

A NEW SOFTWARE PACKAGE MAKES VXI DATA ACQUISITION EASY

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Abstract - VXIbus is an important data acquisition hardware platform for both military and civilian testing programs. Being modular in nature, VXI-based systems lend themselves to a wide variety of applications. However, because of this versatility, significant effort can be expended to set up and run a particular test. Operating under Windows® NT, a new software package called DAQ Director™, allows a user to configure a system and to acquire, display and archive the acquired data easily and without any programming. This software application can be coupled with popular data analysis packages, such as DADiSP® or MATLAB®, or with the LabVIEW® visual programming environment.

INTRODUCTION

In order to fill the need for standardized modular instrumentation, the major instrumentation manufacturers developed the specifications for VXIbus (the VME eXtensions for Instrumentation), now IEEE Standard 1155 [1]. VXI is an ideal standard for data acquisition. Some of its features are:

- It is an open standard with extensive multivendor support.
- Its modular approach allows you to configure systems with off-the-shelf building blocks that meet your specific needs.
- It provides for fully shielded modular instruments, rugged chassis, EMI (electromagnetic interference) protection and tight power supply noise specifications.
- It creates an excellent electrical environment, even for low-level, high-accuracy, analog conversion circuitry.
- It uses the 32-bit VMEbus for primary backplane communication.
- It allows the host software to interrogate the various modules and perform automatic system configuration.

A typical C-size VXIbus chassis (called a *mainframe*) with modules is shown in Figure 1.



Figure 1 - A 13-slot VXIbus mainframe with modules

The VXI hardware standards were created and are maintained by the VXIbus Consortium [2]. These standards define the physical and electrical characteristics of the controllers, modules and mainframes that are necessary for interoperability of products designed by a wide range of manufacturers.

The VXI*plug&play* Systems Alliance [3] was formed in order to provide system-level interoperability and ease of use for VXIbus-based applications. The two most important standards developed by the Alliance are:

- VXI*plug&play* instrument drivers [4] are delivered with compliant instruments (modules). They provide a standard calling interface from the VISA software layer.
- VISA—Virtual Instrument Software Architecture—is a comprehensive software layer [5] for configuring, programming and troubleshooting VXI-based instrumentation systems.

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USER CHOICES

We have just described two levels of standardization for VXI-based systems. The basic VXI standards provide the necessary interoperability at the hardware level, while the *VXIplug&play* standards provide interoperability at the system level. Even with these building blocks, users generally need to do one of the following:

- Develop their own data acquisition application software, using a programming language such as C®, Visual C++® or Visual Basic®.
- Create an application by using a programming environment intended for instrumentation, such as LabVIEW or LabWindows/CVI®.
- Use prepackaged data acquisition software.

Since they are modular in nature, VXI-based systems lend themselves to a wide variety of applications. However, because of this versatility, significant effort can be expended to set up and run a particular test. This paper describes DAQ Director [6], an application software package that allows a user to configure a system and to acquire, display and archive the acquired data easily and without any programming.

DAQ DIRECTOR FEATURES

DAQ Director is prepackaged data acquisition software. It is based on the following industry standards:

- VXI hardware for data acquisition,
- The Windows NT Operating System,

- Visual Basic and Visual C++ for the Data Engine and the operator interface,
- Access® for the configuration database, and
- A VISA library with *VXIplug&play* drivers as the hardware/software "glue"

It has the following basic features:

- It is modular and extensible, and it can be configured to meet the requirements found in a wide variety of test applications.
- It is easy to set up and change configurations.
- It provides excellent configuration control with an unlimited number of user-defined configurations.
- No programming is required in order to use the system as delivered.
- It provides easy linking to data analysis packages such as DADiSP and MATLAB, as well as to the LabVIEW visual-programming environment.
- It supports high I/O throughput using VXI modules that contain multibuffer memories.

HARDWARE CONFIGURATION

A typical data acquisition system using DAQ Director includes a host computer with the Windows NT operating system, a FOXI™ [7] high-speed fiber-optic highway interface with a PCI host adapter and one or more VXI Slot-0 controllers, along with the appropriate VXI data acquisition and signal conditioning modules. This system configuration is shown in Figure 2.

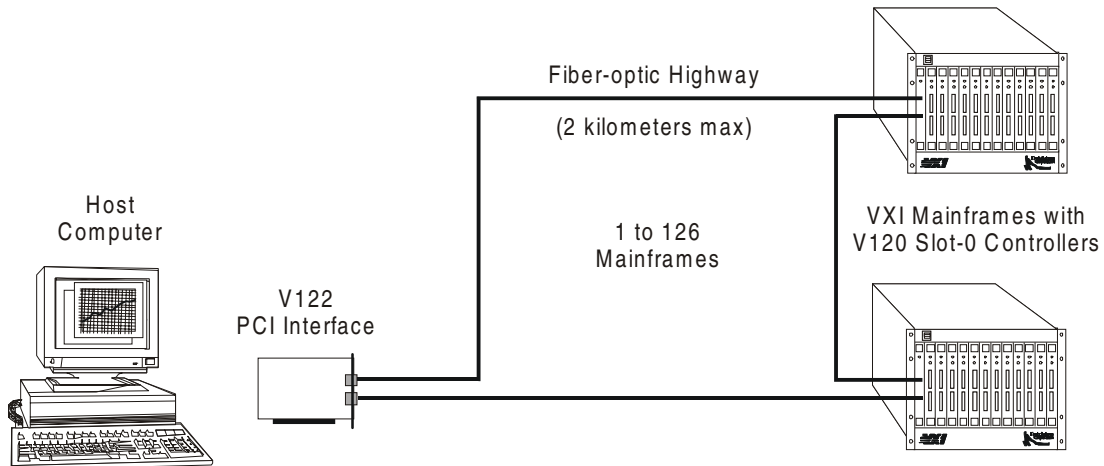


Figure 2 - A typical hardware configuration using the FOXI fiber-optic interface.

SOFTWARE ARCHITECTURE

DAQ Director contains the following software elements, as described below and as shown in Figure 3.

- The *Configuration File* is used to store rudimentary information such as file names and paths.
- The *Module Library* is an Access database that is supplied with the system. It contains the information needed to create a Configuration Database and includes default properties.
- The *DAQ Director Engine and Disk Archive* is the heart of the system. It controls most of the DAQ Director functions. This portion of DAQ Director was created using Visual C++ and Visual Basic software languages.
- The *Configuration Database* contains the information required to initialize and operate all of the modules in the VXI mainframe(s). It also can contain application-specific parameters, such as engineering-unit assignments, transducer identification and calibration history.
- DAQ Director contains several *display utilities*. These include DAQGraph, a versatile graphing utility, and the Digital Display Utility. The display utilities are written in Visual Basic.

DAQ Director can store data in a format that can be used by software analysis tools such as DADiSP and MATLAB

as well as the data analysis and display software modules included in LabVIEW. Additionally, DAQ Director can be linked to LabVIEW in real time.

THE CONFIGURATION UTILITY

DAQ Director includes a simplified interface to the Configuration Database, called the Mainframe Configuration Utility. A typical Configuration Utility window is shown in Figure 4. When you request a new Configuration Database, a pull-down menu includes only those modules that are currently in your system.

Data fields in the Configuration Database Utility window are either read-only or editable. The read-only fields are for information only and cannot be changed by the user. The editable fields either have an unlimited choice of valid entries, such as *Channel_Name*, or a limited number of valid choices, such as *Clock_Setting*. If the number of choices is limited, you are presented with a pull-down selector that contains all of the valid choices.

There is no limit to the number of Configuration Databases that you can create. This allows DAQ Director to have unique configurations for various test applications. This also aids in configuration control. The Configuration Database is archived along with the test data to give a traceable record of the test setup.

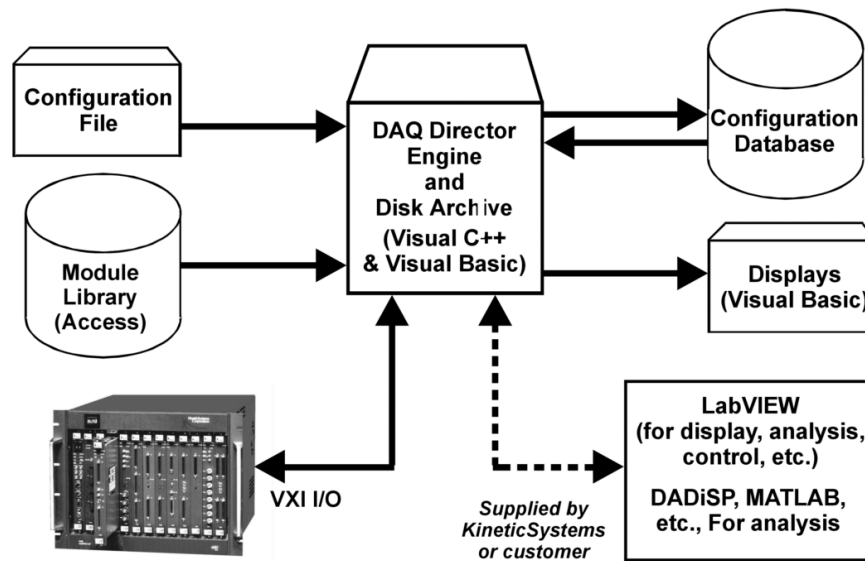


Figure 3 - The DAQ Director software architecture

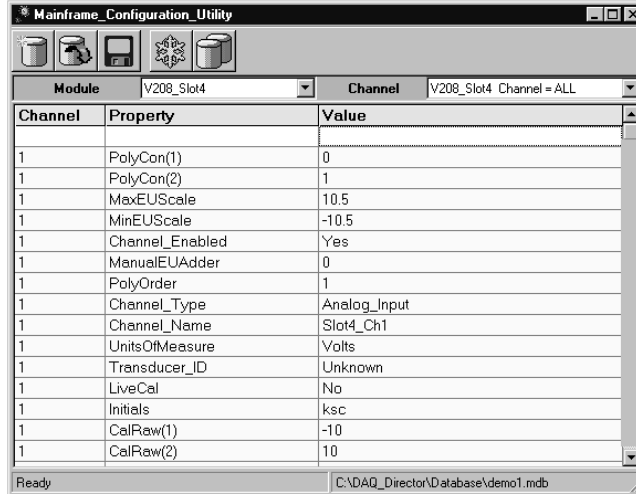


Figure 4 - A typical Mainframe Configuration Utility window

THE DATA ENGINE

Associated with each module in the mainframe is a DAQ Director Data Engine—an executable to control that module or module cluster for data acquisition or control. When you click the *Start Data Engine* button on the DAQ Director toolbar, a control panel window opens and starts a data engine, showing which module in the VXI Mainframe is running. If more than one module is present, their data engines will be activated in sequence.

Data Engine windows associated with analog-to-digital converter modules contain buttons to start and stop recording to disk as well as a button to display a quick graph to check system operation. A typical Data Engine window is shown in Figure 5.



Figure 5 – A typical Data Engine window

DATA COLLECTION

DAQ Director supports two types of data collection, continuous and transient, limited only by the underlying hardware. Most KineticSystems data acquisition modules support both types of collection.

With continuous data acquisition, data is acquired as long as the data engine for that module is running. The data can be viewed in graphical or digital form. Clicking the *Record Data* button causes the data to also be recorded to disk. With the KineticSystems V200 module, for example, disk-recording throughput can be as high as 6.3 megabytes per second with a fast disk drive.

A key element in achieving high data throughput is the use of multibuffer RAM memory in each of the data acquisition modules. A multibuffer can be divided into one to eight segments. The segments are filled in succession by the data acquisition module and similarly emptied by the data acquisition software. This minimizes the effects of dynamic latency caused by the computer operating system. A thorough discussion of buffering can be found in a paper by J. W. Tippie [8].

It is often desirable to base data acquisition on an external event. With transient data capture, you can set the *total* number of samples to be captured and the number of samples to be captured *after* the event—thereby setting the number of samples *before* the event. The multibuffer memory on the module now acts as a circular buffer, and data is recorded to this on-board buffer. The event, such as a crash sled striking a barrier, for example, causes the module to continue recording for the preset post-trigger samples, and recording stops. DAQ Director then transfers the data to disk.

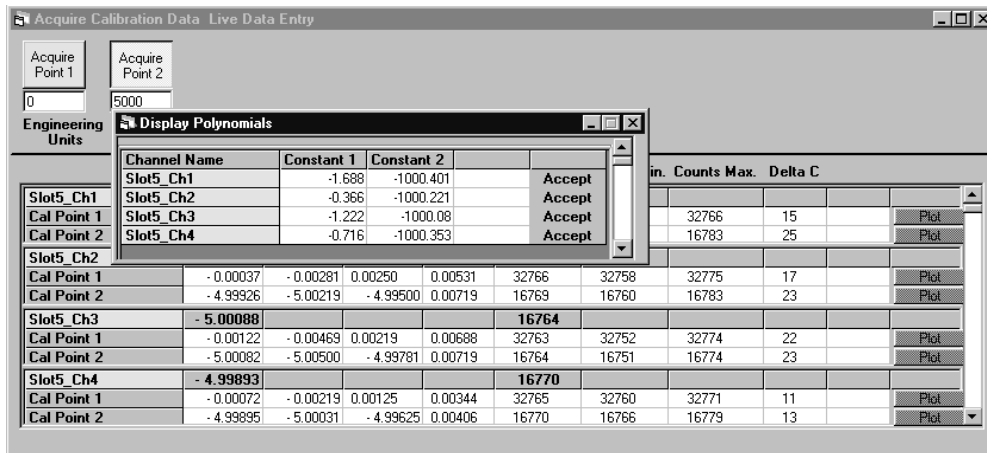


Figure 6 - Accepting calibration data from the Live Data Entry screen

CALIBRATION

Most KineticSystems VXI data acquisition modules as well as many modules from other suppliers include facilities for internal calibration of the entire signal conditioning and digitizing path. The Configuration Database for each of these modules can be set to automatically perform the internal calibration sequence when the data engine is run.

Additionally, DAQ Director contains a rich set of routines to facilitate end-to-end calibration, including the sensor. This can be performed using live data and applying a stimulus to a transducer, or it can be accomplished by text data entry, using calibration information from a sensor calibration certificate. Figure 6 shows two DAQ Director windows—the main live calibration window and the window used to accept live data.

AUTOMATING THE TEST

In addition to the selection of test sequences by using the various toolbar buttons, DAQ Director allows you to create and edit operation sequences. These can range from several steps to the automation of a complete test program. This information can be saved in a sequence file. You can create user buttons, as shown in Figure 7, which can assert any DAQ Director function or execute a test sequence. Figure 8 shows a typical Sequencer window.



Figure 7 – A typical user button window

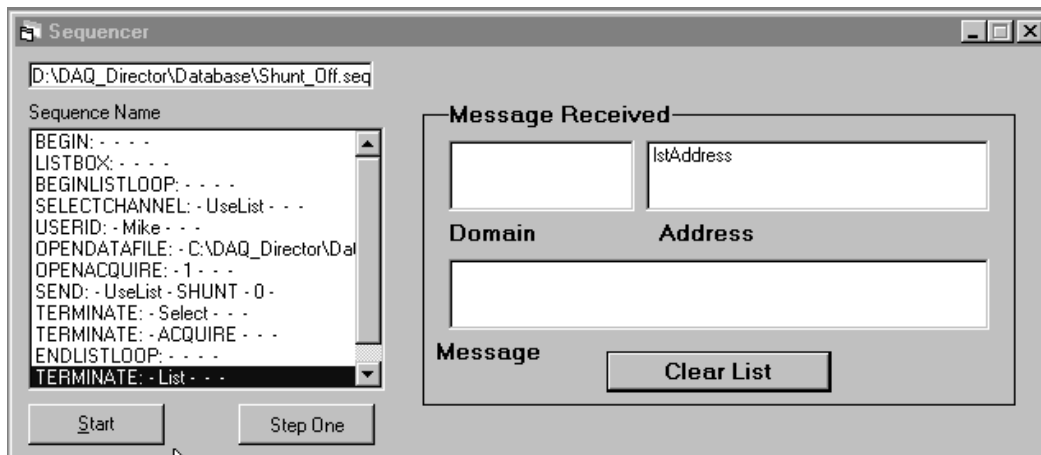


Figure 8 – A typical Sequencer window showing a pre-defined sequence list

DATA ANALYSIS

A key element in any test program is the analysis of the acquired data. DAQ Director includes the *DAQGraph* utility for viewing continuous data as it is being acquired and transient data after it is acquired. The application also includes utilities to simplify the post-test analysis of the data stored on the hard disk. One utility demultiplexes the data and creates a tab-delimited file. This allows the resulting file to be imported into a variety of other applications, including Microsoft Excel. Figure 9 depicts data imported into Excel along with an Excel quick graph.

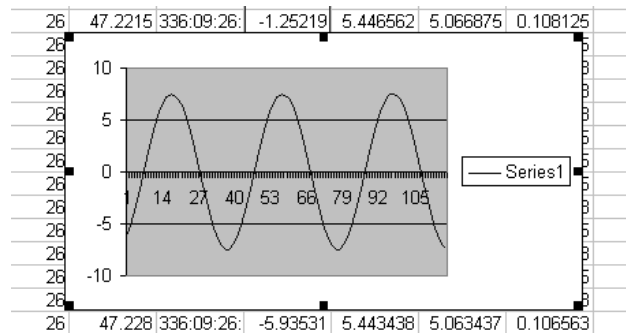


Figure 9 – Data imported into Excel and graphed

Other analysis tools, such as DADiSP and MATLAB can be used to provide post-test analysis. DAQ Director also includes a utility to convert a tab-delimited file to one with a user-selected delimiter character for increased compatibility with third-party analysis tools.

If you are familiar with the LabVIEW programming environment, you can use LabVIEW to provide post-data analysis or to link LabVIEW to live incoming data. Such linking uses the powerful analysis and user-interface tools provided by LabVIEW along with the ease of setup and the high throughput achieved by DAQ Director.

OUTPUT CONTROL

In addition to its data acquisition capabilities, DAQ Director provides a variety of control functions, using modules such as the V285 DAC/Arbitrary Waveform Generator and the V387 Digital I/O module. Control can be asserted via user-defined buttons. The action from these buttons can range from setting individual bits in a digital output module to executing elaborate test sequences. Similar to the output control buttons, you can create user-defined indicators to monitor digital input channels.

CONCLUSIONS

VXIbus is an ideal instrumentation standard for a wide variety of data acquisition applications. *VXIplug&play* instrument drivers and the VISA software layer add a high level of interoperability and standardization, and they increase ease of use. These instrument drivers, along with VISA, aid in the development of data acquisition application software. They are the building blocks that simplify the development of data acquisition applications.

DAQ Director is a prepackaged data acquisition software application. More than 20 systems are in field use, and the results are very positive. This product exhibits the following salient features:

- It is based on industry hardware and software standards.
- It can be used as delivered without any programming.
- It is easy to configure and use, and it provides excellent configuration control.
- It is modular in nature, and it is extensible to meet a wide variety of user requirements.
- It can achieve excellent data acquisition throughput.
- It includes a comprehensive utility to aid in establishing end-to-end calibration.
- It can be used with a wide range of analysis tools. It can be linked with LabVIEW applications in real time.

REFERENCES

- [1] *IEEE Standard 1155*, The Institute of Electrical and Electronic Engineers, Inc., 445 Hoes Lane, Piscataway, New Jersey 08855-1331 USA.
- [2] *VXIbus Consortium*, <http://www.vxi.org/>.
- [3] *VXIplug&play Systems Alliance*, <http://www.vxipnp.org/>.
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