

GETTING STARTED GUIDE

NI Digital Waveform Generator/Analyzer

For NI PXI-6551/6552 Modules

This document explains how to install, configure, test and set up a National Instruments digital waveform generator/analyzer. This document applies specifically to the NI PXI-6551/6552 (NI 655X) modules. For more information on the NI 655X, such as features and programming, refer to the *NI Digital Waveform Generator/Analyzer Help* at **Start»Programs»National Instruments»NI-HSDIO» Documentation»NI Digital Waveform Generator/Analyzer Help**.

Refer to the specifications document that ships with your module for detailed specifications.

For free downloads of the most current versions of product documentation and example programs, visit ni.com/instruments.




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Conventions

The following conventions are used in this guide:

- <> Angle brackets that contain numbers separated by an ellipsis represent a range of values associated with a bit or signal name—for example, DIO<3..0>.
- » The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.
-  This icon denotes a tip, which alerts you to advisory information.
-  This icon denotes a note, which alerts you to important information.
-  This icon denotes a caution, which advises you of precautions to take to avoid injury, data loss, or a system crash. When this symbol is marked on the product, refer to [Safety Information](#) section for precautions to take.
- bold** Bold text denotes items that you must select or click on in the software, such as menu items and dialog box options. Bold text also denotes parameter names.
- CompactPCI CompactPCI refers to the core specification defined by the PCI Industrial Computer Manufacturers Group (PICMG).
- italic* Italic text denotes variables, emphasis, or a cross reference. This font also denotes text that is a placeholder for a word or value that you must supply.

<code>monospace</code>	Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames and extensions, and code excerpts.
<code>monospace italic</code>	Italic text in this font denotes text that is a placeholder for a word or value that you must supply.
PXI	PCI eXtensions for Instrumentation (PXI) is a rugged, open system for modular instrumentation based on CompactPCI, with special mechanical, electrical, and software features. These features, such as the PXI trigger bus, are described in the <i>PXI Specification Revision 2.0</i> , which is available from ni.com/manuals .

Step 1. Unpack the Hardware

The NI 655X ships in an antistatic package to prevent electrostatic discharge (ESD). ESD can damage several components on the module.



Caution *Never* touch the exposed pins of connectors.

To avoid ESD damage in handling the module, take the following precautions:

- Ground yourself with a grounding strap or by holding a grounded object.
- Touch the antistatic package to a metal part of your computer chassis before removing the module from the package.

Remove the module from the package and inspect it for loose components or any other signs of damage. Notify NI if the module appears damaged in any way. *Do not* install a damaged module in your computer or chassis.

Store the module in the antistatic package when the module is not in use.

Step 2. Verify the Components

Make sure you have the following items:

- NI 655X digital waveform generator/analyzer
- NI-HSDIO (High-Speed Digital I/O) driver software CD

- The documentation included with the digital waveform generator/analyzer and driver software. Refer to the *Documentation* section for a listing of the documentation you may have.
- PXI/CompactPCI chassis and controller
- Phillips screwdriver
- One of the following application development environment (ADE) software packages and documentation:
 - NI LabVIEW 7.0 or later
 - NI LabWindows™/CVI™ 6.0 or later
 - Microsoft Visual C++ 5.0 or later

Optional Equipment and Software

NI offers a variety of accessory products to use with the NI digital waveform generator/analyzer, including the following items:

- NI CB-2162—Connector block accessory with a prototyping area for creating custom circuitry.
- SHC68-C68-D2—Shielded cable recommended for connections with NI high-speed digital instruments.

The NI Digital Waveform Editor (DWE) is a separate software application that you can purchase from NI to use with your module to easily create and edit digital patterns.

For more specific product information, refer to ni.com/catalog.

Documentation

The NI digital waveform generator/analyzer ships with several documents designed to familiarize you with different aspects of the module. The documentation set includes the following pieces:

- *NI Digital Waveform Generator/Analyzer Getting Started Guide*—Read this printed document to set up the digital waveform generator/analyzer and configure it to complete your first acquisition or generation.
- *NI Digital Waveform Generator/Analyzer Help*—This online document provides more in-depth information about the hardware capabilities of the module, theory of operation discussion, programming flow, and software reference.
- NI digital waveform generator/analyzer specifications—This printed document provides specifications for your module.

Step 3. Install the Software

This section describes the software installation process for the NI digital waveform generator/analyzer.

Choose and Install Your ADE

You can create applications for your digital waveform generator/analyzer using LabVIEW 7.0 or later, LabWindows/CVI 6.0 or later, or Microsoft Visual C++ 5.0 or later.



Note LabVIEW features interactive graphics, a state-of-the-art interface, and a powerful graphical programming language. LabWindows/CVI is a complete ANSI C ADE that features an interactive user interface, code generation tools, and the LabWindows/CVI Data Acquisition and Easy I/O libraries. Using LabVIEW or LabWindows/CVI can greatly reduce your application development time.

If you have not already installed the ADE, follow the instructions in the product documentation to install your ADE now.

Install NI-HSDIO

The NI digital waveform generator/analyzer ships with the NI-HSDIO driver software. NI-HSDIO features a set of operations and attributes that allow you to programmatically configure and control the digital waveform generator/analyzer. Refer to the *Programming* section of the *NI Digital Waveform Generator/Analyzer Help* for information on creating an application with NI-HSDIO.

To install NI-HSDIO, complete the following steps:

1. Insert the NI-HSDIO CD. The NI-HSDIO installer should open automatically. If not, select **Start»Run**, and enter `x:\setup.exe`, where *x* is the letter of the CD drive.
2. Follow the instructions in the installation prompts. For troubleshooting and operating system-specific instructions, refer to the Hardware Installation Wizard at ni.com/support/install.



Note If you are running Windows 2000/NT 4.0/XP, you must have administrator access to perform the installation.

NI Script Editor

The NI Script Editor is included on the NI-HSDIO CD and is installed when you install the driver. The NI Script Editor provides an intuitive interface to aid you in developing linking and looping pattern generation operations. The *NI Script Editor Help* contains more information about the NI Script Editor.

(Optional) Install the NI Digital Waveform Editor

The DWE is included with the higher-memory versions of the NI 655X and also can be purchased separately. The DWE allows you to easily import data from popular third-party CAD programs, create your own waveforms, edit these waveforms, and view acquired waveforms.

If you are using the DWE, install it after you install NI-HSDIO.

Step 4. Install the Module

You can install the module in any available 5 V peripheral slot in a PXI or CompactPCI chassis. Follow the instructions in the procedure section that describes your chassis.

Procedure 1: Installing the Module in a PXI Chassis

To install the module, refer to Figure 1 and complete the following steps:

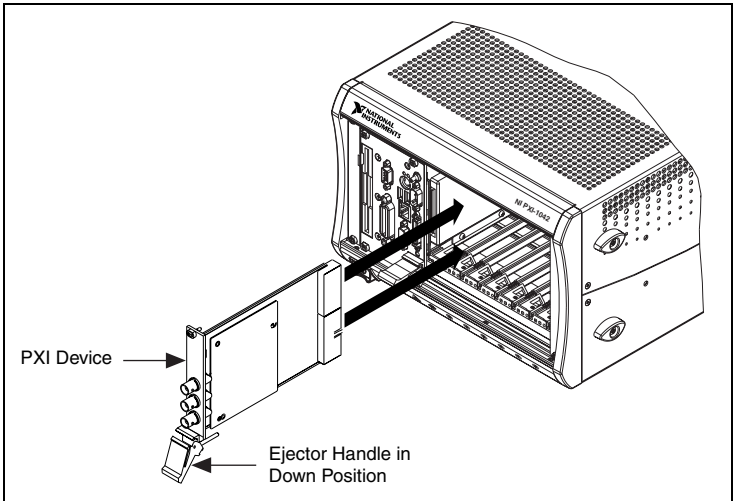


Figure 1. PXI Installation



Caution To prevent damage to the module caused by ESD or contamination, handle the module using the edges or the metal bracket.

1. Power down the chassis before installing the module.
2. If the chassis has multiple fan speed settings, ensure that the fans are set to the highest setting.
3. Position the chassis so that inlet and outlet vents are not obstructed. For more information, refer to the chassis documentation.



Note Clean the fan filters on the chassis regularly to prevent airflow blockage.

4. If you need to use the provided EMI gasket to reduce high-frequency emissions, install it now. Refer to the *Retrofitting Your PXI Module Note to Users* for more information.
5. Ensure that the ejector handle is in the unlatched (downward) position, as shown in Figure 1.
6. Holding the module by the ejector handle, slide it into an empty slot, ensuring that the base card (on the left when looking at the front of the module) engages with the card guides in the chassis.
7. Slide the module completely into the chassis and latch by pulling up on the ejector handle.
8. Tighten the captive screws at the top and bottom of the module front panel.
9. Before operating the module, cover all empty slots using blank (EMC) filler panels.

NI PXI modules are sensitive instruments and should be handled carefully. Do not expose the module to temperatures or humidity beyond the rated maximums. Keep the module free of dust by cleaning with compressed air only. Do not clean the module with any solvents or liquids. For more information about module cooling, refer to the guidelines in the *Maintain Forced-Air Cooling Read Me First* included with your NI digital waveform generator/analyzer.

Procedure 2: Installing the Module in a CompactPCI Chassis

The procedure for installing the module in a CompactPCI chassis is the same as the procedure for installing the module in a PXI chassis, but the following additional considerations apply to using your PXI module with a CompactPCI chassis.

- The CompactPCI specification permits vendors to develop sub-buses that coexist with the basic PCI interface on the CompactPCI bus. Compatible operation of NI PXI modules is not guaranteed between CompactPCI devices with different sub-buses nor between CompactPCI devices with sub-buses from different vendors and PXI. The standard implementation for CompactPCI does not include these sub-buses.
- The module works in any standard CompactPCI chassis adhering to the *PICMG CompactPCI 2.0 R2.1* document. You can obtain this document from picmg.org.
- When you use the NI 655X as a plug-in device in a standard CompactPCI chassis, you cannot access PXI-specific functions. PXI-specific features are implemented on the J2 connector of the CompactPCI bus. The following table lists the J2 pins used by the NI 655X. This module is compatible with any CompactPCI chassis with a sub-bus that does not drive these lines. Even if the sub-bus is capable of driving these lines, the module is still compatible as long as those pins on the sub-bus are disabled by default and never enabled.

Table 1. J2 Pins Used by the NI 655X

PXI Pin	Description	PXI J2 Pin Number
PXI_TRIG<0..7>	PXI trigger lines <0..7>—the eight PXI bused trigger lines are highly flexible and can be used in a variety of ways; for example, triggers can synchronize several PXI peripheral modules	B16, A16, A17, A18, B18, C18, E16, E18
PXI_STAR	PXI star trigger line—the star trigger bus implements a dedicated trigger line between the first peripheral slot (adjacent to the system controller slot) and the other peripheral slots	D17
PXI_CLK10	PXI Clock10 line—10 MHz PXI system clock distributed along the PXI backplane	E17

Step 5. Configure the Module

1. Launch Measurement & Automation Explorer (MAX) to configure and test the digital waveform generator/analyzer. MAX should automatically detect the module you installed.



Note If MAX does not detect the module, you might need to refresh MAX by selecting **File»Refresh** from the MAX menu or pressing F5. If the device is still not recognized, refer to ni.com/support/install for troubleshooting information.

2. Expand **Devices and Interfaces**.
3. Expand **NI-DAQmx Devices**.
4. Check that your module appears under NI-DAQmx Devices.
5. You can perform a self-test on modules listed under NI-DAQmx Devices. The self-test ensures that the device is installed correctly and can communicate with NI-HSDIO. To perform a self-test, complete the following steps:
 - a. Right-click the module you want to test and select **Self-Test** (shown in Figure 2).

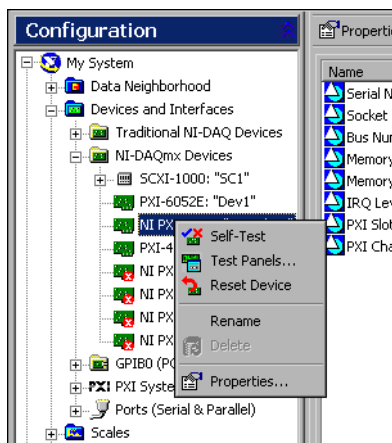


Figure 2. Configuration Tree Shortcut Menu

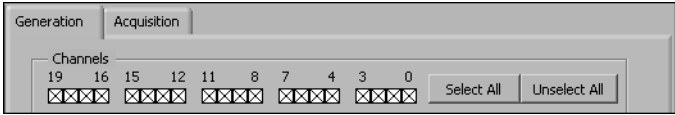
- b. When the self-test finishes, a message window appears to indicate if an error occurred. If an error occurred, refer to ni.com/support for troubleshooting information.
6. Record the device name assigned to the digital device. You will use this information when you program the module.

Step 6. Use the Test Panel to Generate and Acquire Data

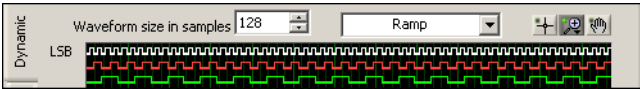
To verify your module configuration, use the device test panel in MAX to generate and acquire simple digital data using your module.

To generate digital data, complete the following steps:

1. Right-click your module under NI-DAQmx Devices, and select **Test Panels** from the shortcut menu shown in Figure 2.
2. Click the **Generation** tab. Select the **Dynamic** tab on the side of the pane.
3. Click **Select All** to select all of your channels. The digital pattern now appears in the graph.



4. Enter the frequency in the **Clock Frequency** control, located on the left side of the Test Panel.
5. Enter values for the generation and acquisition voltages in the controls below the Clock Frequency control. You can choose from standard logic families or enter High and Low values to create your own custom levels.
6. Choose a fill pattern. The following figure shows the pattern control and the first few signals in the window.



Tip When generating a Marching Ones or Marching Zeroes waveform, it is convenient to make the waveform size a multiple of the number of selected channels.

7. Click **Play** to generate the pattern shown in the graph on the selected channels. The default generation option is Continuous, but you can toggle this using the control below the graph.

The Play and Stop buttons are shown in the following figure.



While the data is being generated continuously on all of the channels, as in the previous step, you also can acquire the data on all the channels. Since the data channels on the NI 655X are bidirectional, you can acquire the data being generated on the channel.



Note Refer to the specifications for your device for information on the setup and hold times and propagation delays associated with generation and acquisition operations. At some frequencies, generating and acquiring data on the same channels when no cable is attached to the DDC connector violates these timing parameters and results in incorrectly sampled data. For some information on proper signal acquisition, refer to the *NI Digital Waveform Generator/Analyzer Help*.

To acquire the pattern, complete the following steps:

1. Click the **Acquisition** tab.
2. Click **Play**. The module acquires the digital data you generated in the previous steps, and data is displayed on the graph.
3. Click **Close** when you are finished.

You have now verified your module and are ready to program your module.

Step 7. Connect Signals to the Front Panel

This section discusses what connections you can make to the module, and how to connect signals to the module.

Figure 3 shows the front panel of the NI 655X. The front panel contains four connectors—three SMB jacks (CLK IN, PFI 0, and CLK OUT) and one 68-pin VHDCI connector (Digital Data & Control, or DDC). The connectors and their functions are described in Tables 1 and 2.

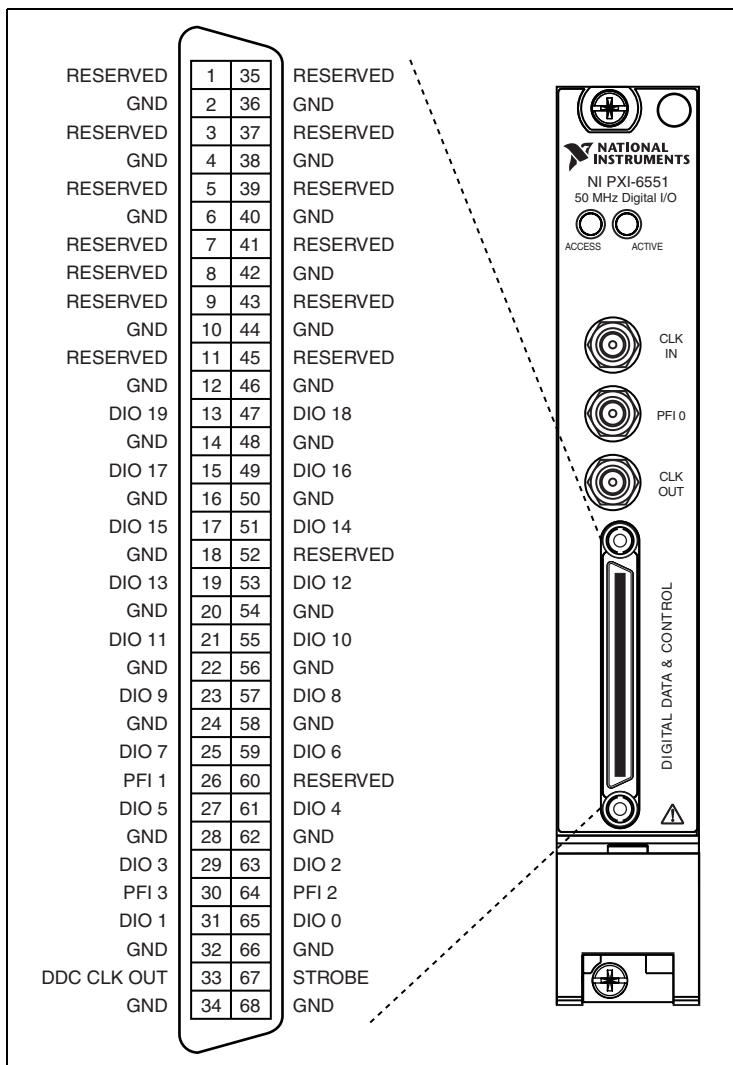


Figure 3. NI 655X Front Panel Connectors

Table 1. NI 655X SMB Connector

Connector	Signal Name	Signal Type	Description
CLK IN	Reference/ Clock Input	Control	External reference clock used for the PLL or external sample clock used for pattern generation and/or acquisition.
PFI 0	Programmable Function Interface (PFI) 0	Control	Input terminal to the NI 655X for external triggers or output terminal from the NI 655X for events.
CLK OUT	Reference/ Clock Output	Control	Terminal for the exported PLL reference clock or the exported sample clock.

Table 2. NI 655X DDC Connector Pins

Pins	Signal Name	Signal Type	Signal Description
33	DDC CLK OUT	Control	Terminal for the exported sample clock.
67	STROBE	Control	External sample clock source which can be used for pattern acquisition.
13, 15, 17, 19, 21, 23, 25, 27, 29, 31, 47, 49, 51, 53, 55, 57, 59, 61, 63, 65	DIO <0..19>	Data	Bidirectional digital I/O data channels 0 through 19.
26, 30, 64	PFI <1..3>	Control	Input terminals to the NI 655X for external triggers or output terminals from the NI 655X for events.
2, 4, 6, 10, 12, 14, 16, 18, 20, 22, 24, 28, 32, 34, 36, 38, 40, 42, 44, 46, 48, 50, 54, 56, 58, 62, 66	GND	Ground	Ground reference for signals.
1, 3, 5, 7, 8, 9, 11, 35, 37, 39, 41, 43, 45, 52, 60	RESERVED	N/A	These terminals are reserved for future use. Do not connect to these pins.

Connecting Cables and Accessories

To make connections to the NI 655X front panel SMB jacks, use a shielded 50 Ω coaxial cable with an SMB plug end.

Use an NI SHC68-C68-D2 cable for connections to the NI 655X DDC connector. The NI SHC68-C68-D2 is designed for single-ended, high-speed digital signal transmission. The cable is shielded, with individual microcoaxial 50 Ω lines for each signal.



Note Do not use cables other than the NI SHC68-C68-D2 cable with your NI 655X.

NI recommends using an NI CB-2162 to access the signals on the 68-pin DDC connector and terminate DATA<0..19>. The NI CB-2162 also provides a platform for circuit prototyping and DUT testing. The NI CB-2162 is specifically designed for use with NI digital instruments. For more information about using the NI CB-2162, refer to the *NI CB-2162 User Guide*.

Figure 4 shows how to connect the NI digital waveform generator/analyzer and the NI CB-2162 using the NI SHC68-C68-D2 cable assembly.

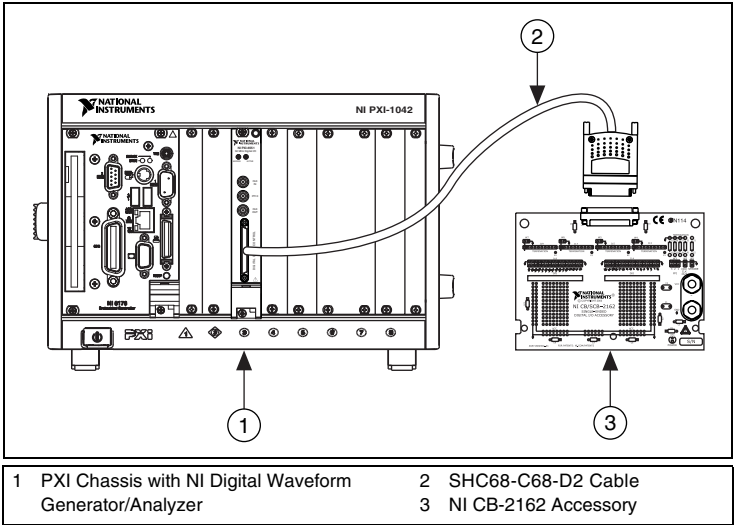


Figure 4. Connecting the NI CB-2162 Accessory

Whether you use NI cables and accessories or design your own, you should properly terminate cables to avoid improper measurements due to signal reflections, overshoot, and undershoot. Refer to the *NI Digital Waveform Generator/Analyzer Help* for more information about signal termination.

Wiring for Common Measurements

Dynamic generation and dynamic acquisition are two categories of applications that you can create for the NI 655X. This section provides information on the general wiring considerations for each type of application. Both examples use the NI CB-2162 for signal termination.

Dynamic Generation

When performing dynamic generation, the NI 655X generates data through a matched impedance system that consists of a 50 Ω output impedance, 50 Ω cable, and 50 Ω accessory. Depending on the loading of the peripheral device, you might need additional parallel termination resistance at the destination for optimal signal quality. Refer to the *NI Digital Waveform Generator/Analyzer Help* for more information about signal termination.

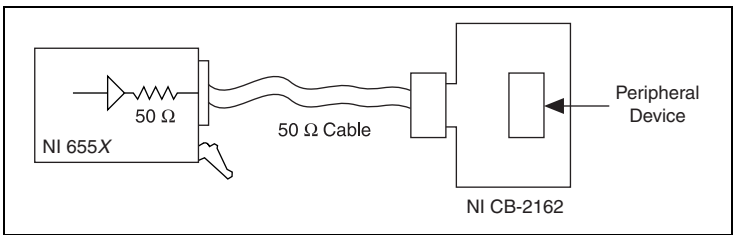


Figure 5. Dynamic Generation Functional Diagram

Dynamic Acquisition

When performing dynamic acquisition, the source generating the signals needs a matched source impedance as close to 50 Ω as possible. This matching minimizes signal reflections and maintains optimal signal quality. Use NI-HSDIO to set the input impedance of the NI 655X to 10 k Ω or 50 Ω , depending on your application. Refer to the *NI Digital Waveform Generator/Analyzer Help* for more information about signal termination.

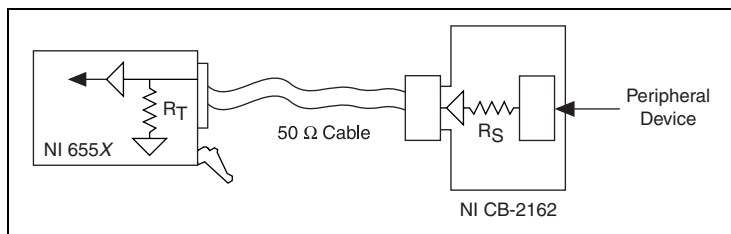


Figure 6. Dynamic Acquisition Functional Diagram

Step 8. Program the Module Using NI-HSDIO

The NI-HSDIO API includes a set of operations and attributes that use all the functionality of the device, including configuration, control, and other module-specific functions.

Information about programming with NI-HSDIO is available in the *NI Digital Waveform Generator/Analyzer Help*. This online document contains hardware information, concepts, a detailed function/VI reference for NI-HSDIO, and information specific to your module.

For the location of example programs you can use as a basis for your first NI-HSDIO program, refer to **Programming»Getting Started with NI-HSDIO** in the *NI Digital Waveform Generator/Analyzer Help*.

Safety and Compliance Information

FCC/Canada Radio Frequency Interference Compliance

Determining FCC Class

The Federal Communications Commission (FCC) has rules to protect wireless communications from interference. The FCC places digital electronics into two classes. These classes are known as Class A (for use in industrial-commercial locations only) or Class B (for use in residential or commercial locations). All National Instruments (NI) products are FCC Class A products.

Depending on where it is operated, this Class A product could be subject to restrictions in the FCC rules. (In Canada, the Department of Communications (DOC), of Industry Canada, regulates wireless interference in much the same way.) Digital electronics emit weak signals during normal operation that can affect radio, television, or other wireless products.

All Class A products display a simple warning statement of one paragraph in length regarding interference and undesired operation. The FCC rules have restrictions regarding the locations where FCC Class A products can be operated.

Consult the FCC Web site at www.fcc.gov for more information.

FCC/DOC Warnings

This equipment generates and uses radio frequency energy and, if not installed and used in strict accordance with the instructions in this manual and the CE marking Declaration of Conformity¹, may cause interference to radio and television reception. Classification requirements are the same for the Federal Communications Commission (FCC) and the Canadian Department of Communications (DOC).

Changes or modifications not expressly approved by NI could void the user's authority to operate the equipment under the FCC Rules.

Class A

Federal Communications Commission

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user is required to correct the interference at their own expense.

Canadian Department of Communications

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la classe A respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Compliance to EU Directives

Readers in the European Union (EU) must refer to the manufacturer's Declaration of Conformity (DoC) for information² pertaining to the

¹ The CE marking Declaration of Conformity contains important supplementary information and instructions for the user or installer.

² The CE marking Declaration of Conformity contains important supplementary information and instructions for the user or installer.

CE marking compliance scheme. The manufacturer includes a DoC for most hardware products except for those bought from OEMs. In addition, DoCs are usually not provided if compliance is not required, for example electrically benign apparatus or cables.

To obtain the DoC for this product, click **Declarations of Conformity Information** at ni.com/hardref.nsf/. This Web site lists the DoCs by product family. Select the appropriate product family, followed by your product, and a link to the DoC appears in Adobe Acrobat format. Click the Acrobat icon to download or read the DoC.

Safety Information

The following section contains important safety information that you *must* follow when installing and using the product.

Do *not* operate the product in a manner not specified in this document. Misuse of the product can result in a hazard. You can compromise the safety protection built into the product if the product is damaged in any way. If the product is damaged, return it to National Instruments for repair.

Do *not* substitute parts or modify the product except as described in this document. Use the product only with the chassis, modules, accessories, and cables specified in the installation instructions. You *must* have all covers and filler panels installed during operation of the product.

Do *not* operate the product in an explosive atmosphere or where there may be flammable gases or fumes. If you must operate the product in such an environment, it must be in a suitably rated enclosure.

If you need to clean the product, use a soft, nonmetallic brush. Make sure that the product is completely dry and free from contaminants before returning it to service.

Operate the product only at or below Pollution Degree 2. Pollution is foreign matter in a solid, liquid, or gaseous state that can reduce dielectric strength or surface resistivity. The following is a description of pollution degrees:

- Pollution Degree 1 means no pollution or only dry, nonconductive pollution occurs. The pollution has no influence.
- Pollution Degree 2 means that only nonconductive pollution occurs in most cases. Occasionally, however, a temporary conductivity caused by condensation must be expected.
- Pollution Degree 3 means that conductive pollution occurs, or dry, nonconductive pollution occurs that becomes conductive due to condensation.

You *must* insulate signal connections for the maximum voltage for which the product is rated. Do *not* exceed the maximum ratings for the product. Do not install wiring while the product is live with electrical signals. Do not remove or add connector blocks when power is connected to the system. Avoid contact between your body and the connector block signal when hot swapping modules. Remove power from signal lines before connecting them to or disconnecting them from the product.

Operate the product at or below the *installation category*¹ marked on the hardware label. Measurement circuits are subjected to *working voltages*² and transient stresses (overvoltage) from the circuit to which they are connected during measurement or test. Installation categories establish standard impulse withstand voltage levels that commonly occur in electrical distribution systems. The following is a description of installation categories:

- Installation Category I is for measurements performed on circuits not directly connected to the electrical distribution system referred to as MAINS³ voltage. This category is for measurements of voltages from specially protected secondary circuits. Such voltage measurements include signal levels, special equipment, limited-energy parts of equipment, circuits powered by regulated low-voltage sources, and electronics.
- Installation Category II is for measurements performed on circuits directly connected to the electrical distribution system. This category refers to local-level electrical distribution, such as that provided by a standard wall outlet (for example, 115 V for U.S. or 230 V for Europe). Examples of Installation Category II are measurements performed on household appliances, portable tools, and similar product.
- Installation Category III is for measurements performed in the building installation at the distribution level. This category refers to measurements on hard-wired equipment such as equipment in fixed installations, distribution boards, and circuit breakers. Other examples are wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed installation, and stationary motors with permanent connections to fixed installations.
- Installation Category IV is for measurements performed at the primary electrical supply installation (<1,000 V). Examples include electricity meters and measurements on primary overcurrent protection devices and on ripple control units.

¹ Installation categories, also referred to as *measurement categories*, are defined in electrical safety standard IEC 61010-1.

² Working voltage is the highest rms value of an AC or DC voltage that can occur across any particular insulation.

³ MAINS is defined as a hazardous live electrical supply system that powers equipment. Suitably rated measuring circuits may be connected to the MAINS for measuring purposes.

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