Design and Implementation of PIC16F877A Microcontroller Based Data Acquisition System with Visual Basic Based GUI

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***Abstract* - Data acquisition (DAQ) is a process of bringing a real world signal in to the computer for processing, analysis, storage or other data manipulation. Here in this paper not only the process of data capture from real world in real time, also the process of data feed to real world in real time from computer in different format is also discussed with a developed user friendly Graphical User Interface (GUI) in Visual Basic platform. To control any parameter of a device it is necessary to have the real time data of that parameter in the controller. Also, to control the device it is required to feed some data back to the real world after some processing of the captured data. Here in this paper capturing and feeding of data with user friendly GUI is developed with the help of PIC16F877A microcontroller.**

Keywords – DAQ; real world signal; GUI; data capturing.

I. INTRODUCTION

Data acquisition is the process of measuring an electrical or physical phenomenon such as voltage, current, temperature, pressure, or sound with a computer.

Data acquisition systems consist of three main components:

- Sensors or Transducers: Transducers sense physical phenomena and produce electrical signals that the DAQ system measures.
- DAQ Hardware: PC-based data acquisition products offer analog input, analog output, digital I/O, or a combination of these capabilities in a board, card, or module that is designed to interface with a personal computer.
- PC: The final component of data acquisition systems is a computer that communicates with the DAQ hardware, to collect what information has been measured, display acquired data, Compute it if required, report generation and data storage can be included in software. It also generates controlling signals.

Data acquisition system is very much essential in industrial control application. It requires a microcontroller and some peripheral hardware components. In this developed module 'Microchip' make PIC16F877A microcontroller is used. Most of the PIC microcontrollers have inbuilt RS232 interfacing based transmit ('TX') and receive ('RX') lines [1-2]. In the developed module RS232 port of computer is used to transfer and receive data from environment. For user interface a GUI may be developed in different platform [3]. In this model the GUI is developed in Visual Basic 6.0 platform which is very much user friendly [4]. The developed GUI can be modified as per the requirement of the control process.

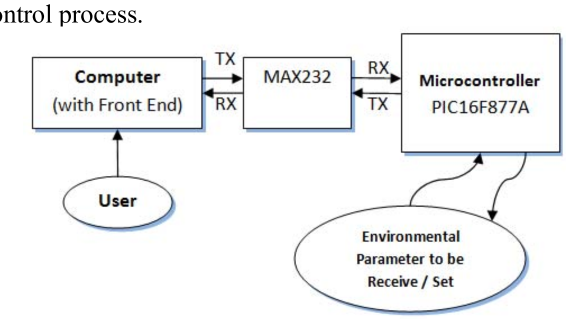

Fig. 1. Block diagram of Data exchange architecture

DAQ system is very much useful to acquire analog voltage by which control of many electrical devices can be done. Also different logical signals in the form of digital bits can be captured to obtain different discrete control of devices [5-7]. For different power electronics application it is require to know at which time the voltage at a node is reaching a fixed level so that proper action can be taken place in real time [8]. The analog data acquisition may be taken from 'n'-numbers of channels if 'n' numbers of different analog inputs are required [9].

The designed system can acquire analog data, digital data and also can feed digital data, Pulse Width Modulation (PWM) signal with variable duty cycle simultaneously.

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Many DAQs are readily available [10] but using the proposed technique DAQ can be fabricated in very low cost and also the interfacing between computer and different parameter of electrical network can be made in very easy manner.

II. System Overview

In the developed prototype the following features are included. It can be further modified as per the requirement of the system for which it will be used. The features of the developed hardware prototype are as follows.

- 8-bits Digital data OUT
- 8-bits Digital data IN
- 1-channel 8-bits Analog data IN
- Variable Duty Cycle PWM Generation

The above mentioned four different operations through a single pair of 'TX', 'RX' line require a dedicated protocol which is shown in Table II. Since RS232 is basically a serial data communication and a single data means 8-bits of data, therefore with proper data sending protocol it also requires proper time management. The details procedure is shown in Fig. 2. The used setting of the RS232 port is shown in Table I.

TABLE I. RS232 Port Settings

Parameter	Value
Baud rate	9600
Parity	None
Data Bits	8
Stop Bits	1

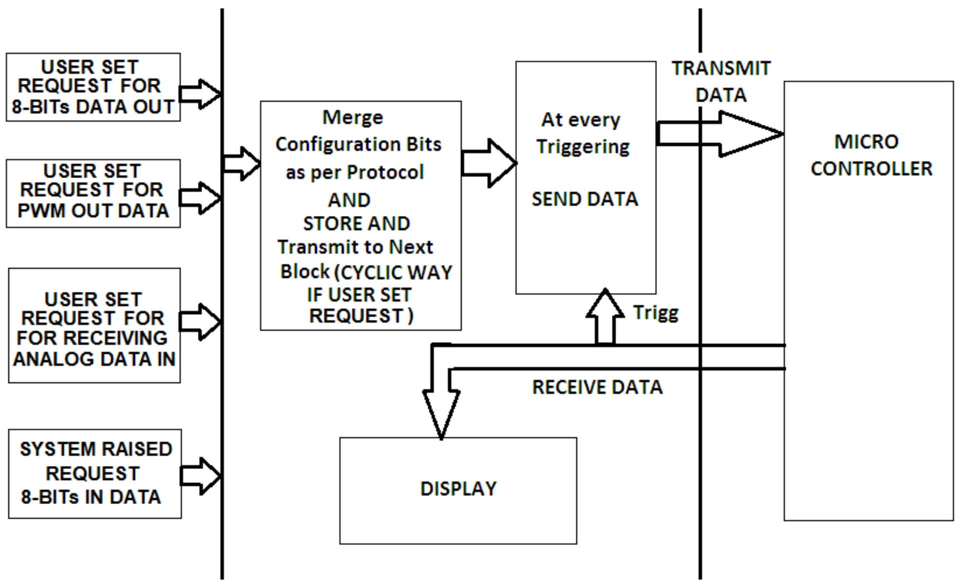

Fig. 2. Operational Block Diagram of the developed DAQ.

TABLE II. Protocol of Data Exchange (Format of Data send from computer)

Control Word				DATA Bits				Operation
D7	**D6**	**D5**	**D4**	**D3**	**D2**	**D1**	**D0**	
1	0	0	0	X	X	X	X	Request for Analog Data
1	0	0	1	X	X	X	X	Request for 8-bits Digital IN DATA
1	1	0	0	D	D	D	D	Send Upper 4-bits OUT DATA
1	1	0	1	D	D	D	D	Send Lower 4-bits OUT DATA
1	1	1	0	D	D	D	D	Send PWM Duty Cycle value DATA

'D'- Data, 'X'-Don't Care

In this system a GUI is developed in visual Basic platform. The GUI is basically for user access. If the user requires to send any digital data then the user will have to press the corresponding button in the GUI, after that, based on the user instruction, a request will be raised and also the request will be processed as per the protocol described in Table II. First GUI will recognize the request made, then it will be merged with corresponding control bits, after which it will enter into the request queue. After that it will pass to microcontroller through the RS232 port. It is similar for the process of variable duty cycle PWM data sending. In this system the analog data receiving is also based on user request. But digital data receiving is not based on the user request in this developed prototype. Digital data receiving is based on a continuous monitoring operation, where an internal request is raised by the GUI program itself after every small time interval. In this system a time out event has incorporated which will be executed after every data send from computer to microcontroller and it will generate a triggering pulse if microcontroller acknowledges within the specified time out interval otherwise a time out event will be raised. After receiving data from microcontroller, GUI will display it in the specified format. The total process is also shown in Fig. 3.

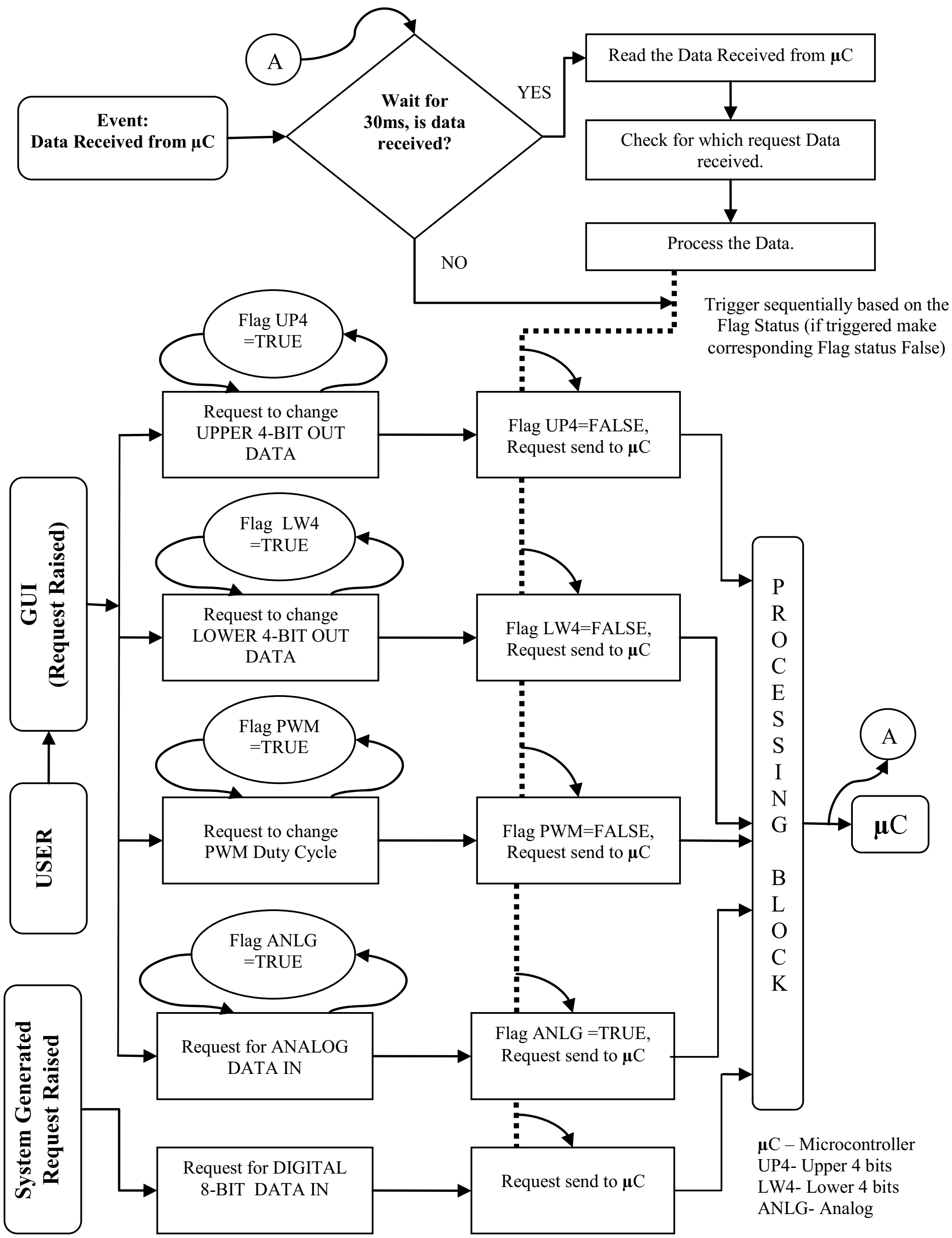

Fig. 3. Operational Flow Diagram of the developed DAQ

III. Hardware Realization & Results

To realize the overall system, a prototype of the system is developed. It consists of a GUI developed in Visual Basic 6.0 platform and a hardware setup based on PIC16F877A microcontroller. The screenshot of the GUI is shown in Fig. 4 and the prototype of the hardware is shown in Fig. 5.

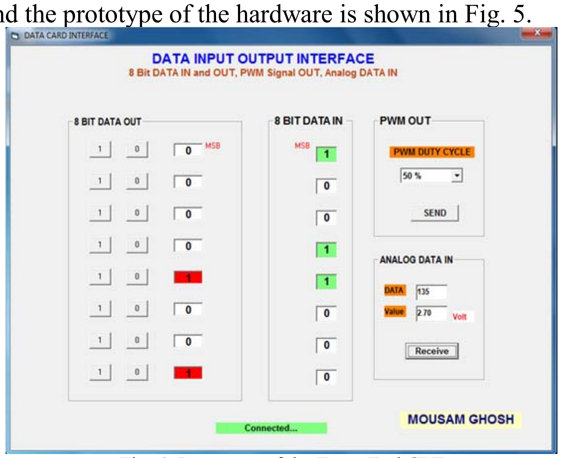

Fig. 4. Prototype of the Front End GUI

In the GUI shown in Fig. 4, the left block is for digital 8-bits data feed from computer to real world in real time. User can send bit wise data by pressing '1' or '0' in the GUI. In this prototype it is realized by 8 numbers of LEDs shown in Fig. 5. For each bit shown in GUI, one LED is assigned. Similarly digital input is realized by 8 numbers of DPDT switches shown in Fig. 5. For this purpose the middle block in the GUI is assigned. When user will press any of the switches, corresponding position in the GUI will indicates the digital input. The receiving of these bits' status is a continuous monitoring process for which system will raise request.

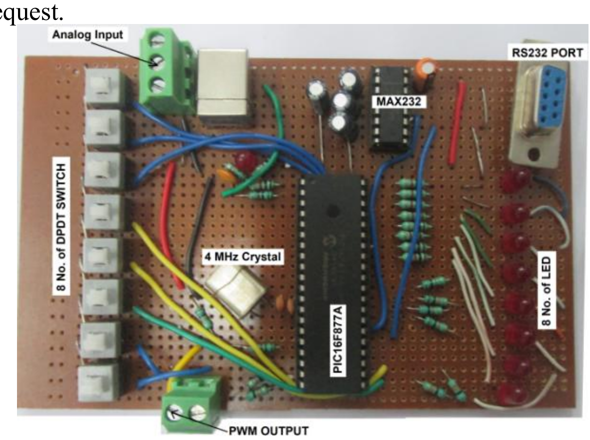

Fig. 5. Prototype of the hardware system

In this prototype, to capture an analog input through GUI, user needs to raise the request through the button shown in GUI. A sample analog voltage was captured through GUI as shown in Fig. 6. Also the same voltage was measured using a digital multimeter as shown in Fig. 6. The both reading are quite closer to each other. Also a comparison of some discrete analog voltage measurement using the developed DAQ and with standard digital multimeter is shown in graphical format in Fig. 8. Further calibration with any standard voltmeter can be done in front-end code level.

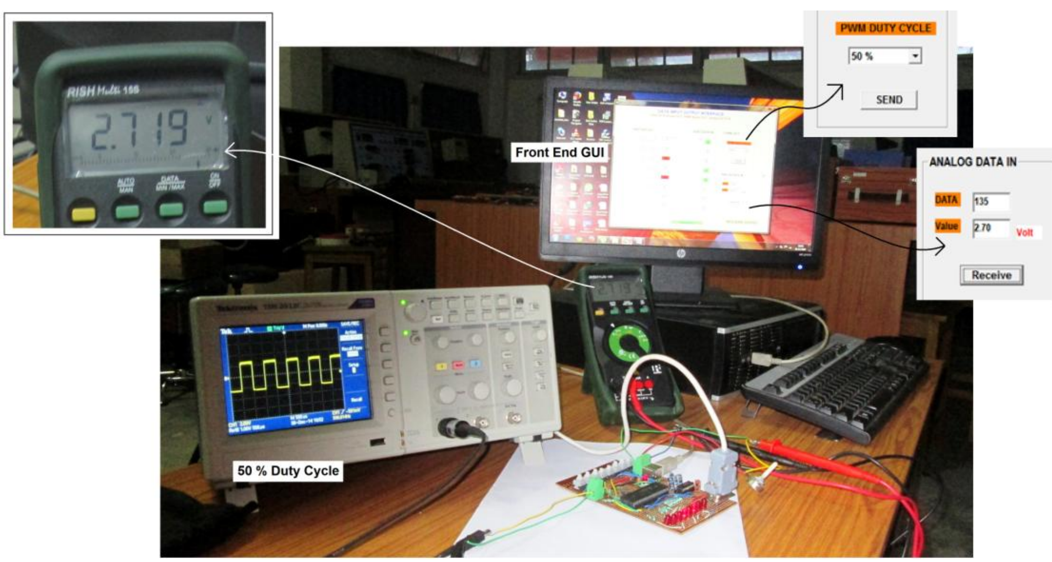

Fig. 6. Overall system prototype in operating condition

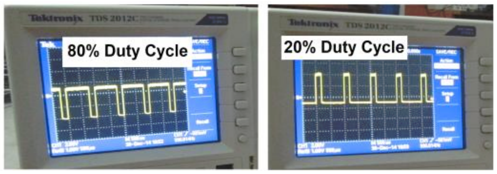

Fig. 7. Different PWM Signal Generation

As shown in Fig. 6, the PWM signal generation is also achieved through this developed prototype. User need to raise the request through the combo box in the GUI to generate/vary the duty cycle of the PWM signal. In this prototype the frequency of the PWM signal is remain constant (1 KHz). Also the frequency can be varied through GUI in real time if required. Here in the Fig. 6, it is visible that the value of PWM duty cycle set by user is 50% through GUI and the actual signal as shown in the Digital Storage Oscilloscope is also same. The duty cycle of the PWM signal can be varied as shown in Fig. 7, which are 80% and 20% respectively.

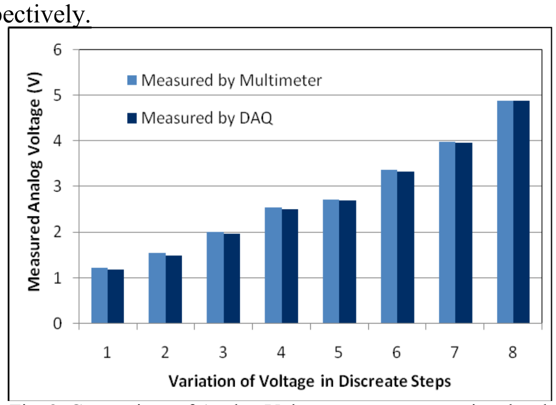

Fig. 8. Comparison of Analog Voltage measurement using developed DAQ and standard Digital Multimeter

IV. Conclusion

The system described in this paper can perform four different operations simultaneously in a single GUI platform. For this purpose a novel data transfer protocol was designed and as well as suitable management for raising events was made. In this designed prototype, a time out event is also incorporated so that the GUI will be getting proper feedback of data transfer. Also, this prototype is capable of sensing the hardware module automatically. Therefore auto detection of the external module has also been achieved. In this prototype an accurate generation of PWM signal with variable duty cycle is also achieved, which has a large number applications in many domains like power electronics, electrical drives, control etc. For the development of a close loop control circuit with real time data monitoring, requires a dedicated data input output system. Using the developed technique, most of the real time control of various electrical equipments can be achieved by only modifying the GUI and data transfer protocol.

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