Design of 32 Channel Advance Pressure Transducer Data Evaluation System

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Abstract— Many sophisticated electronic systems depends on transducers like temperature sensors, pressure sensors, vibration sensors, shock and strain gauge to measure the parameters in engineering units. ADC and DAC with support of high end microcontrollers will play a major role in data acquisition systems. The resolution of ADC will define the accuracy of the system. ADC with analog multiplexer will provide multiple channels to acquire pressure, temperature, vibration and shock. Most of the pressure channels will provide DC voltage from 0 to +5v range full scale. The selected ADC with highly stable reference voltage, the signal conditioner and a low pass filter to suppress the noise will make full fledged data acquisition channel for measurement of pressure in Bar. High end microcontroller ADuC7026 with built in 12 ADC, 4 ADC/DAC, set of timers, general purpose I/O's and UART will provide accurate results to design multichannel data acquisition systems. Now a day's microcontrollers with built in ADC and DAC's, timers, UART's are available to make system very small and compact. One can develop embedded software to suit the system requirement with well defined communication protocol with user defined sampling rates. Data will be provided on RS-232 interface to application software. Where, pressure data will be displayed in tables with time stamp. Application (GUI) will be provided with a set of plots and graphs, where user can visualize the pressure data in engineering units. Data can be logged into excel sheets for feature reference. Advance microcontrollers and application software makes realization of data acquisition system with high degree of accuracy and ease.

Key words: ADC, DAC, Microcontroller, ADuC7026, UART, RS-232, GUI

General Terms: Analog Multiplexer, Data Acquisition, Communication Protocol

I. INTRODUCTION

Data acquisition systems, as the name of this system implies, are processes used to assemble information to paper or analyze some phenomenon. In the simplest form, a technician logging the temperature of an oven on a piece of paper is performing data acquisition. As technology has progressed, this type of process has been simplified and made more accurate, versatile, and reliable through electronic equipment. Equipment ranges from simple recorders to intricate computer systems. Data acquisition products serve as a focal point in a system, tying together a wide variety of products, such as sensors that are a sign of temperature, pressure, flow, or level.

Data acquisition is the process of sampling signals that measure real world physical conditions and converting the resulting samples into digital numeric values that can be manipulated by a computer. Data acquisition systems (abbreviated with the acronym DAS or DAQ) typically convert analog waveforms into digital values for processing. The components of data acquisition systems include:

- Sensors that convert physical parameters to electrical signals.
- Signal conditioning module to convert sensor signal in to a form that can be converted to digital values.
- Multiplexer for selection of signals from the Signal conditioning module.
- Analog-to-digital converters, which convert conditioned, selected signals to digital values.

II. BLOCK DIAGRAM

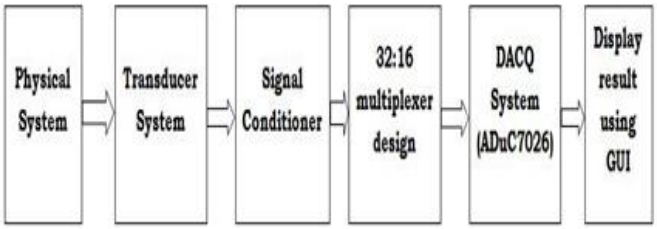

Fig. 1: 32 Channel advance pressure transducer data evaluation system

Data acquisition begins with the physical phenomenon or physical property to be measured. Examples of this include temperature, light intensity, gas pressure, fluid flow, and force. Regardless of the type of physical property to be measured, the physical state that is to be measured must first be transformed into a unified form that can be sampled by a data acquisition system. The task of performing such transformations falls on devices called sensors. However, many real-world sensors and transducers output signals that must be conditioned before a

DAQ device can effectively and accurately acquire the signal.

The front-end preprocessing, which is generally referred to as signal conditioning, includes functions such as signal amplification, filtering and electrical isolation.

III. TRANSDUCER

Transducers are devices that convert one type of physical phenomenon, such as temperature, strain, flow, pressure, or light, into another. The most common transducers convert physical quantities to electrical quantities, such as voltage or resistance. In each case, the electrical signal produced, is proportional to the physical parameter which is monitored.

A. Micro-Electro-Mechanical Systems (Mems):

Micro-Electro-Mechanical Systems or MEMS is a precision device technology that integrates mechanical elements, sensors, actuators, and electronics on a common silicon substrate through micro fabrication technology. MEMS are also referred to as MST (Microsystems Technology in Europe) and MM (Micro machines in Japan). MEMS with

optics are called MOEMS- Micro-Opto-Electro-Mechanical-Systems).

IV. SIGNAL CONDITIONING PROCESS

Signal conditioning means manipulating an analog signal in such a way that it meets the requirements of the next stage for further processing. Most common use is in analog-to-digital converters.

A. Schematic Design for Signal Conditioner Using Orcad Software:

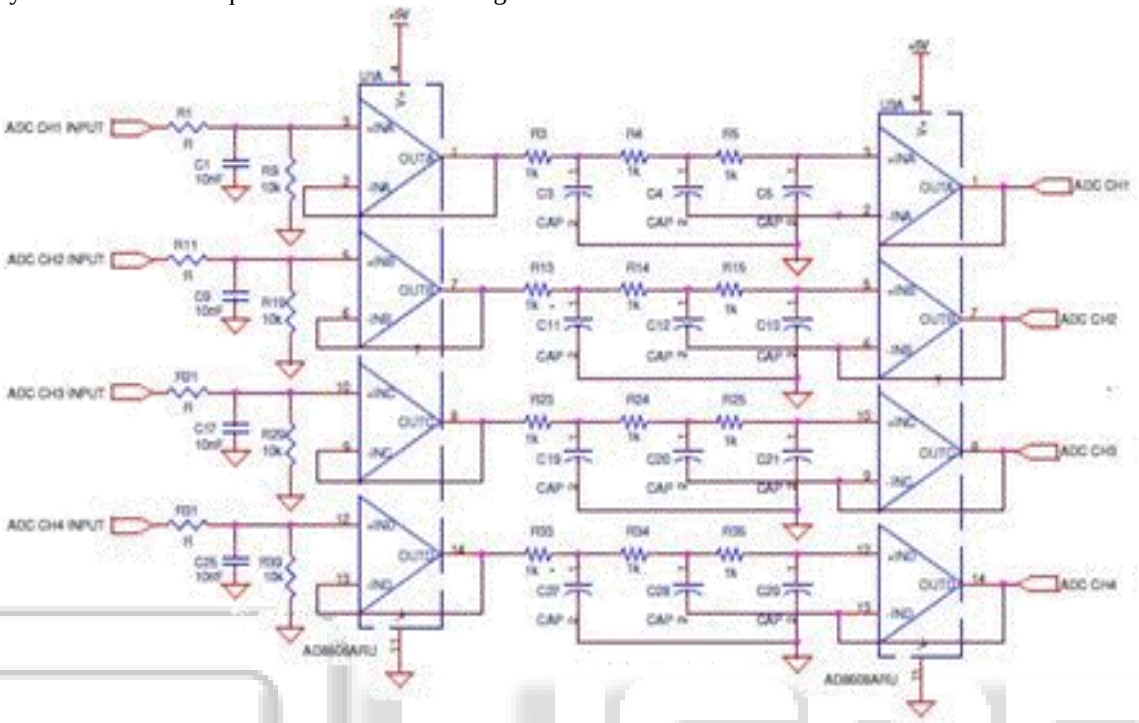

Fig. 2: Signal conditioner

B. The Process of Signal Conditioning:

Signal conditioning process including Buffering, amplification, filtering converting, range matching etc.

1) Buffering:

Is a process to buffer the input signal and keep this signal as usual for the next step filtering this is the most common signal conditioning function, as usually not all the signal frequency spectrum contains valid data. The common example is 50Hz AC power lines, present in most environments, which will produce noise if amplified. So this step of signal conditioning removed the noise and other distortions from the input signals

2) Amplifying:

Signal amplification performs two important functions: increases the resolution of the given input signal, and increases its signal-to-noise ratio.

3) Isolation:

This process of Signal isolation is required to use in order to pass the signal from the source to the measurement device without a physical connection.

V. MULTIPLEXER ADG788

ADG788 are low voltage, CMOS devices comprising three independently selectable SPDT (single pole, double throw) switches and four independently selectable SPDT switches. The multiplexer is designed on an enhanced submicron process that provides low power dissipation yet gives high switching speed, very low on resistance, high signal bandwidths and low leakage currents. On resistance is in the region of a few ohms, is closely matched between switches and very flat over the full signal range. These parts can operate equally well in either direction and have an input signal range which extends to the supplies.

A. Functional Block Diagram For multiplexer ADG788:

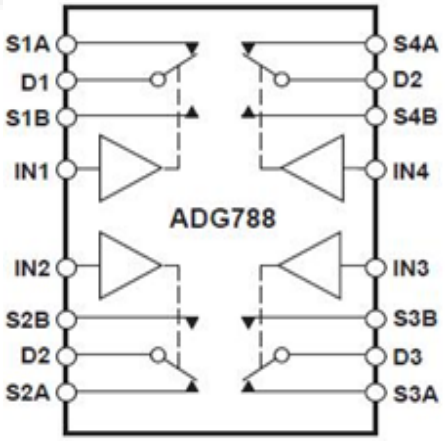

Fig. 3: ADG788

Truth Table:

Logic	Switch A	Switch B
0	OFF	ON
1	ON	OFF

Table 1:

ADG788 ideal for battery powered, portable instruments and many other applications. All channels exhibit break-before-make switching action preventing momentary shorting when switching channels.

B. Schematic Design for Multiplexer Adg788:

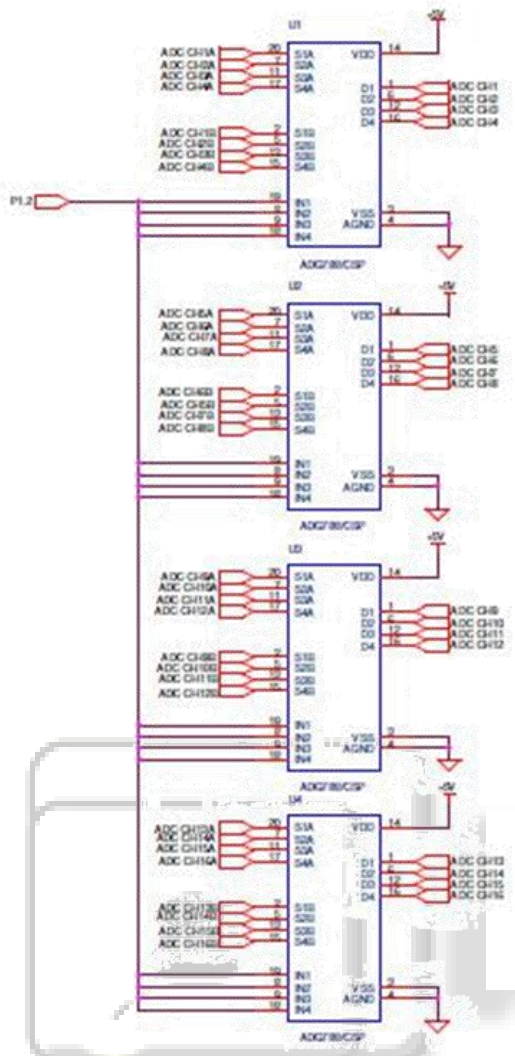

Fig. 4: Design for 32 to 16 Multiplexer using quad 2:1 Mux

C. PCB Design for Multiplexer ADG788:

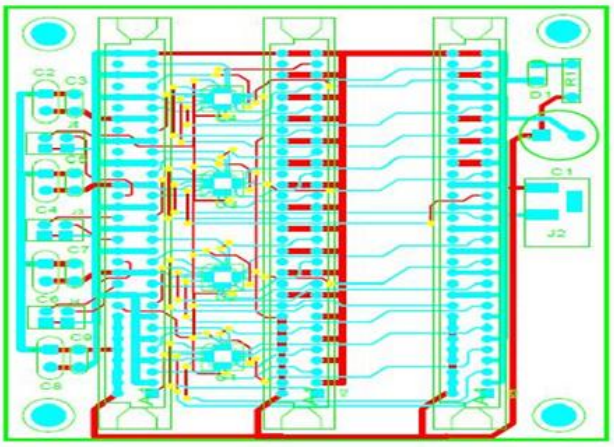

Fig. 5: Multiplexer ADG788

VI. Analog to Digital Converter

An analog-to-digital converter is a device that converts a continuous quantity to a discrete time digital representation. This device is the heart of the most data acquisition systems.

A. Arm Processor:

ARM Processor is a 32-bit reduced instruction set computer (RISC) instruction set architecture (ISA) developed by ARM Holdings. It was named the Advanced RISC Machine, and before that, the Acorn RISC Machine. The ARM architecture is the most widely used 32-bit instruction set architecture in numbers produced.

The ARM7 family is a range of low-power 32-bit RISC microprocessor cores optimized for cost and power-sensitive consumer applications. The ARM7 family incorporates the Thumb 16-bit instruction set - enabling 32-bit performance at 8/16-bit system cost.

B. Schematic Design for Aduc7026:

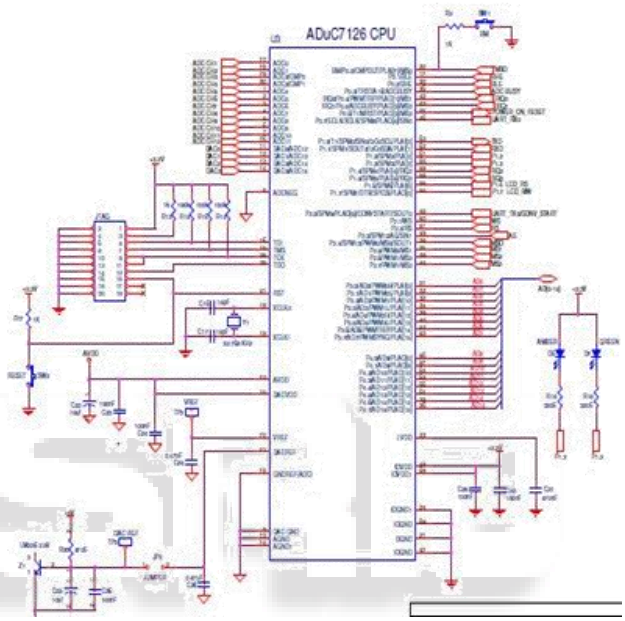

Fig. 6: Design for ADuC7026

C. Max-232

IC is used to convert the TTL/CMOS logic levels to RS232 logic levels during serial communication of microcontrollers with PC. The controller operates at TTL logic level (0-5V) whereas the serial communication in PC works on RS232 standards (-25 V to + 25V). This makes it difficult to establish a direct link between them to communicate with each other.

VII. Software Description

Keil µVision-4 is being used to design program codes for "32 CHANNEL ADVANCE PRESSURE TRANSDUCER DATA ACQUISITION SYSTEM". After creating hex files for microcontroller nodes, functionalities of the system tested and then hex files programmed into microcontroller by using Flash magic tool.

VIII. Results

In data retrieval mode, the acquired data which is stored in FLASH RAM will be transferred through RS-232 to Graphical User Interface application on the host computer. The data retrieval is under the control of GUI application. When the embedded system controller receives a command from GUI application the data stored the FLASH RAM will be transferred.

A. Result On GUI Before Acquiring the Data:

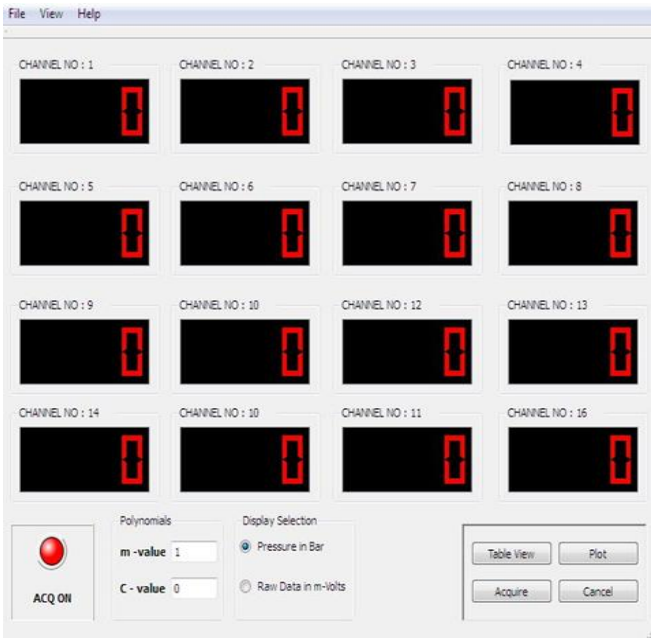

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Fig. 7: Before acquiring the data from system

B. Result on GUI After Acquiring the Data:

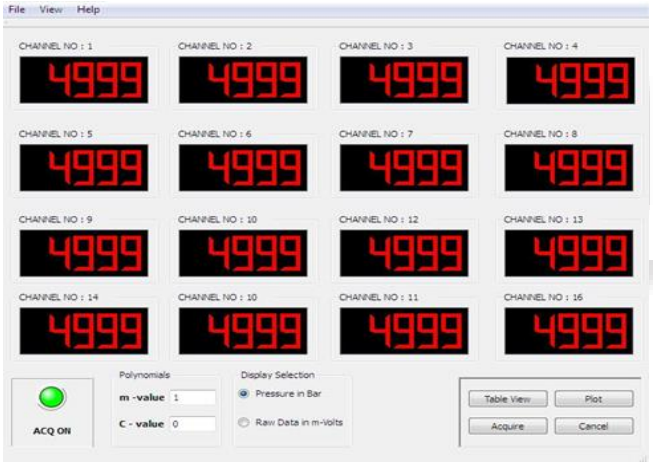

Fig. 8: After acquiring the data


Table View

	Time_Interval	Channel1	Channel2	Channel3	Char
1	1	4999	4999	4999	4999
2	3	4999	4999	4999	4999
3	5	4999	4999	4999	4999
4	7	4999	4999	4999	4999
5	9	4999	4999	4999	4999
6	11	4999	4999	4999	4999
7	13	4999	4999	4999	4999
8	15	4999	4999	4999	4999
9	17	4999	4999	4999	4999
10	19	4999	4999	4999	4999
11	21	4999	4999	4999	4999
12	23	4999	4999	4999	4999
13	25	4999	4999	4999	4999
14	27	4999	4999	4999	4999
15	29	4999	4999	4999	4999

Fig. 9: Data logged on to excel

C. The Application Software Will Have User Selectable Window to Plot the Graph. The Graph Is Plot with Times in Seconds Against Acquired Data Will Be Displayed in Engineering Units:

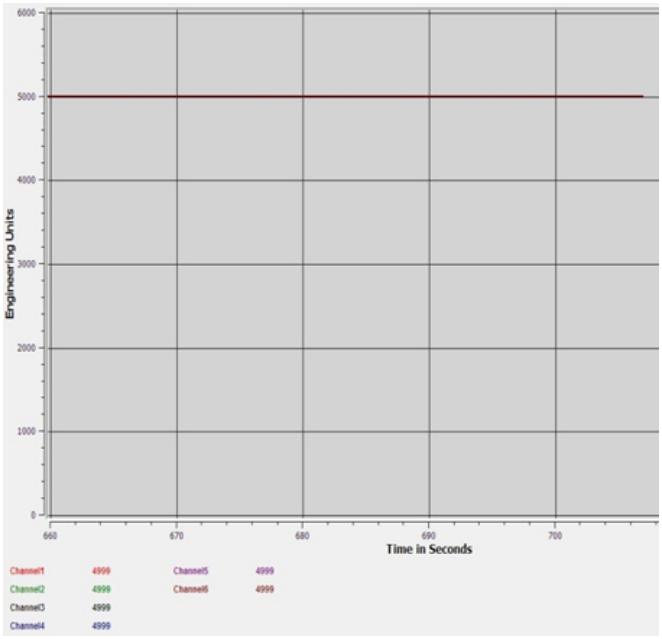

Fig. 10:

IX. CONCLUSION

This data acquisition will be used for qualifying advance pressure sensors for launched vehicles. Development of advance pressure sensors was done using MEMS technology.

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