Measurement experiment, using NI USB-6008 data acquisition

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<u>Abstract</u> – Educators and researchers worldwide are using National Instruments products to automate routine tasks, accomplish new objectives, replace outdated and expensive equipment, and demonstrate students the potential of high technology. Engineers have used virtual instrumentation for more than 25 years to bring the power of flexible software and PC technology to test, control, and design applications making accurate analog and digital measurements from DC to 2.7 GHz.

The goal of this paper is to teach students basic concepts of LabVIEW programming, that can be used to easily integrate hardware and software to acquire, analyze, and present data. The block diagram of your application enables you to define operations to be performed on your data. The front panel allows the user to interact with a program while running.

<u>Keywords:</u> LabVIEW, DAQ Assistant, Express VIs, NI USB-6008.

I. INTRODUCTION

Prior to the 1980s, the oscilloscope and strip-chart recorder represented the most common methods for measurement of time-varying signals. However, with the advent of the personal computer and the introduction of PC-compatible data acquisition cards, PC-based digital data acquisition became standard in most laboratories by the late 1980s. By combining high speed data acquisition cards with graphical software, it is now possible to design complex data acquisition systems with real-time data analysis and plotting features [1].

LabVIEW is a graphical programming language which was first developed in 1986. It combines data acquisition, analysis, and presentation tools into one software program.

The data acquisition hardware used in this paper is NI USB-6008 multifunction I/O device, which interfaces to the PC through a USB connector. It has 8 differential analog voltage inputs, 2 outputs, 12 channels which can be used as either DI or DO (configured individually), and 12-bit resolution. A USB device was chose for simplicity, but it is one of the many different types of data acquisition devices that can be used. Another common interface is a PCI-slot data acquisition card. These cards can be plugged into PCI-slots on the computer's motherboard, much like a sound or Ethernet card. The National Instruments USB-6008 provides basic data acquisition functionality for applications such as simple data logging, portable measurements, and academic lab experiments. The NI USB-6008 are ideal for students. We are create our measurement application by programming the NI USB-6008 using LabVIEW and NI-DAQmx driver software for Windows [3].

DAQ Assistant is a graphical interface for interactively creating, editing, and running NI-DAQmx virtual channels and tasks. A NI-DAQmx virtual channel consists of a physical channel on a DAQ device and the configuration information for this physical channel, such as input range and custom scaling.

The LabVIEW program, prepares students to develop test and measurement, data acquisition, instrument control, data logging, and measurement analysis applications.

LabVIEW includes a set of VIs that let you configure, acquire data from, and send data to DAQ devices. Often, one device can perform a variety of functions: analog-to-digital (A/D) conversion, digital-to-analog (D/A) conversion, digital I/O, and counter/timer operation [2].



Figure 1. Express VIs

II. CONFIGURING AND INTEGRATION OF HARDWARE INSIDE OF LabVIEW

LabVIEW interacts with many kinds of real world hardware.

 To see what devices are recognized by the computer, go to Start » Programs » National Instruments » Measurement & Automation and then select My System » Devices and Interfaces. Under NI-DAQmx Devices section we see all of the devices listed, including NI USB-6008.

Configuration		
🕀 🔇 My System		
🗄 🚽 Data Neighborhood		
😑 🧱 Devices and Interfaces		
😑 🧰 NI-DAQmx Devices		
💋 NI USB-6008: "Dev1"		
🕅 NI PCI-6023E: "Dev2"		
😥 NI ELVIS II: "Dev3"		
152 NI USB-9201: "Dev4"		
🕅 NI PCI-6023E: "Dev5"		
PXI PXI System (Unidentified)		
🕀 💶 Scales		
🗄 🌀 Software		
🗄 🥸 Remote Systems		

Figure 2. My System Configuration

 Open a Blank VI inside of LabVIEW. Right-click on the block diagram and select Measurement I/O » NI-DAQmx » DAQ Assistant.



Figure 3. Selecting the DAQ Assistant from the Block Diagram

3) Select Acquire Signals » Analog Input » Voltage from the dialog box.



Figure 4. Create New Express Task Dialog Box

4) Select **Dev1 (USB-6008)** » ai0 and then click Finish.

DAQ Assistant Select the physical channel(s) to add to the task. If you have previously configured iobal virtual channels of the same measurement type as the same measurement type as the task, click the Yirtual task to add or copy global virtual channels to the task. If you have TEDS configured, click the TEDS tab to add TEDS channels to the task. For hardware that supports multiple channels to add to a task at the same time.	*	Bit Physical Supported Physical Channels □ </th
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Figure 5. Selecting Channel Measurements From Hardware

DAQ Assistant	X emove Channels			H	23 29 lide Help
🛞 Express Task 🦽 Connection Diagram				E Back	₽ 🕺
Configuration Triggering Advanced Ter Configuration Triggering Advanced Ter Configuration Triggering Advanced Ter Configuration Configuration Configuration Triggering Advanced Ter Configuration Configurati	Votage Input Setup	Scoled Units Volts Volts Minimal Configuration Differential atom Scales dNo Scales 2010 Scales	•	Measuring Wolk. Meas measuring- or reading, visitages for measuring- or reading, visitages manuements and AC. DC visitages and phacomas that change allowly with phacomas that change allowly with phacomas that change allowly with the phacomas that change allowly with with the phacomas with the phacomas of the phacomas the phacomas that change allowly with the phacomas that the ph	age d ko bc iul me. b. xe c v xe xe
۲) W		
				ок	Cancel

Figure 6. Configuring Task

5) Click **OK** to close the configuration window. Notice that the **DAQ Assistant** is now configured on the block diagram to output the data that we want.

The DAQ Assistant is used to configure the DAQ device and perform data acquisition.

DAQ Assistant	•
data	Þ

Figure 7. DAQ Assistant Configured

6) **Right-click** the **data** output of the **DAQ Assistant** and select **Create** » **Graph Indicator**. Notice that a waveform graph appears on the front panel.



Figure 8. Sample Data from NI USB-6008

III. PERFORMING CALCULATIONS ON HARDWARE DATA

Typically, various calculations and operations will be performed on acquired data. In this section, we will use an Express VI to perform a statistical analysis and spectral measurement on the acquired data.

 Right-click on the block diagram and select Express » Signal Analysis » Statistics to put the Statistics VI on the block diagram. In the Configure Statistics dialog box that appears, select Arithmetic Mean, Standard Deviation, Maximum, and Minimum. Click OK to close the dialog box.

Statistical Calculations		Input Signal			
Arithmetic mean	📄 Root mean square (RMS)	1.5-			
Median	Standard deviation	1-			
Mode	Variance	-8 0,5-1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1,1			
Sum of values	E Kurtosis	0,5- 10- 10- 10- 10-	Mana ta ang		
	Skewness	§ -0,5-	VUVVIVUVIVU		
Extreme Values		-1- -1.5	VIIIIIIIV		
V Maximum First time		0 1			
Time of maximum	Eirst value	Time			
Index of maximum Last time		Results			
Minimum 🗸	Cast value	Statistic	Result		
Time of minimum		Arithmetic Mean	1,455225E-16	-	
Index of minimum		Standard Dev	0,997519		
		Maximum	1,41		
🖳 Range (maximum - minimu	im)	Minimum	-1,41		
Sampling Characteristics					
Total number of samples	Time between samples (dt)			-	
		OK	Cancel Hel		

Figure 9. Configuring Statistics to be Calculated

- 2) Right-click on the block diagram and select Express » Signal Analysis » Spectral Measurements, to put this VI on the block diagram. In the Configure Spectral Measurements dialog box that appears, select Power spectrum and Linear.
- 3) Wire the data output from the DAQ Assistant to the Signals input of the Statistics VI, and the Spectral Measurements VI. Right-click on each output of the Statistics VI and select Create » Numeric Indicator. Right-click on output of the Spectral Measurements VI and select Create » Graph Indicator



Figure 10. Block Diagram with Statistic and Spectral Measurements



Figure 11. Front Panel with Statistic and Spectral Measurements

III. LOGGING DATA TO FILE

It is often necessary to permanently store data acquired from the DAQ device. LabVIEW contains several builtin functions for saving data to disk. In this step, you will configure the data from the hardware to be written to a file on your computer.

 Right-click on the block diagram and select Programming » File I/O » Write to Measurement File to place this Express VI on the block diagram.

The Write LabVIEW Measurement File Express VI, writes signals to a LabVIEW measurement file.

5) Select **Ask user to choose file** in the Configure Write to Measurement File dialog. Click **Ok** to close the dialog box.

File Name	File Format			
:\Documents and Settings\nreding\My Documents\	Text (LVM)			
.abVIEW Data\test.lvm	Binary (TDMS)			
	Binary with XML Header (TDM)			
	✓ Lock file for faster access			
Action	Segment Headers			
Save to one file				
Ask user to choose file	One header per segment One header only			
Ask only once	O No headers			
Ask each iteration	X Value Columns			
If a file already exists	X Value Lolumns			
 Rename existing file 	One column per channel			
O Use next available file name	One column only			
O Append to file	 Empty time column 			
Overwrite file	Delimiter			
	⊙ Tab			
Save to series of files (multiple files)	Comma			
Settings				
File Description				
	Advanced			

Figure 12. Configure Write to Measurement File Dialog Box

6) Wire the data output from the DAQ Assistant VI to the Signals input of the Write to Measurement File VI.



Figure 13. Block Diagram Completely Built

IV. CONCLUSIONS

NI LabVIEW is an open environment designed to make interfacing with any measurement hardware simple. It combines data acquisition, analysis, and presentation tools into one software program. With interactive assistants, code generation, and connectivity to thousands of devices, LabVIEW makes gathering data as simple as possible.

Because LabVIEW provides connectivity to virtually any measurement device, you can easily incorporate new LabVIEW applications into existing systems without losing your hardware investment. Regardless of your hardware requirements, LabVIEW provides an interface to make connecting to your I/O easy.

NI-DAQmx is a programming interface you can use to communicate with data acquisition devices. Measurement & Automation Explorer (MAX) is a tool automatically installed with NI-DAQmx and used to configure National Instruments hardware and software.

Many applications that do not require advanced timing and synchronization can be performed by using the DAQ Assistant Express VI. For programs that require advanced timing and synchronization, use the VIs that come with NI-DAQmx.

REFERENCES

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