GETTING STARTED GUIDE

NI PXIe-5646R-G

6 GHz Reconfigurable RF Vector Signal Generator with 200 MHz Bandwidth

Note Before you begin, install and configure your chassis and controller.

This document explains how to install, configure, and test the NI PXIe-5646R-G (NI 5646R-G). The NI 5646R-G is a 6 GHz RF vector signal generator (VSG) with 200 MHz bandwidth. The NI 5646R-G ships with the NI-RFSG instrument driver, which you use to program the device.

To access NI 5646R-G documentation, visit *ni.com/manuals* and search for NI 5646R-G.

Caution The protection provided by this product may be impaired if it is used in a manner not described in this document.

Contents

NATIONAL INSTRUMENTS

Electromagnetic Compatibility Guidelines

This product was tested and complies with the regulatory requirements and limits for electromagnetic compatibility (EMC) stated in the product specifications. These requirements and limits provide reasonable protection against harmful interference when the product is operated in the intended operational electromagnetic environment.

This product is intended for use in industrial locations. However, harmful interference may occur in some installations, when the product is connected to a peripheral device or test object, or if the product is used in residential or commercial areas. To minimize interference with radio and television reception and prevent unacceptable performance degradation, install and use this product in strict accordance with the instructions in the product documentation.

Furthermore, any changes or modifications to the product not expressly approved by National Instruments could void your authority to operate it under your local regulatory rules.

Caution To ensure the specified EMC performance, operate this product only with shielded cables and accessories.

Caution To ensure the specified EMC performance, operate this product only with cables less than 3 meters in length.

Verifying the System Requirements

To use the NI 5646R-G, your system must meet certain requirements. For more information about minimum system requirements, recommended system, and supported application development environments (ADEs), refer to the readme, which is available on the software media or online at *ni.com/updates*.

Unpacking the Kit

Caution To prevent electrostatic discharge (ESD) from damaging the device, ground yourself using a grounding strap or by holding a grounded object, such as your computer chassis.

1. Touch the antistatic package to a metal part of the computer chassis.
2. Remove the device from the package and inspect the device for loose components or any other sign of damage.

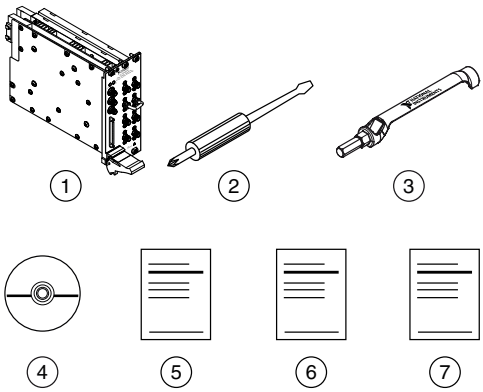
   Caution Never touch the exposed pins of connectors.

   Note Do not install a device if it appears damaged in any way.
3. Unpack any other items and documentation from the kit.

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

Verifying the Kit Contents

Figure 1. NI 5646R-G Kit Contents



1. NI PXIe-5646R-G Module
2. Screwdriver, Part Number 772006-01
3. SMA Driver Bit, Part Number 780895-01
4. Driver Software DVD
5. Read Me First: Safety and Electromagnetic Compatibility
6. Maintain Forced-Air Cooling Note to Users
7. NI PXIe-5646R-G Getting Started Guide (this document)

Other Equipment

There are several required items not included in your device kit that you need to install or operate the NI 5646R-G.

Required Items

- A PXI Express chassis and chassis documentation. The NI PXIe-1085 chassis is one available option for your device. For more information about compatible chassis options, refer to *ni.com*.
- A PXI Express embedded controller or MXI controller system that meets the system requirements specified in this guide and chassis documentation.

Optional Items

- A 1 N · m standard SMA torque wrench (NI part number 780487-01).

Preparing the Environment

Ensure that the environment you are using the NI 5646R-G in meets the following specifications.

Operating ambient temperature (IEC 60068-2-1, IEC 60068-2-2)	0 °C to 55 °C
Operating relative humidity (IEC 60068-2-56)	10% to 90%, noncondensing
Maximum altitude	2,000 m (800 mbar) (at 25 °C ambient temperature)
Pollution Degree	2

Indoor use only.

Caution Clean the hardware with a soft, nonmetallic brush. Make sure that the hardware is completely dry and free from contaminants before returning it to service.

Note Refer to the *NI PXIe-5646R-G Specifications* at *ni.com/manuals* for complete specifications.

Installing the Software

You must be an Administrator to install NI software on your computer.

1. Install an ADE, such as LabVIEW or LabWindows™/CVI™.
2. Insert the driver software media into your computer. The installer should open automatically.

   If the installation window does not appear, navigate to the drive, double-click it, and double-click `autorun.exe`.
3. Follow the instructions in the installation prompts to install the NI-RFSG instrument driver software.

   Note The NI 5646R-G is only supported by the NI-RFSG instrument driver software.

   Note Windows users may see access and security messages during installation. Accept the prompts to complete the installation.
4. When the installer completes, restart your system.

Installing the NI 5646R-G

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

You must install the software before installing the hardware.

Before you install the hardware, refer to the guidelines in the *Maintain Forced-Air Cooling Note to Users* included with the module to ensure that the device can cool itself effectively. This document is also available at *ni.com/manuals*.

The NI 5646R-G is a three-slot module with two backplane connectors. The module must be installed into three adjacent chassis slots, and the left two slots must be PXI Express compatible.

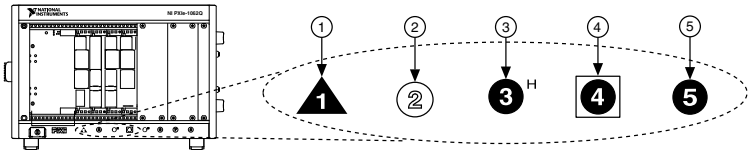
1. Ensure the AC power source is connected to the chassis before installing the module.

   The AC power cord grounds the chassis and protects it from electrical damage while you install the module.
2. Power off the chassis.
3. Inspect the slot pins on the chassis backplane for any bends or damage prior to installation. Do not install a module if the backplane is damaged.
4. If the chassis has multiple fan speed settings, ensure the fans are set to the highest setting.

   Note Inadequate air circulation could cause the temperature inside the chassis to rise above the optimal operating temperature for the device, potentially causing thermal shutdown, shorter lifespans, or improper performance.
5. Position the chassis so that inlet and outlet vents are not obstructed.

   Caution Do not disconnect the cable that connects CAL IN to CAL OUT. Removing the cable from or tampering with the CAL IN or CAL OUT front panel connectors voids the product calibration and specifications are no longer warranted.
6. Remove the black plastic connectors from all the captive screws on the module front panel.
7. Identify a supported slot in the chassis. The following figure shows the symbols that indicate the slot types.

Figure 2. Chassis Compatibility Symbols

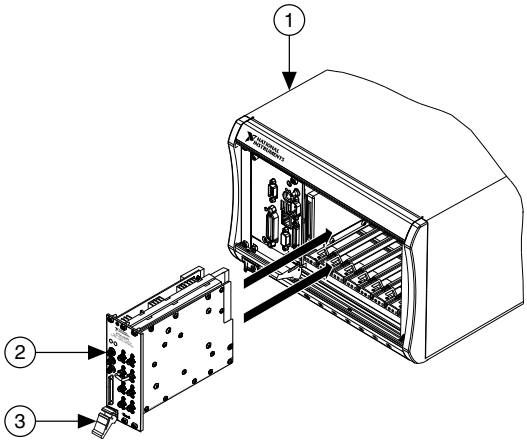


1. PXI Express System Controller Slot
2. PXI Peripheral Slot
3. PXI Express Hybrid Peripheral Slot
4. PXI Express System Timing Slot
5. PXI Express Peripheral Slot

   The NI 5646R-G can be placed in PXI Express peripheral slots, PXI Express Hybrid peripheral slots, or PXI Express system timing slots.
8. Touch any metal part of the chassis to discharge static electricity.
9. Ensure that the ejector handle is in the unlatched (downward) position.

10. Hold the module by the edges and slide it into the empty compatible slots. Ensure the base engages with the guides in the chassis.

Figure 3. NI 5646R-G Module Installation



1. PXI Express Chassis
2. NI PXIe-5646R-G Module
3. Ejector Handle in Down Position

11. Latch the module in place by pulling up on the ejector handle.
12. Secure the device front panel to the chassis using the front-panel mounting screws.

Note Tightening the top and bottom mounting screws increases mechanical stability and also electrically connects the front panel to the chassis, which can improve the signal quality and electromagnetic performance.

13. Cover all empty slots using filler panels or slot blockers to maximize cooling air flow.
14. Power on the chassis.

Related Information

Installing the Software on page 4

Direct Connections to the NI 5646R-G

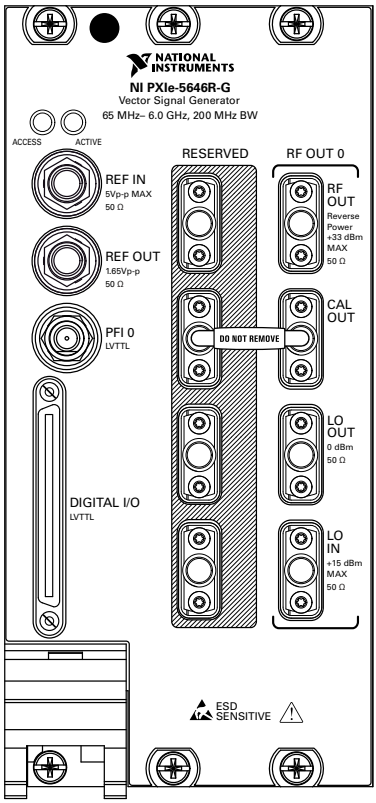
The NI 5646R-G is a precision RF instrument that is sensitive to ESD and transients. Ensure you take the following precautions when making direct connections to the NI 5646R-G to avoid damaging the device.

Note Do not apply external signals to the NI 5646R-G output ports. Applying external signals may cause damage.

- Ensure you are properly grounded when manipulating cables or antennas connected to the NI 5646R-G.
- If you are using noninsulated devices, such as a noninsulated RF antenna, ensure the devices are maintained in a static-free environment.
- If you are using an active device, such as a preamplifier or switch routed to the NI 5646R-G, ensure no signal transients are sourced to the NI 5646R-G.

Hardware Front Panel Connectors and Indicators

Figure 4. NI 5646R-G Front Panel



Caution Apply external signals only while the NI 5646R-G is powered on. Applying external signals while the device is powered off may cause damage.

Table 1. Device Front Panel Icon Definitions

	Refer to the user documentation for required maintenance measures to ensure user safety and/or preserve the specified EMC performance.
	The signal pins of this product's input/output ports can be damaged if subjected to ESD. To prevent damage, turn off power to the product before connecting cables and employ industry-standard ESD prevention measures during installation, maintenance, and operation.

Table 2. NI 5646R-G General Front Panel Connectors

Connector	Use
REF IN	Input terminal that allows for the use of an external 10 MHz Reference Clock.
REF OUT	Output terminal that can export a 10 MHz Reference Clock or the 250 MHz Sample Clock.
PFI 0	Programmable-function digital I/O (DIO) connector for use with triggers or events.
DIGITAL I/O	DIO terminal that contains general-purpose 3.3 V LVTTL DIO signals. DIO lines are direction-configurable as input or output.

Table 3. NI 5646R-G RF Front Panel Connectors

Connector		Use
RF OUT 0	RF OUT	Output terminal for RF signals.
	CAL OUT	**Caution** Do not disconnect the cable that connects CAL IN to CAL OUT. Removing the cable from or tampering with the CAL IN or CAL OUT front panel connectors voids the product calibration and specifications are no longer warranted. Connector that is used when running self-calibration on the device.
	LO OUT	Output terminal for exporting the RF OUT 0 LO source.
	LO IN	Input terminal that allows for the use of an external LO for RF OUT 0.

Table 4. NI 5646R-G Front Panel LEDs

LED	Indications
ACCESS	Indicates the basic hardware status of the device. Off—The device is not yet functional or has detected a problem with a PXI Express power rail. Amber—The device is being accessed. *Accessed* means that you are writing to the device setup registers to control the device, reading from the device to monitor the device status, or transferring data to/from the device. Green—The device is controllable through the software.
ACTIVE	When using NI-RFSG, the ACTIVE LED indicates the state of the device. Off—The device is idle. Solid green—The device is generating a waveform. Solid red—The device has detected an error. The LED remains red until the error condition is removed.

Related Information

Refer to your device specifications document for more information about front panel connectors and LEDs.

Configuring the NI 5646R-G in MAX

Use Measurement & Automation Explorer (MAX) to configure your National Instruments hardware. MAX informs other programs about which devices reside in the system and how they are configured. MAX is automatically installed with NI-RFSG.

1. Launch MAX.
2. In the configuration tree, double-click **Devices and Interfaces** to see the list of installed devices.

   Installed devices appear under the name of their associated chassis.
3. Expand your **Chassis** tree item.

   MAX lists all devices installed in the chassis. Your default device names may vary.

   Note If you do not see your device listed, press <F5> to refresh the list of installed devices. If the device is still not listed, power off the system, ensure the device is correctly installed, and restart.
4. Record the device identifier MAX assigns to the hardware. Use this identifier when programming the NI 5646R-G.

Self-Calibration

Self-calibration adjusts the NI 5646R-G for variations in the module environment using an onboard high-precision calibration tone. Perform a complete self-calibration after first installing your module and letting it warm up for 30 minutes.

Note Warm up begins when the PXI Express chassis has been powered on and the operating system has completely loaded.

The NI 5646R-G modules are externally calibrated at the factory; however, you should perform a self-calibration in any of the following situations:

- After first installing the NI 5646R-G into your chassis
- After any module in the chassis is installed, uninstalled, or moved
- When the system is in an environment where the ambient temperature varies or the module temperature has drifted more than ±5 °C from the temperature at the last self-calibration
- To periodically adjust for small performance drifts that occur with product aging

NI recommends you perform the self-calibration from the installed self-calibration executable located at **Start»All Programs»National Instruments»Vector Signal Transceivers»VST Self Calibrate**. When using LabVIEW, you can also use the niVST Self-Calibrate VI, located on the **Functions»Instrument I/O»Instrument Drivers»NI VST Calibration** palette.

Related Information

Refer to the NI RF Vector Signal Transceivers Help for more information about self-calibration and self-calibrating in text-based languages.

Programming the NI 5646R-G

You can generate signals interactively using the NI-RFSG Soft Front Panel (SFP), or you can use the NI-RFSG instrument driver to program your device in the supported ADE of your choice.

Table 5. NI 5646R-G Programming Options

Application Programming Interface (API)	Location	Description
NI-RFSG SFP	Available from the Start menu at **Start»All Programs»National Instruments»NI-RFSG»NI-RFSG Soft Front Panel**.	The NI-RFSG SFP controls, generates, and presents data similar to stand-alone RF vector signal generators. The NI-RFSG SFP operates on the PC, so it provides additional processing, storage, and display capabilities.
NI-RFSG Instrument Driver	LabVIEW—Available on the LabVIEW Functions palette at **Measurement I/O»NI-RFSG**.	NI-RFSG configures and operates the device hardware, performs waveform programming and generation, and performs basic modulation tasks using LabVIEW VIs or LabWindows/CVI functions.
	LabWindows/CVI—Available at **Program Files»IVI Foundation»IVI»Drivers»niRFSG**.	
	Microsoft Visual C/C++	Add all required include and library files to your project to create an NI-RFSG application in Microsoft Visual C/C++.

Related Information

For detailed instructions about how to generate signals in a specific ADE, refer to the Getting Started section of the NI RF Signal Generators Help.

Refer to the Creating an Application with Microsoft Visual C and C++ topic of the NI RF Signal Generators Help to manually add all required include and library files to your project.

NI-RFSG Examples

Examples demonstrate the functionality of the device and serve as programming models and building blocks for your own applications. The NI Example Finder is a utility available for some ADEs that organizes examples into categories and allows you to easily browse and search installed examples. You can see descriptions and compatible hardware models for each example or see all the examples compatible with one particular hardware model.

You can locate LabVIEW or LabWindows/CVI examples with the NI Example Finder. Within LabVIEW or LabWindows/CVI, select **Help»Find Examples** and navigate to **Hardware Input and Output»Modular Instruments**.

Generating a Signal Using the NI-RFSG Soft Front Panel

To verify your device configuration, use the NI-RFSG Soft Front Panel (SFP) in MAX to generate a simple signal.

1. Within MAX, select the NI 5646R-G module in the configuration tree.
2. Select **Soft Front Panel** from the MAX toolbar.

   The NI-RFSG SFP launches.
3. Within the NI-RFSG SFP, specify a frequency and a power level for signal generation.

   Caution Clicking **RF On/Off** generates a signal from the RF OUTPUT connector of the NI 5646R-G front panel. Disconnect any equipment that can be damaged by the test signal prior to clicking the **RF On/Off** button on the NI-RFSG SFP.
4. Click **RF On/Off** to begin signal generation.

   Note Refer to the *Troubleshooting* section of this document if an ACTIVE LED does not turn on or if the NI-RFSG SFP generates an error.

   During signal generation, the ACTIVE LED on the NI 5646R-G hardware module illuminates.
5. Click **RF On/Off** to stop signal generation.

Troubleshooting

If an issue persists after you complete a troubleshooting procedure, contact NI technical support or visit *ni.com/support*.

Why Is the ACCESS LED Off When the Chassis is On?

The LEDs may not light until the device has been configured in MAX. Before proceeding, verify that the NI 5646R-G appears in MAX.

If the ACCESS LED fails to light after you power on the chassis, a problem may exist with the chassis power rails, a hardware module, or the LED.

Caution Apply external signals only while the NI 5646R-G is powered on. Applying external signals while the device is powered off may cause damage.

1. Disconnect any signals from the module front panels.
2. Power off the chassis.
3. Remove the module from the chassis and inspect it for damage. Do not reinstall a damaged device.
4. Reinstall the module in a different chassis slot.
5. Power on the chassis.
6. Verify that the device appears in MAX.

7. Reset the device in MAX.

What Should I Do if the NI 5646R-G Doesn't Appear in MAX?

1. In the MAX configuration tree, click **Devices and Interfaces**.
2. Expand the **Chassis** tree to see the list of installed devices, and press <F5> to refresh the list.
3. If the module is still not listed, power off the system, ensure that all hardware is correctly installed, and restart the system.
4. Navigate to the Device Manager.

Operating System	Description
Windows 8	Right-click the Start screen, and select **All apps»Control Panel» Hardware and Sound»Device Manager**.
Windows 7	Select **Start»Control Panel»Device Manager**.
Windows Vista	Select **Start»Control Panel»System and Maintenance»Device Manager**.
Windows XP	Select **Start»Control Panel»System»Hardware»Device Manager**.

5. If you are using a PXI controller, verify that a **National Instruments** entry appears in the system device list. Reinstall NI-RFSG and the device if error conditions appear in the list. If you are using an MXI controller, right-click **PCI-to-PCI Bridge**, and select **Properties** from the shortcut menu to verify that the bridge is enabled.

What Should I Do if the Thermal Shutdown Error Appears?

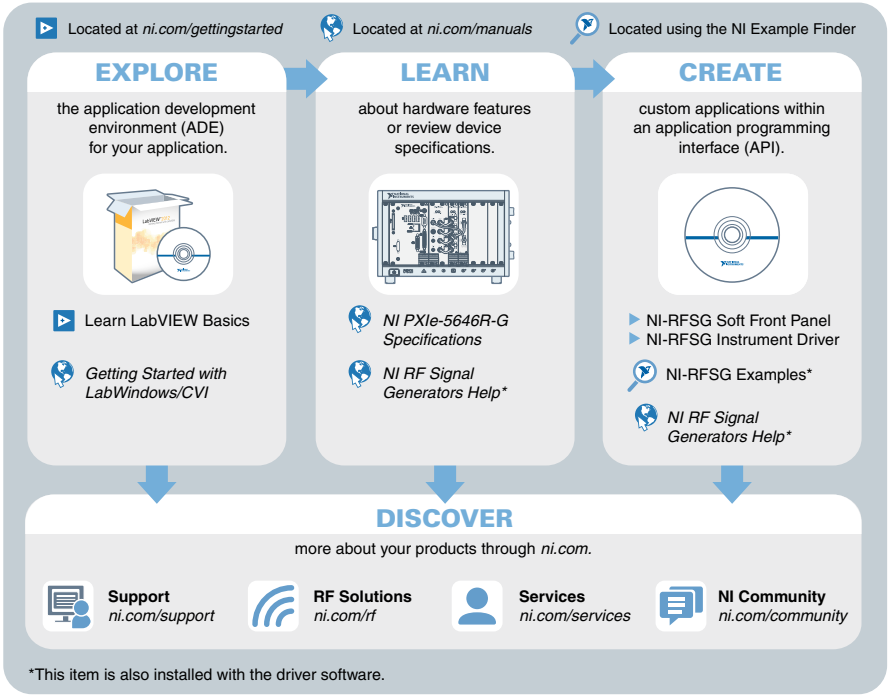
The thermal shutdown error appears when device temperatures exceed safe limits. The NI 5646R-G shuts down until temperatures fall to acceptable levels and you reset the device in MAX.

1. Power off the chassis that contains the device.
2. Review the *Maintain Forced-Air Cooling Note to Users* included in the NI 5646R-G kit and make any necessary adjustments to ensure that the device is effectively cooled.
3. Reset the device in MAX.

   The thermal shutdown error continues to be reported until you successfully reset the device.

Where to Go Next

Refer to the following figure for information about other product tasks and associated resources for those tasks.



Tip The *NI RF Signal Generators Help* is an HTML version of a traditional user manual that includes detailed information about RF fundamentals, device features, and programming with NI-RFSG.

Worldwide Support and Services

The National Instruments website 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.

Visit *ni.com/services* for NI Factory Installation Services, repairs, extended warranty, and other services.

Visit *ni.com/register* to register your National Instruments product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

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 electromagnetic 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*.

National Instruments corporate headquarters is located at 11500 North Mopac Expressway, Austin, Texas, 78759-3504. National Instruments also has offices located around the world. For telephone support in the United States, create your service request at *ni.com/support* or dial 1 866 ASK MYNI (275 6964). For telephone support outside the United States, visit the *Worldwide Offices* section of *ni.com/niglobal* to access the branch office websites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

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