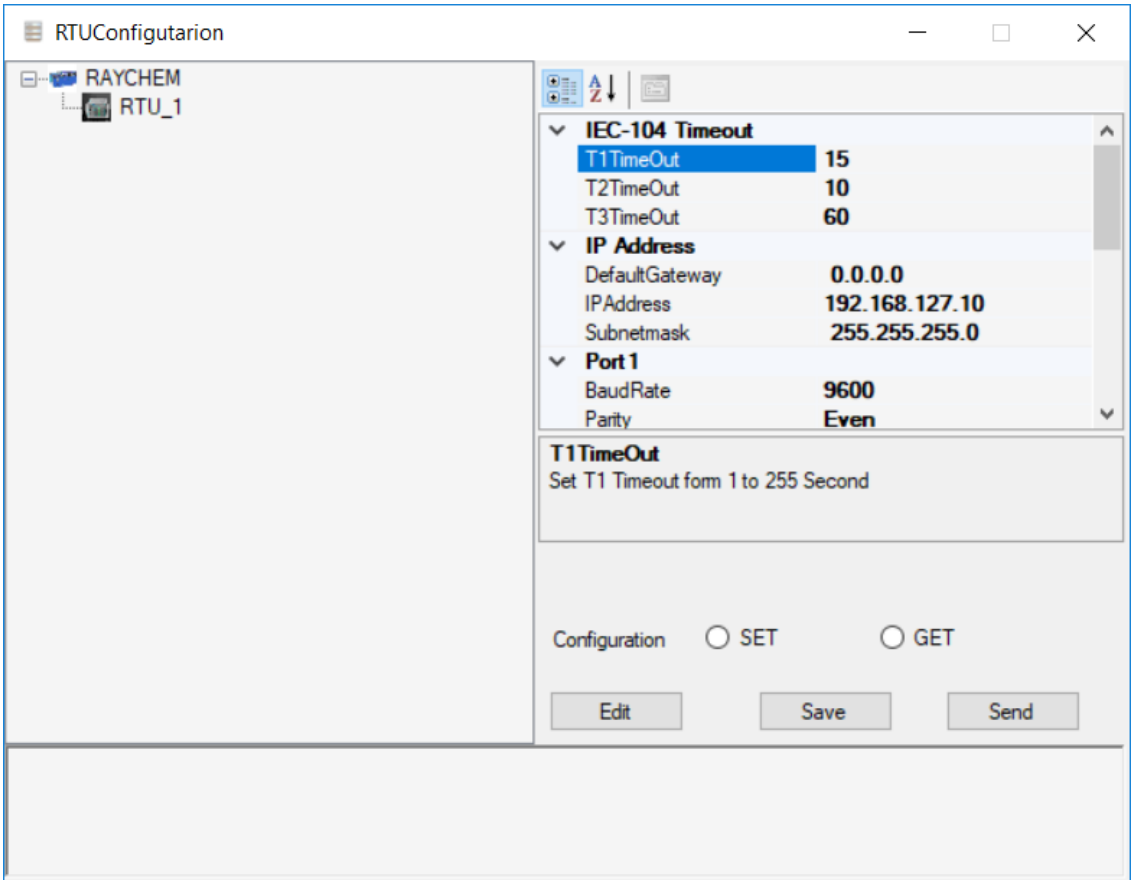


Figure 6.5: RTU Parameter

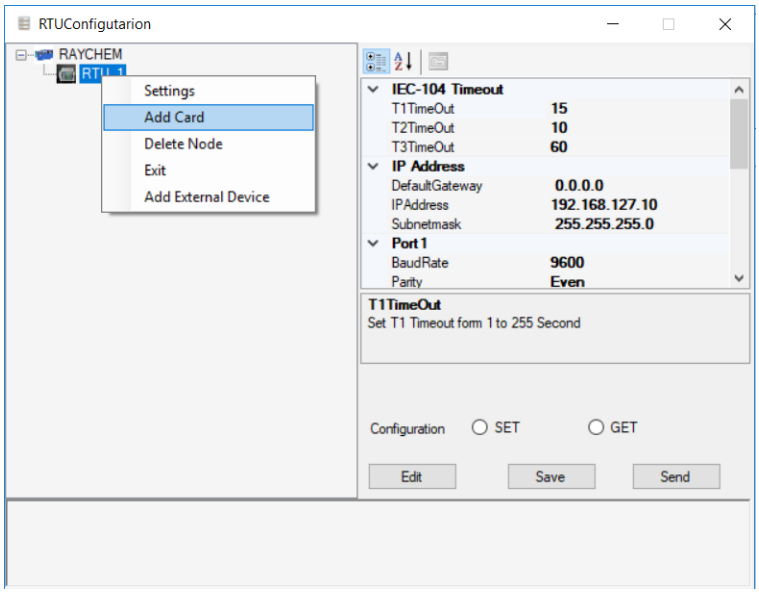


Figure 6.6: Add Card

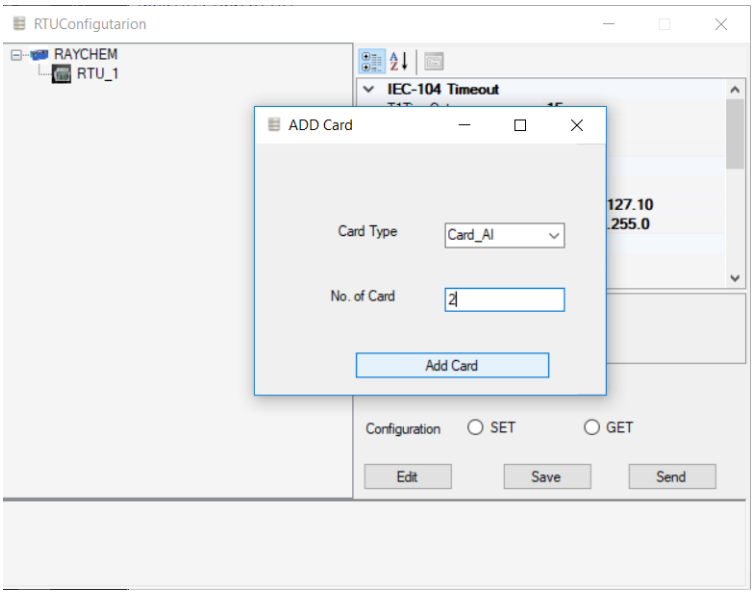


Figure 6.7: Add Card Window

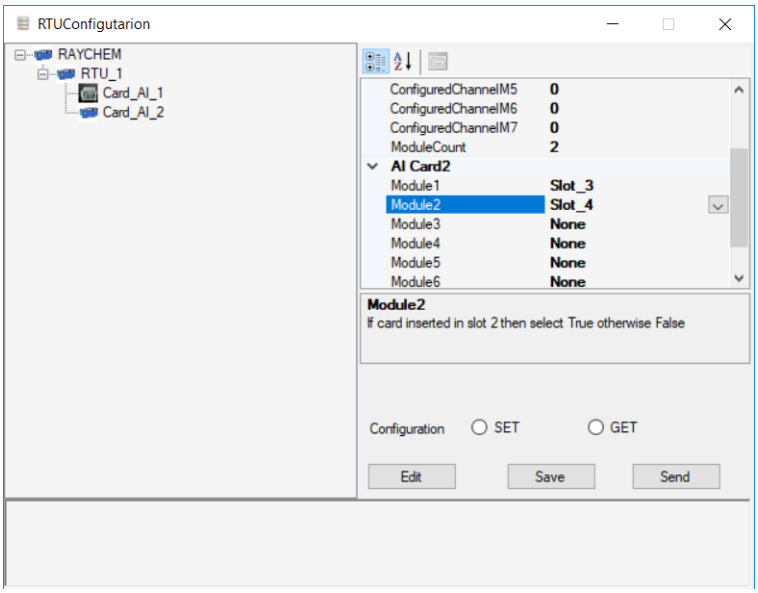


Figure 6.8: Card Information

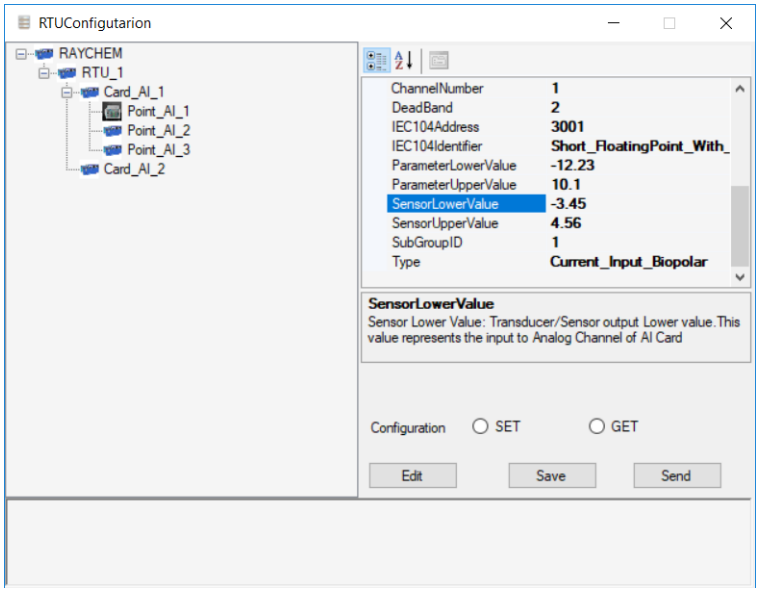


Figure 6.9: Point Information

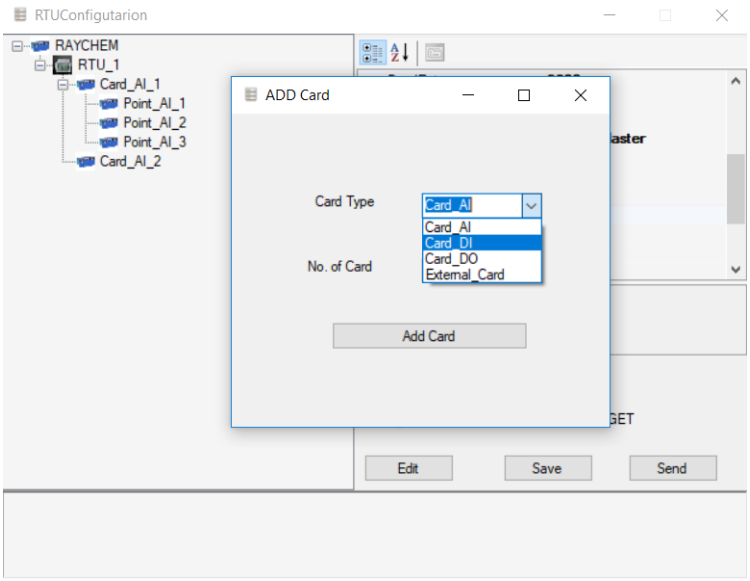


Figure 6.10: Different Card Selection

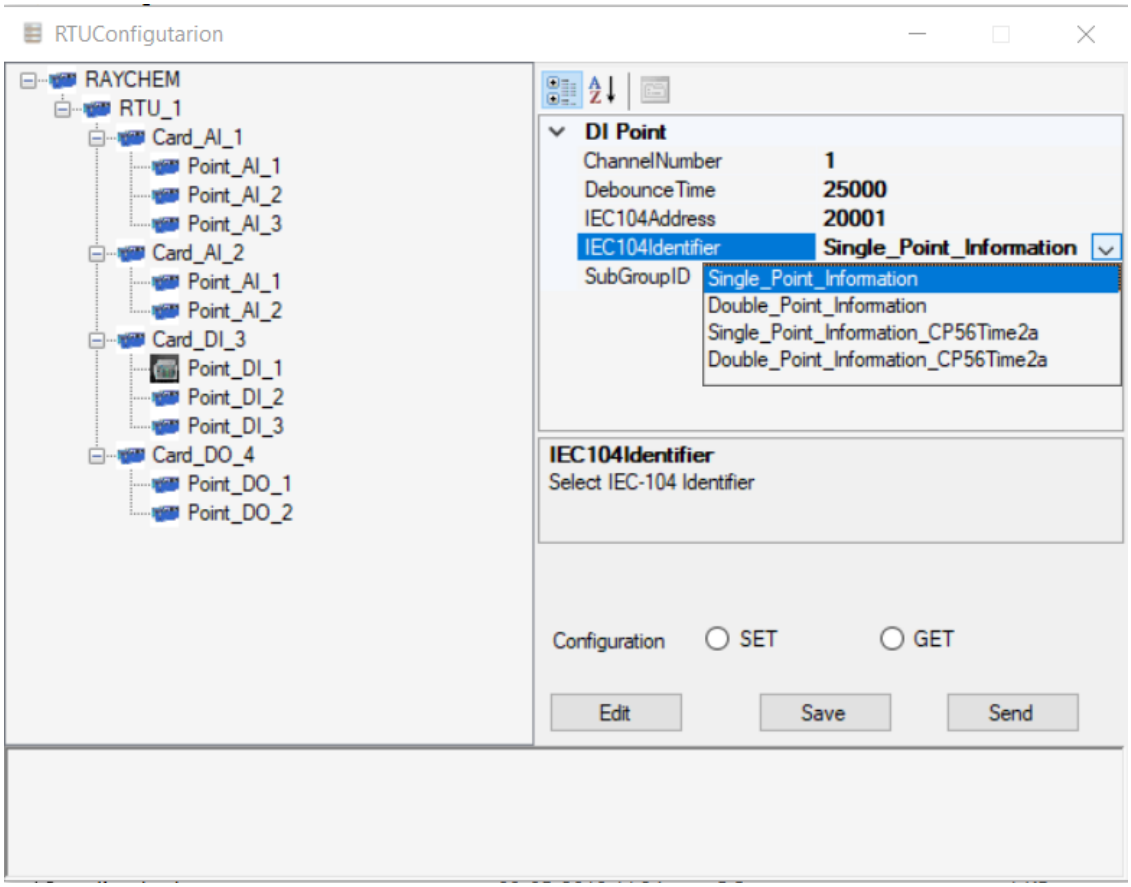


Figure 6.11: Point DI Information

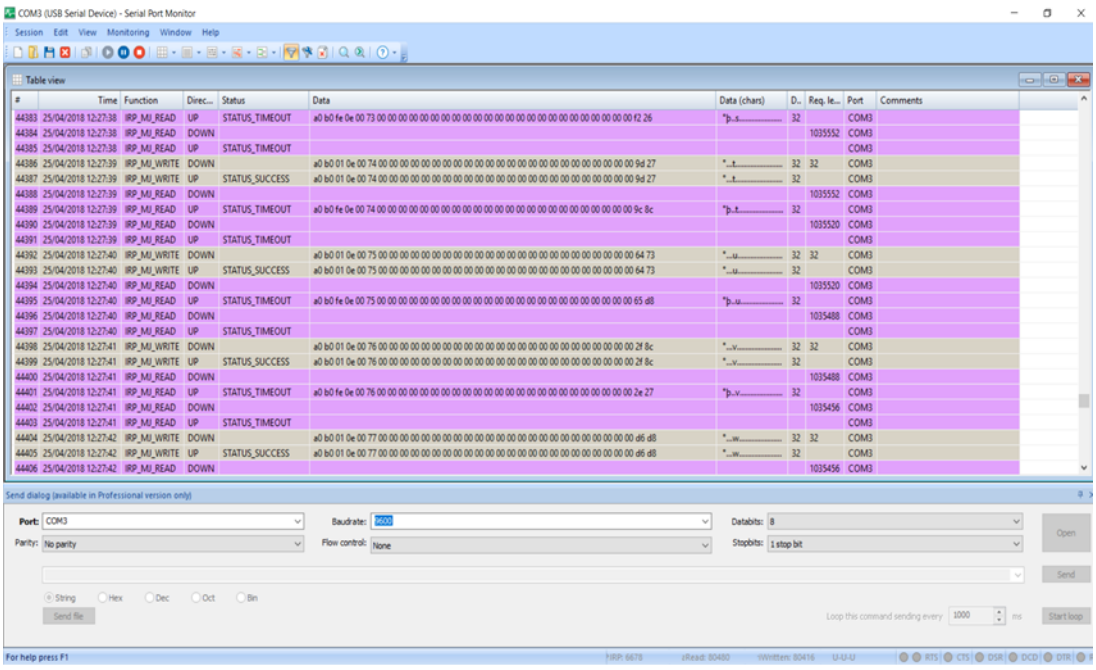


Figure 6.12: Monitor Data

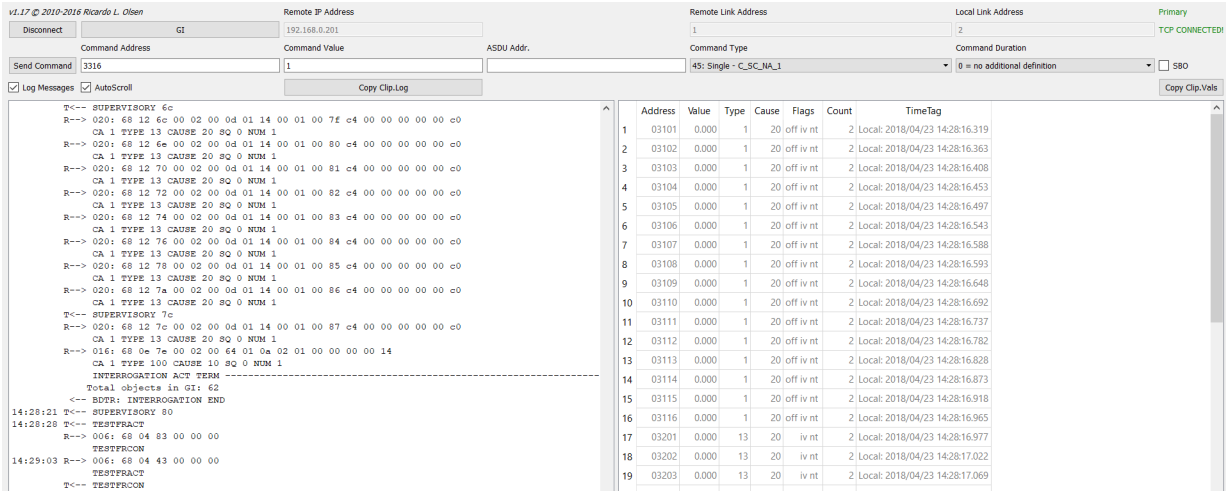


Figure 6.13: IEC104 Address Data

Chapter 7

Conclusion

This tool is configuring all the data of RTU from substation using serial/Ethernet connection.This tool is suitable for remotely and locally configuring data. This provides customized menu. If user needs some additional parameters then in customized menu it is easy to develop. Using this application TreeView can be expand as per requirement. This tool can configured any behaviour of field structure i.e. Analog Input, Digital Input and Digital Output. This project is more efficient, flexible and reliable

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