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Remote Control of Drive system Using Modbus Communication Protocol through PLC

S. S. Abarna[1], S. Siva Kumar[2], Dr. V. Saravanan[3]

[1]PG student, Department of ECE, Embedded system Technologies, SRR Engineering College, Chennai, India
[2,3]Professor, Department of ECE, SRR Engineering College, Chennai, India

ABSTRACT

Ground testing of rocket engines are carried out in test facilities. Programmable logic controller (PLC) based system is used for control, monitor and store the status of field elements like EP valves, control valves. Hot standby PLC with full redundancy in all levels is designed for testing purpose. Drive System is used to achieve the variable speeds of pump and it is controlled by another PLC. For remote operation the third party Drive system PLC has to be interfaced with the existing PLC. This is done by serial communication using Modbus TCP/IP protocol. Snet module is used as MODBUS RTU/ASCII master to communicate with third party MODBUS RTU slave devices. PLC software is used as programming language with windows environment to realize the software and HMI web display builder software is used to create custom displays for station.

Keywords: Modbus, PLC,SCADA, Drive system.

I. INTRODUCTION

Testing is mainly done to check or verify the integrity of propulsion subsystems[1]. These tests are chemically inert, safe and relatively less expensive to perform. Programmable logic controller based system is used for control, monitor and store the status of field elements like EP valves, control valves. PLC system is used for this operation. PLC is a digital computer used for automation of electromechanical processes[2].Drive system is used to achieve the variable speeds of pump and it is controlled by another PLC of different brand. Remote control and monitoring of Drive system during test are planned to perform using main master control system. This is done by serial communication using MODBUS TCP/IP protocol. In this paper we used two PLCs with different makes and brand. Main PLC provides a fully redundant system having redundant CPU, redundant power, redundant I/O .The CPU contains an internal program that tells the PLC how to perform the functions. A typical PLC has three components such as central processing unit (CPU), the input/output (I/O) section, the power supply and the programming device. PLC communicates the status of the main PLC through Human Machine Interface and display it in Scada.

II. SYSTEM DESIGN

Preparing and conducting hot firings of a propellant can be expensive and time consuming process. To investigate the flow behavior of a propellant system, one can employ cold flow techniques to record and study the flow characteristics. For this operation PLC is mainly used. Programmable Logic Controller (PLC) adds power and robustness to interlock sequence batch control capabilities [3].

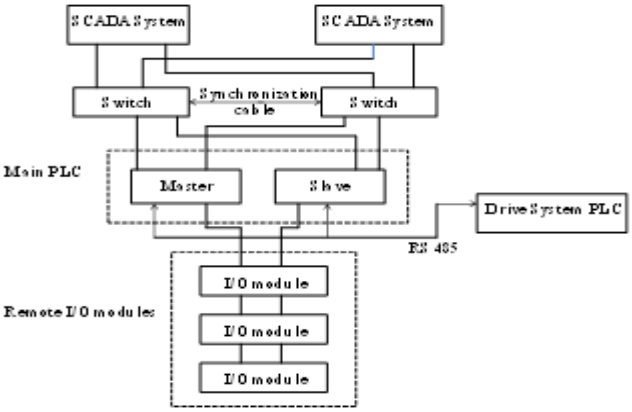

Fig.1 Block diagram of the system

Main PLC used here is hot standby configuration. It provides the control system designers with various redundancy options that fits the requirement.We can configure drive system PLC i.e, the motor to main PLC through RS 485 or through TCP/IP protocol. Control system and application software is development using PLC software and has standard programming languages as per IEC 61131-3 standard .The program is stored in PLC have sufficient memory for program execution. Through P2P communication data is read from main PLC by scada PLC and displayed in mimic for monitoring.

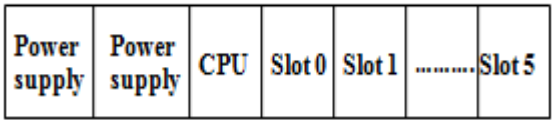

Fig.2 Base of a I/O module

CPU provides a fully redundant system, which includes redundant CPU ,redundant power, redundant I/O cable.CPU provides high speed execution of program instructions and communication data transfers as shown in Fig.2.High memory of CPU combined with high speed and huge I/O capacity feature provides a robust platform for efficient performance in large applications.

PLC programming controllers features analog and digital I/O modules along with special modules like high speed counter module. Here we configure both PLC by using RS 485 protocol. For this we are using Snet (serial communication network) module. The main features of Snet is that it establishes communication with various devices also it emulates a communication modem to control a remote PLC. we can connect up to eight I/O modules to the PLC. The CPU module can perform a self diagnosis to locate any errors in the PLC system. It can also prevent abnormal operations resulting from the error. The main system enables to change the modules while the PLC is in RUN mode. One of two CPU modules is a master system in control of main operation and another is a standby system for backup control in case the master fails during operation.

A. Scan program

The scan program is a basic method of executing a program repeatedly on a PLC. It sequentially performs the same operation as per the program starting from the first step to the last step [4].In case interrupt program is running while executing the scan program, it stops the program being executed and executes the related interrupt service program.

B. Snet

Snet is Serial Communication Network. Snet module is used as Modbus RTU/ASCII master to communicate with third party Modbus RTU slave devices. Serial communication protocol used is RS 485. Drive system is having different I/O cards, which get differ from the I/O ports in the main PLC. So Snet module is used for interfacing both. The transmission specifications such as transmission speed and data type such as data/stop bit should be specified in order to use Snet I/F module. Specified basic setting values are saved in PLC CPU, and will not be changed until overwritten. In addition, even if Snet I/F module is replaced with a new module, the basic setting values previously specified and saved in CPU will be automatically applied to the new module as well. The features of Snet I/F module is as follows:

- It establishes communication with various devices such as PLC's, computers and so on, which use different types of serial communication protocols. In addition, it is possible to integrate many devices supporting ASCII communication in the PLC network.
- It emulates a communication model to control the remote PLC.

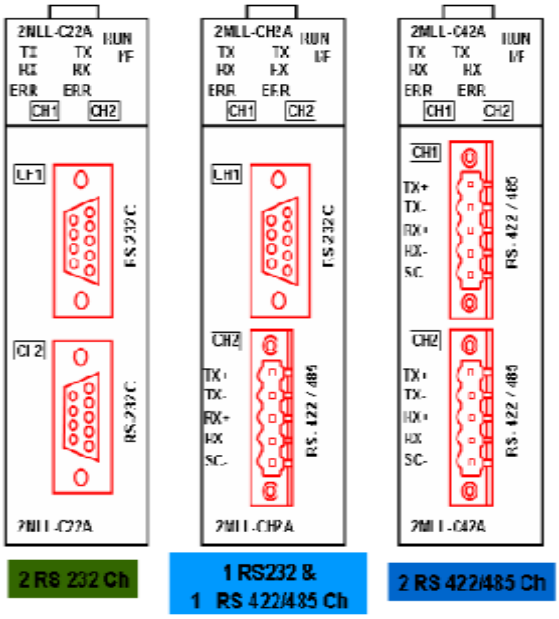

Fig.3 Front view of Snet I/F module

User can specify communication speed and communication mode using Network Manager application in windows environment. This is the main characteristic of Snet I/F module. Snet I/F module is available in three types RS232C 2 port, RS 422(485) 2 port, RS 232C 1 port/ RS 422 1 port [5].By using RS 485 channel, multi drop configuration of up to 32 devices is possible. Module supports functions such as dedicated communication, Modbus server/client function with open standard serial devices, user defined protocol with proprietary serial devices.

Fig.4 MasterLogic-200 PLC Snet(server)

C. Modbus Rtu/Ascii

There are two basic transmission modes found in serial MODBUS connection, RTU and ASCII. MODBUS is regarded as an open protocol [6]-[7]. MODBUS RTU is a open, serial (RS 485) protocol from the Master/Slave architecture. MODBUS transaction informs the server to which type of action to perform. In MODBUS ASCII, the messages are encoded with hexadecimal value, represented with ASCII character. In ASCII format the messages are in readable form. The characters used for encoding are 0 to 9 and A to F.

III. SOFTWARE TOOL

A. PLC software

PLC software is used as programming language with windows environment to realize the software. It is a software tool designed to perform and debug system[8]. This software package can be installed on computers running one of the following operating systems Windows xp/vista/7/8/8.1/10.. This package consists of PLC programming and Network Manager. Features of software are

1. Slot assignment
2. Peer to Peer networking configuration.
3. Data transfer definition.

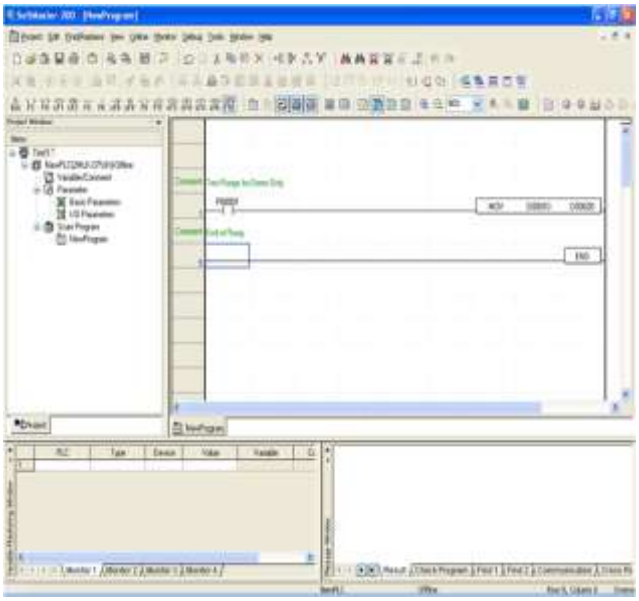

Fig.5 PLC Software platform

PLC Software platform is used to program the PLC. The Software can be connected remotely to PLC using any one of the following communication media such as RS-232C,USB,Extended base USB, Ethernet. PLC Software provides three modes of operation, Run, Stop and Debug. Run executes a program operation normally. Stop is to stop the operation with no program execution. Debug verifies a program while checking the program execution and data. Address monitoring of the PLC Software enables the monitoring of all the address areas data in the PLC. It can write or read data value on the PLC's specific address.

Table.1 System requirements of Soft master

ITEM	SPECIFICATION
Personal computer and memory	A Pentium computer and 128 MB memory
COM port	RS-232C serial port or USB port
Hard disk	At least 100MB or more space
Monitor	Monitor should have 1024 x 768 and higher resolution
Operating system	Compatible with windows XP/vista/7

It can write or read data value on the PLC's specific address. In addition, address monitoring can display the data value continuously when displayed or entered on the window depending on the bit format and display method. Address areas are necessary for effective and correct control of various types of data. Based on the PLC series and the CPU type, PLC provides various address areas such as I,Q,M,R,W of data to manage the data.

Fig.6 Address Monitoring section of PLC Software

The Master PLC is based on the standard IEC language. The PLC language standardized by IEC consist of two illustrated languages, two character languages and Sequential Function Chart SFC).The illustrated languages are Ladder Diagram (LD) and Function Block Diagram (FBD).Ladder Diagram is a graphical language based on ladder logic. Function Block Diagram is a graphical language for depicting signal and data flow through function blocks. The character languages are Instruction List (IL) and Structured Text (ST).Instruction List is a low level assembly like language based on similar Instruction languages. Structured Text is a high level language. Ladder Diagram and Structured Text are mainly used to program the Master PLC.

B. HMI Web Display Builder

Human Machine Interface (HMI) can be defined as the interaction between PLC system and an operator. The interaction is presented by a screen with dynamic icons, figures and text [9]. HMI can be implemented using HMI Web display builder . HMI web display builder is a Specialized drawing application that enables to create our own (custom) displays for station[10]. The parameters of drive system are displayed as mimic using this HMI software. We can present information in a user friendly manner using custom displays. The mimics created are simulated using station.

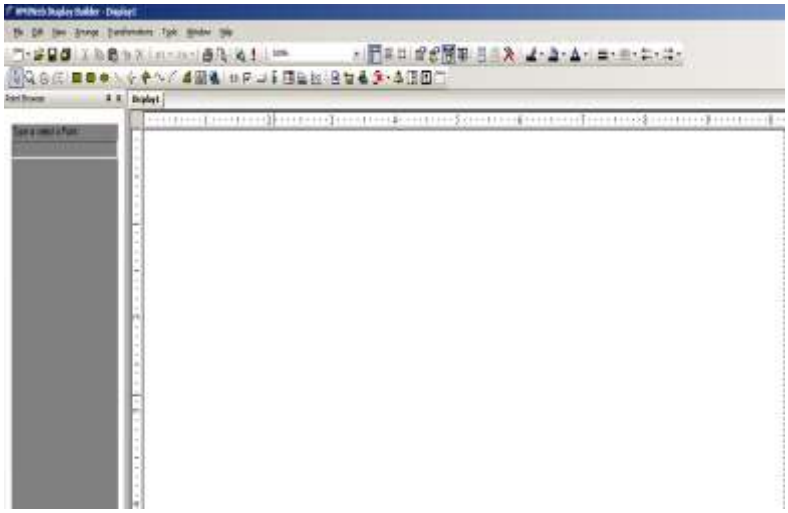

Fig.7 HMI web display builder platform

IV. RESULTS

The parameters of drive system are read by the main PLC and are displayed as mimic in scada. The outputs are both in the form of analog and digital. The analog outputs are in the form of alphanumeric values such as the values of temperature, pressure etc. These values can also be viewed in the Address Monitoring window of PLC Software. Each of these values are viewed in the corresponding memory locations.

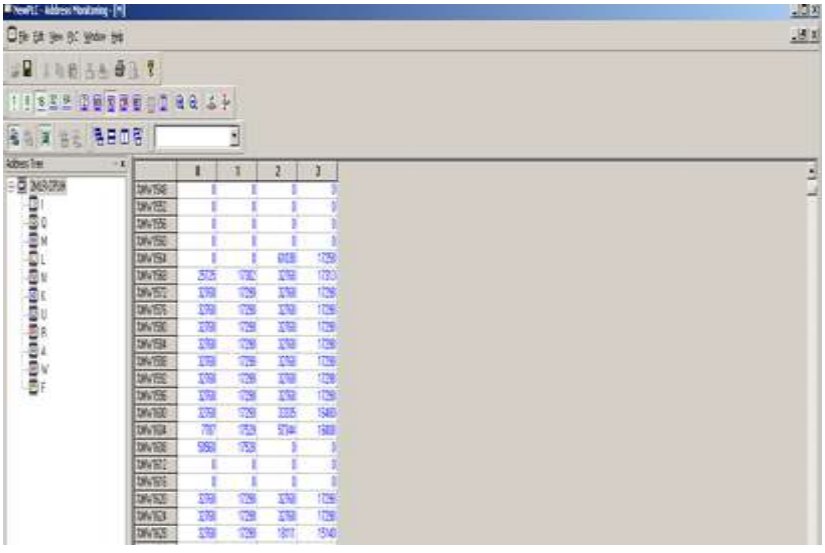

Fig.8 Values of ABB parameters viewed in the Address Monitoring section of Soft master

The same parameter values are displayed as mimic in scada using HMI web display builder.The values are displayed for the corresponding tag names.

Fig.9 Values of the parameters displayed as mimic using HMI in scada.

The other parameters of drive system are displayed digitally by making an LED to blink as red and green according to the corresponding functions.For this VB script is written on the HMI platfom for each of all LED's.

Fig.10 Digital output of drive system

CONCLUSION

In this paper, the above proposed system will control the drive system using MODBUS communication protocol. Use of PLC based system helps in controlling, monitoring and for storing the status of field elements . The Snet module is used as MODBUS RTU/ASCII master to communicate with third party MODBUS slave devices. Here the two PLCs are first interfaced through peer to peer configuration and data are read from the drive system by the main PLC and are displayed it in SCADA. The software can be realized by Softmaster as a programming language with windows environment.

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