DEVELOPMENT OF PC BASED VOLTAGE TRANSDUCER

Pema Chentsho[1] Jigme wangchuk[2], Karma Kelzang Eudon[3]

Electronics and Communication Engineering Department, College of Science and Technology.

* E-mail: [1]2010077@cst.edu.bt, [2]2010032@cst.edu.bt, [3]karmakelzang.cst@rub.edu.bt

ABSTRACT

This project will deal with partial development of basic circuitry and programming for the IEDs deployed at power station as per their functionalities, wherein only voltage parameters may be acquired from the field. The functionality can be replicated on a design of a basic voltage transducer. Initially the transducer will measure certain AC voltage level and the measured values may be displayed on a LCD display or on Personal Computer (PC). For display of parameter on PC, the measured value will be digitized by a microcontroller and then encapsulated in a communication frame on serial communication. The encapsulation of digitized data into frames is done through UART programming. A complier may be used for developing software at PC to extract the encapsulated value from the transducer via serial interfaces. The software may also provide a platform to configure the communication parameter and scaling parameters of the transducer as per the user's requirement

Key Words : *Remote Terminal Unit (RTU), Aanalog to Digital Conversion(ADC), Universal Asynchronous Reciever and Transmitter(UART) and Substation Automation(SA).*

1. INTRODUCTION

Substation Automation (SA) systems plays the major role of advancement power system coordination, whereby performing local supervision in substations from a remote end. SA system is also implemented in Bhutan Power Cooperation, wherein Remote Terminal Unit (RTU) are used for data acquisition and also for controlling field devices.

The data acquired by RTU is categorized into two parts where the indication and alarm signals falls under digital signal. i.e. the signals can be interpreted with the help of one digit (1 for On and 0 for Off signal). Nevertheless the RTU also acquires analog values which provide the measurement values from the field. The analogue values are represented in terms of byte or a word as per the system specifications and a separate device namely Multifunction Transducer (MFT) is used for measuring the real time data. Further these data is transferred to the RTU via various communication interfaces. Henceforth this project deals with prototyping a part of multifunction transducer so to realize technology and to further develop the device as and when required.

A microcontroller would be used for sensing and measurement of voltage level from the field. Since PIC microcontroller is popularly used in industrial application we have choose PIC16F877A as per its merits for the application.

The microcontroller would be programmed using suitable compiler so that it can display the measured values either on a LCD or a PC.

For design and simulation of this project we have used Proteus 8 Professional and Mikro C pro compiler was used for loading the embedded C program on PIC16F877A.

There was a need of communication interface between the transducer and the PC for exchange of data. Therefore UART chip was used for implementing serial communication between the microcontroller and the PC. The serial communication provides enough bandwidth for

the exchange of data between the two devices. The UART was programmed to encapsulate the measured value provided by microcontroller into a communication frame structure and the data sent to PC for display and data interpretation.

2. ARCHITECTURE

The block diagram below shows the architecture of voltage transducer.

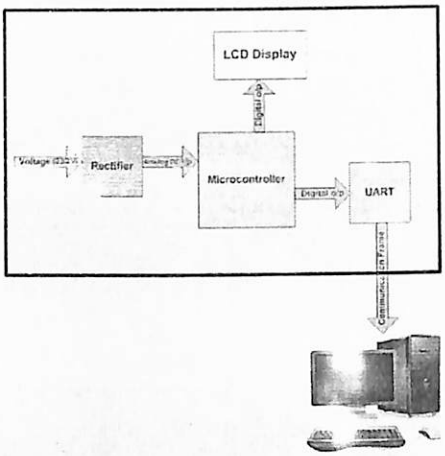


Fig. : Architecture of voltage Transducer

2.1 Power source supply

The PIC16F877a can operate from 0 to 5 power supply voltages. A 5V DC power supply voltage is the most suitable so in this project 5V power supply is used . The standard substation voltage 110 V or 230 V mains is step down to 12 V and then it is rectified using a full wave rectifier. The rectified dc output is regulated using IC 7805 to 5V.

2.2 Reset signal

In order for the microcontroller to operate properly, a logic one (VCC) must be applied on the reset pin. A push button connecting the MCLR reset pin to GND is provided as it enables the microcontroller to recover fast if something goes wrong. By pressing this button, the MCLR pin is supplied with 0V, the microcontroller reset occurs and the program execution starts from the beginning.

A 10K resistor is used to prevent shortening the 5V DC rail to earth from occurring when the RESET button is pressed.

2.3 Clock signal

Even though the microcontroller has a built-in oscillator (George, 2012), it cannot operate without external components which make its operation stable and determine its operating frequency. In this project operating frequency is 11.0592 MHz (mikroElecktronika, 2013).

2.4 LCD connection

The ADC output is displayed in 2x16 Liquid Crystal Display (LCD) by interfacing it with PIC16F877A microcontroller in 4 bit mode (George, 2012). For displaying ADC output on LCD interfaced with PIC16F877A microcontroller proteus 8 professional for hardware arrangement and simulation to see the result is needed (Shenoy, 2013). Also Mikro C pro v.6 is used to write the embedded C program and build the hex file of that to load in memory of microcontroller (Mazidi, Mckinlay, & Causey, 2013).

2.5 RS232 Serial Communication

This project illustrates the use of the microcontroller's UART module. Connection between the microcontroller and a PC is established in compliance with the RS232 communication standard. (mikroElecktronika, 2013). The program works as follows. Every byte received via serial communication is displayed using PC connected to UART port immediately after the user sends commands from PC. The easiest way to test the program operation is by using a standard Windows program called Hyper Terminal. In this project MatLab GUI is used for data framing (Zytrax Inc., 2013).

3. PROTEUS SIMULATION

Circuit diagram of Voltage transducer is shown in the figure, which is drawn and simulated in proteus.

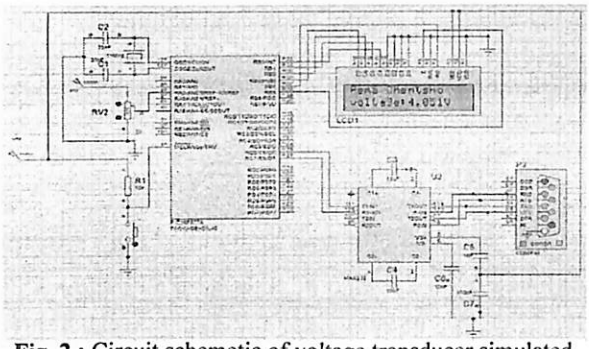


Fig. 2 : Circuit schemetic of voltage transducer simulated in proteus

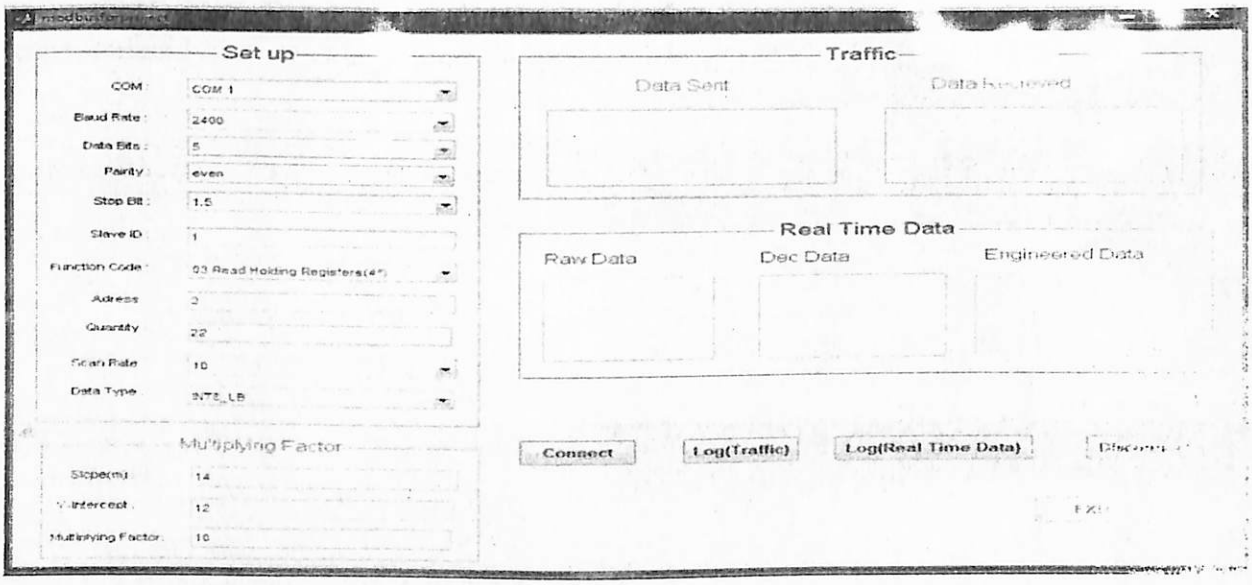
The PIC Microcontroller PIC16F877A 40 pin package is used for sensing and interfacing the voltage for the measurement. The step down DC analog voltage (5V) is given to PIC microcontroller with oscillation frequency of 11.0592 MHz using crystal quartz oscillator and two capacitors connected in parallel with 33pF. The oscillation circuit is connected to pin 13 and 14 of PIC16F877A (Microchip, 2015).

(Abdulla, 2010) This GUI display real time values of voltage and engineered dara in different textboxes and it will starts to display by using connect button (Mathworks, 2013). Data frame structure is created where data type, parity check, baud rate, start bit and stop bit should be provided before connecting it to pic16f877a.

The data frame is constructed using MatLab GUI. The ADC voltage is encapsulated in data frame and sends to PC and displayed on it.

4. SOFTWARE DEVELOPMENT IN MATLAB GUI

GUI (graphical user interface) allows users to perform tasks interactively through controls such as buttons and sliders (Gilat, 2009). Within MATLAB, GUI tools enable you to perform tasks such as creating and customizing plots of various data (Nuer, 2009). There is a provision of creating



The analog signal is given to pin 4 (AN2/RA2) of PIC16F877A from the power source through potentiometer of 10K which acts as a voltage regulator in this circuit. The regulated voltage is read by PIC microcontroller and displayed in LCD or it is serially transferred to PC and displayed in PC. The voltage cannot be directly displayed without digitizing, so ADC programming is

custom GUIs for others to use either by running them in MATLAB or as standalone applications

5. FABRICATION

The prototype for the voltage transcuder is fabricated on a vero board and bread board after the simulation is done. The picture below shows the prototype developed.

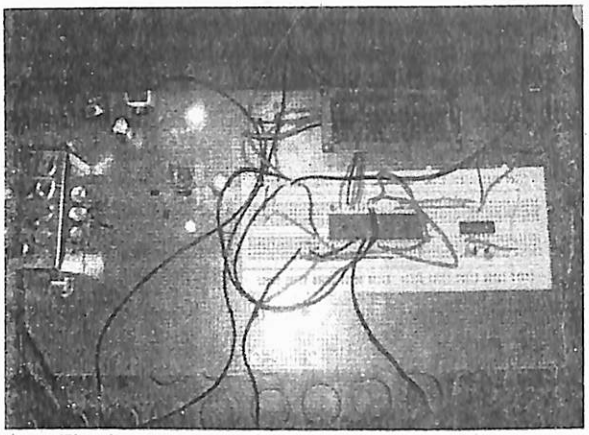


Fig. 4 : Prototype of pc based voltage transducer

6. CONCLUSION AND FUTURE SCOPE

This project mainly deals with the PIC Microcontroller programming and implementation of MatLab GUI for protocol software development for PC b ed voltage transducer. It also includes the development of basic circuitry and programming or the IEDs found in RTUs, whereby only voltage parameters are acquired from the field. Its functions can be replicated on a design of a basic voltage transducer which is pc based.

Initially the transducer will measure certain AC voltage level and the measured values are displayed on a LCD or on Personal Computer (PC). For display of parameters on PC, the microcontroller digitizes the measurements and then encapsulate in a communication frame using standard substation automation communication protocol like Modbus protocol. Since these protocol functions on serial communication, the encapsulation of digitized data into frames is done using a UART.

The MatLab GUI was used for developing software at PC to extract the encapsulated value from the transducer via serial interfaces. The software also provides a platform for configuring the communication parameter and scaling parameters of the transducer.

6.1 Future Scopes

a. Voltage and current transducer development (reads voltage as well as current values).
b. With this project it is possible to develop and prototype MFT (multifunction transducer - which reads both current and voltage values and calculates MW, MVAR, frequency, energy and other parameters).
c. Finally develop energy meter of accuracy higher than MFT.
d. Develop relays for protection schemes.

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