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A Channel Enhanced Real Time USB Data Acquisition Module

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Abstract **- Data acquisition is a common operation in control, monitoring and command applications. Data from external world is read, processed, used for decision making and eventually, memorized by a digital system. The digital system may be a PC with dedicated interfaces or a microcontroller based system. This project intends to make a Data Acquisition Module with USB interface meeting requirements of channel enhancement and portability. This design uses Microchip PIC18F4550 microcontroller and analog to Digital converter ADS1218 and optocouplers HCPL-0731.**

Keywords: *Data Acquisition Module, USB interface, PIC microcontroller.*

I. INTRODUCTION

This paper presents a Universal Serial Bus (USB) based real time data acquisition module aimed at fulfilling the industry requirement of enhanced number of channels. The data from the external world is read, processed, used for decision making and eventually memorized by a digital system. The digital system is a PC with USB interface. One of the main requirements of a data acquisition module is its portability. Most of the commercially available portable data acquisition modules can acquire maximum of up to four differential analog channels and eight or sixteen digital channels. A possible solution to meet a common industrial requirement of more number of channels is to use more number of DAQ modules. But this approach will affect the overall portability of the system. So that it is desirable to develop a DAQ module that can acquire more number of channels. Proposed data acquisition system can acquire enhanced eight differential or sixteen single ended analog channels and sixteen optically isolated digital inputs meeting the requirements for a portable channel enhanced data acquisition system. This data acquisition system is realized for systems with lower bandwidth requirement, typically less than 20Hz, which is the case with most of the signals in industrial environment.

Embedded application developers require an interface for communicating their devices with a personal computer, for that they used parallel port, serial port, Peripheral Component Interconnect (PCI), Industry Standard Architecture (ISA) etc. The USB and Ethernet are good choice to overcome the disadvantages of previously available communication interfaces. USB is a fast, bi-directional, isochronous, low-cost, dynamically attachable serial interface that is consistent with the requirements of the PC platform. Attractive feature of this interface is its portability [2-4].

II. HARDWARE DESIGN

Proposed DAQ hardware is capable of acquiring data from analog as well as digital channels. PIC microcontroller is used as the core component in this design. PIC is one of the commonly used 8-bit microcontroller chip. It communicates with ADC via SPI interface and PC via USB HID interface. The USB port of PC supplies the power required for operating this module.

Analog channels of Texas instruments ADS1218 ADC chip was used for analog to digital conversion and digital inputs were interfaced through optocouplers to the digital channels of this chip. The ADS1218 is a precision, wide dynamic range, delta-sigma, Analog-to-Digital (A/D) converter with 24-bit resolution and Flash memory operating from 2.7V to 5.25V supplies. The A/D conversion is accomplished with a second-order delta-sigma modulator and programmable sinc filter. Eight bits of digital I/O pins are provided, that can be used for input or output. HCPL-0731 Optocouplers were used in the design. The ADC meets isolation requirements isolation requirements of analog channels and optocoupler isolates digital channels. The acquired data is send to PIC uC via SPI which sends this data to PC through USB interface.

The USB PIC operates internally at a frequency of 48MHZ which is synchronized to a reference 12MHz provided externally. Figure below shows the block diagram of the hardware components involved in this design.

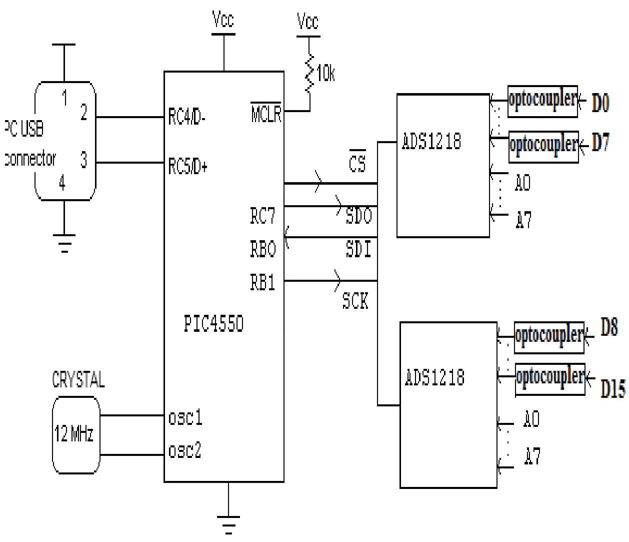

Fig. 1. Hardware block diagram.

III. SOFTWARE DESIGN

Software for PIC program is written in C language and compiled using MikroElektronika's MikroC Pro for PIC. The software was chosen because of the availability of a large number of libraries for harnessing different interfaces provided by PIC microcontrollers. PIC microcontroller requests and receives the data from analog to digital converter via serial peripheral interface and communicates this data to PC via USB interface. USB interface and SPI port should be initialized initially in the microcontroller program. This rou-

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tines provided by MikroC library allow us to configure and enable SPI module with default settings or advanced settings as required in this design.. Number of channels that a DAQ can acquire can be increased by attaching more than one ADS1218 chip to PIC's SPI port. Master PIC can select these ADCs by asserting chip select pin. But this number is limited by portability constraints. We have chosen two chips here to meet the conflicting requirements of more number of channels and portability. The PIC selects between ADC chips and acquires data from each and stores in USB data buffer which is transmitted to PC by USB interface. For this proposed design, two ADS1218 are used where each can acquire 8 bit of digital data and four differential or eight single ended analog channels.

PC side Programming was done in C++ with Qt support, using LibUSBv1.0 driver in Linux platform. Libusb is an open source library that allows communicating with USB devices from user space. It has a fully portable API and is supported by several operative systems including Windows, Linux and MacOS X. QtCreator software was used for software development. The PC side software communicates with microcontroller and acquires data from it. The data is stored in PC and displayed in real time in GUI. Since digital channels in industrial environments use two bit monitoring, PC side requirement is to display eight digital channels with two bit monitoring in each or sixteen digital channels in single bit monitoring mode along with eight differential or sixteen single ended analog channels. These are configurable from a data file in PC side and require configuration change in microcontroller that can be done in real time. Figure 2 shows software design flow for the proposed system.

IV. TESTING AND RESULT

A fully configurable real time data acquisition module was developed which can acquire eight differential or sixteen single ended analog input channels and sixteen digital input channels or eight input channels in two bit monitoring scheme. The module was tested in all configurations discussed here and meets the design requirements of portability and channel enhancement. The acquisition periodicity achieved was less than 50ms which meets the design criteria of designing for systems with bandwidth less than 20MHz. Figure 3 shows GUI snap shot showing the acquired data from channels interfaced to the DAQ module.

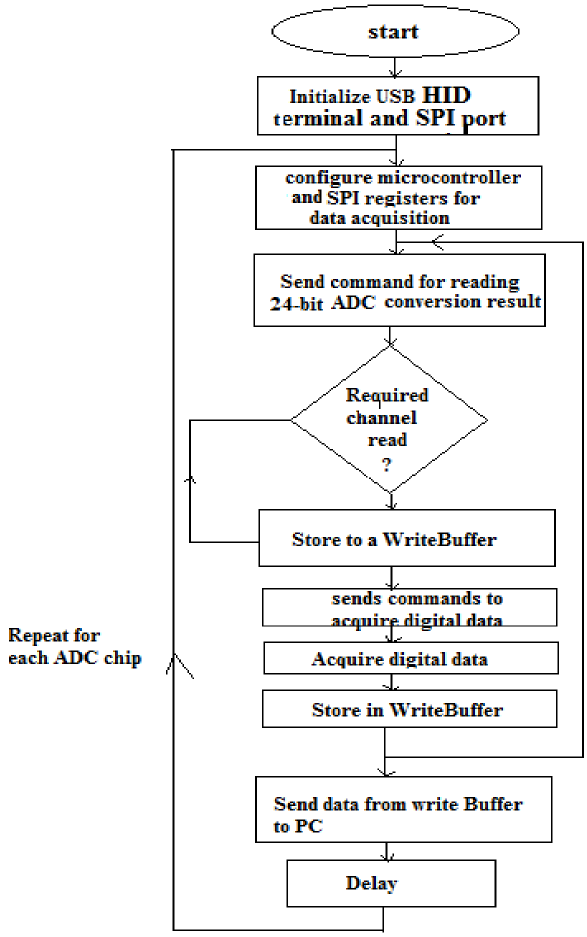

Fig. 2 . Software design flow.

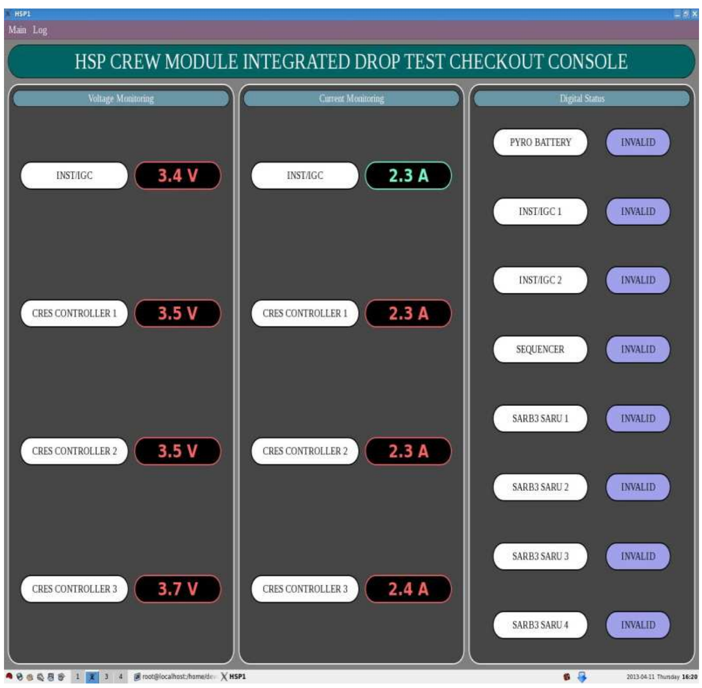

Fig.3.GUI at PC side displaying data from DAQ.

V. CONCLUSION

This paper explains the Data Acquisition Modules already available and their drawbacks. Also explained a method for realizing a channel enhanced portable Data Acquisition Module with USB interface. A fully configurable real time data acquisition module is developed with PIC18F4550, ADS 1218 and optocouplers, which can acquire eight differential or sixteen single ended analog input channels and sixteen digital input channels or eight input channels in two bit monitoring scheme. In future additional channel enhancement can achieve by interfacing additional number of analog to digital converters with PIC microcontroller.

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