

Introduction to VXIbus

Modular products conforming to IEEE Standard 1155

The Value of Standards

Increasingly, customers are demanding that the instrumentation they purchase conforms to one or more system-level standards that are supported by a number of suppliers. In fact, they often specify which standards are required. Large companies and the U.S. Government are leading this charge.

VMEbus, while developed as a backplane for Motorola processors, can be used for data acquisition, control and other instrumentation applications. However, because of many limitations in the VME specifications—particularly for analog conversion—the major instrumentation manufacturers developed the specifications for VXIbus (VME eXtensions for Instrumentation), now IEEE (Institute of Electrical and Electronic Engineers) Standard 1155. The popularity of VXIbus is growing at a very high rate.

The Benefits of VXIbus

VXI offers you numerous benefits. Some of these are:

- It is an open standard with extensive multivendor support. There are over 1200 commercial VXI products available from a wide variety of manufacturers.
- 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 supports geographic addressing, allowing the host software to interrogate the various modules and perform automatic system configuration. Even though this feature is not mandatory, *all* of our modules support geographic addressing.
- It includes a variety of features—such as a Local Bus for intermodule communication, a precision clock for timing and trigger lines for event handling—to facilitate high-performance systems.

- It is easy to configure, use and support because of the specifications that have been generated by the VXIplug&play Systems Alliance.

The VXIbus Building Blocks

The basic building block of any VXIbus system is the *module*. There are three sizes of modules: B, C and D. B-size modules are the same size as standard 6U VME modules and are unshielded, while D-size modules are 9U high and generally are too large for most applications. Nearly all VXI modules produced—and all in our product line—are the popular C-size. These modules are fully shielded and have sufficient board space for signal conditioning. The dimensions of a C-size module are shown in Figure 1.

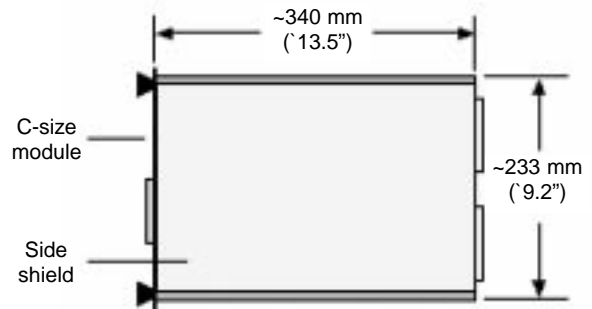


Figure 1. The side view of a typical C-size module

A full-size VXI chassis—called a *mainframe*—contains 13 slots, numbered 0 through 12 from the left as viewed from the front. Five- or six-slot mainframes are also available for smaller systems or for development. The left-most slot on a mainframe is used to house a special module, called a *Slot-0 controller*. The remaining slots can house instrumentation, processors, memory or other modules types. A typical full-size VXI mainframe with modules is shown in Figure 2.

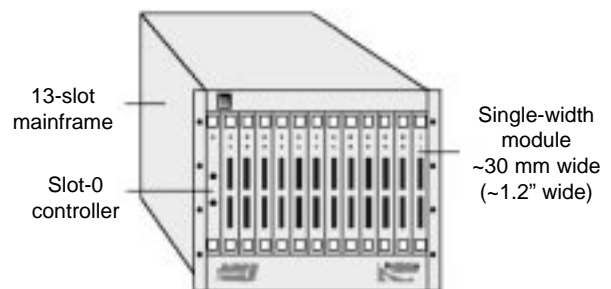
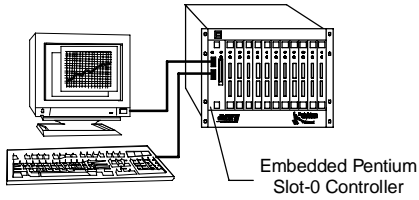
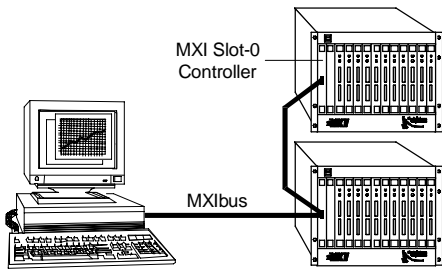


Figure 2. A C-size VXI mainframe with modules

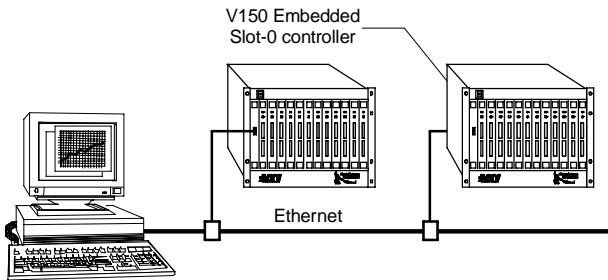
Slot-0 controllers provide the communication path between the other modules in the mainframe and the host computer. A controller may contain an embedded processor and/or they can communicate with an external computer. The primary interface alternatives are shown in Figure 3.



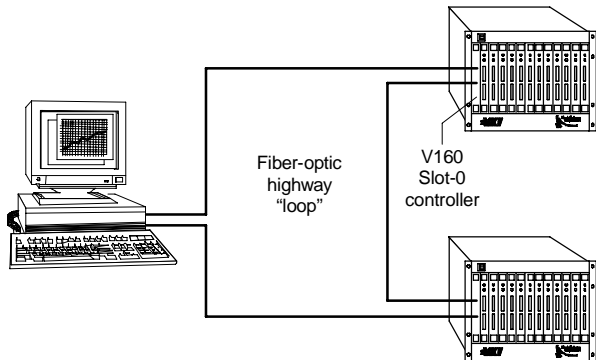
a. An embedded Pentium controller with disk drives



b. An external computer communicates by MXIbus



c. Embedded Slot-0 controllers communicate over Ethernet



d. The Grand Interconnect uses a fiber-optic highway

Figure 3. The primary VXIbus interface alternatives

Many VXI-based systems use an embedded computer as shown in Figure 3a. When connected to an external monitor and keyboard, a complete stand-alone system is formed. LabVIEW (page 439) is the primary application software chosen for such systems. The V145 (page 24) is a Slot-0 controller with an embedded Pentium® computer. This module includes a 3.5" diskette drive and an internal hard drive.

The same functions as an embedded Pentium controller can be performed by the use of MXIbus (Multisystem eXtensions for Instrumentation bus) with an external computer as shown in Figure 3b. By using MXIbus the host computer can be upgraded at reasonable cost as computer technology advances. MXIbus also supports several daisy-chained mainframes on the same host computer. The V133 MXI-2 Interface Kit for ISA/EISA (page 15) and the V134 MXI-2 Interface Kit for PCI (page 19) are examples of this configuration.

Another example of an embedded computer is shown in Figure 3c. In this case a V150 Slot-0 controller (page 28) includes a 68040 or 68060 embedded processor. This processor uses the realtime kernel, VxWorks, to perform the necessary realtime tasks. Data can be written to disk at high speed directly from the controller. Ethernet is used to download the programs from the external host computer and to provide operator control and display. A powerful software package called Reality® (page 431) uses this configuration.

For applications that require the connection of one or more VXI mainframes along with high throughput, deterministic response or the remote mainframe(s) located at some distance from the host computer, the Grand Interconnect (GI) is an ideal choice. This configuration is shown in Figure 3d. The nodes in this system can be separated by distances up to 2 kilometers and I/O throughput can approach 10 Mbytes/s. The system supports up to 126 I/O chassis.

The Grand Interconnect also supports CAMAC crates as well as mixed VXI and CAMAC I/O chassis in the same system. For synchronous multi-mainframe data acquisition, Reality-based systems can use this network configuration. The 2961 is a GI host adapter for VME (page 201), while the 2962 (page 203) performs a similar function for host computers with PCI bus. The V160 Slot-0 controller (page 35) provides the VXI mainframe interface, and the 3972 (page 327) provides the CAMAC crate interface.

Deterministic Intermodule Communication

In order to guarantee a deterministic response or to transmit analog information between two or more modules, it often is desirable to have a private information path between these modules. One of the features of the VXI standard for C-size mainframes is the backplane *Local Bus*. This 12-line bus is split at each module slot. Many of our VXI modules use this bus to transmit information from one module to the module immediately to its left. This allows a number of modules to function as an integral group. We have developed two innovative protocols, MUX-bus™ for analog information and Digi-bus™, a 10 megabyte/second deterministic bus, for digital information.

Figure 4 shows a typical jet aircraft engine test system using both MUX-bus and Digi-bus. This example includes 4 signal conditioning modules, 1 V246, 2 V243 and 1 V253, using the MUX-bus protocol to transmit analog information to the V208 Scanning ADC. The V208 can forward the digitized data over VXI bus and/or via Digi-bus to a module such as the V165 DSP for data reduction or analysis. The processed data from the DSP is transmitted via VXI bus and/or forwarded over Digi-bus to an output module, such as the V285 Arbitrary Waveform Generator. Other Digi-bus combinations include the use of the V110 Memory as a data *source* for modules such as the V285 or as a data *sink* for modules such as the V200 Sigma-Delta ADC.

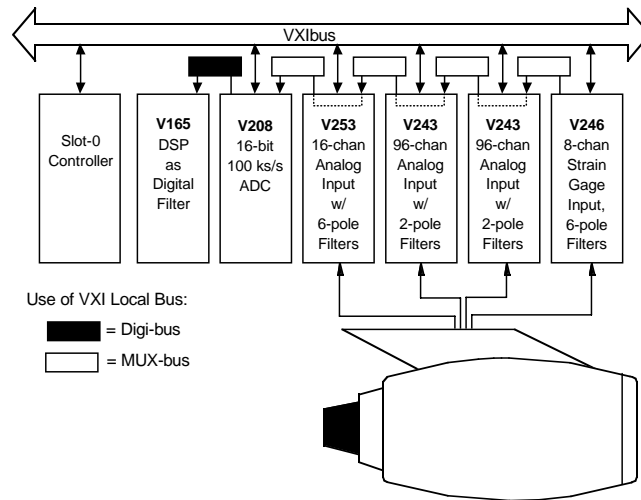


Figure 4. A typical test set-up using MUX-bus and Digi-bus for intermodule communication

Computer Interfaces and VXIbus Controllers

This catalog contains a wide range of alternatives for interfacing VXI mainframes to host computers. The Grand Interconnect computer interfaces, the MXI inter-

face kits, the Grand Interconnect Slot-0 controller and the embedded Slot-0 controllers are listed in the following table. Additional information on the Grand Interconnect is found on page 423.

Model	Description	Comments	Page
2961	VME Grand Interconnect Host Adapter	A 6U VME card	201
2962	PCI Grand Interconnect Host Adapter	A single-width PCI card	203
V130	GPIB Slot-0 controller	Controls VXI instruments from an IEEE-488 port	12
V131	MXI Interface kit for Sun Sbus	Includes Sbus interface, VXI controller and cable	14
V133	MXI-2 interface kit for ISA or EISA	Includes an ISA interface, VXI controller and cable	15
V134	MXI-2 interface for PCI	Includes a PCI interface, VXI controller and cable	19
V136	MXI-2 extender	Use in any VXI slot to extend VXIbus w/ MXI-2 cable	22
V145	Embedded Pentium Slot-0 controller	The power of a Pentium in a Slot-0 controller	24
V150	Embedded 68040/060 Slot-0 controller	Excellent realtime performance w/ VxWorks software	28
V151	PowerPC Slot-0 controller	Excellent price/performance	31
V160	Grand Interconnect Slot-0 Controller	A single-width controller	35

A Full Set of Analog Input Solutions

The acquisition of *good* data involves good signal conditioning and precision analog-to-digital conversion. Most signals from sensors need to be conditioned. This generally includes applying gain and low-pass filtering to the signal. In the case of bridge-type sensors, it also includes bridge excitation and bridge completion. Sensor signals should be connected to the data acquisition system as differential pairs to attenuate ground-coupled noise.

This catalog includes a wide range of signal conditioning and A-to-D conversion modules. Our MUX-bus

family of modules includes voltage and bridge signal conditioning modules and the choice of two ADC host modules with maximum sampling rates of 100,000 samples/s and 500,000 samples/s, respectively. Particularly exciting are two new members of our analog input family are: The V200 16 or 32-channel ADC, which uses the new Sigma-delta technology to achieve as sample rate of 200,000 samples/s *per channel*, and the V213 32-channel scanning ADC with DAC and TTL options. Both of these modules include on-board signal conditioning.

The products that represent our most popular analog input solutions are listed in the following table.

Model	Description	Comments	Page
V200	16 or 32-channel Sigma-Delta ADC	Sigma-delta channels that each scan at 200ks/s	49
V207	16-bit, 500,000 sample/s ADC subsystem	Hosts up to 256 MUX-bus channels	53
V208	16-bit, 100,000 sample/s ADC subsystem	Hosts up to 2048 MUX-bus channels	56
V213	32 or 64-channel scanning ADC	Includes DAC and TTL options	59
V241	96-channel scanning high-level MUX	An economical choice for pre-conditioned signals	72
V243	96-channel, low level signal conditioner	Provides exceptionally high accuracy	74
V246	8-channel bridge signal conditioner	A full-featured, high-accuracy signal conditioner	77
V252	8 or 16-channel, 8-pole filter	Provides excellent anti-alias filtering	80
V253	16-channel, programmable gain analog filter	Provides programmable cut-off frequencies	83

An Array of Other Popular Products

The two previous tables listed the computer interface products that are associated with VXIbus systems as well as the most popular VXI-based signal conditioning

and analog input products. The following table lists the most popular analog and discrete modules, and mainframes not previously listed of the 79 products found in the VXI section.

Model	Description	Comments	Page
V110	4 to 128 megabyte memory	Supports Digi-bus input or output (choose one)	9
V165	Digital signal processor	A TI-based DSP with 40 MFLOP processing power	38
V195	13-slot C-size VXI mainframe	A full-featured VXIbus mainframe	42
V266	64-channel, 16-bit DAC	Includes ± 10 V, ± 16 V and 4-20 mA output options	89
V285	16-chan., 16-bit DAC/waveform generator	Provides arbitrary waveforms at rates to 500 ks/s	96
V387	128-channel digital input/output	Mezzanine options with TTL, isolated I/O, relay out	107
V635	8-channel, 50 kHz frequency counter	Counts from 0.06 Hz to 50 kHz w/o changing ranges	147
V710	Signal conditioning chassis	Provides the chassis for the SC20 signal conditioner	157
V750	Front-panel termination assembly	Plugs on the module; options for V213, V243, V246	159
V751	Front-panel termination assembly	Plugs on the module; used for V266	159
V752	Front-panel termination assembly	Plugs on the module; options for V252, V253	159
V754	Front-panel termination assembly	Plugs on the module; used for V285	159
V765	Rack-mount termination panel	Interfaces with most VXI modules	160
V792	Rack-mount isothermal termination panel	Includes a sensor to measure the panel temperature	162
SC20	Wideband Bridge Signal Conditioner	Adds bridge conditioning to the V200 and the V213	167