Data Acquisition Units Using For Student Labs

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Abstract: - High-speed intelligent multichannel analogue input/output interface units have been developed by the combination of high-performance digital signal processors with high resolution A/D and D/A converters. The device is able to generate pre-programmed arbitrary signals with the synchronous capture of input signals on eight channels, and is, thereby, ideal for system control and analysis. The simple control of the device and the easy access to captured data helped our students to gain their own approach to digital measurements, digital signal generation, real-time system control and analysis.

Key-Words: - digital measurements, digital control, virtual instruments

1 Introduction

Virtual measurement technique is widely used nowadays, thanks to the advanced hardware and software background. VLSI and ULSI technologies produce smaller and smaller devices with increased speed and more sophisticated functions at lower cost, and in parallel the available software becomes more efficient and user-friendly. Today’s digital devices can be found everywhere, from home electronics to advanced medical and scientific instruments, from cellular phones to aircraft navigation and space research. The connection possibilities between the real world signals and digital devices are gaining more and more interest, since this makes possible to use the efficient digital signal processing and control methods in real world applications. Education of these fields including virtual instrumentation is not avoidable in any kind of natural science education. In addition to the software background, efficient teaching of virtual measurement techniques requires flexible, easily programmable multipurpose input/output devices. These devices are usually available with specialized functionality and are quite expensive. Our aim was to develop an inexpensive, very flexible data acquisition and control unit to help the education and visualization of virtual measurement techniques, digital signal processing and control including even real-time processing options.

2 The Structure of the Device

The block diagram of data acquisition system can be seen on Fig.1. The intelligent control unit of the system is a high-performance 16-bit fixed point digital signal processor (DSP). The processor communicates with the host PC, controls all timings including sampling and triggering, drives the D/A and A/D converters, relays and handles digital I/O.

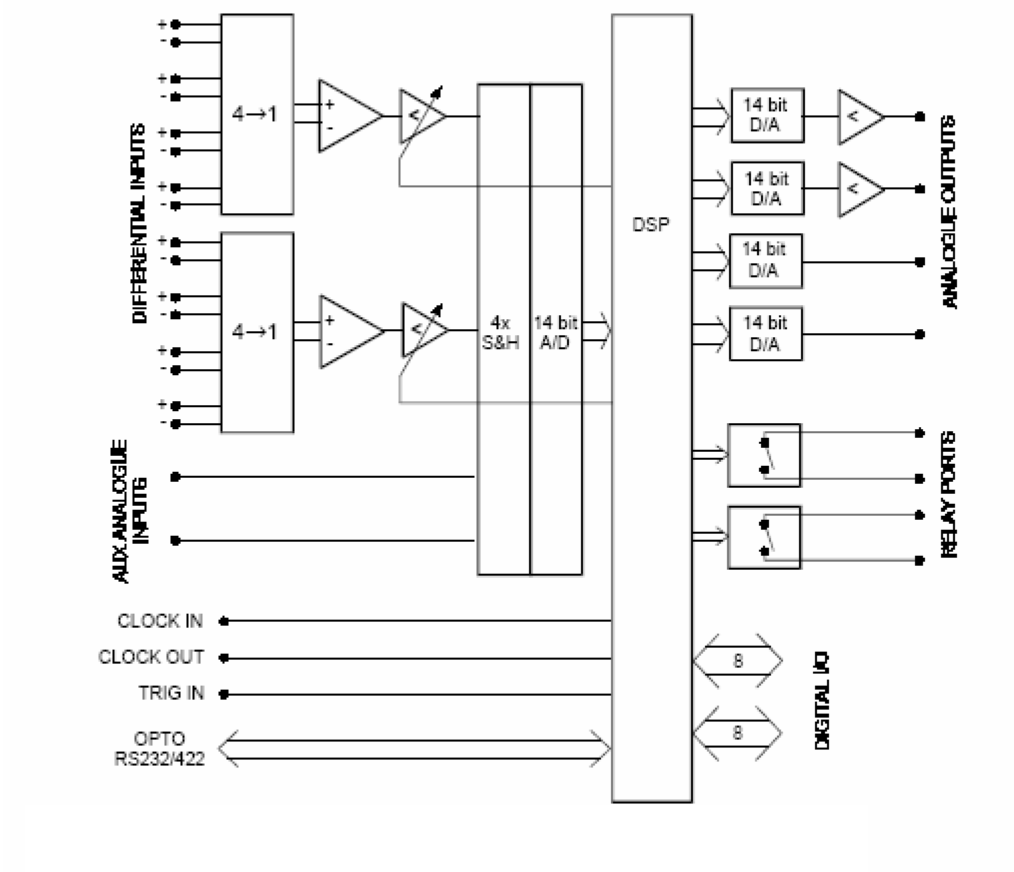

Fig.1 The block diagram of the data acquisition unit

2.1 Analogue Inputs

The eight differential input channels are divided into two four-channel groups. The channels of each group have the same signal conditioning methods, but the two channels can be configured fully independently. The channels are connected to an overvoltage-protected multiplexer followed by a differential amplifier. This amplifier can be configured as single ended by software, if necessary. The next stage is a software programmable gain amplifier, which provides three possible input signal ranges:-0.1V..0.1V, -1V..1V, -10V..10V. The two processed signals are connected to two of the four inputs of a simultaneously sampling 14-bit A/D converter that can be clocked by up to 400 kHz. To the other two inputs, two auxiliary input channels with fixed -10V..10V input range are connected. In this way four input signals can be routed to the A/D converter: the two conditioned inputs and the two auxiliary inputs. Any subset of these four inputs can be selected for conversion, which yields effective conversion speeds of 400 kSPS on a single channel, 200 kSPS/channel on two channels and close to 100kSPS/channel on four simultaneously measured channels.

2.2 Analogue Outputs

Four independent analogue outputs are provided with 14-bit resolution in the fixed –10V..10V range. The output of the four D/A converters are buffered; two of them provide currents up to 10mA, and two high current outputs are available to drive external objects with currents up to 1A. The maximum update rate is about 350 kSPS.

2.3 Digital Input/Output
Two 8-bit blocks of standard TTL signals are available as general purpose 8-bit output and 8-bit input.

2.4 Relays
Two relays serve as isolated switches for external signals. The maximum switched current is about 2A.

2.5 Serial Interface
The device uses one optically isolated standard RS232 interface. The bit rate can be set to a maximum of 115200 baud.

3 DSP Driver Software
After power up, the booting process starts a simple monitor program from an EPROM and the on-board DSP wait for a driver software to be loaded from the host PC. This allows the user to simply replace or modify the instrument's driver software without any hardware interventions. The currently available software supports the following operations:

3.1 Measurement of Static or Slowly Varying Signals
Using simple commands sent over the serial interface, the host PC can modify voltages on the analogue outputs. The voltages remain unchanged until the instrument gets an instruction for modification. The analogue input is repeatedly sampled by the A/D converter using the last valid configuration settings for channel selection, sampling frequency, gain and differential mode. The last converted value is available for reading at any time.

3.2 Dynamic Signal Acquisition and Generation
There are two blocks of memory in the instrument to support dynamic signal acquisition and generation. A sequence of up to 4096 samples taken by the A/D converter can be stored, and another 4096 14-bit words serve as a signal generation pattern using one of the D/A converters. The sampling timing is controlled by the DSP, which can perform triggering, fully synchronous acquisition and generation and measure several sequences with options of skipping the transients and realizes averaged measurements of up to 256 consecutive sequences. The synchronous excitation/measurement operation and low distortion make the instrument ideal for system transfer function analysis. The on-line averaging function can be used to accurately measure lower frequency signals with increased precision and reduced noise. These signal acquisition/generation features easily turn the instrument into a storage oscilloscope, spectrum analyzer, and chart-recorder or correlation analyzer.

3.3 Real-time functions
The fast on-board DSP can perform immediate operations on the sampled data and modify the output signals. This allows real-time functions to be executed, such as digital control, with on-the-fly modifications of the parameters. Note here, that National Instruments has just released LabView and the DAQ boards to support real-time signal processing.

4 Using a PC to Control the Instrument

The host computer can control the unit via a standard serial interface. The different functions and modes are controlled by sending simple scripts, which can be easily done using even the simplest Basic programming. LabView is standard software to build virtual instruments using personal computers and data acquisition hardware. Our system can be controlled very easily with LabView using its serial input/output VIs . Since our instrument has an intelligent part to drive all peripherals and memory for captured and generated data, there is no need for complicated interrupt or DMA handling on the host PC, the simple serial interface is just enough to use all features efficiently.

5 Stand-alone Operations

Our data acquisition system can be operated in a stand-alone mode without the control of a host computer. Six buttons and a 2 row x 16 character alphanumeric LCD display can be found on the front panel helping the manual control of the system. In this mode the system can be used as a multi-channel voltmeter, programmable voltage source, signal generator and transient recorder.

6 Conclusion

A cost-efficient, high-performance, precision data acquisition system has been developed for education of virtual measurement technology. The device helps students to learn and practice the basics of data conversion, digital signal processing including real-time operations, and allows them to build their own virtual instruments using standard virtual instrumentation software, LabView. With its enhanced general features, the instrument is also very useful in visualization of digital measurement techniques.

References

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