

NI 5660 RF Vector Signal Analyzer

Getting Started Guide

Worldwide Technical Support and Product Information

ni.com

National Instruments Corporate Headquarters

11500 North Mopac Expressway Austin, Texas 78759-3504 USA Tel: 512 683 0100

Worldwide Offices

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About This Manual

This guide explains how to install, configure, test, and begin using the NI 5660 RF Vector Signal Analyzer, introduces available programming methods and examples, and familiarizes you with useful documentation. Additional documents, such as the *NI-RFSA Help* (which includes the ni5660 LabVIEW VI reference information) and the *NI PXI-5660 Specifications* document, are accessible from **Start»Programs»National Instruments»NI-RFSA»Documentation**.

For free downloads of the most current versions of drivers, documentation, and example programs, refer to ni.com/instruments.

Conventions

The following conventions are used in this manual:

- » The » symbol leads you through nested menus 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.
- bold** Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names.
- italic* Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. This font also denotes text that is a placeholder for a word or value that you must supply.
- `monospace` Text in this font denotes text or characters that you enter from the keyboard. This font is also used for the proper names of paths, directories, programs, functions, operations, variables, and filenames.
- monospace italic* Italic text in this font denotes text that is a placeholder for a word or value that you must supply.

Key Terms

digitizer	A device that converts analog voltages into digital representations and stores the results in memory; refers to the NI 5620 IF digitizer hardware module.
downconverter	A device that frequency-translates RF signals to center around a specified IF frequency—refers to an NI 5600 3-slot RF downconverter hardware module.
IF	Intermediate Frequency—refers to the signal passed from the NI 5600 downconverter module front panel OUTPUT connector to the NI 5620 IF digitizer module front panel INPUT connector.
module	Refers to one of the hardware components of the RF Vector Signal Analyzer: the NI 5620 IF digitizer or the NI 5600 wideband RF downconverter.
ni5660	Refers to the set of LabVIEW virtual instruments (VIs) included with the RF Vector Signal Analyzer hardware. The ni5660 VIs operate both the NI 5620 IF digitizer module and the NI 5600 RF downconverter module as a single instrument for data acquisition.
PLL	Phase-Locked Loop—an electronic circuit that controls an oscillator so that the circuit maintains a constant phase angle relative to a reference signal.
RF	Radio Frequency—refers to the signal input to the INPUT connector on the NI 5600 RF downconverter module front panel.
RF Vector Signal Analyzer	Refers to the NI PXI-5660 RF Vector Signal Analyzer device consisting of the NI 5620 IF digitizer module, the NI 5600 RF downconverter module, and software included on the <i>NI-RFSA</i> CD. There is no single physical device labeled “NI PXI-5660 RF Vector Signal Analyzer.”

Getting Started with the NI 5660 RF Vector Signal Analyzer

Overview

The NI PXI-5660 is a modular RF Vector Signal Analyzer consisting of two individual PXI hardware modules:

- NI PXI-5620—14 bit, 64 megasample-per-second (MS/s) IF digitizer module
- NI PXI-5600—wideband RF downconverter module with input frequencies between 9 kHz and 2.7 GHz

The hardware modules interconnect using the included SMA-SMA coaxial cables as illustrated in the [Interconnecting the Hardware Modules](#) section.



Note There is no single physical device labeled “NI PXI-5660.” The NI 5660 RF Vector Signal Analyzer is the instrument comprised of the two hardware modules (NI 5600 and NI 5620) and the software included in the kit.

The RF Vector Signal Analyzer has the following characteristics and features:

- 9 kHz to 2.7 GHz frequency range
- 20 MHz real-time bandwidth
- 10 MHz oven-controlled crystal oscillator (OCXO) timebase
 - ± 20 ppb frequency stability
 - ± 50 ppb frequency accuracy
- >80 dB spurious-free dynamic range
- +30 dBm full signal input range
- Up to 64 MS of onboard waveform memory
- Software for performing frequency-domain and IQ measurements
- Four slots wide PXI/3U Compact PCI form factor

The RF Vector Signal Analyzer follows industry-standard Plug and Play specifications for the PXI bus and seamlessly integrates with compliant systems.

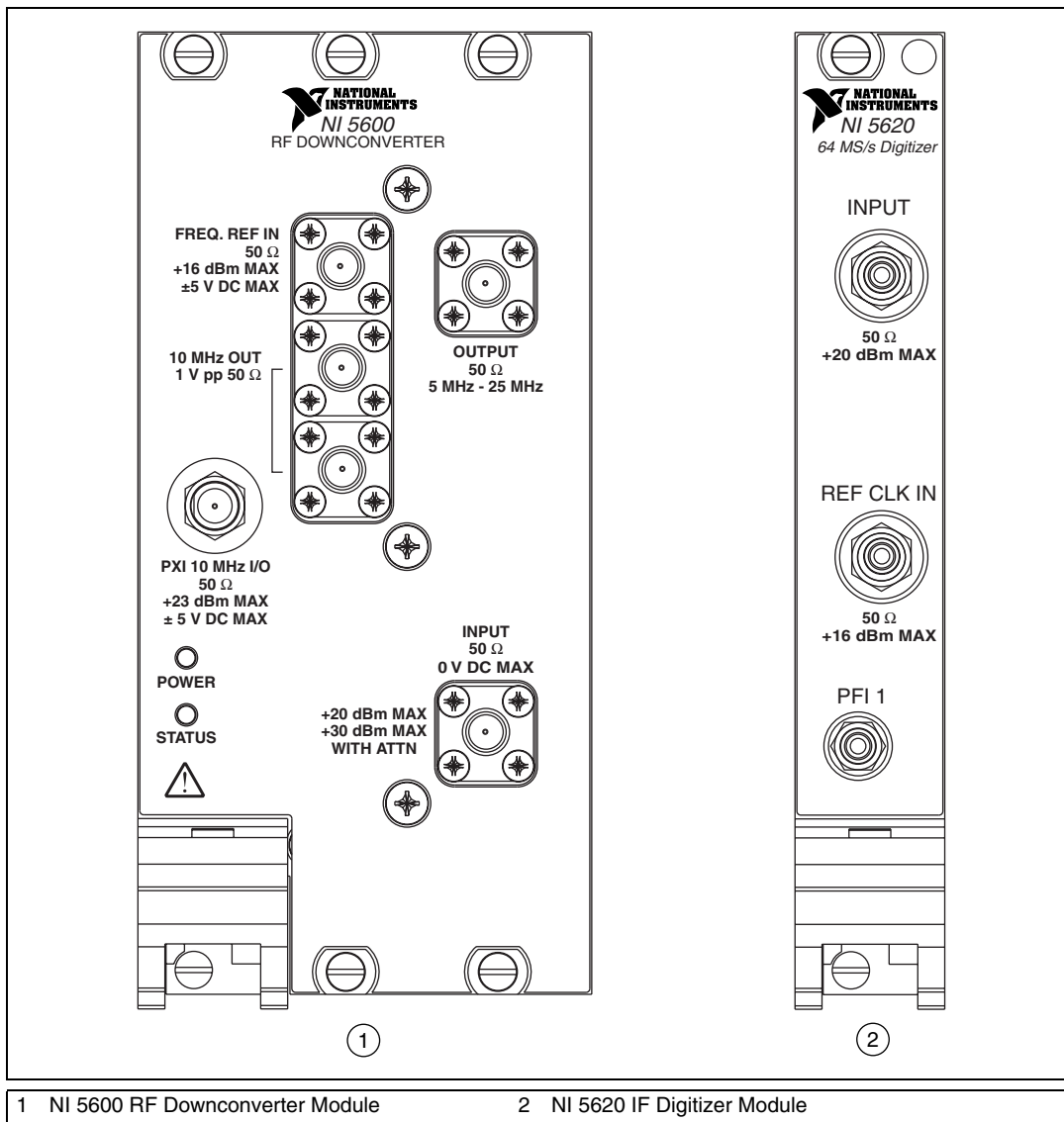


Figure 1-1. RF Vector Signal Analyzer Hardware Modules

NI 5600 RF Downconverter Module

The NI 5600, shown in Figure 1-1, is a wideband RF downconverter module with input frequencies from 9 kHz to 2.7 GHz and real-time bandwidth of 20 MHz. It includes a highly accurate onboard oven-controlled crystal oscillator (OCXO) frequency reference that can be software-configured to drive the PXI 10 MHz backplane clock when the NI 5600 is installed in PXI Slot 2.

NI 5620 IF Digitizer Module

The NI 5620, shown in Figure 1-1, is a single-channel 14-bit 64 MS/s IF digitizer module.



Tip The NI 5600 downconverter module (three slots wide) is installed in the leftmost of its three occupied PXI slots. Installing the NI 5600 module in PXI Slot 2, for instance, occupies PXI Slots 2, 3, and 4. Slot numbers are printed on the PXI chassis.

Verifying System Requirements

Minimal System

Before installing the RF Vector Signal Analyzer hardware and software, verify that your PXI system meets the following requirements:

- Pentium III or comparable processor
- Windows 2000/XP/NT 4.0 Service Pack 6 or later
- 1 GB of free hard drive space
- 256 MB of RAM

Recommended System

For optimal performance with large waveforms, NI recommends that your PXI system meet the following requirements:

- Pentium IV or comparable processor
- Windows 2000/XP/NT 4.0 Service Pack 6 or later
- 2 GB of free hard drive space
- 512 MB of RAM

Application Development Software

If you are developing applications for the RF Vector Signal Analyzer, you must install one of the following application development environments:

- NI LabVIEW version 7.0 or later, Full Development System or Professional Development System
- LabWindows™/CVI™ version 7.0 or later
- Any C compiler capable of calling a 32-bit DLL

Unpacking

Both hardware modules of the RF Vector Signal Analyzer ship in antistatic packages to prevent damage from electrostatic discharge (ESD). Because ESD can damage several components of both RF Vector Signal Analyzer hardware modules, store both modules in the antistatic envelopes when not in use.



Caution *Never* touch exposed connector pins.

To avoid damage in handling the RF Vector Signal Analyzer hardware modules, take the following precautions:

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

Remove each hardware module from the package and inspect it for loose components or any signs of damage. Notify NI if either hardware module appears damaged in any way. Do *not* install a damaged module into your system.

Verifying Kit Contents

You need the following items to set up and use the RF Vector Signal Analyzer. Listboxes represent physical kit items, as shown in Figure 1-2.



Note Refer to the [Programming the RF Vector Signal Analyzer in LabVIEW](#) section for details about included software.

- *NI-RFSA* software CD—installs the following software components:
 - ni5660 VIs, which configure and operate both RF Vector Signal Analyzer hardware modules for common signal acquisition and measurement tasks; includes LabVIEW examples for use as instructional programming models or building blocks in your own applications
 - The RF Signal Analyzer Demo Panel application, a convenient interactive interface that operates the RF Vector Signal Analyzer hardware to perform most frequency-domain and IQ measurements
 - NI-TUNER instrument driver VIs and CVI functions, which control the NI 5600 RF downconverter module; includes examples for LabVIEW and CVI
 - NI-SCOPE instrument driver VIs and CVI functions, which control the NI 5620 IF digitizer module; includes examples for LabVIEW and CVI
 - Instrument driver software online documentation
- *NI Spectral Measurement Toolkit* CD—installs the following Spectral Measurements Toolkit (SMT) software components:
 - SMT VIs and CVI functions
 - SMT examples for LabVIEW and CVI
 - SMT online documentation



Note The Spectral Measurements Toolkit is used to perform measurements and analysis of modulated signals acquired with the RF Signal Analyzer. For full functionality, you *must* install the Spectral Measurements Toolkit CD packaged with the RF Vector Signal Analyzer. Refer to the [Introduction to the Spectral Measurements Toolkit](#) section for more information.

- Two hardware modules:
 - NI 5620 IF digitizer module
 - NI 5600 RF downconverter module
- One short, semi-rigid SMA-to-SMA coaxial cable
- One long, semi-rigid SMA-to-SMA coaxial cable
- One semi-flexible SMA-to-SMA coaxial cable
- 1/8 in. combination Phillips/flathead screwdriver
- Plastic collars (cable wrenches) for gripping the coaxial cable hex connectors
- The following printed documentation:
 - *NI 5660 RF Vector Signal Analyzer Getting Started Guide* (this document)
 - *NI PXI-5660 Specifications* document

In addition to the kit contents, you need the following items to set up the RF Vector Signal Analyzer:

- A PXI chassis with at least four empty slots. NI recommends an NI PXI-1042 or NI PXI-1045 chassis.
- A PXI embedded or MXI-3 controller system that meets the system requirements specified in this guide
- A 100 N-cm standard SMA torque wrench (recommended)

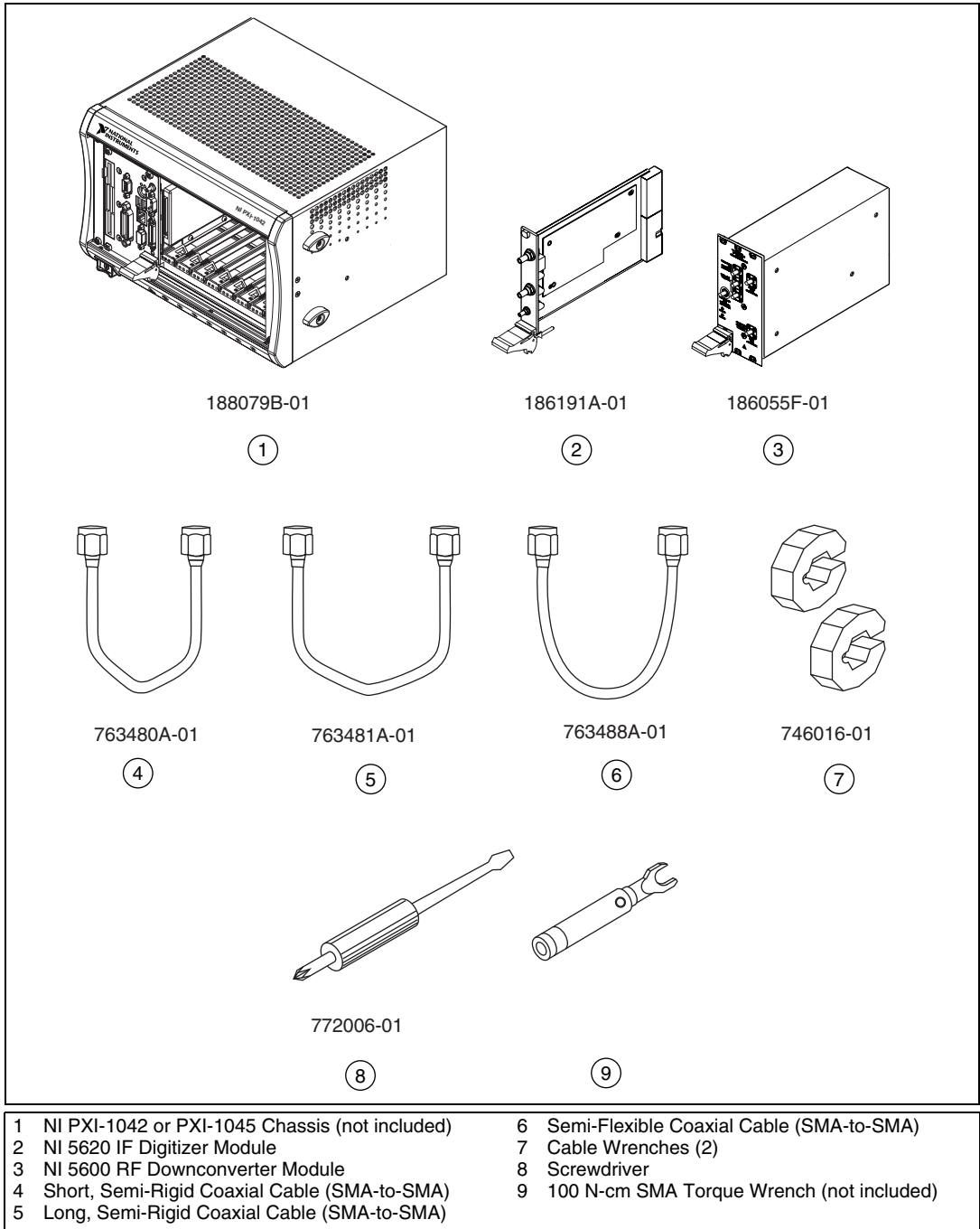


Figure 1-2. Required Parts Inventory and Replacement Part Numbers

Installing the Software

Complete the following steps to install the contents of the *NI-RFSA* software CD. You *must* install all of the included software before installing any RF Vector Signal Analyzer hardware.

1. Install a development environment such as NI LabVIEW and/or LabWindows/CVI according to its instructions. Any development environment you intend to use must be installed before you install the *NI-RFSA* and *Spectral Measurements Toolkit* CDs.
2. Install the contents of the *NI-RFSA* CD by navigating to your CD drive and clicking `setup.exe`.



Note You *must* install the *NI-RFSA* CD before installing the *Spectral Measurements Toolkit* CD.

3. When installation completes, remove the *NI-RFSA* CD.
4. Insert the *Spectral Measurements Toolkit* CD.
5. Click **OK**.



Note You *must* install the *Spectral Measurements Toolkit* CD packaged with your RF Vector Signal Analyzer in order to enable proper operation.

6. Install any additional software that you intend to use with the RF Vector Signal Analyzer *after* installing the *NI-RFSA* CD and the *Spectral Measurements Toolkit* CD.

If toolkits or other software that you intend to use with the RF Vector Signal Analyzer was installed before you installed the *NI-RFSA* software CD, repeat or repair those installations after installing the *NI-RFSA* and *Spectral Measurements Toolkit* software CDs.

Installing the Hardware

PXI Slot Location Considerations

Installation of both RF Vector Signal Analyzer hardware modules requires four vacant PXI slots—three slots for the NI 5600 downconverter module and one slot for the NI 5620 IF digitizer module. The NI 5620 IF digitizer module must be installed in the adjacent slot immediately to the right of the NI 5600 downconverter module in order to use the included coaxial cables.



Note The published *RF Vector Signal Analyzer Specifications* assume use of the included cables. Substituting different cables may affect performance.

The NI 5600 downconverter module onboard frequency reference can drive the PXI backplane clock *only* if the downconverter module is installed in PXI Slot 2. When the NI 5600 is installed in PXI Slot 2, you can configure it to lock the PXI backplane to the highly accurate and stable NI 5600 onboard OCXO, or to an external frequency reference clock signal connected to the FREQ REF IN connector on the NI 5600 module front panel.



Tip The NI 5600 downconverter module (three slots wide) is installed in the leftmost of its three occupied PXI slots. Thus, installing the NI 5600 module in PXI Slot 2 occupies PXI Slots 2, 3 and 4. Slot numbers are printed on the PXI chassis.

NI 5600 RF Downconverter Module Installation

Install the NI 5600 RF downconverter module by completing the following steps:

1. Power off your PXI chassis.
2. Remove the rubber screw covers from the six captive screws in the module front panel.



Note The NI 5600 *must* be installed in PXI Slot 2 to optionally drive the PXI backplane with the NI 5600 onboard OCXO reference clock or an external reference clock signal.

3. Insert the NI 5600 downconverter module as shown in Figure 1-3. This module requires three vacant PXI slots.
 - a. Slide the NI 5600 into an available PXI slot until the ejector handle locks in the upward position.
 - b. Tighten the six screws in the module front panel.

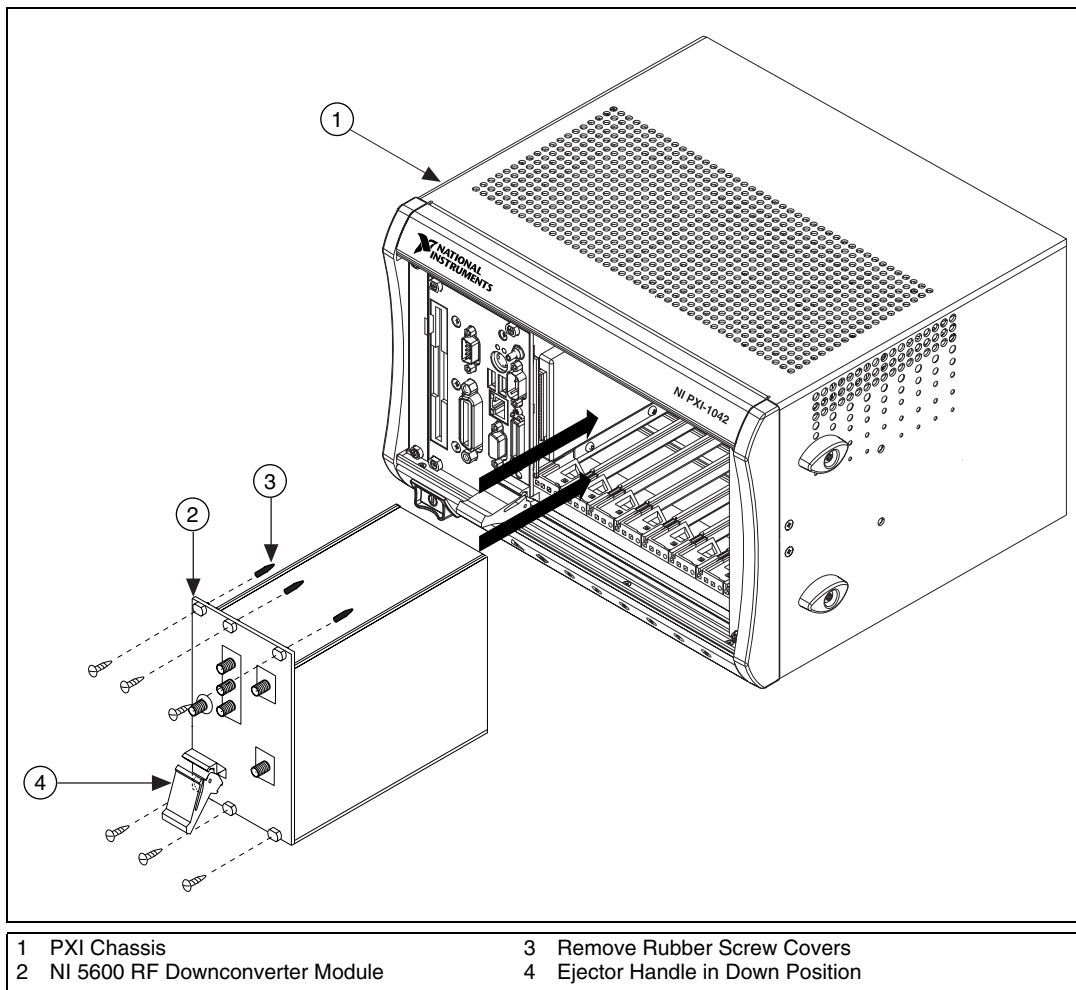
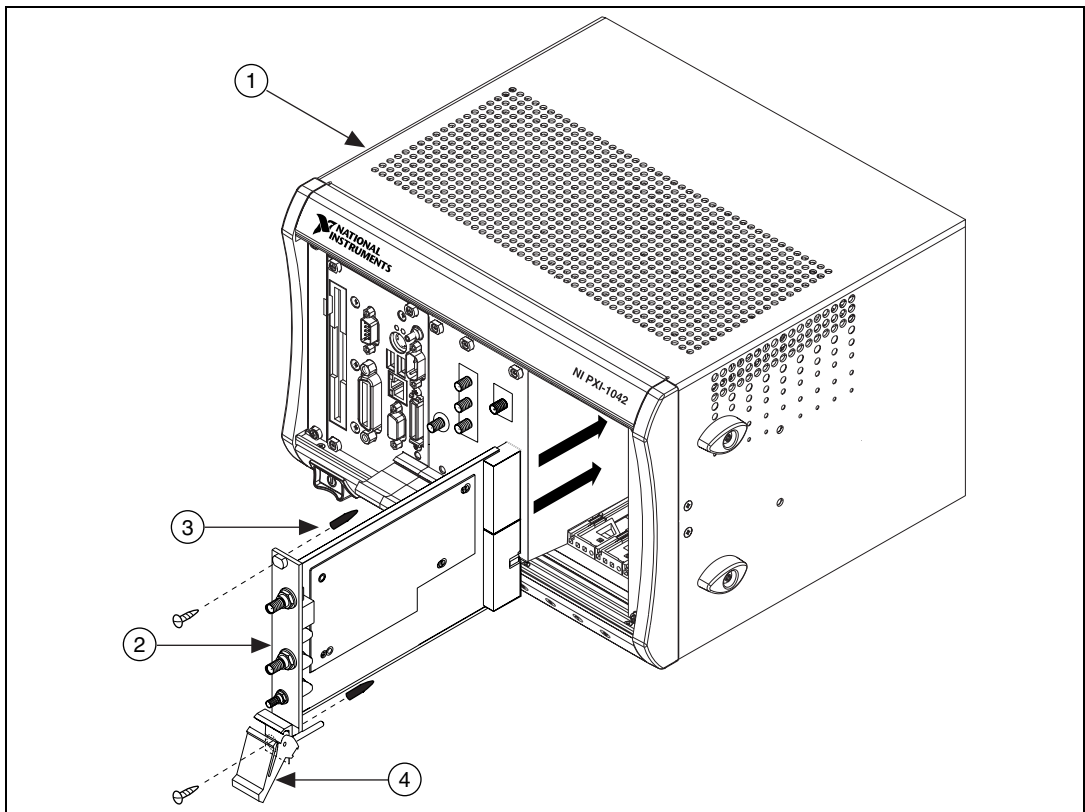


Figure 1-3. Install the NI 5600 RF Downconverter Module

INI 5620 IF Digitizer Module Installation

Install the NI 5620 IF digitizer module in the adjacent PXI slot immediately to the right of the NI 5600 downconverter module by completing the following steps:

1. Ensure that the PXI chassis is powered off.
2. Remove the rubber screw covers from the two captive screws in the module front panel.
3. Insert the NI 5620 IF digitizer module as shown in Figure 1-4.
 - a. Slide the NI 5620 into the slot immediately to the right of the NI 5600 downconverter module. Press firmly until the ejector handle locks in the upright position.
 - b. Tighten both screws in the NI 5620 front panel.



1 PXI Chassis
2 NI 5620 IF Digitizer Module

3 Remove Rubber Screw Covers
4 Ejector Handle in Down Position

Figure 1-4. Install the NI 5620 IF Digitizer Module

4. Continue with the procedure in the [Interconnecting the Hardware Modules](#) section after you have read and understood the [Cooling](#) section.

Cooling



Caution Inadequate air circulation could cause the temperature inside the chassis to rise above the optimal operating temperature for the RF Vector Signal Analyzer hardware modules, potentially causing thermal shutdown, shorter lifespans, or improper performance.

Use the following guidelines to help maintain optimal forced-air cooling within the PXI chassis:

- Install all chassis covers and filler panels after installing the RF Vector Signal Analyzer hardware modules, as shown in Figure 1-5. Missing filler panels disrupt necessary air circulation in the chassis.

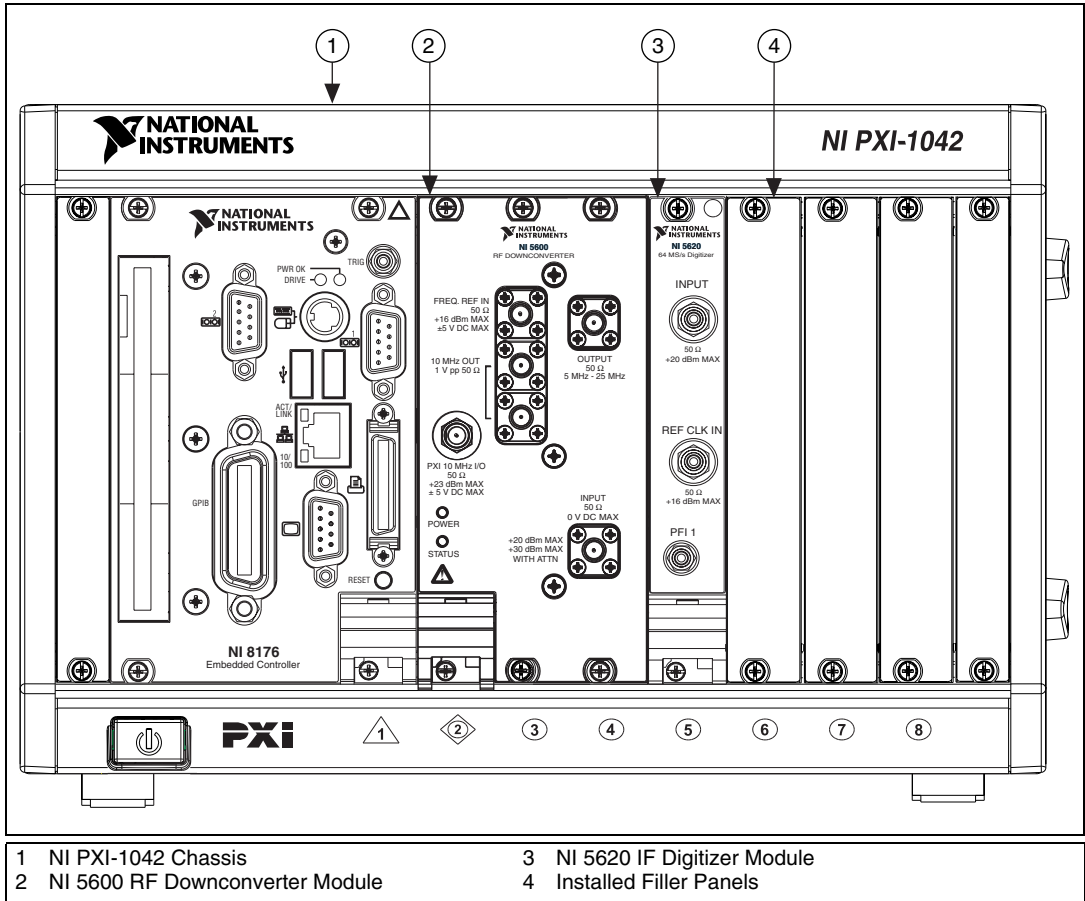


Figure 1-5. Recommended Installation Includes all PXI Filler Panels

- Allow plenty of space around the vents at the rear of the chassis. Blockage by walls or obstructions affects the air flow needed for cooling.
- Set all chassis fans to the highest possible setting. Do *not* set the fan speed to LOW or turn the fan off.
- Clean the fan filters on a regular basis to avoid fan and air circulation path blockage. Refer to your chassis documentation for cleaning procedures and other recommended maintenance.

- (Optional) NI recommends installing slot blockers in adjacent vacant PXI slots to maximize cooling air flow to the RF Vector Signal Analyzer hardware modules. The PXI Chassis Slot Blocker Kit, part number 778678-01, is shown in Figure 1-6.

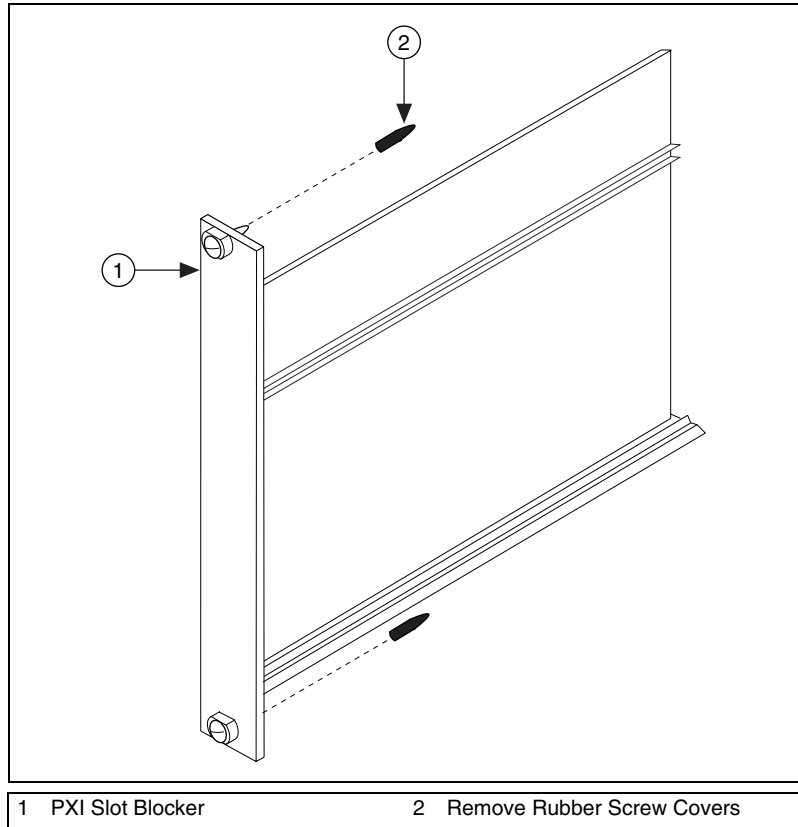


Figure 1-6. Optional Slot Blockers Enhance Cooling

Interconnecting the Hardware Modules

The RF Vector Signal Analyzer hardware modules interconnect through the device front panels using the included coaxial cables. Complete the following steps to interconnect the RF Vector Signal Analyzer hardware module front panel connectors as shown in Figure 1-7.

1. Using the short semi-rigid coaxial cable, connect the OUTPUT connector on the NI 5600 downconverter front panel to the INPUT connector on the NI 5620 IF digitizer front panel.
2. Using the long semi-rigid coaxial cable, connect the lower of the two 10 MHz OUT connectors on the NI 5600 downconverter front panel to the REF CLK IN connector on the NI 5620 IF digitizer front panel.
3. Using the semi-flexible coaxial cable, connect the bidirectional PXI 10 MHz I/O connector on the NI 5600 front panel to the other 10 MHz OUT connector on the NI 5600 front panel.



Note Refer to Appendix A, *Hardware Front Panel Connectors and Indicators*, for more information on RF Vector Signal Analyzer hardware front panel connectors.

4. Carefully tighten all SMA connectors to 100 N-cm using an SMA torque wrench (not included) as shown in Figure 1-7. Tighten only until the wrench clicks.



Note The semi-rigid cables must be installed so the bends point upwards, as shown in Figure 1-7.

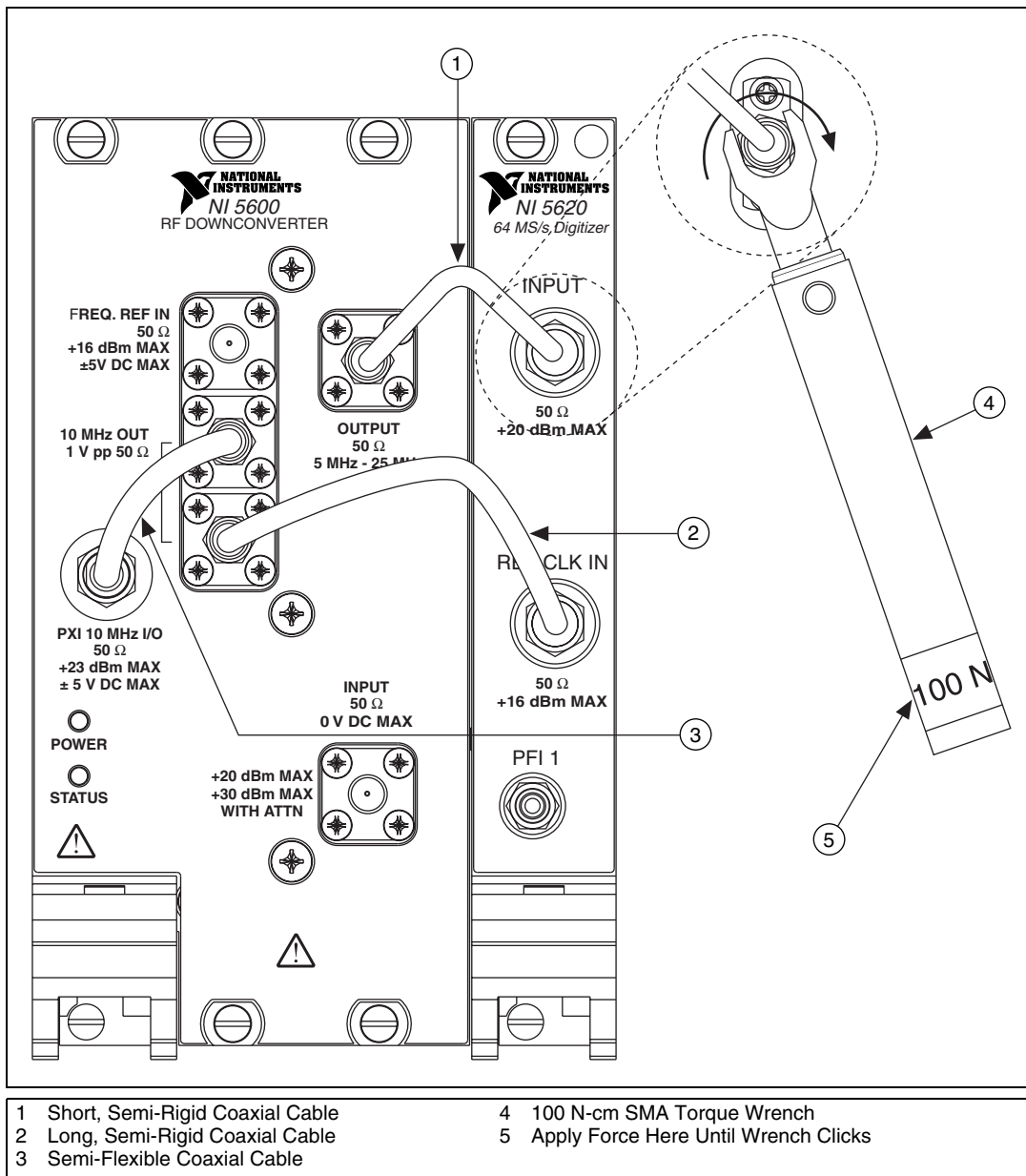


Figure 1-7. Installation of Included Cables

5. Power on your PXI chassis and controller system.
6. Verify that the POWER LED on the NI 5600 downconverter module is illuminated. If the LED is not illuminated, refer to Appendix B, *Troubleshooting*.



Caution Incorrect torque at SMA connections can degrade signal fidelity, PLL performance, and insertion loss. Use an SMA torque wrench to ensure all SMA connections are properly torqued to 100 N-cm.

Configuring the Hardware Modules in MAX

Measurement & Automation Explorer (MAX) is used to configure your National Instruments hardware. You must run MAX at least once after hardware installation to ensure that other programs are informed about which devices reside in the system and how they are configured. MAX is automatically installed by the *NI-RFSA* software CD.



Note MAX treats the NI 5600 RF downconverter module and the NI 5620 IF digitizer module as separate devices.

To use MAX to configure, self-test, and functionally test the RF Vector Signal Analyzer hardware modules, complete the following steps:



1. Launch MAX by navigating to **Start»Programs»National Instruments»Measurement & Automation** or by clicking the MAX desktop icon.
2. In the Configuration pane, double-click **Devices and Interfaces** to see the list of installed devices.

- Expand the **Traditional NI-DAQ Devices** folder. You will see a list of installed devices that includes the NI 5600 and NI 5620 modules, as shown in Figure 1-8 (your default device names may vary).

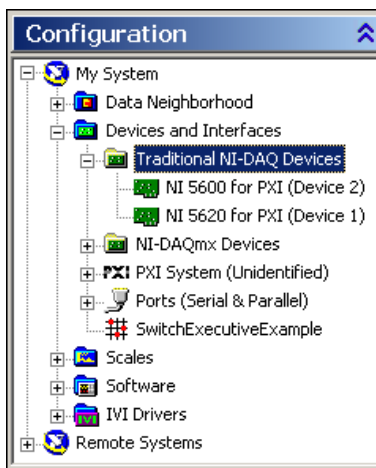


Figure 1-8. Both Modules Appear in MAX



Note If you do not see the NI 5600 and NI 5620 modules listed, refer to Appendix B, [Troubleshooting](#).

Note Device Numbers

Note the device numbers assigned to your RF Vector Signal Analyzer hardware modules by MAX (refer to Figure 1-8). These numbers are used to program the RF Vector Signal Analyzer.



Note When programming the RF Vector Signal Analyzer, specify the NI 5620 IF digitizer module using the DAQ Resource Name with the following syntax: `DAQ: : DeviceNumber`. The DAQ Resource Name for the NI 5620 in Figure 1-8 is `DAQ: : 1`.

Specify the NI 5600 downconverter module using the MAX device number without modifiers.

Self-Test Both Modules

The MAX self-test performs a basic verification of hardware resources. Complete steps 4 through 10 to self-test both modules.

- Right-click the NI 5600 and select **Properties**, as shown in Figure 1-9.

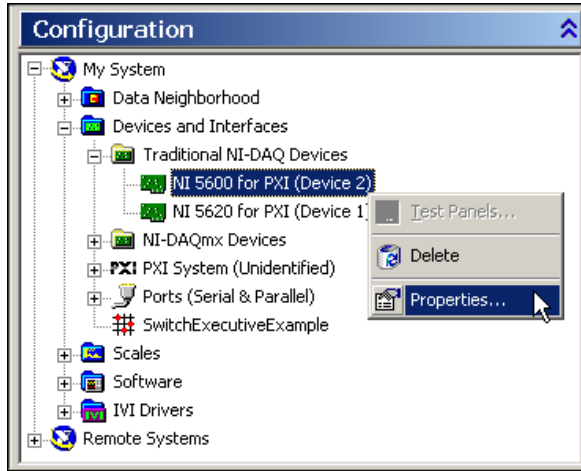


Figure 1-9. Select Properties from the NI 5600 Right-Click Menu

- The Configuring Device dialog appears as shown in Figure 1-10. Click **Test Resources** to self-test the NI 5600 RF downconverter hardware module.

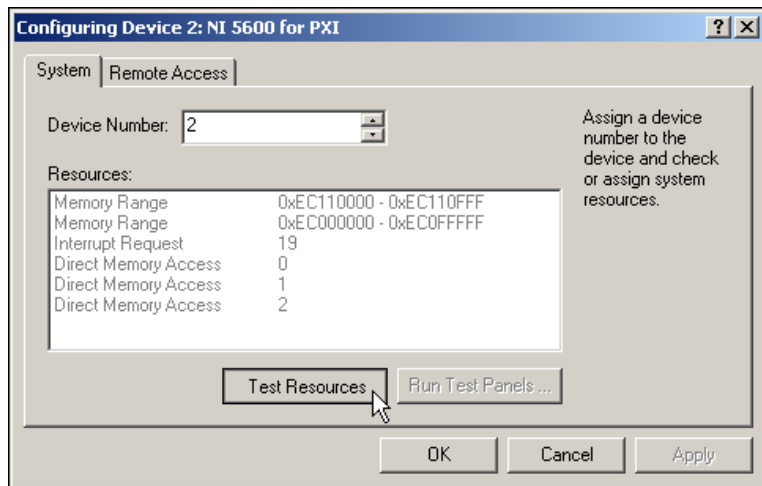


Figure 1-10. Select Test Resources in the NI 5600 Configuring Device Window

6. The NI-DAQ Configuration Utility dialog appears as shown in Figure 1-11. Click **OK** to return to the Configuring Device window.

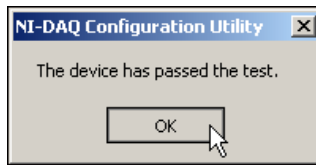


Figure 1-11. Self-Test Result for the NI 5600 RF Downconverter Module



Note If the NI 5600 downconverter module fails the self-test, refer to Appendix B, [Troubleshooting](#).

7. In the NI 5600 Configuring Devices window, shown in Figure 1-12, click **OK** to return to MAX.

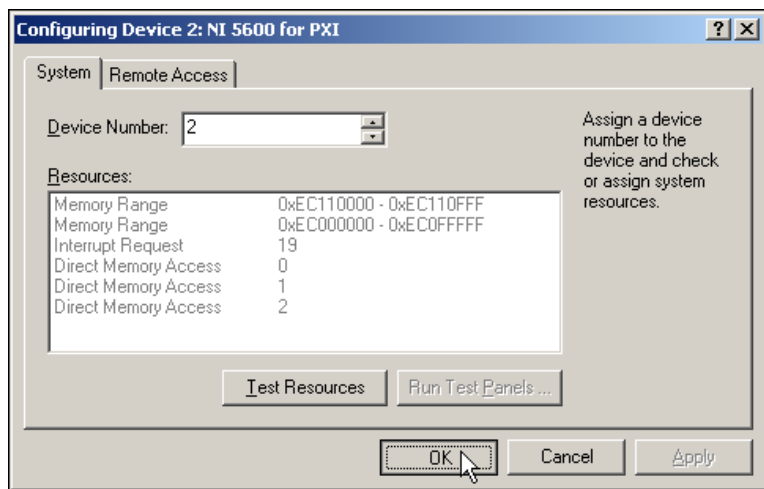


Figure 1-12. Click OK to Return to MAX

8. Right-click **NI 5620** and select **Properties**, as shown in Figure 1-13.

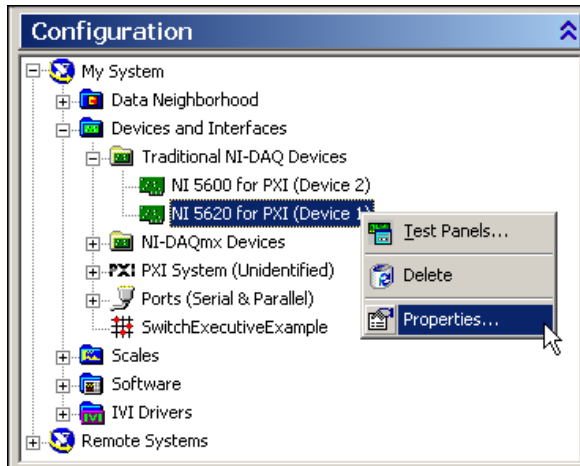


Figure 1-13. Select Properties from the NI 5620 Right-Click Menu

9. The Configuring Device dialog appears as shown in Figure 1-14. Click **Test Resources** to self-test the NI 5620 IF digitizer hardware module.

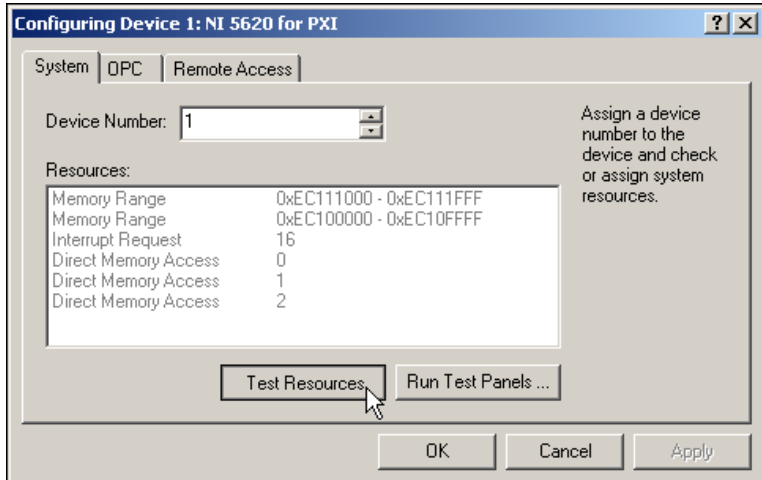


Figure 1-14. Select Test Resources in the NI 5620 Configuring Device Window

10. The NI-DAQ Configuration Utility dialog appears as shown in Figure 1-15. Click **OK** to return to the Configuring Device window and continue with the NI 5620 test panel.

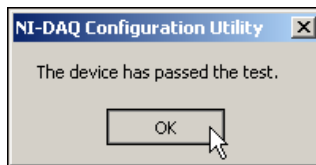


Figure 1-15. Self-Test Result for the NI 5620 IF Digitizer Module



Note If the NI 5620 IF digitizer module fails the self-test, refer to Appendix B, [Troubleshooting](#).

11. Continue to the *Acquiring Data Interactively* section.

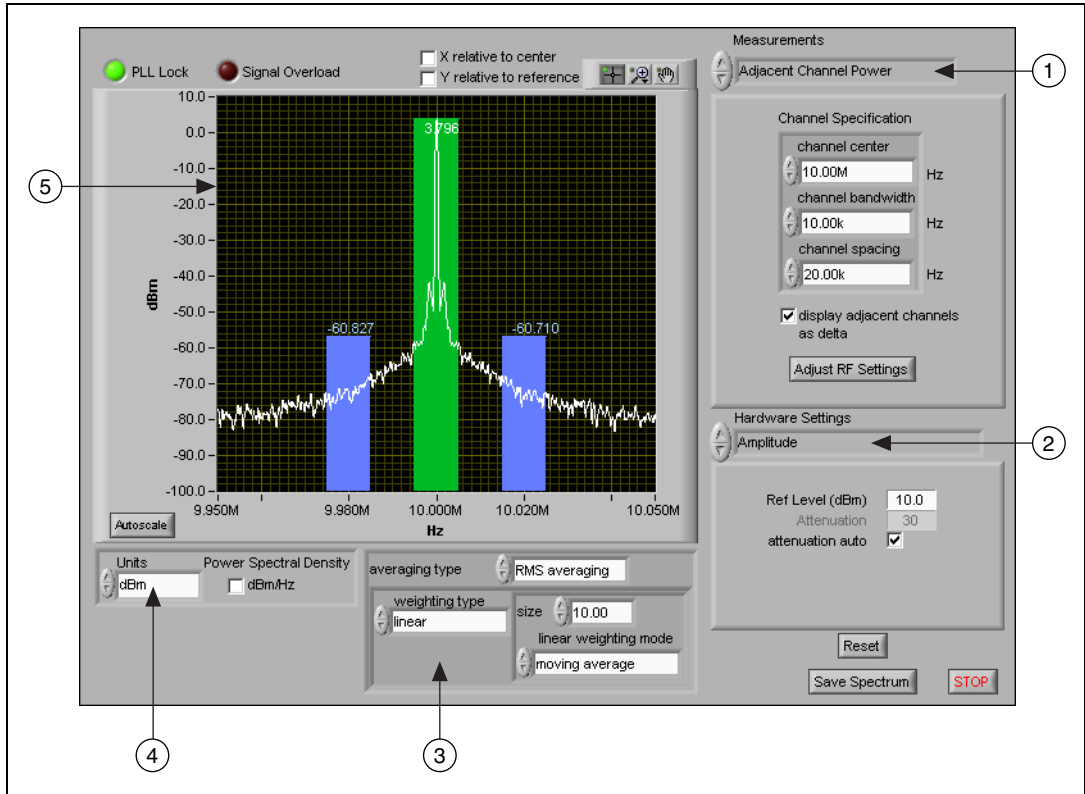
You have completed setup, configuration, and testing of the RF Vector Signal Analyzer.

Acquiring Data Interactively

To interactively acquire data and perform measurements with the RF Vector Signal Analyzer, use the included RF Signal Analyzer Demo Panel application. The RF Signal Analyzer Demo Panel is accessible from within MAX at **Tools»Soft Front Panels»NIRFSA - RFSA Demo Panel**, and from the Start menu at **Start»Programs»National Instruments»NI-RFSA»RFSA Demo Panel**.



Tip If an external signal source is not available, the signal output from the 10 MHz OUT connector on the NI 5600 RF downconverter module front panel can be used as a source to verify proper RF Vector Signal Analyzer installation, and as a live signal for exploring the RF Signal Analyzer Demo Panel. To use this signal, connect the 10 MHz OUT connector to the INPUT connector on the NI 5600 RF downconverter module front panel.



- | | |
|------------------------------|------------------|
| 1 Measurements Controls | 4 Units Controls |
| 2 Hardware Settings Controls | 5 Waveform Graph |
| 3 Averaging Controls | |

Figure 1-16. RF Signal Analyzer Demo Panel Performing ACP Measurement

The RFSA Demo Panel (shown in Figure 1-16) provides a convenient software interface with which you can operate the RF Vector Signal Analyzer hardware to perform common frequency-domain and IQ measurements.



Tip Press <Ctrl-H> to view context-sensitive help for all RF Signal Analyzer Demo Panel controls and indicators.

To use the RF Signal Analyzer Demo Panel, configure the following controls:

1. The RFSADeviceNumbers dialog appears as shown in Figure 1-17. Verify that the device numbers reflect those assigned to the RF Vector Signal Analyzer hardware modules in MAX, and click **OK**.



Figure 1-17. The RFSADeviceNumbers Dialog

2. The **Hardware Settings** controls specify hardware parameters for your measurement, including the following:
 - RF Spectrum Settings
 - Amplitude
 - Timing
 - Advanced Spectral Parameters
 - Devices
3. The **Measurements** controls specify the measurement you want to perform. Choose one of the following options:
 - Peak Search
 - Delta Peak
 - Power in Band
 - Adjacent Channel Power (ACP)
 - Occupied Bandwidth
 - IQ Data

4. The **Averaging Type** controls specify averaging applied to returned data. Figure 1-18 illustrates the hierarchy of options for spectrum averaging.

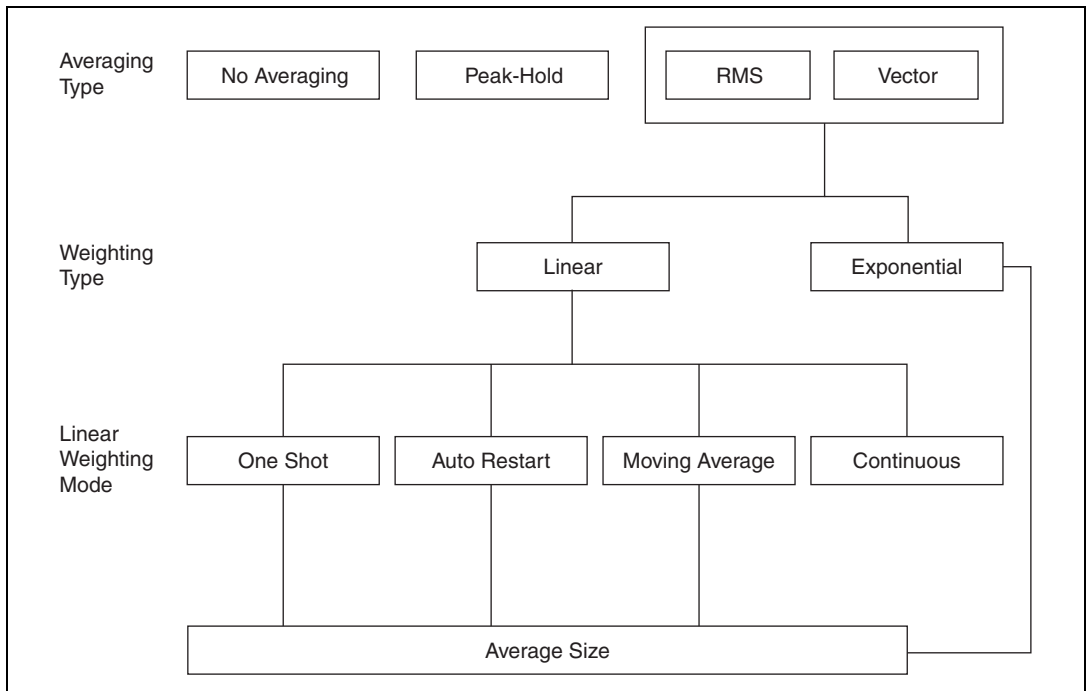


Figure 1-18. RFS Demo Panel Spectrum Averaging Options

5. The **Units** controls specify units in which to return measurement results. Several commonly used units are available.

Refer to the [Configuring the Hardware Modules in MAX](#) section for more information about device numbers.

Configuring Hardware Programmatically

Two paradigms are available to programmatically configure the RF Vector Signal Analyzer hardware for data acquisition, as shown in Table 1-1.

Table 1-1. Programmatic Configuration Paradigms for RF Vector Signal Analyzer Hardware

Programming Paradigm	Benefits	ADE Support
ni5660 VIs	<ul style="list-style-type: none"> • Ease of use from a higher-level application programming interface: both RF Vector Signal Analyzer hardware modules controlled as a single instrument • Addresses common frequency-domain and IQ measurement applications 	LabVIEW 7.0 or later
Spectral Measurements Toolkit; NI-SCOPE and NI-TUNER drivers	<ul style="list-style-type: none"> • Maximum flexibility for unique applications from a lower-level application programming interface • Provides full access to functionality provided by the drivers for the downconverter and digitizer modules 	LabVIEW 7.0 or later, LabWindows/CVI 7.0 or later, C compilers capable of calling a 32-bit DLL

The ni5660 VIs configure both RF Vector Signal Analyzer hardware modules as a single instrument for typical frequency-domain and IQ acquisitions through an easy-to-use API. Refer to the *Programming the RF Vector Signal Analyzer in LabVIEW* section for details.

You also can programmatically configure the RF Vector Signal Analyzer hardware using the Spectral Measurements Toolkit and calls to the NI-SCOPE and NI-TUNER drivers. These software components are automatically installed by the *NI-RFSA* software CD. This lower level programming option lends maximum flexibility for unique measurements. Refer to the *Programming the RF Vector Signal Analyzer in LabWindows/CVI and C* section for details.



Note The Spectral Measurements Toolkit is used to perform measurements on the acquired data regardless of configuration paradigm. Refer to the *Introduction to the Spectral Measurements Toolkit* section for more information.

Programming the RF Vector Signal Analyzer in LabVIEW

To programmatically configure the RF Vector Signal Analyzer hardware for data acquisition in LabVIEW, use the ni5660 VIs. These VIs control both the NI 5600 RF downconverter module and the NI 5620 IF digitizer module as a single instrument for frequency-domain and IQ data acquisitions. The ni5660 VIs are located on the LabVIEW function palette at **Instrument I/O»Instrument Drivers»ni5660**.



Note Refer to the [Introduction to the Spectral Measurements Toolkit](#) section for more information about performing measurements on data acquired using the RF Signal Analyzer.

Refer to the *NI-RFSA Help* for assistance finding the ni5660 VIs on the LabVIEW palette and ni5660 VI reference information. The *NI-RFSA Help* is available at **Start»Programs»National Instruments»NI-RFSA»Documentation**.

ni5660 LabVIEW VIs Programming Flow

Two programming flows are used with the ni5660 VIs: a frequency-domain acquisition programming flow and an IQ acquisition programming flow. Every application built using the ni5660 VIs must call the ni5660 Initialize and ni5660 Close VIs.



Note When programming the RF Vector Signal Analyzer, specify the NI 5620 IF digitizer module with the DAQ Resource Name using the following syntax:

`DAQ::DeviceNumber`

Specify the NI 5600 RF downconverter module using the MAX device number without modifiers.

Frequency-Domain Measurements Programming Flow

Use the programming flow shown in Figure 1-19 to acquire data and perform frequency-domain measurements using the ni5660 VIs.

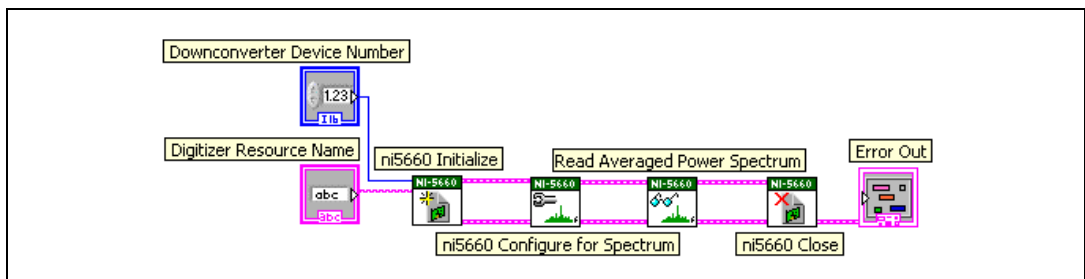


Figure 1-19. Use the ni5660 Configure Spectral Settings VI and the ni5660 Read Spectrum VI When Acquiring a Frequency Spectrum

IQ Acquisition Programming Flow

Use the programming flow shown in Figure 1-20 and Figure 1-21 to acquire IQ data in single-shot or continuous modes, respectively.

Single-Shot IQ Acquisition

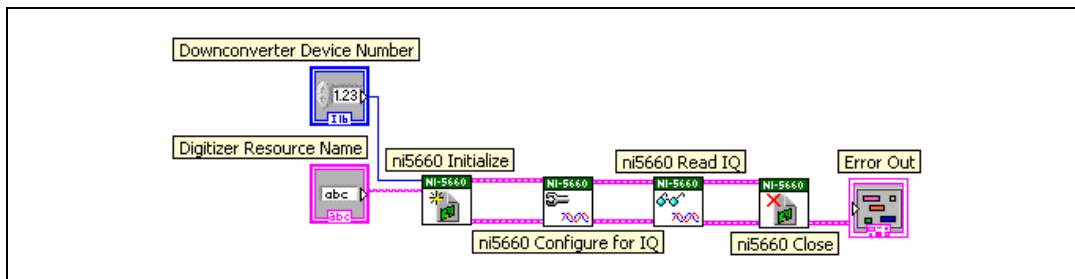


Figure 1-20. Use the ni5660 Configure IQ Settings VI and the ni5660 Read IQ VI when Acquiring Single-Shot IQ Data

Continuous IQ Acquisition

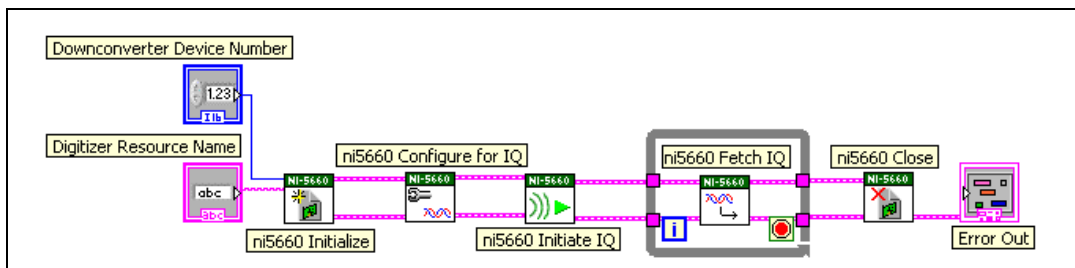


Figure 1-21. Use the ni5660 Configure IQ Settings VI, the ni5660 Initiate VI, and the ni5660 Fetch IQ VI when Acquiring Continuous IQ Data

Example Applications for LabVIEW

Several example ni5660 VI applications are available for LabVIEW. These examples are intended to serve as interactive tools, programming models, and building blocks in your own applications.

With LabVIEW running, select **Help»Find Examples** to launch the LabVIEW Example Finder. The Example Finder offers two ways to access all installed LabVIEW example VIs and their descriptions:

- Click the **Browse** tab to locate ni5660 VI examples by task at **Hardware Input and Output»Modular Instruments»NI-RFSA** or by directory structure at **instr»ni5660**.
- Click the **Search** tab to search all installed examples by keyword. Enter the keyword `power`, for instance, to locate an example that demonstrates making power in band measurements using the RF Vector Signal Analyzer.

ni5660 VI Examples

All installed ni5660 example files are located in the `<LabVIEW home>\examples\instr\ni5660` folder.

Examples Available Online

LabVIEW examples also are available online at ni.com/examples that demonstrate integration of the NI RF Vector Signal Analyzer with NI RF Signal Generators and NI toolkit software, including the Modulation Toolkit. Refer to the NI Developer Zone on the Web at ni.com/examples for these examples and more information.

Programming the RF Vector Signal Analyzer in LabWindows/CVI and C

LabWindows/CVI and C users program the RF Vector Signal Analyzer hardware modules individually, using function calls to the Spectral Measurements Toolkit and the individual drivers for the downconverter and digitizer modules:

- The Spectral Measurements Toolkit contains specialized functions for programming the RF Vector Signal Analyzer hardware for frequency-domain and IQ measurements.
- The NI-SCOPE driver controls the NI 5620 IF digitizer module and triggering of the RF Vector Signal Analyzer.



Note For more information on NI-SCOPE and triggering, refer to the *NI-SCOPE Help*, located at **Start»Programs»National Instruments»NI-SCOPE»Documentation**.

- The NI-TUNER driver controls the NI 5600 downconverter module.



Note For more information on NI-TUNER, refer to the *NI-TUNER Help*, located at **Start»Programs»National Instruments»NI-TUNER»Documentation**.

The NI-SCOPE and NI-TUNER software components are depicted in Figure 1-22.

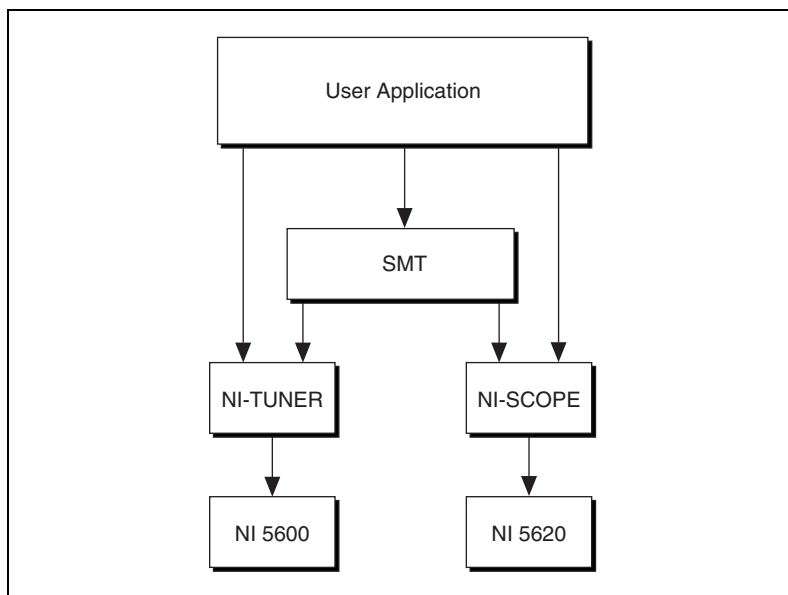


Figure 1-22. Flow Diagram for LabWindows/CVI and C



Note When programmatically operating the RF Vector Signal Analyzer hardware, specify the NI 5620 IF digitizer module using the DAQ Resource Name with the following syntax:

`DAQ::DeviceNumber`

Specify the NI 5600 RF downconverter module using the MAX device number without modifiers.

Introduction to the Spectral Measurements Toolkit

NI provides add-on software toolkits, such as the Spectral Measurements Toolkit (included) and the Modulation Toolkit, that extend the capability of the RF Vector Signal Analyzer to include frequency- and modulation-domain measurements, and analysis of analog- and digitally-modulated IF signals.



Note You *must* install the Spectral Measurements Toolkit CD packaged with your RF Vector Signal Analyzer. The Spectral Measurements Toolkit is necessary for analysis of modulated signals using the RF Signal Analyzer.

Use the Spectral Measurements Toolkit (SMT) VIs and functions for frequency-domain analysis, measurement, and display of data acquired using the RF Vector Signal Analyzer. The SMT can perform several operations, including the following:

- Zoom FFT processing and spectrum averaging
- Spectral measurements such as band power, adjacent channel power, and peak frequency and magnitude
- Spectrogram display and analysis
- RF Vector Signal Analyzer hardware configuration for frequency-domain measurements

For complete information about SMT VIs and functions, refer to the Spectral Measurements Toolkit documentation, accessible from **Start»Programs»National Instruments»Spectral Measurements»Documentation**. For more information about the Modulation Toolkit, refer to the NI RF Signal Analyzers Help, accessible at **Start»Programs»National Instruments»NI-RFSA»Documentation**.

SMT Example Applications for LabWindows/CVI and C

The Spectral Measurements Toolkit includes LabWindows/CVI and C examples for the RF Vector Signal Analyzer hardware. You can access the Spectral Measurements Toolkit examples at **Start»Programs»National Instruments»Spectral Measurements»CVI Support**. The example files are located in the <CVI home>\samples\smt folder.

Hardware Front Panel Connectors and Indicators

The following sections describe the connectors and LED indicators on the front panels of both RF Vector Signal Analyzer hardware modules. All inputs and outputs are AC-coupled.



Note Refer to Figure 1-7, *Installation of Included Cables*, for an image of standard RF Vector Signal Analyzer hardware module front panel interconnections.

NI 5600 RF Downconverter Module

The NI 5600 downconverter module front panel contains six connectors and two LEDs, as shown in Figure A-1.

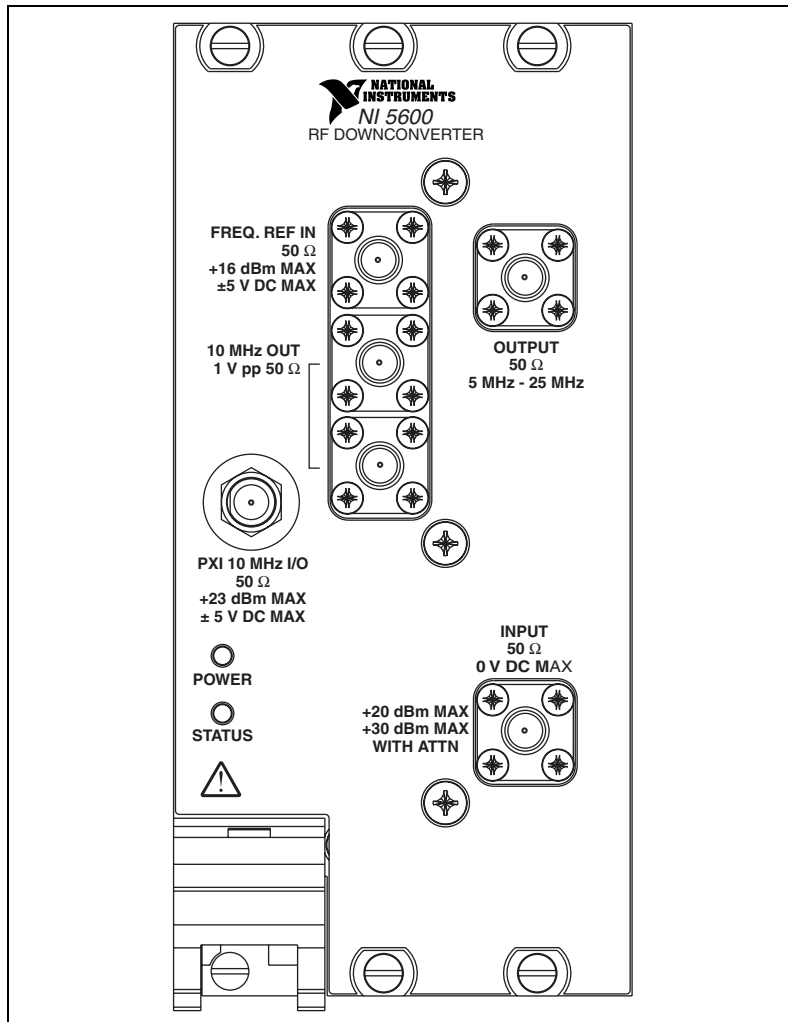


Figure A-1. NI 5600 RF Downconverter Module Front Panel



Note The PXI 10 MHz I/O connector can be used to route reference clock signals to the PXI backplane *only* when the NI 5600 downconverter module is installed in PXI Slot 2. This connector can export the PXI 10 MHz backplane clock from any NI 5600 PXI

installation slot. Refer to the *NI-RFSA Help*, accessible at **Start»Programs»National Instruments»NI-RFSA»Documentation**, for more information.

Table A-1. NI 5600 RF Downconverter Module Front Panel Connectors

Connector	Use
FREQ REF IN	Routes an external frequency reference signal to which the NI 5600 can lock. This signal can be propagated to the PXI backplane when the NI 5600 is installed in PXI Slot 2.
10 MHz OUT	Connect the lower 10 MHz OUT connector to the REF CLK IN connector on the NI 5620 module front panel.
10 MHz OUT	Both connectors output replications of the downconverter 10 MHz frequency reference signal, useful for driving other devices. Each replication is 180 degrees out-of-phase with the other. The signal output at these connectors is always on and cannot be disabled.
PXI 10 MHz I/O	Bidirectional connection to the PXI 10 MHz backplane clock. This connector can be used to drive the PXI 10 MHz backplane clock <i>only</i> when the NI 5600 downconverter module is installed in PXI Slot 2. This connector can be used to export the PXI 10 MHz backplane clock when the NI 5600 downconverter is installed in any PXI slot. Refer to the <i>NI-RFSA Help</i> , available at Start»Programs»National Instruments»NI-RFSA»Documentation , for more information.
OUTPUT	Connect to the INPUT connector on the NI 5620 digitizer module front panel. Outputs the frequency-translated IF signal for digitization.
INPUT	Connect to the analog RF input signal to be measured by the RF Vector Signal Analyzer.

Table A-2. NI 5600 RF Downconverter Module Front Panel LEDs

LED	Indications
POWER	<p>Indicates the basic hardware power status of the NI 5600 downconverter module. This LED functions identically to the ACCESS LED on the digitizer module front panel.</p> <p>OFF—The module is not yet functional, or has detected a problem with a PXI power rail.</p> <p>GREEN—The module is functional and receiving power.</p>
STATUS	<p>Indicates the status of the NI 5600 downconverter module PLLs.</p> <p>OFF—The module is in an uninitialized state, or the module PLLs are attempting to lock.</p> <p>GREEN—The module is in a ready state; applicable PLLs are locked.</p>

NI 5620 IF Digitizer Module

The front panel of the NI 5620 IF digitizer module contains three connectors, as shown in Figure A-2.

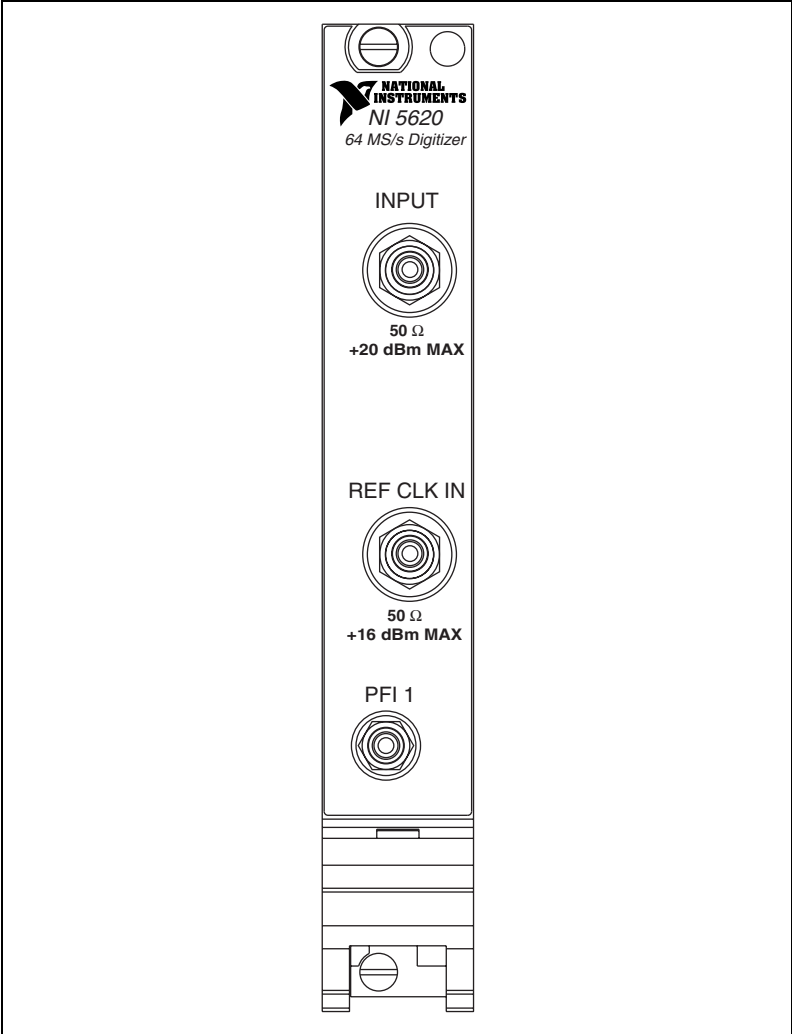


Figure A-2. NI 5620 IF Digitizer Module Front Panel

Table A-3. NI 5620 IF Digitizer Module Front Panel Connectors

Connector	Use
INPUT	<p>Inputs a frequency-translated IF waveform from the NI 5600 downconverter for digitization and measurement.</p> <p>Connect to the OUTPUT connector on the NI 5600 downconverter module front panel.</p>
REF CLK IN	<p>Inputs the NI 5600 internal reference clock signal.</p> <p>Connect to the lower 10 MHz OUT connector on the NI 5600 downconverter module front panel.</p>
PFI 1	<p>Inputs a digital trigger from an external source. Refer to the <i>NI-SCOPE Help</i>, located at Start»Programs»National Instruments»NI-SCOPE»Documentation, for more information about triggering.</p>

Troubleshooting

This section discusses issues you may encounter during installation, configuration, and use of the RF Vector Signal Analyzer hardware and software. You also can refer to the *NI-RFSA Help* file, accessible from **Start»Programs»National Instruments»NI-RFSA»Documentation** for more information.

Installation

NI 5600 RF Downconverter Module Front Panel POWER LED is Off When PXI Chassis is On

If the POWER LED fails to light when the PXI chassis is powered on, a problem may exist with the PXI power rail, a hardware module, or the LED. Complete the following steps to troubleshoot this issue:

1. Power off your PXI chassis.
2. Remove any module front panel interconnections between the RF Vector Signal Analyzer hardware modules.
3. Remove both RF Vector Signal Analyzer hardware modules and inspect for damage. Do *not* reinstall a damaged device.
4. Reinstall both RF Vector Signal Analyzer hardware modules in different PXI slots. Use the procedure detailed in the *Installing the Hardware* section of Chapter 1, *Getting Started with the NI 5660 RF Vector Signal Analyzer*.
5. Power on your PXI chassis.
6. If the POWER LED still fails to light, and failures continue, contact NI technical support at ni.com/ask, or call 866-275-6964 and ask to speak to a customer service representative.

A Hardware Module Does Not Appear in MAX

Use the following procedure if either RF Vector Signal Analyzer hardware module does not appear in MAX:

1. In the MAX Configuration pane, click the **NI-DAQmx Devices** folder and press <F5> to refresh the list of installed devices.
2. If either module is still not listed, power off the system, ensure that the RF Vector Signal Analyzer hardware is correctly installed, and restart the system. If your hardware still does not appear, continue to step 3.
3. Open the Windows Control Panel and select **System»Hardware»Device Manager**. Complete the appropriate step for your setup:
 - If using a PXI controller, verify that a **National Instruments** entry appears in the system device list. Reinstall the *NI-RFSA* CD and the RF Vector Signal Analyzer hardware modules if error conditions are present in the list.
 - If using a MXI-3 controller, right-click **PCI-to-PCI Bridge** and select **Properties** from the shortcut menu to verify that the bridge is enabled.
4. If either module still fails to appear in the MAX **NI-DAQmx Devices** folder, contact NI technical support at ni.com/ask, or call 866-275-6964 and ask to speak to a customer service representative.

The NI 5600 RF Downconverter Module Fails the Self-Test

The MAX self-test performs a brief test of device resources. If the NI 5600 downconverter module does not pass the self-test, complete the following steps:

1. Reboot your system.
2. Launch MAX and perform the self-test again. If the module still fails the self-test, proceed to step three.
3. Uninstall the RF Vector Signal Analyzer software using the Add/Remove Programs option on the Windows Control Panel. Never attempt to uninstall by deleting files.
4. Reinstall the RF Vector Signal Analyzer software by running *setup.exe* on the *NI 5660* CD.
5. If the NI 5600 downconverter module still fails the self-test, contact NI technical support at ni.com/ask, or call 866-275-6964 and ask to speak to a customer service representative.

The NI 5620 IF Digitizer Module Fails the Self-Test

The MAX self-test performs a brief test of device resources. If the NI 5620 IF digitizer module does not pass the self-test, complete the following steps:



1. Launch MAX by navigating to **Start»Programs»National Instruments»Measurement & Automation** or by clicking the MAX desktop icon.
2. In the Configuration pane, double-click **Devices and Interfaces** to see the list of installed devices.
3. Expand the **Traditional NI-DAQ Devices** folder. You will see a list of installed devices that includes the NI 5600 and NI 5620 modules.
4. Right-click **NI 5620** and select **Properties**, as shown in Figure B-1.

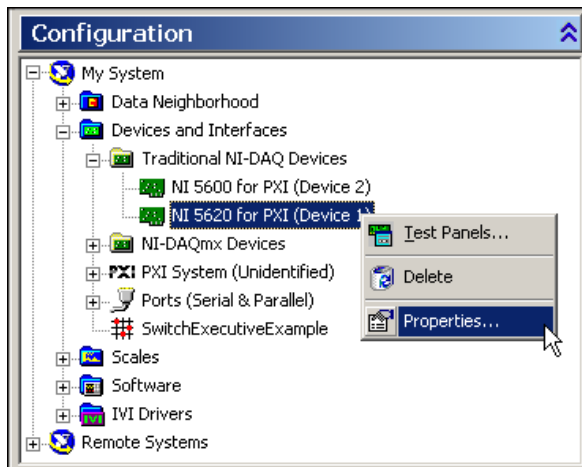


Figure B-1. Select Properties from the NI 5620 Right-Click Menu

5. The Configuring Device dialog appears as shown in Figure B-2. Click **Test Resources** to self-test the NI 5620 IF digitizer hardware module.
6. In the NI 5620 Configuring Device window, select **Run Test Panels** as shown in Figure B-2. The NI 5620 test panel performs a functional test of the IF digitizer module.

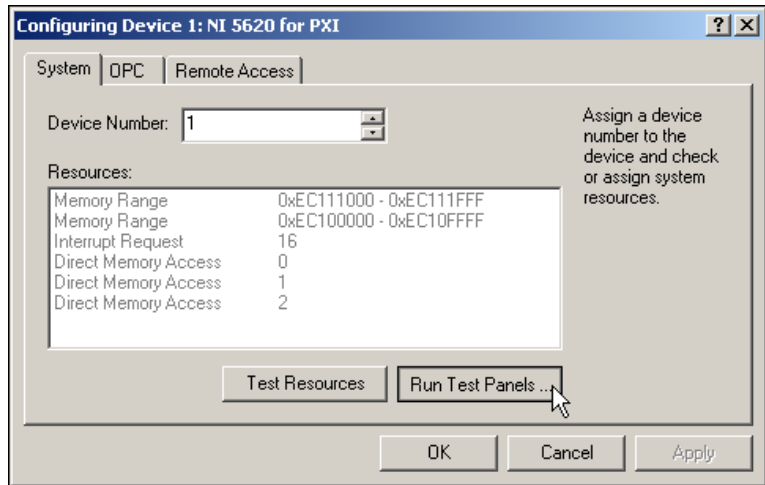


Figure B-2. Select Run Test Panels to Test NI 5620 IF Digitizer Function

7. Click **Start** as shown in Figure B-3 to run the NI 5620 test panel.

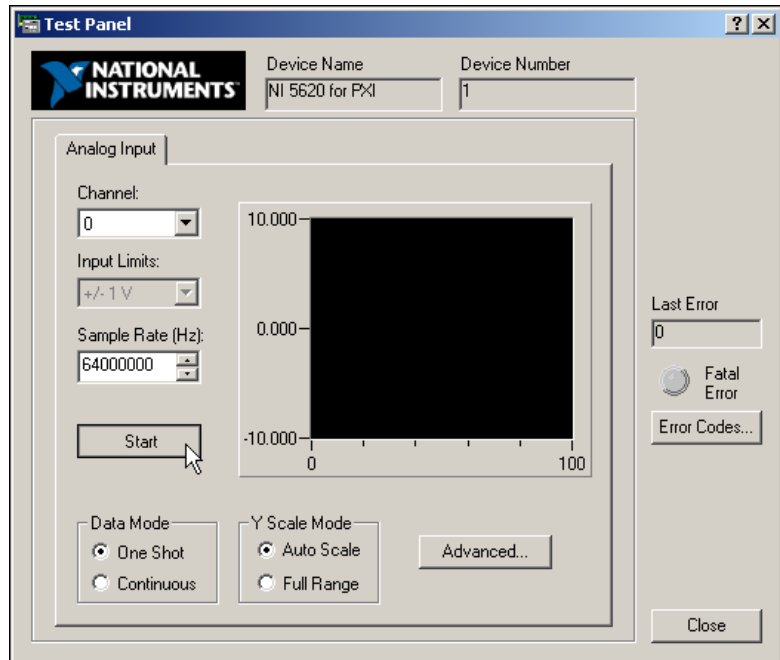


Figure B-3. Click Start to Run the NI 5620 Test Panel

- When the NI 5620 test panel has run successfully, click **Close** as shown in Figure B-4.

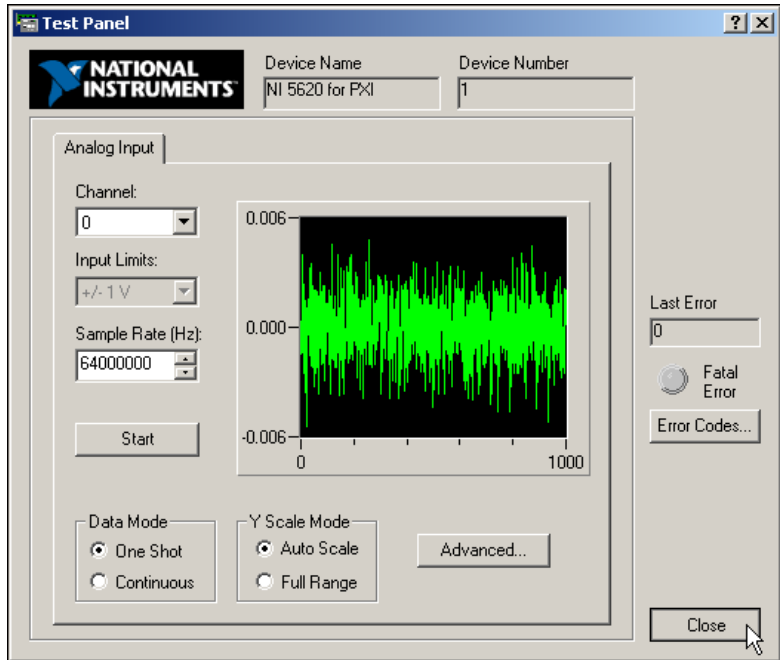


Figure B-4. Click Close to Stop the NI 5620 Test Panel

- Click **OK** in the NI 5620 Configuring Devices window to return to MAX.

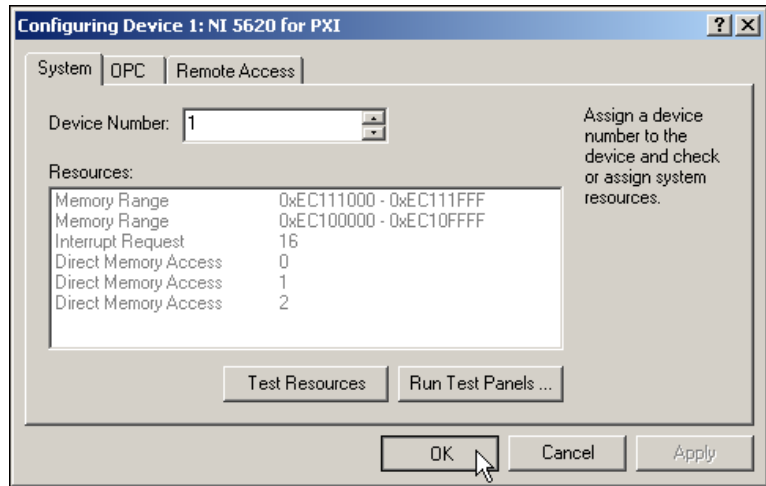


Figure B-5. Click OK in the NI 5620 Configuring Devices Window to Return to MAX

- If the NI 5620 test panel fails and continues to fail, contact NI technical support at ni.com/ask, or call 866-275-6964 and ask to speak to a customer service representative.

Configuration

RF Vector Signal Analyzer Does Not Initialize

Failure to initialize may indicate a problem with module interconnection or with MAX. If the RF Vector Signal Analyzer fails to initialize, complete the following steps:

- Reconnect the RF Vector Signal Analyzer hardware module front panel cables securely as shown in the [Interconnecting the Hardware Modules](#) section of Chapter 1, [Getting Started with the NI 5660 RF Vector Signal Analyzer](#).
- Power on your system and run the MAX configuration and self-test procedures in the [Configuring the Hardware Modules in MAX](#) section of Chapter 1, [Getting Started with the NI 5660 RF Vector Signal Analyzer](#).

Refer to the *Configuring the Hardware Modules in MAX* section in Chapter 1, *Getting Started with the NI 5660 RF Vector Signal Analyzer*, for instructions on using MAX. If failures continue, contact NI technical support at ni.com/ask, or call 866-275-6964 and ask to speak to a customer service representative.

STATUS LED Does Not Light

If the RF Vector Signal Analyzer is programmed to lock to an external reference source or to the PXI backplane, but the STATUS light does not indicate a phase locked status, check for the following errors:

1. Make sure a cable is connected from the external source or the PXI 10 MHz I/O connector to the **FREQ REF IN** connector.
2. Ensure that the external source signal is large enough—typically greater than -10 dBm.

If you programmed the RF Vector Signal Analyzer to use the NI 5600 downconverter module internal timebase, check for the following errors:

1. If the RF Vector Signal Analyzer measures the frequency incorrectly or detects no signal when one is supplied, one or more of the local oscillators is not phase-locked.
2. If the RF Vector Signal Analyzer measures the frequency correctly but the LED does not light, there could be a driver software error or the LED is damaged.

If failures continue, contact NI technical support at ni.com/ask, or call 866-275-6964 and ask to speak to a customer service representative.

The IF Digitizer Module Does Not Phase-Lock to the RF Downconverter Module

If you programmed the NI 5620 digitizer module to phase-lock to the NI 5600 downconverter module internal reference through the front panel and you encounter failure, first verify that the cable is not faulty. Next, verify that there is a reference signal output from the NI 5600 10 MHz OUT front panel connectors. If there is no signal at these outputs, contact NI.

If you programmed the NI 5620 digitizer module to phase-lock to the PXI backplane driven by the NI 5600 downconverter module internal reference and you encounter failure, make sure that the NI 5600 is in Slot 2 of the PXI chassis, immediately adjoining the PXI controller slot. Also verify that the PXI 10 MHz I/O connector is securely wired to one of the

10 MHz OUT connectors using the included cable, as shown in the *Interconnecting the Hardware Modules* section of Chapter 1, *Getting Started with the NI 5660 RF Vector Signal Analyzer*.

If failures or errors continue, contact NI technical support at ni.com/ask, or call 866-275-6964 and ask to speak to a customer service representative.

Measurement

For more information about making measurements with the RF Vector Signal Analyzer, refer to the *NI-RFSA Help*, available at **Start» Programs»National Instruments»NI-RFSA»Documentation**.

RF Vector Signal Analyzer Amplitude Reading Does Not Match Source

If the RF Vector Signal Analyzer reports an incorrect amplitude reading, check for the following possible errors:

1. Check that the discrepancy between the RF Vector Signal Analyzer and the source is within the error limits of the devices, as follows:
 - a. Verify the absolute amplitude accuracy of the RF Vector Signal Analyzer.
 - b. Verify the output level accuracy of the source.
2. Check for loss in the cables, which can be substantial. For example, RG58 coaxial cable loses about 2.1 dB of signal amplitude per foot at 2 GHz. Unless you are using high-quality cables, expect losses when working with high-frequency signals.
3. Ensure that you are using the amplitude calibration functions in the SMT. Failure to apply calibration functions can result in large amplitude errors.

If errors continue, contact NI technical support at ni.com/ask, or call 866-275-6964 and ask to speak to a customer service representative.

RF Vector Signal Analyzer Frequency Reading Does Not Match Source

If the RF Vector Signal Analyzer reports an incorrect frequency reading, check for the following possible errors:

- Check that the RF Vector Signal Analyzer is programmed to lock to the reference of the source.
- Ensure that the RF Vector Signal Analyzer and the source are phase-locked. If the source and both RF Vector Signal Analyzer modules are not phase-locked, it is normal for a small frequency deviation to exist.
- Make sure the cable used to synchronize the source and RF Vector Signal Analyzer by phase-locking is properly installed and is not faulty.

If the NI 5620 digitizer module is phase-locked to the NI 5600 downconverter module, either through the front panel SMA connectors or the PXI backplane, and errors continue, contact NI technical support at ni.com/ask, or call 866-275-6964 and ask to speak to a customer service representative.



Technical Support and Professional Services

Visit the following sections of the National Instruments Web site at ni.com for technical support and professional services:

- **Support**—Online technical support resources at ni.com/support include the following:
 - **Self-Help Resources**—For immediate answers and solutions, visit the award-winning National Instruments Web site for software drivers and updates, a searchable KnowledgeBase, product manuals, step-by-step troubleshooting wizards, thousands of example programs, tutorials, application notes, instrument drivers, and so on.
 - **Free Technical Support**—All registered users receive free Basic Service, which includes access to hundreds of Application Engineers worldwide in the NI Developer Exchange at ni.com/exchange. National Instruments Application Engineers make sure every question receives an answer.
- **Training and Certification**—Visit ni.com/training for self-paced training, eLearning virtual classrooms, interactive CDs, and Certification program information. You also can register for instructor-led, hands-on courses at locations around the world.
- **System Integration**—If you have time constraints, limited in-house technical resources, or other project challenges, National Instruments Alliance Partner members can help. To learn more, call your local NI office or visit ni.com/alliance.
- **Declaration of Conformity (DoC)**—A DoC is our claim of compliance with the Council of the European Communities using the manufacturer’s declaration of conformity. This system affords the user protection for electronic compatibility (EMC) and product safety. You can obtain the DoC for your product by visiting ni.com/certification.
- **Calibration Certificate**—If your product supports calibration, you can obtain the calibration certificate for your product at ni.com/calibration.

If you searched ni.com and could not find the answers you need, contact your local office or NI corporate headquarters. Phone numbers for our worldwide offices are listed at the front of this manual. You also can visit the Worldwide Offices section of ni.com/niglobal to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.