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USB Based-PIC Microcontroller for Real Time Application Measured in Both Analog and Digital System

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***Abstract*— *In today's world, a new device is being developed almost every day. In order to write a device driver for an embedded device this will communicate with the microcontroller via the SPI interface. Actually the USB (Universal Serial Bus) interface will be used to download updated code externally and used during the verification phase. USB is a new personal computer interconnection protocol developed to make the connection of peripheral devices to a computer easier and more efficient. It reduces the cost for the end user, improves communication speed and supports simultaneous attachment of multiple devices. All such devices need a device driver for them to be compatible with the PC (Personal Computer). The objective of this work is to design and develop a USB (Universal Serial Bus) driver. It's a combination of Firmware and Software. Firmware is constituted by the codes written into the Master and Slave Microcontrollers. Software using VB (Visual Basic) code has been developed for the frontend computer system. An USB protocol has been used. This explains the development of new application used in communication industries for connecting modems, routers, hubs etc. and also it provides an easy way to install and operate the devices. This is the latest technology and has wide range of application in the world today*.**

***Index Terms*— Embedded Device, Firmware and Software, Master and Slave Microcontroller, USB driver.**

I. INTRODUCTION

Popular in the desktop PC market for several years but now moving into the embedded field, USB is the serial bus, which can realize the Plug and Play connection for PC peripherals. In the mid-1990s, a group of engineers from the companies Compaq, DEC, IBM, Intel, Microsoft, NEC and Northern Telecom worked out the specification for a very high-speed serial interface that would largely replace conventional RS232 and Centronics ports on the PC. Today, more than1000 companies develop products, which can be connected to the PC via USB. These can range from standard PC peripherals like printers and modems but now increasingly to specialist devices like scientific instruments, machine controls and even on-board networks in racing cars!

In today's world every day a new device is being developed. All such devices need a device driver for them to be compatible with the PC. The USB abbreviation stands for "universal serial bus" – this means the specification of a serial bus for easy connection of the peripherals to the PC. It removes the need to open up a PC when adding a new peripheral device and via the PC Plug-and-Play BIOS, allows the required software to be installed automatically. Technology keeps getting faster and more customer friendly as the USB continues to take over conventional serial and parallel ports as the primary source of data communication for PG peripherals. At rates of up to480 Mbps for high-speed and 12 Mbps for full speed USB communication, data transfer over a USB interface is at least ten times faster than over a parallel port.

USB was designed from the ground up to be an interface for communicating with many types of peripherals without the limits and frustrations of older interfaces. The USB interface is versatile enough for a wide range of peripheral devices. Standard peripheral that use USB include mice, keyboards, and drives, printers, web cameras and audio/video devices. USB is also suitable for data-acquisition units, control systems and other devices with specialized functions, including one-of-a-kind designs.

II. HARDWARE DESIGN OF THE PROPOSED WORK

The experimental set up for "**USB Based – PIC Microcontroller for Real Time Application Measured in Both Analog and Digital System**" is shown in figure (1) below. This mainly consists of two microcontroller sections. One is Master section and another is Slave section, along with temperature sensor section and voltage variable network.

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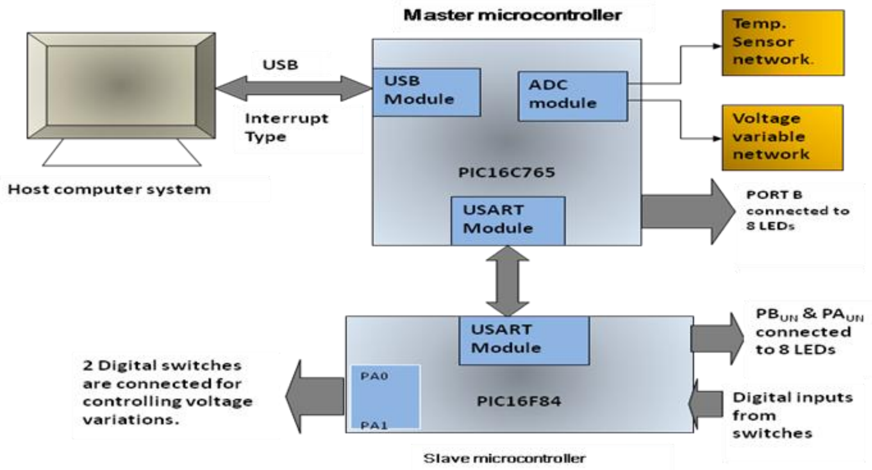

Fig (1) Block Diagram of the Proposed Work.

The block diagram of the work is shown in figure. The three main blocks are Master microcontroller, Slave microcontroller and computer host system. PIC16C765 is used as a master microcontroller which has inbuilt ADC module, USART and USB module. The ADC is connected to two analog devices through channel 1 and channel 2. Channel 1 is connected to temperature sensor network and channel 2 is connected to voltage variable network. Port B of the master microcontroller is connected to 8 LED's for displaying the binary data and for checking the input and output port operation.

A PIC16F84 microcontroller has been used as a slave and is mainly used for EEPROM read and writes operations. Three bits of PORT-B are connected to three digital switches and are used to accept digital inputs. PIC16F84 microcontroller is interfaced to master microcontroller via USART for communication purpose. The data flow between the master and slave microcontroller are in ASCII format.

On plugging the USB hardware to the PC, master microcontroller detects the sensor data via ADC. The digital data read by the master microcontroller is then transmitted to computer system via USB. The software written in VB code creates the front-end screen to display the graphical view of the measured analog values. In this work, full duplex communication has been used between the computer and microcontrollers. Port A of the slave microcontroller is connected to the digital switches. By using these digital switches we can control the variation of voltage (both increasing and decreasing) and the same is transmitted to host system for reading the digital values.

III. DETAIL WORKING OF THE CIRCUIT

In the circuit s temperature sensor (LM35) and the potentiometer for voltage variations has been used. When the temperature is increased, temperature sensors convert the temperature into voltage. As this voltage is very low, an instrumentation amplifier ca3140E has been used. This will amplify the voltage from .2V to 1.8V and this data is then fed to the PIC16C765 to the ADC channel 1. The software for the same has been developed using the assembly language programming. The program converts the parallel data into serial and will send the same to the PC using the USB cable. The software in the PC has been developed using the VB software and the USB wind driver header files. This program will read the data and displays the same on the VB using graphics. Similarly the voltage when varied from the port will vary from 0V to +5V dc and this data is fed to the USB IC, which will then send the data to the PC as said above.

In the same way, we have connected 2 PIC 16F84A IC's to the USB as shown in the circuit diagram Figure (2). The PIC is programmed using the assembly programs. Whenever an user enters / select a LED from the panel, this data is sent to the USB IC, which will then send the data to the PIC and PIC will glow that LED. Similarly by varying the toggle switches, the data is sent from the PIC to the USB IC and to the PC and the same is displayed on the PC immediately. Hence the circuit has PIC IC, USB IC, LED's, Potentiometer, temperature sensor, amplifier, toggle switches and an USB cable.

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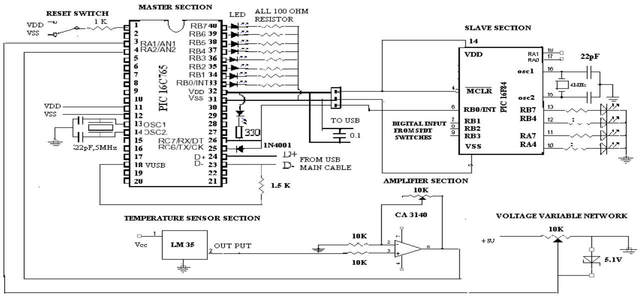

Fig (2) Circuit Diagram

IV. EXPERIMENTAL RESULTS

The following figures show the different stages of the proposed work.

Step 1: Initially install the entire software module in the host computer system and then say **"execute"**, it provides a small window which shows the name of the project.

Step 2: To initialize the process, double click on above window, which creates one more window. Here, to start the operation click on **"set properties"** icon or else click on **"exit"** button.

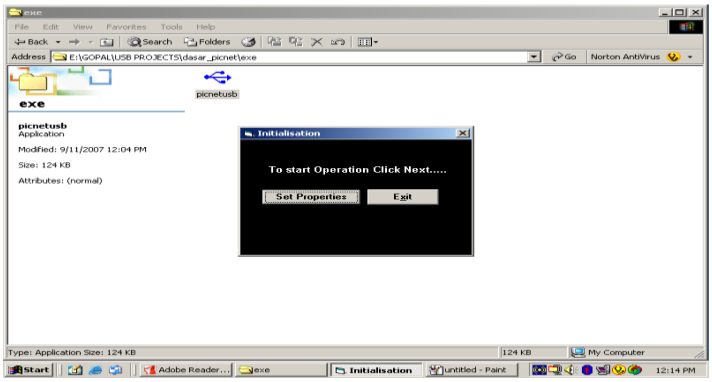

Fig 3: Snapshot of starting the operation

Step 3: Once you click on "set properties" icon, it will create different parameters window. The window implemented in this project is as shown in Figure (4)

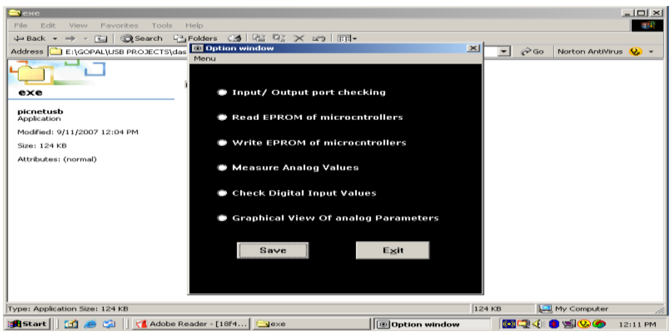

Fig 4: Snapshot of optional parameter window.

Step 4: Select any one option from the list. "Input/output port checking" property is used for checking the conditions of master and slave microcontroller and to check whether they work properly or not.

Example: In this project, separate node number has been provided for master and slave microcontrollers. For master it is 20 and for slave it is 10. Data can vary from 0 to 255.

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For input output checking operation, desired inputs are: Master: 10 Data: 255

Then select **“send to USB”** operation

Output: all LED’s are ON on slave board.

If inputs are: Master: 10 Data: 0 ; Then, Output: all LED’s are OFF on slave board

.

Result: This shows that the given input values are transmitted correctly and I/O ports are working properly

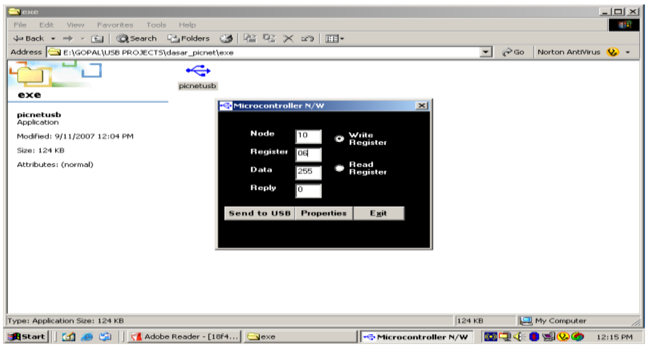

Fig 5: Snapshot of Micro controller network for data 255.

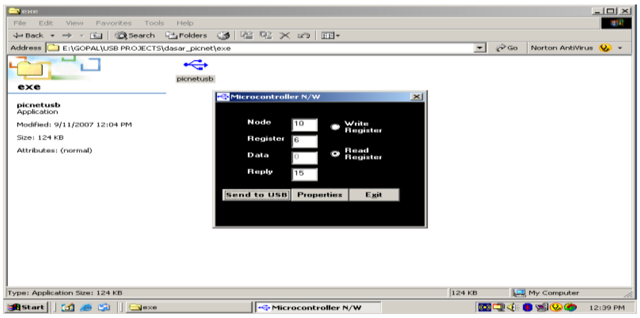

Fig 6: Snapshot of microcontroller network for data 0.

Step 5: Then select “check digital input values” parameter from the list. For this, the node number for slave microcontroller is 10 or 24. First enter the node number. Then we get window shown in Figure (7), where all the status of the device inputs are shown. Initially all are blank

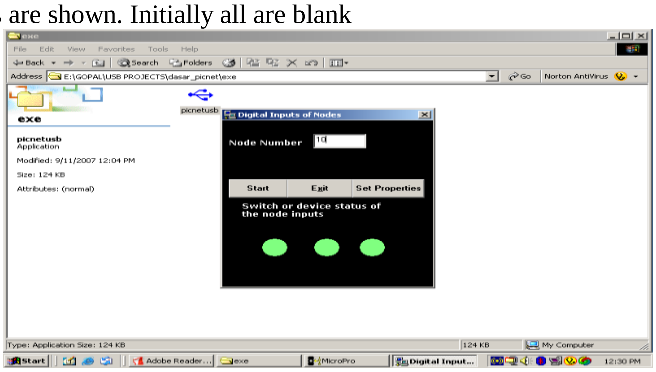

Fig 7: Snapshot of Digital Inputs of nodes.

Step 6: Then say **“start”** and change the conditions of the digital switch and the same is played on the host computer screen as shown in Figure (8) for binary data 101.

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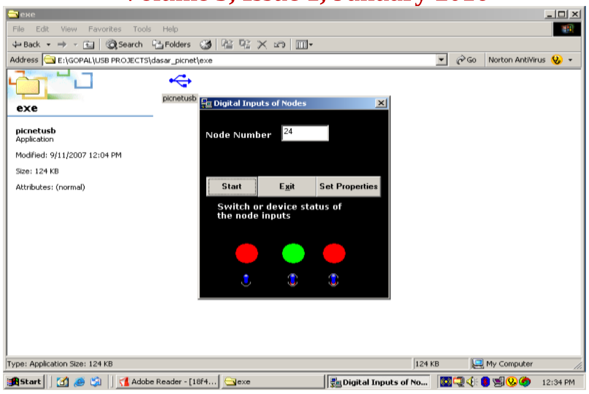

Fig 8: Snapshot of switch or device status of the node inputs.

Step 7: Next select **"measuring analog values"** property from the list which creates the window shown in Figure (9) and it shows the external temperature and voltage variation in both digital and analog formats.

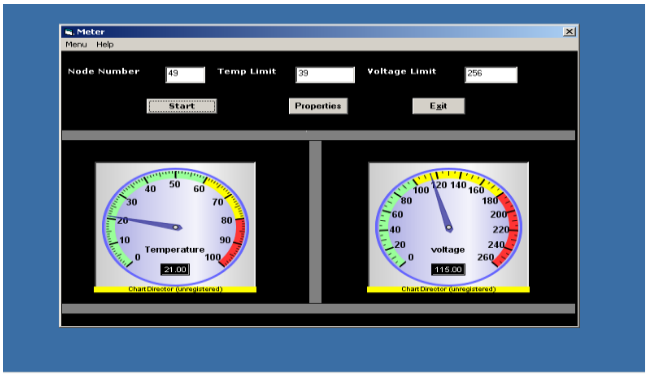

Fig 9: Snapshot of measuring the analog values.

To see graphical view, go to **"menu"** and select **"start".** Here, red color line is used for voltage variation and blue colour line for temperature variation. Temperature can be varied up to 200 degree centigrade and voltage limit is 200V.

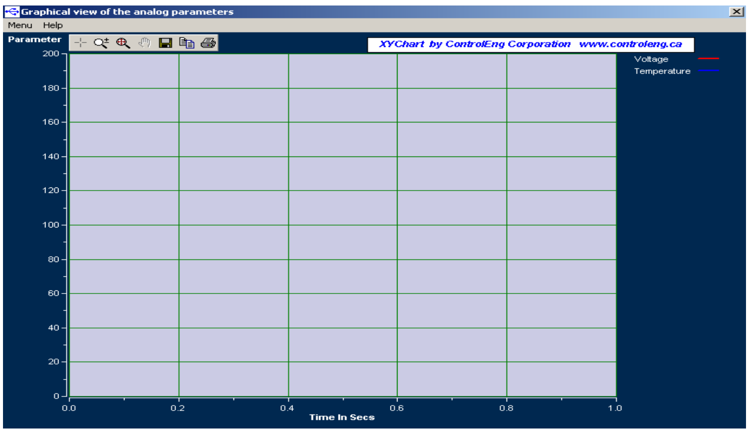

Fig 10: Snapshot of graphical view of initialization of analog process

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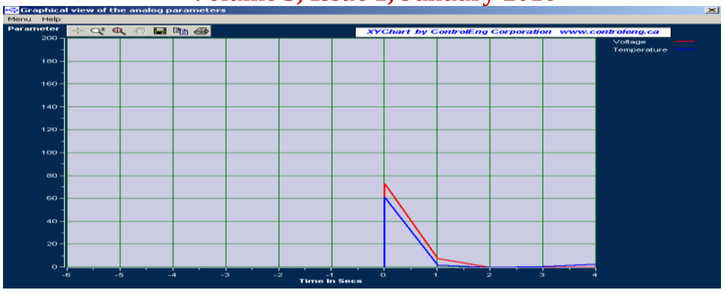

Fig 11: Snapshot of graphical view of analog process.

Step 8: Next, select "write EEPROM of microcontrollers" property. Here also the node number given for slave microcontroller is 10 or 24. Initially enter the node number 10 or 24. Then write any data in internal EEPROM, where byte number varies from 64-99 and then say **"write node".** So all the data's are written to particular location selected by users.

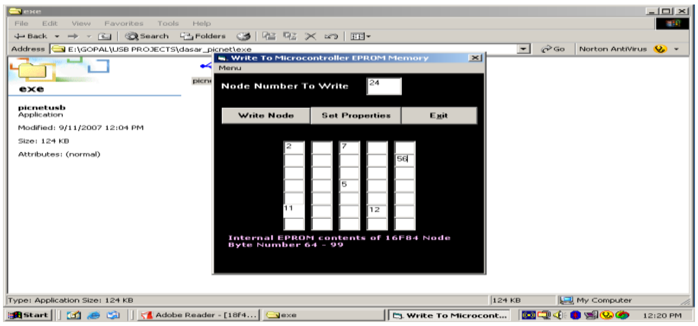

Fig 12: Snapshot of write to Microcontroller EEPROM

Step 9: Next, select **"EEPROM read microcontroller"** property. Set the particular node number and select **"Read node".** Then internally microcontroller reads all the data's and displays the same on the monitor screen as shown in Figure (13).

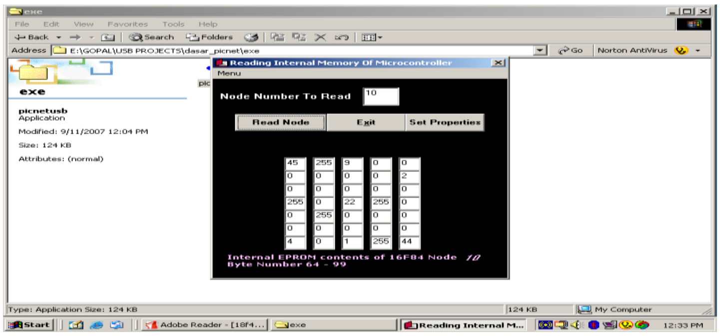

Fig 13: Snapshot of Reading internal data of ROM chip.

V. NUMERICAL RESULTS

The practical results for the temperature and the voltage measured are shown in tables 1 and 2. In the experiment, temperature is varied from 0 degree centigrade to 150 degree centigrade and the analog input voltage for the 8 bit ADC is varied ferom0 to 5 volts. The measured digital data is obtained from the ADC through the master microcontroller and is transmitted to computer host system. The table1 and 2 shows the equivalent analog inputs for the parameters measured, digital output in hexadecimal, decimal equivalent values have been calculated and are tabulated in the tables 1 and 2. The corresponding binary values for the same are shown by glowing LEDs.

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Table 1: Practical result for Temperature variation.

Temperature in °C	Analog input voltage	Digital output in HEX	Digital output in decimal	Output on LEDs
0	0.001	00	0.0	00000000
12	0.825	2A	42.75	00101010
25	1.1	38	56.1	00111000
40	1.35	45	68.85	01000101
80	2.6	85	132.6	10000101
120	3.85	C5	196.35	11000101

Table 2: Practical result for Voltage variation.

Voltage in Volts	Analog input voltage	Digital output in HEX	Digital output in decimal	Output on LEDs
0	0.001	00	0.0	00000000
10	0.25	0D	12.85	00001101
30	0.625	20	31.87	00100000
50	1.25	40	63.75	01000000
100	2.5	80	127.8	10000000
170	4.25	D9	216.75	11011001

VI. ADVANTAGES

- ✓ It works at very high speed when compared to the serial or parallel ports.
- ✓ It gets power from the USB port to drive the ICs which we don't get from the other ports.
- ✓ Any device can be connected which cannot be done by other ports.
- ✓ This is the latest technology and has wide range of applications in the world today.
- ✓ Easy to install and operate and the settings are taken automatically by the PC unlike the serial ports where the details are to be set manually.

VII. DISADVANTAGES

- ✓ Very costly.
- ✓ Very complex to develop interface program

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VIII. APPLICATIONS

- ✓ Used in Communication Industry. We can use USB to connect the modems, routers, hubs etc. Even the cell phones are connected to the PC using USB ports.
- ✓ Used in Process Control Industries. Here we use the PC to read the temperature, pressure, motor RPM and other parameters of the production unit
- ✓ Used in Defense and USB ports are used in computers for control action.
- ✓ Used in games accessories, phones, pen drives etc.
- ✓ Used in Data Loggers. This is used to read the data of the device under test like the automobiles, spring behaviors etc.
- ✓ Used in R and D Industries, in testing high speed modems and in the network areas.

IX. CONCLUSION

The demonstration was taken for few analog parameters only. With the slight modification, it can also be used for many other different modules. Here slave microcontrollers were used for EEPROM read and write operations, and also for accepting digital inputs from external switches. In the same way this can be also further extended for controlling some other I/O devices.

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AUTHOR BIOGRAPHY

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