

Introduction to PXI for Structural Monitoring and Testing

Overview

PXI is a rugged PC-based platform that offers a high-performance solution for structural test and monitoring systems. PXI combines the PCI electrical bus with the rugged, modular Eurocard mechanical packaging of CompactPCI, and adds specialized synchronization buses and key software features. PXI also incorporates mechanical, electrical, and software features that define complete high-channel-count testing systems. Built on PXI, PXI Express combines the PXI Express bus with additional timing and synchronization features, delivering an ideal platform for high-channel-count structural monitoring and dynamic structural test.

This document is part of the [Structural/Seismic Monitoring and Testing Resource Kit for Lab Applications](#).

Hardware Architecture

PXI systems feature three basic components: chassis, system controller, and peripheral modules.

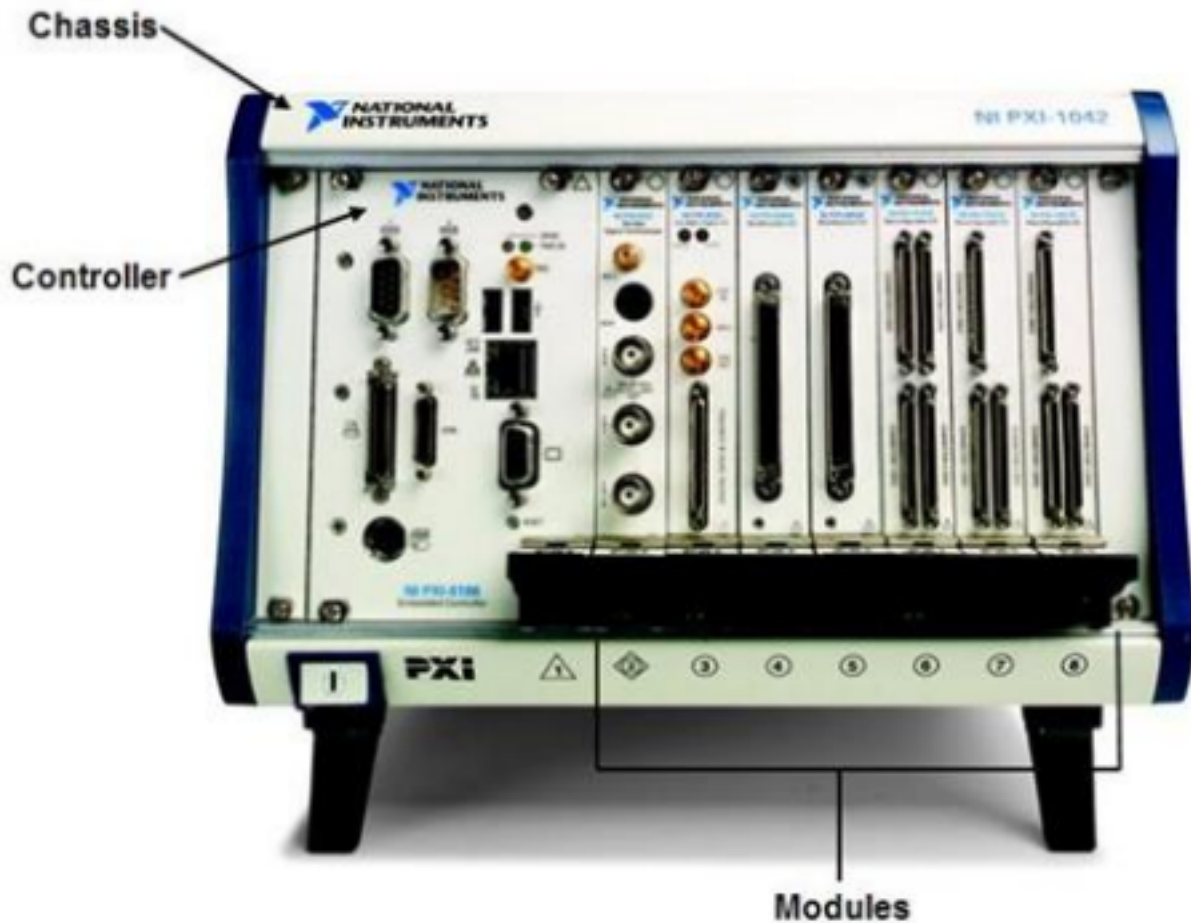


Figure 1. Standard Eight-Slot PXI Chassis Containing an Embedded System Controller and Seven Peripheral Modules

PXI Express Chassis

This chassis contains the high-performance PXI Express backplane, which includes the PCI Express bus and timing and triggering buses. PXI Express modular instrumentation adds a dedicated 100 MHz differential system reference clock, differential signaling, and star triggers. By using differential clocking and synchronization, PXI Express systems benefit from increased noise immunity for instrumentation clocks and the ability to transmit at higher-frequency rates.

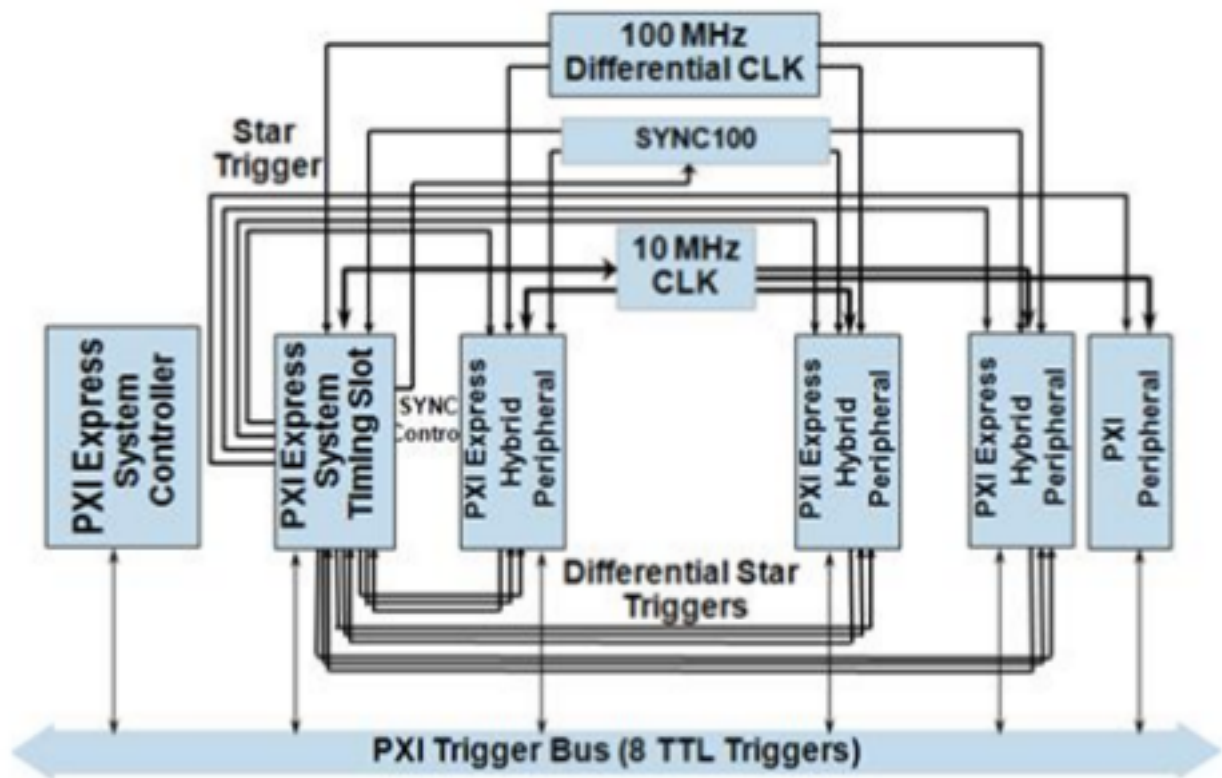


Figure 2. PXI Express timing and triggering buses provide a differential system clock, differential signaling, and differential star triggers on the backplane.

Using these timing and triggering buses, you can develop systems for applications requiring precise synchronization. To learn more about PXI specifications for timing and triggering buses, refer to the NI Developer Zone document titled [PXI Specification Tutorial](#).

For more information on in-depth timing and synchronization concepts, refer to the NI Developer Zone tutorial titled [Introduction to Distributed Clock Synchronization and the IEEE 1588 Precision Time Protocol](#).

PXI Express Controllers

Most PXI chassis contain a system controller slot in the leftmost slot of the chassis (slot 1). You can choose from a few options when determining the best system controller for an application, including remote controllers from a desktop, workstation, server, or laptop computer and high-performance embedded controllers with either a Microsoft OS (Windows Vista/XP) or a real-time OS (LabVIEW Real-Time). The two types of controller options are laptop control of PXI and PC control of PXI.

PXI Express Embedded Controllers

Embedded controllers eliminate the need for an external PC, therefore providing a complete system

contained within the PXI chassis. These embedded controllers come with standard features such as an integrated CPU, hard drive, RAM, Ethernet, video, keyboard/mouse, serial, USB, and other peripherals, as well as the Microsoft Windows OS and all device drivers already installed. They are available for systems based on PXI or PXI Express, and you have a choice of OSs, including Windows Vista/XP or LabVIEW Real-Time.

For more information, refer to the NI [PXI Controllers](#) resource page.



Figure 3. The NI PXIe-8108 controller has a 2.53 GHz Intel Core 2 Duo T9400 dual-core processor embedded controller.

Laptop Control of PXI Express

With NI ExpressCard MXI interfaces, you can control PXI systems directly from laptop computers through a software-transparent link. During boot-up, the laptop computer recognizes all peripheral modules in the PXI Express system as PCI Express boards, and you can then control these devices through the laptop computer. Laptop control of PXI consists of an ExpressCard CardBus card in the laptop and a PXI Express module in slot 1 of your PXI system, connected by a copper cable.



Figure 4. Laptop Control of PXI with NI PXIe-ExpressCard8360 MXI Interface

The NI ExpressCard MXI interface kit provides sustained throughput up to 214 MB/s. You can purchase any laptop compatible with NI ExpressCard MXI to remotely control your PXI system. For more information, refer to the [Laptop Control of PXI](#) resource page.

PC Control of PXI Express

With NI MXI-Express interface kits, you can control PXI systems directly from desktop, workstation, or server computers. You can control PXI systems from PCs through a software- and driver-transparent link. During boot-up, the computer recognizes all peripheral modules in the PXI Express system as PCI Express boards, and you can then work with these devices through the controller. PC control of PXI Express consists of a PCI Express board in your computer and a PXI Express module in slot 1 of your PXI Express system, connected by a copper or fiber-optic cable.



Figure 5. Remote control with two-port MXI-Express provides simultaneous control of two PXI chassis with a combined 838 MB/s throughput.

The MXI-Express interface kit offers up to 838 MB/s throughput from the PC to the PXI Express chassis. Using a MXI-Express interface, you can create multichassis PCI systems using the star topology configuration, with either 3 or 7 m copper cables. This interface is compatible with x1, x4, x8, and x16 PCI Express slots, so you can use this option in a wide variety of desktop computers.

Because all remote control products are software-transparent, no additional programming is required. You can purchase many desktops, workstations, or server computers and then remotely control your PXI system using a MXI-Express or copper/fiber-optic link. For more information, refer to the [PC Control of PXI](#) resource page.

PXI Express Peripheral Modules

National Instruments offers more than 200 different PXI modules, and, because PXI is an open industry standard, more than 1,500 modules are available from more than 70 vendors. These include instruments, bus interface and communication modules, switching, image acquisition, and motion control.

NI SC Express and NI SCXI modules can interface with a wide range of sensors and I/O for structural monitoring and test applications.

To learn more about NI PXI modules, refer to the NI [PXI Modules](#) resource page. You also can view a categorized list of [PXI modules offered by National Instruments and third parties](#).

SC Express



Figure 6. NI PXIe-4330 PXI Express Module for Bridge-Based Sensors

NI SC Express data acquisition modules feature the integrated signal and sensor-specific conditioning required for measuring high voltages and sensors, such as strain gages, bridge-based transducers, and thermocouples. SC Express modules are built on the x1 PXI Express interface and feature multiple analog-to-digital converters (ADCs), up to 24-bit resolution, and up to 250 kS/s per channel sampling rates. Because of the added bandwidth provided by PXI Express, these modules offer simultaneous sampling options using the same channel counts as multiplexed devices. All SC Express modules feature NIST-traceable calibration and software-selectable configurations, such as gain, filtering, and excitation. The modules include high accuracy, maximum data throughput, and tight synchronization that make them ideal

for scalable measurement systems from low- to high-channel counts.

To learn more about SC Express, refer to the [SC Express](#) resource page.

SCXI

National Instruments SCXI signal conditioning complements the PXI platform with a selection of static analog input, analog output, digital I/O, and switching modules. Examples of SCXI modules for structural monitoring and test include the NI SCXI-1521 (24-channel, quarter-bridge strain gage module) and the NI SCXI-1540 (eight-channel LVDT input module).

To learn more about SCXI, refer to the [SCXI](#) resource page.

Software Architecture

The development and operation of Windows-based PXI Express systems is no different from that of a standard Windows-based PC. Additionally, because the PXI Express backplane uses the industry-standard PCI Express bus, writing software to communicate with PXI modules is, in most cases, identical to that of PCI Express boards.

As an alternative to Windows-based systems, you can use a real-time software architecture for time-critical applications requiring deterministic loop rates and headless operation (no keyboard, mouse, or monitor). Real-time OSs help you prioritize tasks so that the most critical task always takes control of the processor when needed. With this feature, you can program an application with predictable results and reduced jitter. Find additional information on using LabVIEW Real-Time with PXI Express systems at ni.com/realtime.

The PXI Express specification presents software frameworks for PXI Express systems based on Microsoft Windows OSs. As a result, the controller can use industry-standard application programming interfaces, such as NI LabVIEW, LabWindows™/CVI, and Measurement Studio; Visual Basic; and Visual C/C++. Initialization files that define system configuration and system capabilities are required for PXI Express components. Finally, implementation of Virtual Instrument Software Architecture (VISA), which has been widely adopted in the instrumentation field, is required by PXI Express for configuration and control of VXI, GPIB, serial, and PXI Express instruments.

Summary

PXI Express modular instrumentation defines a rugged computing platform that takes advantage of the technology advancements in the mainstream PC industry. By using the standard PCI Express bus, PXI Express modular instrumentation systems can benefit from widely available software and hardware components. Engineers are already familiar with the software applications and OSs that run on PXI Express systems because these applications and OSs are already in use on common desktop computers. PXI

Express meets your needs by adding rugged industrial packaging, plenty of slots for I/O, and features that provide advanced timing and triggering capabilities.

For more structural health monitoring resources, visit the [Structural Health and Seismic Monitoring home page](#).

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