GETTING STARTED GUIDE
NI 5640R IF Transceiver

This document explains how to install and configure a National Instruments PCI-5640R IF transceiver and explains how to program it. The NI PCI-5640R offers two 100 MS/s, 14-bit input channels with built-in digital downconversion and two 200 MS/s, 14-bit output channels with built-in digital upconversion.

For more information about hardware features and programming, refer to the *NI 5640R Help* at **Start»All Programs»National Instruments» NI-5640R»Documentation»NI 5640R Help**.

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

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

Contents

NATIONAL INSTRUMENTS

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, AO <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 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 the *Read Me First: Safety and Radio-Frequency Interference* document that shipped with your device for precautions to take.
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. Italic text 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 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.
`monospace italic`	Italic text in this font denotes text that is a placeholder for a word or value that you must supply.
PCI	Peripheral Component Interconnect (PCI) is a high-performance expansion bus architecture originally developed by Intel to replace ISA and EISA.

1. Verifying the System Components

Your system must meet certain requirements to use the NI PCI-5640R IF transceiver. For more information on minimum system requirements, refer to the *NI-5640R Readme*, which is available on the NI-5640R CD.

Note After you install the NI-5640R software, you can access the *NI-5640R Readme* at **Start»All Programs»National Instruments»NI-5640R»Documentation**.

2. Unpacking

The NI PCI-5640R IF transceiver ships in an antistatic package to prevent electrostatic discharge (ESD). ESD can damage several components on the device.

Caution *Never* touch the exposed pins of connectors.

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

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

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

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

3. Verifying the Kit Contents

Verify that the kit contains the following items:

- ❑ Paper sleeves that contain the NI-5640R instrument driver software CDs, which includes the following documentation:
  - *NI 5640R Help*
  - *Getting Started with the NI PCI-5640R IF Transceiver and the LabVIEW FPGA Module*
  - *NI PCI-5640 Specifications*
- ❑ *NI 5640R IF Transceiver Getting Started Guide* (this document)

- ❑ NI PCI-5640 device
- ❑ Other documentation included with the IF transceiver and driver software:
  - *Read Me First: Safety and Radio-Frequency Interference*
  - *Maintain Forced-Air Cooling Note to Users*

4. Installing the Software

This section describes the software installation process for the NI PCI-5640R.

Choose Your Application Development Environment (ADE)

You can create applications for your IF transceiver using LabVIEW. LabVIEW features interactive graphics, a state-of-the-art interface, and a powerful graphical programming language. Using LabVIEW can greatly reduce your application development time.

You can use the NI-5640R instrument driver in LabVIEW or you can use the LabVIEW FPGA Module to create your program. More information about each of these methods is provided in the following sections, and the differences are summarized in Table 1, *NI PCI-5640R Programming Methods Comparison*.

NI-5640R Instrument Driver

The NI-5640R instrument driver API features a set of operations that exercise all the functionality of the device, including configuration, control, and other device-specific functions. With the NI-5640R API, you program the NI PCI-5640R with its default personality—two synchronized input and two synchronized output channels.

Information about programming with the NI-5640R instrument driver is available in the *NI 5640R Help.* This online document contains hardware information, concepts, a detailed VI reference for the NI-5640R instrument driver API, and information specific to your device.

LabVIEW FPGA Module

Using the LabVIEW FPGA module, you can configure the behavior of the FPGA core in the NI PCI-5640R to closely match the requirements of your system. The behavior of this module is fully user-defined, and can be implemented as a VI, creating an application-specific I/O device. However, the programming time required to create an application using the LabVIEW FPGA module is greater than using the NI-5640R instrument

driver and more advanced programming skills are required. Refer to the *Getting Started with the NI PCI-5640R IF Transceiver and the LabVIEW FPGA Module* document for more information about this programming method.

Table 1. NI PCI-5640R Programming Methods Comparison

NI-5640R Instrument Driver	LabVIEW FPGA Module
Easy-to-use application programming interface (API)	Advanced LabVIEW and LabVIEW FPGA programming skills required. Using the LabVIEW FPGA Module allows you to create programs that exercise the maximum capabilities of the device.
Two synchronous input and two synchronous output channels	User-defined I/O
Support for software and digital edge triggering using the NI-5640R API	Ability to create custom signal processing on FPGA
No FPGA compilation cycles[1]	Required FPGA compilation cycles
Applications return calibrated IQ data	Applications return raw data; you must perform scaling and calibration if needed
[1] Digital upconversion and downconversion still done onboard with hardware.	

For information about which versions of LabVIEW are supported with the NI PCI-5640R, refer to the *NI-5640R Readme*.

Install Your ADE

After you choose which programming method you will use, install LabVIEW. Optionally, if you choose to use the LabVIEW FPGA Module, install this product after installing LabVIEW.

Install the NI-5640R Software

To install NI-5640R software, complete the following steps:

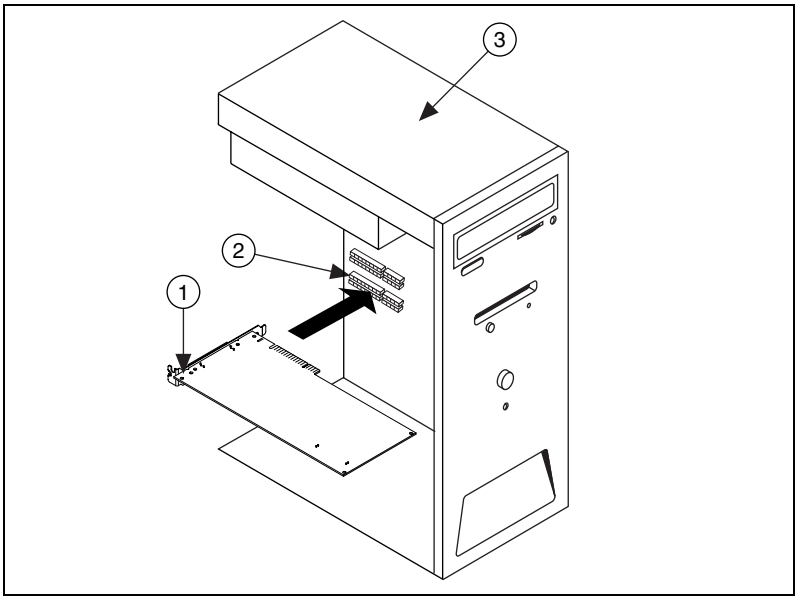
1. Insert the NI-5640R CD. The NI-5640R installer should open automatically. If not, select **Start»Run**, and enter `x:\setup.exe`, where *x* is the letter of the CD drive.
2. Follow the instructions in the installation prompts. For troubleshooting and operating system-specific instructions, refer to the Hardware Installation/Configuration Troubleshooter at `ni.com/support/install`.
3. When the installer completes, a dialog box appears that asks if you want to restart, shut down, or restart later. Select **Restart**.

5. Installing the Hardware

When installing your hardware, follow the instructions in this section to ensure that your device can cool itself effectively. If the device temperature rises above the optimal operating temperature range, the device could be damaged or have its life cycle reduced. For more information about re-enabling your device, refer to the *The ni5640R Check Thermal Status VI Indicated an Overtemperature Condition* section in *Appendix B: Troubleshooting*.

To install your PCI device, complete the following steps:

1. Power off and unplug the PC.
2. If the PC has multiple fan speed settings, ensure that the fans are set to the highest setting.
3. Remove the PC cover.
4. Insert the device into an open full-length PCI slot, as shown in Figure 1.



1	NI PCI Device	2	PCI Slot	3	Personal Computer

Figure 1. PCI Installation

NI recommends either leaving the slot adjacent to the fan side of the device empty or using lower-profile devices in the slot adjacent to the fan side.

5. Secure the device with the screw provided in the kit.

Caution It is important to completely screw the device into the PCI slot, both for mechanical stability and for creating a solid ground connection, which reduces signal noise. Some computer manufacturers use a plastic securing lever to secure PCI devices; such a lever is unacceptable and *must* be removed, or you must use a different chassis. Improperly secured devices may affect the accuracy of device specifications.

6. Before operating the device, install all filler panels. Missing filler panels disrupt the necessary air circulation in the PC.
7. Replace the PC cover.
8. Plug in and power on the PC.

Maintaining PCI Systems

Inspect the onboard fan on a regular basis to prevent fan and air circulation path blockage. Cleaning frequency depends on the amount of use and the operating environment.

6. Configuring in MAX

To configure the NI PCI-5640R in Measurement & Automation Explorer (MAX), complete the following steps:

1. Launch MAX to configure the IF transceiver. MAX should automatically detect the device you installed.
2. Expand **Devices and Interfaces**.
3. Expand **NI-RIO Devices**.
4. Check that your device appears under NI-RIO Devices.

Note If your device does not appear under NI-RIO Devices, MAX did not detect the device, so you might need to refresh MAX by selecting **File»Refresh** from the MAX menu or by pressing <F5>.

5. (Optional) You can create an alias for your device name in MAX, by right-clicking the device and selecting **Rename Alias**.
6. Click the **Save** button.
7. Record the device name assigned to the IF transceiver. You need this information when you program the device.

7. Connecting Signals

This section discusses connections you can make to the device and how to connect signals to the device. For device front panel diagrams and connector descriptions, refer to *Appendix A: Device Front Panels*.

You can connect three kinds of signals to the NI PCI-5640R: analog input (AI) signals, analog output (AO) signals, and digital input/output (DIO) signals.

Connecting Analog Input (AI) Signals

Observe the following requirements when connecting AI signals to the NI PCI-5640R.

- Ensure that analog signals do not exceed the maximum input voltage ratings specified in the *NI PCI-5640R Specifications* to avoid damage to the device.
- Use external lowpass or bandpass filters when necessary to avoid aliasing effects. Refer to the *Alias Effects* and *Digital Downconverter (DDC)* topics of the *NI 5640R Help* for more information about aliasing and undersampling.
- Use a connector saver (a replaceable SMA adapter used on test equipment) on the SMA connectors of the NI PCI-5640R device to protect the connectors from wear and tear.

Note Observe the maximum input thresholds specified in the *NI PCI-5640R Specifications*. NI is not liable for any damage resulting from such signal connections.

Connecting Analog Output (AO) Signals

Observe the following requirements when connecting AO signals to the NI PCI-5640R.

- Terminate AO signals in 50 Ω impedance for best performance.
- Use external lowpass or bandpass filters when necessary to avoid imaging effects. For digital-to-analog converter (DAC) update rates of 200 MS/s, images should be less than –50 dBc without any external lowpass filters. Refer to the *Digital Upconversion (DUC)* topic of the *NI 5640R Help* for more information about imaging.
- Use a connector saver (a replaceable SMA adapter used on test equipment) on the SMA connectors of the NI PCI-5640R to protect the connectors from wear and tear.

Connecting Digital Input/Output (DIO) Signals

The NI PCI-5640R front panel DIO connector provides the nine pins shown in Figure 3 in *Appendix A: Device Front Panels*. DIO lines are direction-configurable by pin as input or output.

You can use the front panel DIO connector to control external signal conditioning device settings, such as analog radio frequency (RF)-to-intermediate frequency (IF) downconverter frequency or gain.

Note If you are using LabVIEW FPGA, you can write an application to customize the functionality of this connector for your application. Refer to the *8. Programming the NI PCI-5640R* section for more information about using LabVIEW FPGA for programming.

A pin on the DIO connector supplies +5 V from the computer power supply using a self-resetting fuse. The fuse resets automatically within a few seconds after the overcurrent condition is removed. The +5 V pins are referenced to Digital Ground (DGnd) and can power external circuitry.

Caution Do *not* connect the +5 V power pins directly to analog or digital ground or to any other voltage source on the NI PCI-5640R or any other device under any circumstance. Doing so can damage the NI PCI-5640R and the host computer. NI is *not* liable for damage resulting from such a connection.

Caution Exceeding the maximum input voltage ratings, which are listed in the *NI PCI-5640R Specifications*, can damage the NI PCI-5640R and the host computer. NI is not liable for any damage resulting from such signal connections.

If required by your application, you can connect multiple NI PCI-5640R digital output lines in parallel to provide higher current sourcing or sinking capability. If you connect multiple digital output lines in parallel, your application must drive all of these lines simultaneously to the same value. If you connect digital lines together and drive them to different values, excessive current may flow through the DIO lines and damage the NI PCI-5640R. NI is *not* liable for damage resulting from such signal connections.

8. Programming the NI PCI-5640R

You have two options for programming your NI PCI-5640R. The first option is using the NI-5640R software to generate or acquire data with the NI-5640R LabVIEW API. The second method is to use the LabVIEW FPGA Module to program the FPGA core in the NI PCI-5640R module to fit your needs. More information about these two programming methods is provided in the *Choose Your Application Development Environment (ADE)* section of step *4. Installing the Software*.

NI-5640R Examples

The NI-5640R examples demonstrate some of the functionality of the NI PCI-5640R that you can use or integrate into your applications.

To access example programs that you can use as a basis for your first NI-5640R program, refer to the *NI-5640R Readme* for example locations.

Appendix A: Device Front Panels

This section contains front panel connector figures and connector description tables that describe the signal connection options.

NI 5640R Front Panels and Connectors

The NI PCI 5640R front panels contain seven connectors—four SMA jacks (Analog Input CH0 and CH1, and Analog Output CH0 and CH1), two SMB connectors (CLK IN and TRIG), and one 9-pin mini-circular DIN connector.

Figure 2 shows the NI PCI 5640R front panels and pinout. The connectors are described in Table 2.

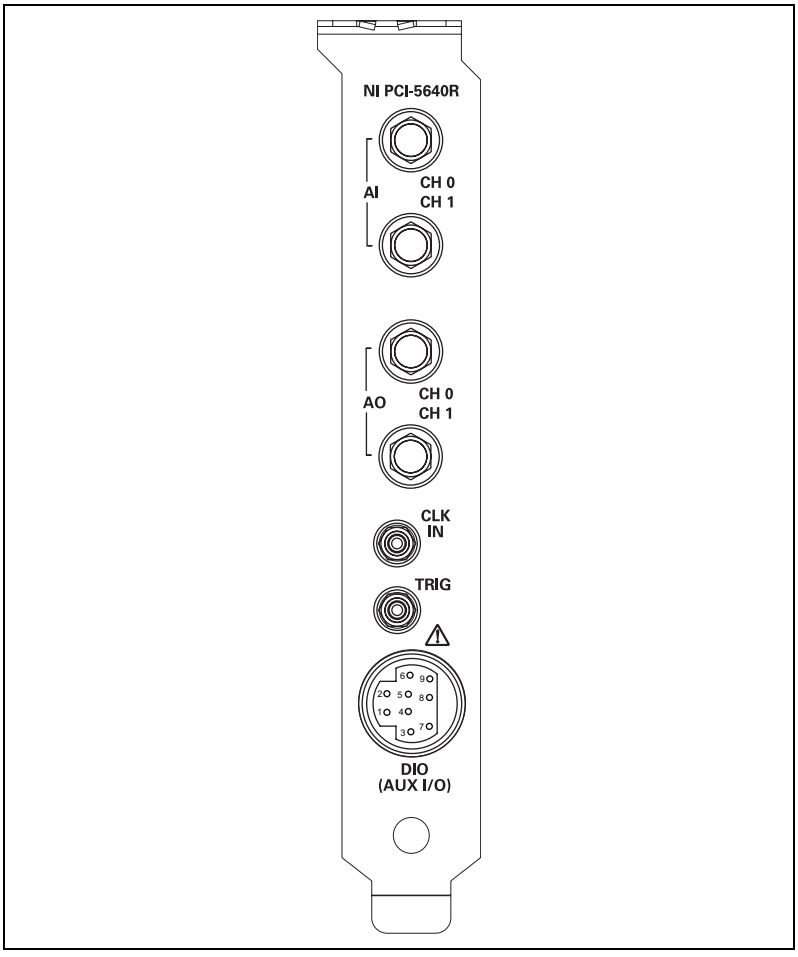


Figure 2. NI 5640R Front Panel Connectors

Table 2. NI 5640R Connectors

Connector Name	Type	Description
AI CH <0..1>	SMA	Analog input terminals for the NI PCI-5640R.
AO CH <0..1>	SMA	Analog output terminals for the NI PCI-5640R.
CLK IN	SMB	Input terminal for an external reference clock.

Table 2. NI 5640R Connectors (Continued)

Connector Name	Type	Description
TRIG	SMB	Input or output terminal for device trigger signals.
DIO (AUX I/O)	9-pin DIN mini-circular	Input or output terminal for device digital I/O (DIO) channels. DIO lines are direction-configurable by pin as input or output. Figure 3 and Table 3 provide the detailed pinout for this connector.

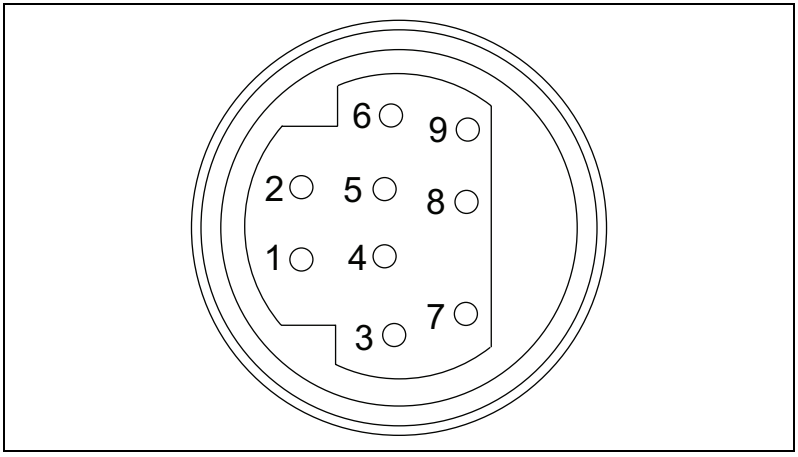


Figure 3. DIO 9-Pin DIN Connector

Table 3. DIO 9-Pin DIN Connector Pinout

Pin Number	Connection
1	+5 V
2	Ground
3	DIO_01
4	DIO_02
5	DIO_03
6	DIO_04
7	DIO_05

Table 3. DIO 9-Pin DIN Connector Pinout (Continued)

Pin Number	Connection
8	DIO_06
9	DIO_07

Appendix B: Troubleshooting

Device Does Not Appear in MAX

Complete the following steps if the NI device does not appear in MAX:

1. In the MAX Configuration pane, click **Devices and Interfaces** to expand the category.
2. Click **NI-RIO Devices** and press <F5> to refresh the list of installed devices.
3. If the device is still not listed, power down the system, ensure the device and the NI-5640R instrument driver software is correctly installed, and restart.
4. If the device still does not appear under NI-RIO Devices, contact NI support at `ni.com/support`.

The ni5640R Check Thermal Status VI Indicated an Overtemperature Condition

I received an overtemperature error, and my device shut down. What should I do next?

To re-enable your device after a thermal shutdown, you must perform a hard reset, in which the device integrated circuits (ICs) are reloaded. To re-enable your device after thermal shutdown, complete the following steps:

1. Power down the computer or chassis that contains the device.
2. Review the procedure in step *5. Installing the Hardware* and make any necessary adjustments to ensure that your device is effectively cooled.
3. Restart the computer.

My Signal Looks Very Noisy

I am seeing my acquired high-frequency signals appear as lower frequency signals, which is also known as aliasing.What can I do to reduce the effects of aliasing?

To avoid alias effects, band-limit the input signal so that most of the energy is inside a single Nyquist zone. For more information about avoiding alias effect, refer to the *Alias Effects* topic in the *NI 5640R Help*.

Where to Go for Support

The National Instruments Web site is your complete resource for technical support. At `ni.com/support` you have access to everything from troubleshooting and application development self-help resources to email and phone assistance from NI Application Engineers.

A Declaration of Conformity (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`. If your product supports calibration, you can obtain the calibration certificate for your product at `ni.com/calibration`.

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Czech Republic 420 224 235 774, Denmark 45 45 76 26 00,
Finland 385 (0) 9 725 72511, France 33 (0) 1 48 14 24 24,
Germany 49 89 7413130, India 91 80 41190000, Israel 972 3 6393737,
Italy 39 02 413091, Japan 81 3 5472 2970, Korea 82 02 3451 3400,
Lebanon 961 (0) 1 33 28 28, Malaysia 1800 887710,
Mexico 01 800 010 0793, Netherlands 31 (0) 348 433 466,
New Zealand 0800 553 322, Norway 47 (0) 66 90 76 60,
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