PXIe-5654

User Manual

Contents

PXIe-5654 User Manual

The PXIe-5654 User Manual provides detailed descriptions of the product functionality and the step-by-step processes for use.

Looking For Something Else?

For information not found in the User Manual for your product, such as specifications and API reference, browse ***Related Information***.

Related information:

- NI Hardware and Software Operating System Compatibility
- PXIe-5654 Specifications
- PXIe-5654 Calibration Procedure
- RFmx User Manual
- NI RF Signal Generators User Manual
- Software and Driver Downloads
- License Setup and Activation
- Release Notes
- NI Learning Center
- NI Community

PXIe-5654 Overview

The PXIe-5654 is a PXI RF analog signal generator designed for testing phase noise and frequency tuning time. Use the PXIe-5654 for blocker test and receiver desensitization, high-performance intermodulation distortion measurements, and electronic warfare applications. The PXIe-5654 meets the requirements of RFIC characterization, satellite test, and radar applications.

The PXIe-5654 name encompasses the following instruments:

Table 1. PXIe-5654 Instruments

Instrument	Part Numebrs	Constituent Modules
PXIe-5654	783126-01, 783126-02, 783127-01, 783127-02	PXIe-5654
PXIe-5654 with Amplitude Extender	784776-01, 784776-02, 784777-01, 784777-02	PXIe-5654 , PXIe-5696

Key Features

- 250 kHz to 20 GHz frequency range
- -10 dBm to +13 dBm amplitude range, depending on frequency
- Up to +27 dBm extended amplitude range
- Up to +27 dBm output power (typical) with 130 dB of RF output power range
- 100 µs frequency-switching speed
- -133 dBc/Hz phase noise at 1 GHz, 10 kHz offset (typical)

Driver Support

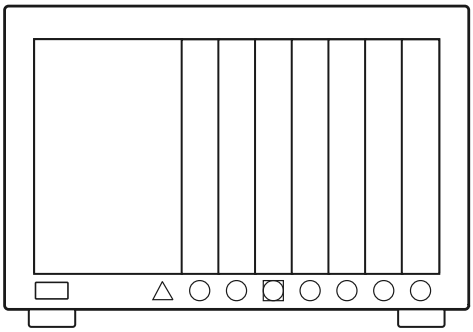
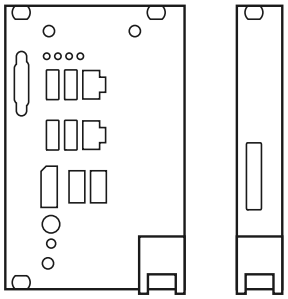
Use NI-RFSG to configure and operate the PXIe-5654 , perform waveform programming and generation, and perform basic modulation tasks using LabVIEW VIs or LabWindows/CVI functions. NI-RFSG provides the standard IVI-based functionality needed for most RF signal generator applications. NI-RFSG includes an interactive soft front panel and examples.

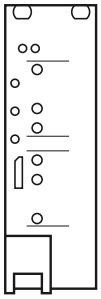
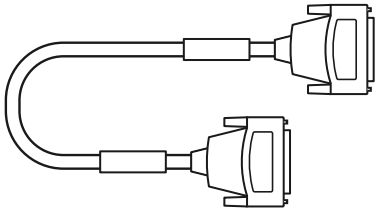
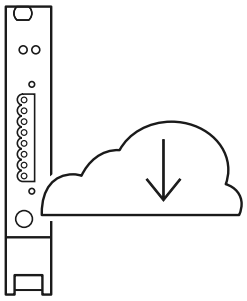
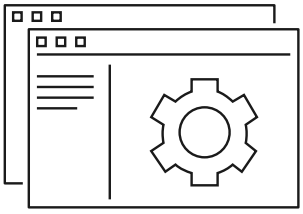
Tip To optimize product performance, update to the most recent driver version.

Components of a PXIe-5654 System

PXIe-5654 is designed for use in a system that may require hardware, drivers, and software to optimize PXIe-5654 for your application. Use the minimum required PXIe-5654 system components as a starting point for building your system.

Table 2. Minimum Required PXIe-5654 System Components

Component	Description and Recommendations
PXI Chassis 	A PXI chassis houses the PXIe-5654 and supplies power for PXIe-5654 functions.
PXI Controller or PXI Remote Control Module 	You can install a PXI controller or a PXI remote control (MXI) module depending on your system requirements. These components, installed in the same PXI chassis as the PXIe-5654 , interface with the instrument using NI device drivers.
PXI RF Analog Signal Generator	Your generator instrument.

Component	Description and Recommendations
	
Cables and Accessories 	Cables and accessories allow connectivity to/from your instrument for measurements. Refer to ***Cables and Accessories*** for recommended cables and accessories and guidance.
Driver Software 	Instrument driver software that provides functions to interact with the PXIe-5654 and execute measurements using the PXIe-5654 . **Note** For optimal performance, use the most current version of driver software with the PXIe-5654 . You can find the driver requirements on ni.com.
NI Applications 	Instrument driver software offers support for the following applications: • InstrumentStudio • LabVIEW • LabWindows/CVI

Component	Description and Recommendations
	• C/C++ • .NET • Python

Part Numbers for Recommended Cables and Accessories

Use part numbers to purchase the cables and accessories NI recommends to optimize the performance of PXIe-5654 .

Contact NI for purchase information.

Table 3. Part Numbers for Recommended Cables and Accessories

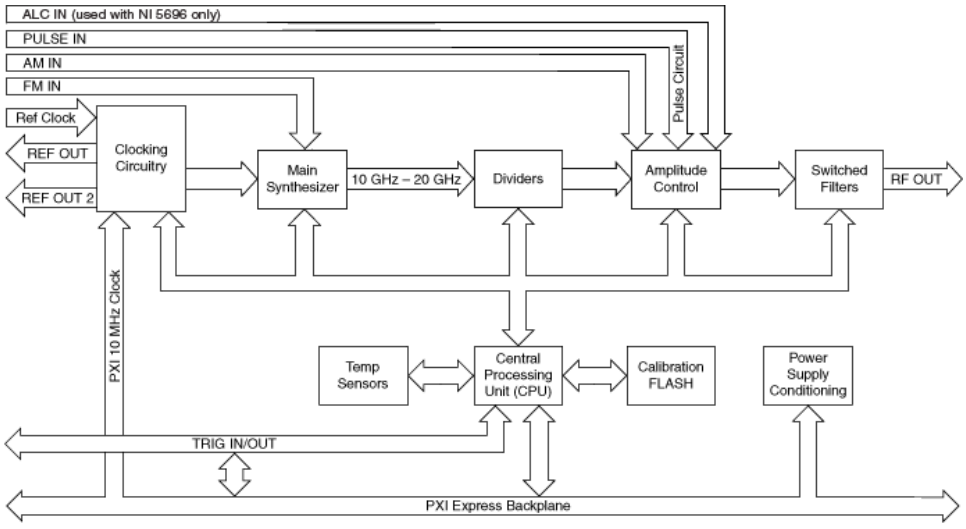
Accessory/Cable	Description	Part Number
Cable assembly, semi-rigid	SMA-SMA, RF-AMP OUT-ATTEN IN	155081B-01
Cable	SMB-SMB, ALC IN PXIe-5654 to ALC OUT PXIe-5696 , 5"	157672A-05
Cable assembly, semi-rigid	SMA-SMA, RF-OUT PXIe-5654 to RF AMP-IN, PXIe-5696	155082B-01

PXIe-5654 Theory of Operation

Refer to block diagrams and state models to understand the hardware and software design behind the PXIe-5654 .

PXIe-5654 Block Diagram

This section contains a high-level block diagram for the PXIe-5654 RF Analog Signal Generator and descriptions of individual blocks.



The CPU manages the control signals and data transferred between the circuit blocks. The CPU controls all internal registers and components necessary for frequency generation, modulation, and amplitude control. The CPU communicates directly with the host computer. Additionally, the CPU monitors temperature, health, and status of the module and flags any operation or temperature problems. The following list describes the individual blocks of the PXIe-5654:

- ***Clocking circuitry*** contains the system clock reference and the direct digital synthesizer (DDS). The system clock is a 100 MHz oven-controlled crystal oscillator (OCXO) that you can configure to phase-lock to an external reference of 1 MHz to 20 MHz in 1 MHz intervals that is present at the REF IN front panel connector.

  The REF OUT connector provides a 10 MHz reference output signal and the REF OUT 2 provides a 100 MHz reference output signal. You can independently

control these output signals and use them to provide a reference to additional test instruments.

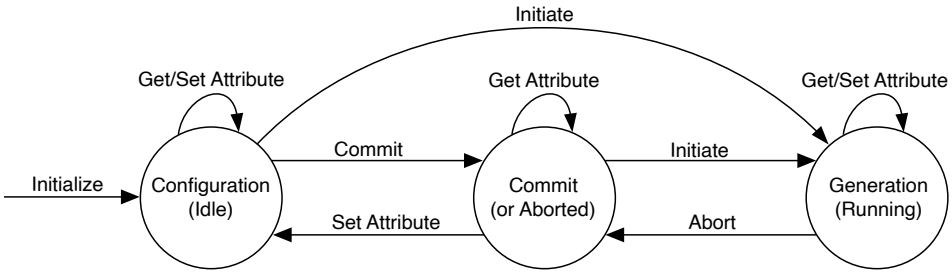
Additionally, you can calibrate the internal frequency reference to remove the effects of aging by applying an external frequency reference standard, such as GPS or rubidium, to the REF IN connector, and then you can execute an OCXO calibration sequence.

- Signal generation occurs inside the ***main synthesizer*** circuit. The synthesizer is phase-locked to the Reference Clock. Following the main synthesizer are the ***dividers*** to scale the frequency.
- The ***amplitude control circuit*** performs amplitude control, and the power control circuit has a control range of ≥20 dB with 0.01 dB resolution.
- After the amplitude control circuit, a switched filter bank ensures adequate harmonic suppression for each hardware band. Refer to the ***PXIe-5654 Specifications*** document for typical suppression values.
- Modulation capabilities include amplitude modulation (AM), frequency modulation (FM), phase modulation (PM), and pulse modulation. The ***pulse modulation*** circuit performs the pulse modulation, the ***main synthesizer*** performs the FM, and the ***amplitude control*** circuit performs the AM.
- Use the ALC IN front panel connector only in conjunction with the PXIe-5696 Amplitude Extender (AE). The automatic leveling control (ALC) utilizes a temperature-stable voltage reference and digital-to-analog converter (DAC) in the AE module to perform fine amplitude corrections in the amplitude control circuit of the PXIe-5654. This provides accurate power levels over the whole frequency generation range from 250 kHz to 20 GHz and -110 dBm to +30 dBm, although the maximum power varies with frequency. Refer to the PXIe-5654 Specifications document for output power specifications according to frequency.
- Use the TRIG IN/OUT front panel connector for synchronization of various steps during RF list mode operation.

The CPU uses the calibration data stored in the FLASH memory to correctly set up the hardware for signal generation. The device uses the calibration data to compensate for non-ideal components and temperature variation.

Hardware State Diagram

The following diagram shows the hardware states of the PXIe-5654



- ***Configuration (Idle)***- The device is not generating a signal. All session properties or attributes can be programmed in the Configuration state. In the Configuration state, the properties or attributes have not necessarily been applied to hardware, and the hardware configuration of the device may not match the session property or attribute values. The device remains configured as it was the last time a session was committed. If the computer has just been powered on, reset, or theniRFSG Reset Device VI or the niRFSG_ResetDevice function has just been called, the device is in the default hardware state.
- ***Commit (or Aborted)***- Applies the device properties or attributes to the hardware.
- ***Generation***- In the Generation state, the device is generating a waveform as specified by the session properties or attributes configured. Dynamic (or on-the-fly) properties and attributes are applied immediately to hardware. Dynamic properties and attributes can be applied to the device immediately if set while the session is in the Generation state.

PXI Trigger Lines

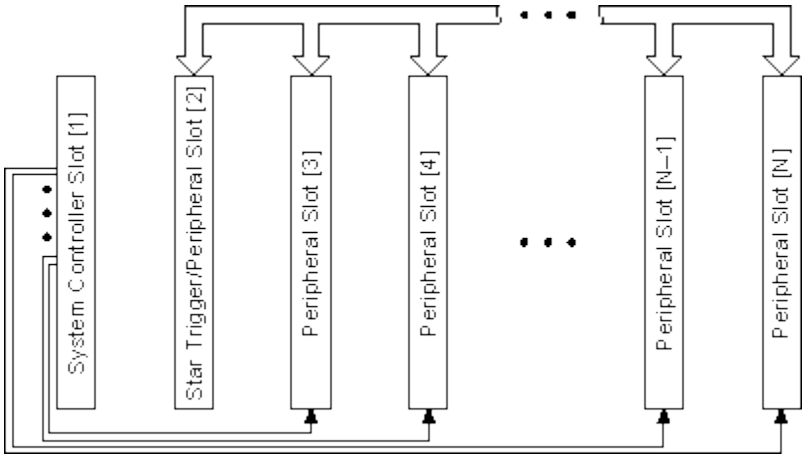
Eight PXI bus trigger lines are highly flexible and can be used in a variety of ways.

You can use PXI bus lines in the following ways:

- To synchronize the operation of several different PXI peripheral devices
- To use one device to control carefully timed sequences of operations performed on other devices in the system
- To pass triggers between devices, allowing precisely timed responses to

asynchronous external events that are being monitored or controlled

The number of triggers that an application requires varies with the complexity and number of events involved.



The PXI Specification is implemented with the RTSI bus through the PXI trigger lines. PXI Specification requires eight lines, PXI_Trig<0..7>, on the P2/J2 connector of the PXI chassis for the trigger lines.

System Reference Clock

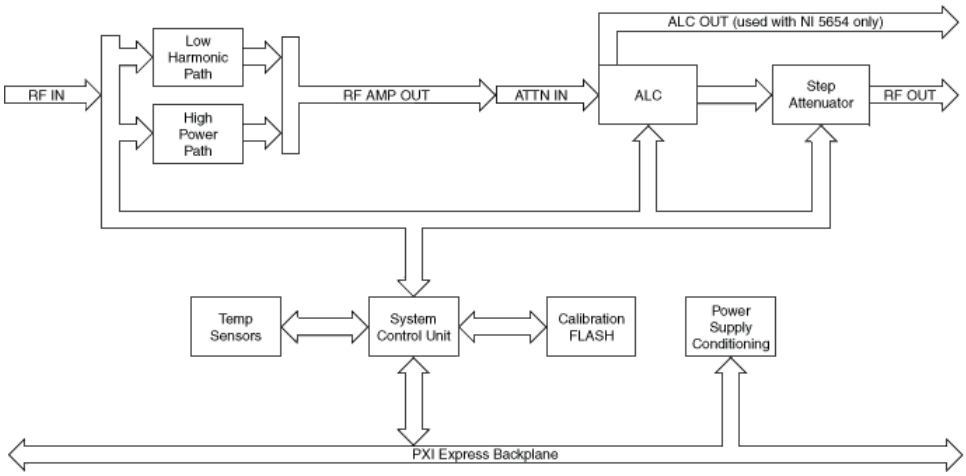
The PXI chassis supplies the PXI 10 MHz system Reference Clock signal (PXI_CLK10), independently to each peripheral slot.

An independent buffer drives the clock signal to each peripheral slot. The buffer has a source impedance matched to the backplane and a skew ranging from less than 1 ns to greater than 250 ps between slots. You can use this common Reference Clock signal to synchronize multiple devices in a measurement or control system. Sourcing an external clock on this pin automatically disables the 10 MHz source on the backplane. You can synchronize multiple chassis that have connectors on the back panel for 10 MHz reference in and 10 MHz reference out. Refer to your PXI chassis documentation for more information.

Note PXI Express chassis have a PXI 10 MHz system clock signal, but NI-RFSG devices cannot drive it.

PXIe-5696 Block Diagram

This topic contains information about the PXIe-5696 Amplitude Extender high-level block diagram and descriptions of the individual blocks.



The system control unit (SCU) manages the control signals and data transferred between the circuit blocks. The SCU controls all internal registers and components necessary for filtering, amplification, automatic level control (ALC), and amplitude control. The SCU communicates directly with the host computer. Additionally, the SCU monitors temperature, health, and status of the module and flags any operation or temperature problems. The following list describes the individual blocks of the PXIe-5696:

- The PXIe-5696 amplitude extender (AE) module contains two input terminals, including the RF IN and the ATTN IN front panel connectors.
- The RF IN connector provides two internal paths, including the ***low harmonic path*** and the ***high power path***.
  - The internal low harmonic path contains a bank of switched amplifiers and filters to ensure adequate harmonic suppression for each hardware band. Refer to the ***PXIe-5654 Specifications*** document for harmonic performance specifications.
  - The internal high power path contains a power amplifier to boost the output power output from 250 MHz to 20 GHz. Refer to the ***PXIe-5654 Specifications*** document for PXIe-5696 output power values.
- The ATTN IN connector includes an ALC and a 110 dB mechanical ***step***

attenuator.

- The ALC utilizes a temperature-stable voltage reference and digital-to-analog converter (DAC) in the AE module to perform fine amplitude corrections using the ***amplitude control*** circuit of the PXIe-5654 RF Analog Signal Generator. The ALC is used to provide accurate RF power levels over the whole frequency generation range from 250 kHz to 20 GHz and amplitude control range. Use the ALC OUT front panel connector only in conjunction with the PXIe-5654 module. Refer to the ***PXIe-5654 Specifications*** document for PXIe-5696 amplitude accuracy.
- The mechanical step attenuator provides coarse amplitude control and can be set in 10 dB steps from 0 dB to 110 dB. When you use the PXIe-5696 with the PXIe-5654, the PXIe-5654 performs fine amplitude control.

The SCU uses the calibration data stored in the FLASH memory to correctly set up the hardware for accurate power control. The device uses the calibration data to compensate for internal components and temperature variation.

Frequency Tuning Times

The PXIe-5654 is a highly agile frequency synthesizer. When the fast tuning option is available, the PXIe-5654 can usually tune to and from any frequency in 100 µs or 150 µs when tuning to frequencies less than 250 MHz.

One exception occurs when the device switches from a higher frequency to a frequency of 250 MHz or less; if a frequency switch crosses the 250 MHz threshold in a high-to-low direction, the frequency settling time increases. The standard switching time without the fast tuning option is 1 ms.

Note Refer to the ***PXIe-5654 Specifications*** document for frequency settling times.

Amplitude Settling Times

Each time the frequency switches, there is an accompanying amplitude settling time associated with the internal hardware settings change. You can use NI-RFSG to set desired amplitude settling values and ensure that the amplitude is settled. You may experience overshoot or undershoot in amplitude level while the amplitude settles.

Amplitude settling takes different lengths of time depending on whether the device ALC is operating in open-loop mode or closed-loop mode.

Note Refer to the ***PXIe-5654 Specifications*** document for amplitude settling times.

Phase Noise and Signal-to-Noise Ratio

The PXIe-5654 uses a patented QuickSyn architecture to allow quick frequency changes in 100 µs, while retaining good close-in phase noise that is typically reserved for YIG-based signal sources.

This close-in phase noise performance allows good signal-to-noise ratio (SNR) for radar and communication applications. This SNR combined with fast frequency switching reduces production measurement testing time while the accuracy of each measurement is maintained.

Note Refer to the ***PXIe-5654 Specifications*** document for specified phase noise performance.

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**.

PXIe-5654 Front Panel and LEDs

This section describes the connectors and LED indicators on the PXIe-5654 RF Analog Signal Generator front panel.

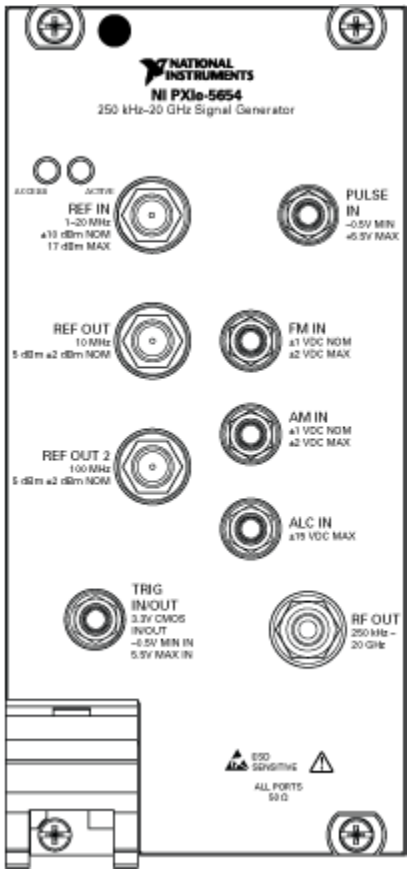


Table 6. General Connector Descriptions

Connector	Type	Use
REF IN	SMA	An input terminal that routes an external reference signal to the PXIe-5654. This connector accepts a frequency range from 1 MHz to 20 MHz. REF IN has an input range of -5 dBm to +15 dBm and an input damage level of >+20 dBm.
REF OUT	SMA	An output terminal that routes a 10 MHz signal from the PXIe-5654. The device outputs the 10 MHz reference signal at +5 dBm, ±2 dBm.
REF OUT 2	SMA	An output terminal that routes a 100 MHz signal from the PXIe-5654. The device outputs the 100 MHz reference signal at

Connector	Type	Use
		+5 dBm, ±2 dBm.
TRIG IN/OUT	SMB	An input/output terminal with a +3.3 V logic level high impedance input or low impedance output. This connector has a maximum input level of +5 V and an input damage level of ≤-0.5 V and ≥5.5 V. **Notice** Do not apply an input signal to the TRIG IN/OUT connector when it is configured as an output or damage may occur.
PULSE IN	SMB	An input terminal that accepts a modulating square wave to pulse the RF output. PULSE IN has a +3.3 V logic level high impedance input. This connector has a maximum input level of +5 V and an input damage level of ≤-0.5 V and ≥5.5 V.
FM IN	SMB	An input terminal for frequency modulation with an input range of ±1 V_{pk-pk}. FM IN has an input damage level of ±2 V.
AM IN	SMB	An input terminal for amplitude modulation with an input range of ±1 V_{pk-pk}. AM IN has an input damage level of ±2 V.
ALC IN	SMB	If you use the PXIe-5654 with the PXIe-5696 Amplitude Extender, this terminal connects to the ALC OUT connector on the PXIe-5696. This connector has an input damage level of ±15 V.
RF OUT	SMA	An output terminal for the generated RF signal at the requested frequency and power level. This connector covers a frequency range from 250 kHz to 20 GHz.

The following table provides information about the PXIe-5654 module front panel LEDs and the device states they indicate:

Table 7. LED Indicators

LED	Indications
ACCESS	Indicates the basic hardware status of the PXIe-5654 module.

LED	Indications
	Off—The module is not yet functional or has detected a problem with a PXI Express power rail. Amber—The module is being accessed. ***Accessed*** means that the device setup transferred in order to control the device. Green—The module is ready to be programmed.
ACTIVE	Indicates the state of the PXIe-5654 module: Off—The module is not generating a signal. Green—The module is generating a signal; applicable phase-locked loops (PLLs) are locked. Red—The module has detected an error state; this may indicate a PLL lock failure or a thermal shutdown condition.

Reference Input and Output Connectors

You can use the PXIe-5654 REF IN connector to phase-lock to an external reference source. In addition to using a 10 MHz reference source, you can also lock the reference to additional frequencies. The REF IN connector accommodates a wide range of input power levels for the RF signal generator to successfully lock to an external reference signal.

Note Although the devices may be frequency-locked together, their generated RF signals are not phase-synchronized.

The PXIe-5654 REF OUT connector provides a 10 MHz output signal, and the PXIe-5654 REF OUT 2 connector provides a 100 MHz output signal. The output power levels on both connectors are not adjustable. You can use both REF OUT and REF OUT 2

connectors as a reference source to synchronize the RF signal generator with other test equipment. You can also independently turn on or off both the REF OUT and REF OUT 2 outputs.

Refer to the ***PXIe-5654 Specifications*** for onboard frequency reference input and output specifications.

PXIe-5696 Front Panel and LEDs

This section describes the connectors and LED indicators on the PXIe-5696 Amplitude Extender (AE) front panel.

Table 6. General Connector Descriptions

Connector	Type	Use
RF AMP OUT	SMA	An output terminal that routes the amplified output signal to the ATTN IN connector. **Notice** Do not disconnect the cable that connects RF AMP OUT to ATTN IN. Removing the cable from or tampering with the RF AMP OUT or ATTN IN front panel connectors voids the product calibration and specifications are no longer warranted.

Connector	Type	Use
ATTN IN	SMA	An input terminal that connects to the RF AMP OUT connector. This connector has an input damage level of +30 dBm. **Notice** Do not disconnect the cable that connects RF AMP OUT to ATTN IN. Removing the cable from or tampering with the RF AMP OUT or ATTN IN front panel connectors voids the product calibration and specifications are no longer warranted.
RF IN	SMA	An input terminal that amplifies the incoming signal from the PXIe-5654 RF Analog Signal Generator and provides additional signal conditioning. RF IN connects to the RF OUT connector of the PXIe-5654. This connector has an input damage level of +15 dBm.
ALC OUT	SMB	An output terminal that connects to the ALC IN connector of the PXIe-5654. This connector has a maximum output signal level of ±15 VDC. **Notice** Connect this output terminal only to the ALC IN connector of the PXIe-5654. Do not connect this output terminal to an external source or damage may occur.
RF OUT	3.5 mm	An output terminal for a leveled RF output signal over the specified power range. This connector is protected against reverse RF power up to +30 dBm.

The following table provides information about the PXIe-5696 module front panel LEDs and the device states they indicate:

Table 7. LED Indicators

LED	Indications
ACCESS	Indicates the basic hardware status of the PXIe-5696 module.

LED	Indications
	Off—The module is not yet functional or has detected a problem with a PXI Express power rail. Amber—The module is being accessed. ***Accessed*** means that the device setup transferred in order to control the device. Green—The module is ready to be programmed.
ACTIVE	Indicates the state of the PXIe-5696 module: Off—The module is not enabled. Green—The module has been initiated and is running Red—The module has detected an error state; this may indicate an internal failure or a thermal shutdown condition.

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 PXIe-5654 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.

> **Notice** Apply external signals only while the PXIe-5654 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 and perform a self-test.

Safety Guidelines

Hot Surface If the PXIe-5654 has been in use, it may exceed safe handling temperatures and cause burns. Allow the PXIe-5654 to cool before removing it from the chassis.

Caution Observe all instructions and cautions in the user documentation. Using the product in a manner not specified can damage the product and compromise the built-in safety protection. Return damaged products to NI for repair.

Attention Suivez toutes les instructions et respectez toutes les mises en garde de la documentation d'utilisation. L'utilisation du produit de toute autre façon que celle spécifiée risque de l'endommager et de compromettre la protection de sécurité intégrée. Renvoyez les produits endommagés à NI pour réparation.

Device Warm-Up

NI recommends warming up the PXIe-5654 hardware for 30 minutes before operation.

The unit is fully functional prior to this time, but frequency, amplitude accuracy, and other specifications are not at warranted levels until the device has fully completed warming up.

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

Temperature Monitoring

Both the PXIe-5654 RF signal generator module and the PXIe-5696 Amplitude Extender module have an internal temperature sensor that monitors the RF analog circuitry temperature. You can query these internal temperature sensors using NI-RFSG .

The PXIe-5654 RF signal generator module queries its temperature sensor at defined intervals to correct for amplitude deviations as the operating temperature and ambient temperature changes. NI-RFSG polls the temperature sensor of the PXIe-5696 to correct for amplitude deviations as the operating temperature and ambient temperature changes.

Note If a temperature sensor reports a temperature above 80 °C, the PXI Express power rails to the RF signal generator or amplitude extender shuts down to protect the RF circuitry from damage.

Thermal Shutdown

NI-RFSG supports thermal shutdown monitoring for NI RF signal generator modules. This feature allows the module to detect when it has reached a dangerously high temperature and to then power off, preventing damage to the device.

If safe temperature limits are exceeded, the RF enclosure is powered off, and NI-RFSG returns an error.

Note The PXIe-5654 is warm to the touch during normal operation. The device should never reach a temperature high enough to cause thermal shutdown unless the fan or vents on the PXI or PXI Express chassis are blocked or the filters on the fans are excessively dusty.

Querying Device Temperature

Query the value of the Device Temperature property or the NIRFSG_ATTR_DEVICE_TEMPERATURE attribute to return the temperature of the internal RF circuitry of the PXIe-5654 .

If using the PXIe-5654 with PXIe-5696 , you can also query the temperature of the PXIe-5696 AE module with the AE Temperature property or the NIRFSG_ATTR_AE_TEMPERATURE attribute.

Note Serial signals between the sensor and the central processing unit could potentially modulate the signal being generated, causing phase spurs. After the device is thoroughly warmed up, its temperature varies only slightly and slowly, so you do not need to constantly poll the temperature sensor.

Re-enabling the Device After Thermal Shutdown

Complete the following steps to restore power to the RF enclosure:

1. Ensure the filters are clean and that you have a clear path for airflow through your PXI Express chassis.
2. Review the guidelines in the ***Maintain Forced-Air Cooling Note to Users*** that shipped with the device, and make any necessary adjustments to ensure that the chassis can cool the device effectively.
3. Perform a device reset in MAX by selecting the device in the MAX configuration tree and clicking **Reset** from the MAX toolbar.

Unpacking the Kit

Notice 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.

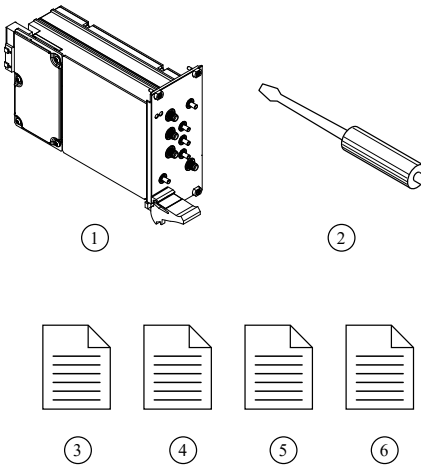
   Notice Never touch the exposed pins of connectors.

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

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

Verifying the Kit Contents

Figure 1. PXIe-5654 Kit Contents



1. PXIe-5654 RF Signal Generator Module
2. Screwdriver, Part Number 772006-01
3. PXIe-5654 Getting Started Guide

4. Read Me First: Safety and Electromagnetic Compatibility
5. Maintain Forced-Air Cooling Note to Users
6. Export Requirements Note to Users

Other Equipment

There are several required items not included in your device kit that you need to install or operate the PXIe-5654 .

Required Items

- A PXI Express chassis and chassis documentation. The 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).

Environment

Maximum altitude	2,000 m (800 mbar) (at 25 °C ambient temperature)
Pollution Degree	2

Indoor use only.

Operating Environment

Ambient temperature range	0 °C to 55 °C

Relative humidity range	10% to 90%, noncondensing

Storage Environment

Ambient temperature range	-40 °C to 71 °C
Relative humidity range	5% to 95%, noncondensing

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 are designed to 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 modifications to the product not expressly approved by NI 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, the length of all I/O cables must be no longer than 3 m (10 ft).

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. Download the driver software installer from ni.com/downloads.
   Package Manager downloads with the driver software to handle the installation. Refer to the Package Manager Manual for more information about installing, removing, and upgrading NI software using Package Manager.
3. Follow the instructions in the installation prompts.

   Note Windows users may see access and security messages during installation. Accept the prompts to complete the installation.

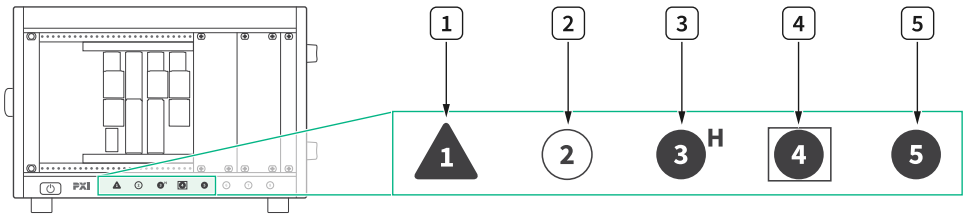
4. When the installer completes, select **Restart** in the dialog box that prompts you to restart, shut down, or restart later.

Installing the PXIe-5654

> **Notice** To prevent damage to the PXIe-5654 caused by ESD or contamination, handle the module using the edges or the metal bracket.

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. Remove the black plastic covers from all the captive screws on the module front panel.
5. Identify a supported slot in the chassis. The following figure shows the symbols that indicate the slot types.

Figure 1. Chassis Compatibility Symbols

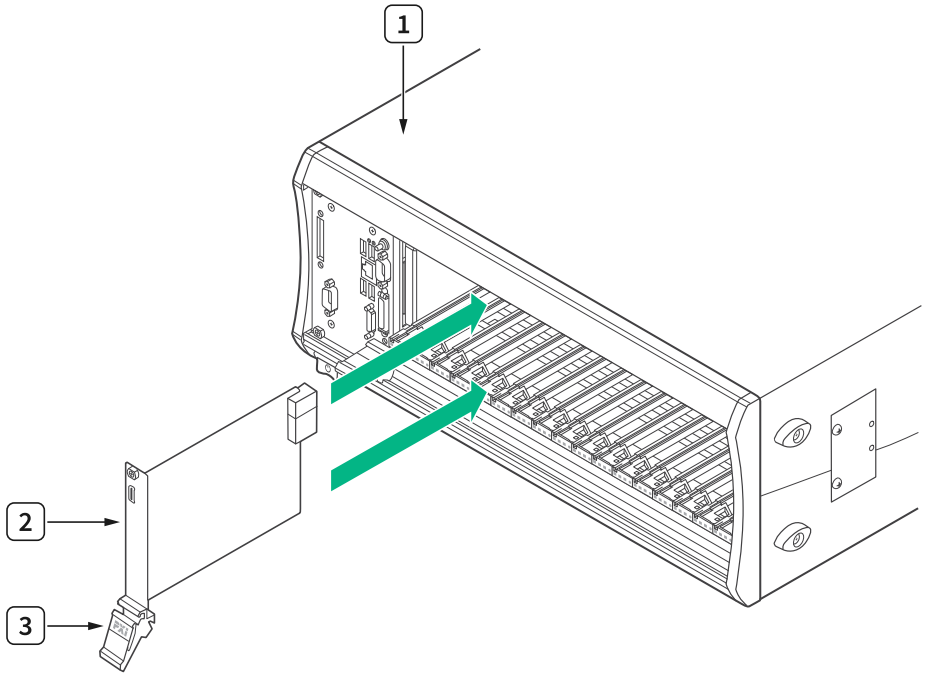


1. PXI Express System Controller Slot
2. PXI Peripheral Slot
3. PXI Express Hybrid Peripheral Slot
4. PXI Express System Timing Slot
5. PXI Express Peripheral Slot

PXIe-5654 modules can be placed in PXI Express peripheral slots, PXI Express hybrid peripheral slots, or PXI Express system timing slots.

6. Touch any metal part of the chassis to discharge static electricity.
7. Ensure that the ejector handle is in the downward (unlatched) position.
8. Place the module edges into the module guides at the top and bottom of the chassis. Slide the module into the slot until it is fully inserted.

Figure 1. Module Installation



1. Chassis
2. Hardware Module
3. Ejector Handle in Downward (Unlatched) Position

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

> **Note** All front panel screws must be attached to the PXI chassis to ensure all backplane connectors are fully mated. Tightening the mounting screws also increases mechanical stability and electrically connects the front panel to the chassis, which can improve the signal quality and electromagnetic performance.

11. Cover all empty slots using either filler panels (standard or EMC) or slot blockers with filler panels, depending on your application.

> **Note** For more information about installing slot blockers and filler panels, go to ni.com/r/pxiblocker.

12. Power on the chassis.

Installing the SMA Cables

To operate the modules that comprise the PXIe-5654 , you must interconnect the modules using SMA cables.

Notice The signal pins of this product's input/output ports can be damaged if subjected to ESD. To prevent damage, remove power from the product before connecting cables and employ industry-standard ESD prevention measures during installation, maintenance, and operation.

1. Connect the cable center pin on the SMA cable to the SMA connector on the appropriate device.

   Note Ensure that the SMA cable center pins properly align with the SMA connectors to avoid bending the cable pins or damaging the front panel connectors on the device. If the SMA cable does not exactly align with the SMA connector, bend the cable slightly by hand to align the cable and the connector. The amount of bending should be minimal. The cables can be damaged by excessive bending.

2. Hand-tighten the SMA cable end on the SMA connector after the cable center pins are correctly aligned and connected. The cable connectors should tighten without much torque or effort. If a cable bends due to incorrect alignment, remove the cable from the front panel connector and repeat step 1 before continuing with this step.
3. Use a 1 N · m torque wrench (not included) or RF torque screwdriver and SMA driver bit included in your device kit to complete the tightening of the SMA cable to 1 N · m. Rotate the torque wrench no more than one revolution to tighten the SMA cable before reaching maximum torque.

Direct Connections to the PXIe-5654

The PXIe-5654 is a precision RF instrument that is sensitive to ESD and transients. Ensure you take the following precautions when making direct connections to the PXIe-5654 to avoid damaging the device.

Note Do not apply external signals to the PXIe-5654 . Applying external signals may cause damage.

- Ensure you are properly grounded when manipulating cables or antennas connected to the PXIe-5654 .
- If you are using nonisolated devices, such as a nonisolated 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 PXIe-5654 , ensure no signal transients are sourced to the PXIe-5654 .

PXIe-5654 RF Signal Generator Module

The PXIe-5654 RF signal generator contains nine connectors and two multicolor LEDs.

Figure 1. PXIe-5654 RF Signal Generator Module Front Panel

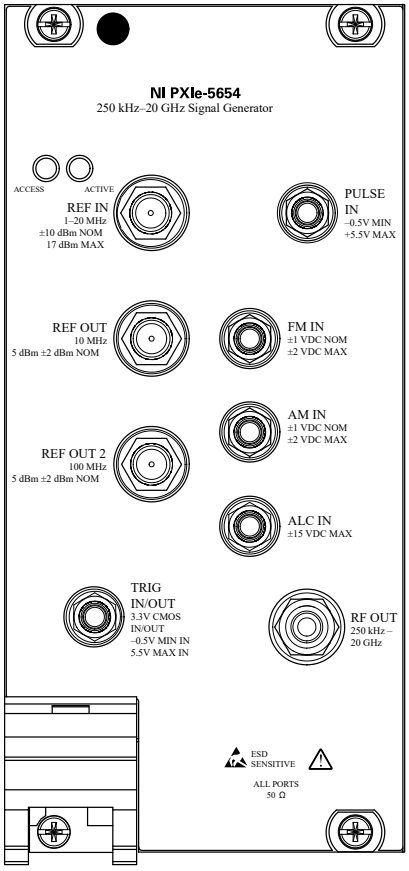


Table 8. Device Front Panel Icon Definitions

⚠	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 9. Front Panel Connectors

Connector	Use
REF IN	Input terminal that routes an external reference signal to the module.
REF OUT	Output terminal that can route a 10 MHz reference signal from the PXIe-5654 .
REF OUT 2	Output terminal that can route a 100 MHz reference signal from the module.
TRIG IN/OUT	Input/output terminal that can route a trigger to or from the module.  **Caution** Do not apply an input signal to the TRIG IN/OUT connector when it is configured as an output or damage may occur.
PULSE IN	Input terminal that accepts a modulating square wave to pulse the RF output.
FM IN	Input terminal for frequency modulation.

Connector	Use
AM IN	Input terminal for amplitude modulation.
ALC IN	Input terminal that connects to the ALC OUT connector of the PXIe-5696 AE.
RF OUT	Output terminal for the generated RF signal at the requested frequency and power level.

Table 10. Front Panel LEDs

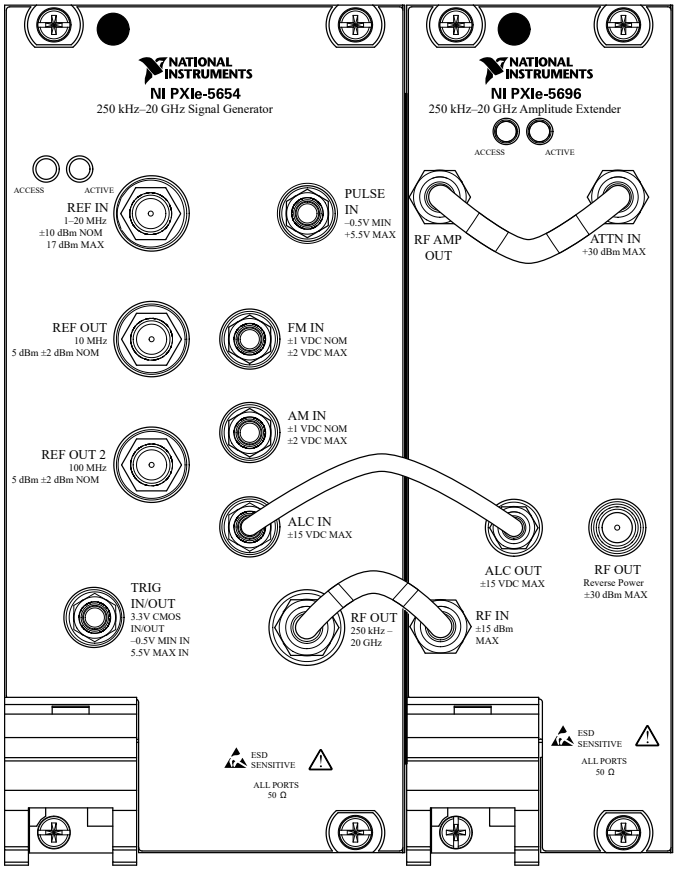
LED	State	Indications
ACCESS	Off	The module is not yet functional or has detected a problem with a PXI Express power rail.
	Amber	The module is being accessed. ***Accessed*** means that the device setup is being transferred in order to control the device.
	Green	The module is ready to be programmed by NI-RFSG .
ACTIVE	Off	The module is not generating a signal.
	Green	The module is generating a

LED	State	Indications
		signal; applicable phase-locked loops (PLLs) are locked.
	Red	The module has detected an error state; this may indicate a PLL lock failure or a thermal shutdown condition.

Connecting to the PXIe-5654

The PXIe-5654 and PXIe-5696 hardware modules interconnect using semi-regid RF cables, included in your hardware kit.

The following figure illustrates the default hardware configuration of the PXIe-5654 interconnected with the PXIe-5696 .



Refer to the ***PXIe-5696 Getting Started Guide*** for instructions on how to interconnect the hardware modules.

The PXIe-5696 helps provide better harmonic suppression or higher output power. You can use both of these options in conjunction with the PXIe-5696 ALC or step attenuator for better amplitude accuracy and wider amplitude dynamic range by interconnecting the PXIe-5654 with the PXIe-5696 , as shown in the preceding figure.

Low Harmonic Path Versus High Power Path

The PXIe-5696 RF IN connector provides two internal paths, including the ***low harmonic path*** and the ***high power path***. The low harmonic path provides lower second and third harmonic spurious responses, whereas the high power path provides higher output power.

NI-RFSG switches the amplifier to use the low harmonic path to obtain the best harmonic performance and switches to the high power path above a certain power level. The power level at which the transition occurs varies according to frequency. You can override the path chosen by NI-RFSG to specify the amplification path to use.

Note Refer to the ***PXIe-5654 Specifications*** document for PXIe-5654 second harmonic values.

ALC Closed Loop Versus Open Loop

The PXIe-5654 with PXIe-5696 has two modes for using the automatic leveling control (ALC): ALC disabled (open-loop mode) and ALC enabled (closed-loop mode).

If the ALC is enabled, the ALC is closed, also known as closed-loop mode. The main purpose of the closed loop is to provide greater amplitude accuracy across the whole frequency range, from 250 kHz to 20 GHz. When the ALC is closed, the digital-to-analog converter (DAC) becomes the master reference for output power, which provides greater accuracy. However, the step attenuator hinders the PXIe-5654 switching speed when the ALC is closed.

If the ALC is disabled, the ALC is open, also known as open-loop mode. Open-loop mode is ideal for utilizing modulation capabilities.

You can configure the ALC connection between the PXIe-5654 and PXIe-5696 using the default hardware configuration.

Note Refer to the ***PXIe-5654 Specifications*** document for PXIe-5654 switching speed values.

Verifying the Installation in MAX

You can use Measurement & Automation Explorer (MAX) to configure your NI hardware. MAX informs other programs about which NI hardware products are in the system and how they are configured. MAX is automatically installed with NI-RFSG .

Note MAX is not available on Linux.

1. Launch MAX.
2. In the configuration tree, expand **Devices and Interfaces** to see the list of installed NI hardware.
   Installed modules appear under the name of their associated chassis.
3. Expand your **Chassis** tree item.
   MAX lists all modules installed in the chassis. Your default names may vary.

   Note If you do not see your module listed, press <F5> to refresh the list of installed modules. If the module is still not listed, power off the system, ensure the module is correctly installed, and restart.

4. Record the name MAX assigns to the hardware. Use this identifier when programming the PXIe-5654 .
5. Self-test the hardware by selecting the item in the configuration tree and clicking **Self-Test** in the MAX toolbar.
   MAX self-test performs a basic verification of hardware resources.

What Should I Do if the PXIe-5654 Does Not Appear in MAX?

1. In the MAX configuration tree, expand **Devices and Interfaces**.
2. Expand the **Chassis** tree to see the list of installed hardware, 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 by right-clicking the Start button, and selecting **Device Manager**.
5. Verify the PXIe-5654 appears in the Device Manager.

a. Under an NI entry, confirm that a PXIe-5654 entry appears.

> **Note** If you are using a PC with a device for PXI remote control system, under **System Devices**, also confirm that no error conditions appear for the **PCI-to-PCI Bridge**.

b. If error conditions appear, reinstall NI-RFSG .

What Should I Do if the PXIe-5654 Fails the Self-Test?

1. Restart the system.
2. Launch MAX.
   - Failed self-test—Perform self-calibration, then perform the self-test again. The PXIe-5654 must be calibrated to pass the self-test.
   - Failed self-calibration—Perform self-calibration again.
3. Power off the chassis.
4. Reinstall the failed module in a different slot.
5. Power on the chassis
6. Perform the self-test again.

Power On and Reset Conditions

The PXIe-5654 hardware is in the following state after powering on or restarting the system and allowing the PC operating system and NI-RFSG to fully load. These conditions are also true after a device reset that you perform directly from NI Measurement & Automation Explorer (MAX).

- The RF analog signal generator frequency is set to 1 GHz.
- The RF analog signal generator power level is set to -7 dBm.
- The RF output signal is off.
- The REF IN connector is set to use the internal frequency reference.
- The REF OUT connector is set to off.
- The REF OUT 2 connector is set to off.
- The TRIG IN/OUT connector is configured as in input.
- The AM IN connector is set to off.
- The FM IN connector is set to off.
- The PULSE IN connector is set to off.
- The ALC is disabled.
- Thermal shutdown monitoring is activated.

PXIe-5654 with PXIe-5696 Power On and Reset Conditions

The PXIe-5654 RF Analog Signal Generator with the PXIe-5696 Amplitude Extender is in the following state after powering on or restarting the system.

- The mechanical attenuator is set to a maximum attenuation of 110 dB.
- The RF signal generator frequency is set to 1 GHz.
- The RF signal generator power level is set to -110 dBm.
- The RF output signal is off.
- The REF IN connector is set to use the internal frequency reference.
- The REF OUT connector is set to off.
- The REF OUT 2 connector is set to off.
- The TRIG IN/OUT connector is configured as in input.
- The AM IN connector is set to off.
- The FM IN connector is set to off.
- The PULSE IN connector is set to off.

- The ALC is disabled.
- Thermal shutdown monitoring is activated.

The PXIe-5654 with PXIe-5696 returns to the power-on state after a device reset that you perform directly from Measurement & Automation Explorer (MAX).

Using the PXIe-5654

Understand how to use the PXIe-5654 , including taking basic measurements, programming the PXIe-5654 , and optimizing the performance of complex applications.

Power Search

A power search temporarily enables the ALC (closed-loop mode), adjusts the RF output power for better accuracy, and then disables the ALC (open-loop mode). Performing a power search is useful during modulation, specifically when you desire the accuracy of the ALC closed-loop mode but cannot enable ALC because doing so interferes with the modulated signal.

Power search is supported only when using the PXIe-5654 with PXIe-5696 .

Configuring Power Search Using NI-RFSG

Perform a power search by completing either of the following options:

1. Set the Automatic Power Search property to Enable or the NIRFSG_ATTR_AUTO_POWER_SEARCH attribute to NIRFSG_VAL_ENABLE for a power search to perform once the frequency or power level changes.

   Automatic power search is the default option.

2. Call the niRFSG Perform Power Search VI or niRFSG_PerformPowerSearch function for a power search to perform immediately.

Power Level Adjustment

The PXIe-5654 RF signal generator has two modes for power level adjustment: automatic leveling control (ALC) disabled (open-loop mode) and ALC enabled (closed-loop mode).

Note When using the PXIe-5654 as a stand-alone device, only open-loop mode is supported because the ALC is in the PXIe-5696 Amplitude Extender module. When you use the PXIe-5654 with the PXIe-5696 , both open-loop and closed-loop modes are supported.

ALC Disabled (Open-Loop Mode)

As a stand-alone device, the PXIe-5654 open-loop operation mode provides fine amplitude adjustment over the power control range and is temperature compensated over the operating temperature range. With the PXIe-5654 stand-alone device, you can adjust the power level in 0.01 dB steps.

ALC Enabled (Closed-Loop Mode)

When you pair the PXIe-5654 with an PXIe-5696 , a 110 dB mechanical step attenuator extends the power adjustment range, and the power accuracy improves by engaging the ALC loop.

The ALC loop performs fine amplitude adjustment, and the step attenuator performs coarse attenuation in 10 dB steps. The ALC is calibrated for amplitude and temperature variation and is used to adjust the power within the power control range of the PXIe-5654 . NI-RFSG uses the ALC and step attenuator together to optimize the absolute and relative accuracy at the specified power[1].

When the ALC is closed, NI-RFSG sets the amplifier to use the low harmonic path or the high power path based on frequency and power settings. Power settings are independent of the ALC; however, power level accuracy increases in closed-loop mode.

Note Refer to the ***NI PXIe-5654 Specifications*** document for guaranteed output power range and accuracy.

Programming the PXIe-5654

You can generate signals interactively using the NI-RFSG Soft Front Panel (SFP), or you

1. Power accuracy varies depending on power level.

can use the NI-RFSG instrument driver to program your device in the supported ADE of your choice.

Table 11. PXIe-5654 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 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++.

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 PXIe-5654 RF signal generator 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 OUT connector of the PXIe-5654 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 ***Why Is the ACCESS LED Off When the Chassis Is On?*** topic or ***Verifying the Installation in MAX*** 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 PXIe-5654 hardware module illuminates.

5. Click **RF On/Off** to stop signal generation.

Related tasks:

- Verifying the Installation in MAX
- Why Is the ACCESS LED Off When the Chassis Is On?

Building a Basic NI-RFSG Application

You can build a basic NI-RFSG application in LabVIEW for generating continuous sine wave signals.

Adding the Core NI-RFSG VIs to a Blank VI

Create a new application that includes the core NI-RFSG VIs.

1. Launch LabVIEW.
2. To create a blank VI, select **File » New VI**.
3. Display the block diagram by selecting **Window » Show Block Diagram**.

> **Tip** Activate the LabVIEW context help by selecting **Help » Show Context Help**.

4. Right-click the VI block diagram to launch the Functions palette.
5. Navigate to the NI-RFSG VIs on the **NI-RFSG** palette.

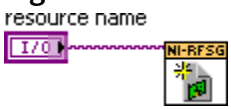
> **Tip** You can use the **Search** button on the **Functions** palette to find the **NI-RFSG** palette.

6. Add the core NI-RFSG VIs from the NI-RFSG palette to the block diagram, and wire the VIs together as shown in the following figure.

Figure 1. Basic NI-RFSG Block Diagram

7. Right-click the `resource name` input on the niRFSG Initialize VI, and select **Create » Control** to create a front panel control where you specify the RF signal generator device name.

Figure 1. Resource Name Input on the niRFSG Initialize VI



8. Right-click the `frequency (Hz)` input on the niRFSG Configure RF VI, and select **Create » Control**.
9. Right-click the `power level (dBm)` input on the niRFSG Configure RF VI, and select **Create » Control**.
10. Display the VI front panel by clicking it or by selecting **Window » Show Front Panel**.
11. In the VI front panel **power level (dBm)** control, enter `0`. In the **frequency (Hz)** control, enter `100M` (100 MHz).
12. In the VI front panel **resource name** control, enter the PXIe-5654 device name that you specified in MAX.

Adding a While Loop

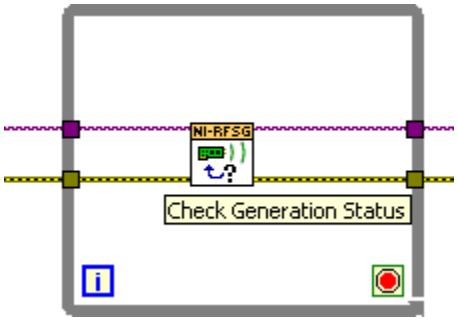
Add a While Loop to continuously generate the signal and check the generation status until you click the **Stop** button.

1. Display the VI block diagram, and select the While Loop on the Structures palette.

Tip You can use the **Search** button on the Functions palette to find the Structures palette.

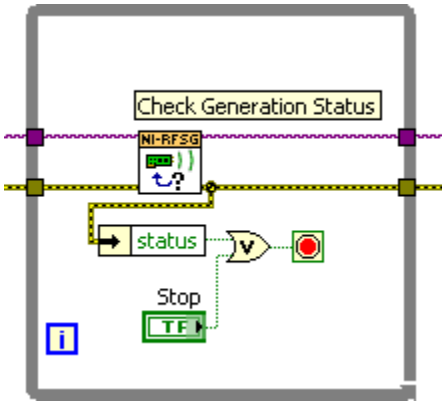
2. Enclose the niRFSG Check Generation Status VI in the While Loop, as shown in the following figure.

Figure 1. The niRFSG Check Generation Status VI Enclosed in the While Loop



3. Right-click the While Loop tunnels, and select **Replace with Shift Register**.
4. Select the Or function on the Boolean palette. Place the function inside the While Loop.
5. Wire the output of the Or function to the conditional terminal of the While Loop.
6. Select the Unbundle by Name function on the Cluster, Class, & Variant palette. Place the function inside the While Loop.
7. Wire the `error out` output of the niRFSG Check Generation Status VI to the Unbundle by Name function.
8. Wire the output of the `status` element to an input of the Or function.
9. Right-click the unused input of the Or function, and select **Create** » **Control** to create a **Boolean** control.
10. In the VI front panel, right-click the Boolean control created in step 9, and select **Replace** » **Modern** » **Boolean** » **Stop Button** to create a **Stop** button.

Figure 1. While Loop with Stop Button



Adding an Error Indicator

Add an error indicator to the VI front panel.

1. Create an error indicator by right-clicking the `error out` output of the niRFSG Close VI and selecting **Create** » **Indicator**.
2. Verify that the VI block diagram and VI front panel now look similar to the following figures.

Figure 1. Basic Sine Wave Generation VI Block Diagram

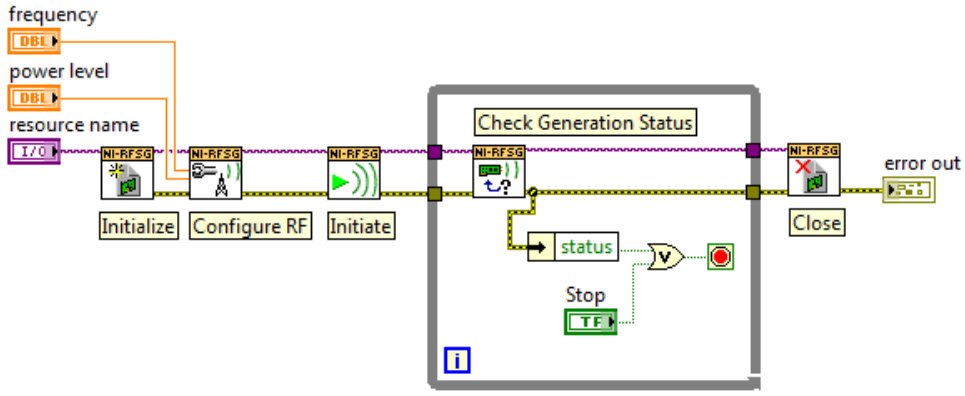
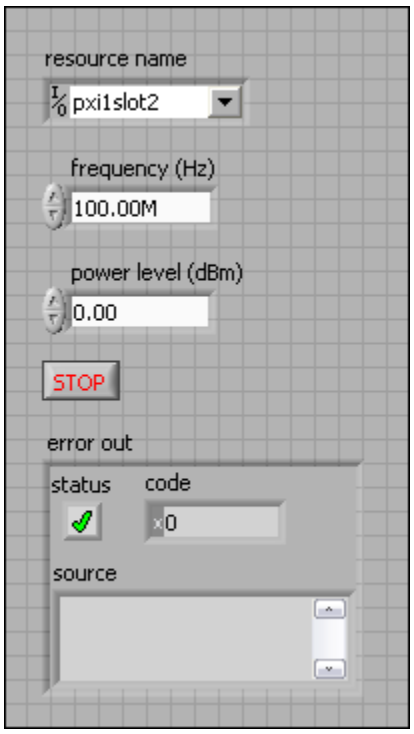


Figure 1. Basic Sine Wave Generation VI Front Panel



3. Open the VI front panel, and select the PXIe-5654 module name specified in MAX in the **resource name** control.
4. Click the **Run** button on the toolbar to initiate sine wave generation.

5. Click the VI front panel **STOP** button to stop sine wave generation.

You have successfully generated a continuous sine wave signal using the NI-RFSG instrument driver and the PXIe-5654 .

Modulation Schemes

The PXIe-5654 /5654 with PXIe-5696 can generate the following types of modulated signals:

Amplitude Modulation (AM)

AM is a process that varies the amplitude of an RF carrier signal proportional to the amplitude of the message signal.

The PXIe-5654 /5654 with PXIe-5696 does not provide a calibrated AM function; rather, you can supply a message signal for the device to modulate. Apply the modulating signal at the PXIe-5654 AM IN connector, where the nominal input signal is ±1 V, and the input damage level of the modulating signal is ±2 V.

Using NI-RFSG , you can adjust the AM sensitivity to the appropriate level to achieve the desired AM profile.

Frequency Modulation (FM)

FM is a form of modulation in which changes in the frequency of the carrier wave correspond directly with changes in the message signal.

The PXIe-5654 /5654 with PXIe-5696 does not provide a calibrated FM function; rather, you can supply a message signal for the device to modulate. Apply the modulating signal at the PXIe-5654 FM IN connector, where the nominal input signal is ±1 V, and the input damage level of the modulating signal is ±2 V.

You can control the following frequency modulation characteristics:

- FM band (narrowband or wideband)
- FM narrowband integration

- FM sensitivity

Using NI-RFSG , you can select the FM band to apply, specify a FM narrowband modulating signal rate range, and adjust the FM sensitivity to the appropriate level to achieve the desired FM profile.

FM Bands

The following table indicates the appropriate FM band to use in relation to the rate of the modulating signal.

Modulating Signal Rate	FM Band
100 Hz to 1 kHz	Narrowband
1 kHz to 10 kHz	
10 kHz to 100 kHz	
>100 kHz	Wideband

Use the wideband FM band when you seek FM at modulation rates greater than 100 kHz. Wideband FM has the added benefit that it can achieve relatively higher deviations than narrowband FM.

FM Narrowband Integration

Phase modulation is related to frequency modulation by integration.

For closed-loop frequency modulation, the device implements phase modulation and processes the modulating signal through an integrator. An integrator can cause significant loss with increasing frequency. Integrators have a frequency response that rolls off proportional to 1 divided by the modulating frequency. Select the narrowband integrator as recommended in the preceding table.

Phase Modulation (PM)

PM is a type of modulation in which the phase angle of a carrier wave deviates from its reference value by an amount proportional to the instantaneous value of the

modulating signal.

The PXIe-5654 /5654 with PXIe-5696 does not provide a calibrated PM function; rather, you can supply a message signal for the device to modulate. Apply the modulating signal at the PXIe-5654 FM IN connector, where the nominal input signal is ±1 V, and the input damage level of the modulating signal is ±2 V.

You can control the following phase modulation characteristics:

- PM mode
- PM sensitivity

Using NI-RFSG , you can select the PM mode to apply and adjust the PM sensitivity to the appropriate level to achieve the desired PM profile.

PM Modes

You can apply PM in either high deviation mode or low phase noise mode. Low phase noise mode is ideal when you require the ability to adjust the phase of the RF signal and utilize low phase noise simultaneously, allowing the device to meet its phase noise specification. High deviation mode provides higher phase deviation, but the modulating signal has higher phase noise and may not meet the device phase noise specification.

Note Refer to the ***PXIe-5654 Specifications*** document for specified phase noise performance.

Pulse Modulation

The PXIe-5654 /5654 with PXIe-5696 allows you to do pulse modulation, and you apply the modulating signal at the PXIe-5654 PULSE IN connector.

The modulating signal levels should be consistent with transistor-transistor logic (TTL) levels. The damage levels of the PXIe-5654 PULSE IN connector are ≤-0.5 V and ≥5.5 V. The modulating frequency should be ≤10 MHz. At high modulation frequencies, pulse width compression occurs. To achieve 50% duty cycle, you may need to increase the duty cycle of the modulating signal.

Using NI-RFSG , you can select the pulse modulation mode to apply to achieve the desired pulse modulation profile.

Pulse Modulation Modes

You can apply pulse modulation in either the optimal match mode or high isolation mode. High isolation mode allows for the best on/off power ratio of the pulsed signal. Optimal match mode provides for a more optimal power output match for the PXIe-5654 /5654 with PXIe-5696 during the off cycle of the pulse mode operation.

Maintaining PXI Express Systems

Clean the fan filters on the chassis regularly to prevent fan blockage and ensure efficient air circulation.

Cleaning frequency depends on the amount of use and the operating environment. For specific information about cleaning procedures and other recommended maintenance, refer to the module specifications and the chassis user documentation.

Uninstalling the Hardware

Notice Disconnect or disable any external RF, clock, or digital connections to the device front panel. Applying external signals while the device is powered off may cause damage.

Notice 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.

1. Power off the chassis.
2. Ground yourself with a grounding strap or touch a grounded metal surface.
3. Disconnect any cables from the module front panel connectors.
4. Unlatch the module by pushing down on the ejector handle.
5. Pull the ejector handle and hold the module by the edges to remove it from the chassis.

Store the module in the original antistatic packaging when not in use to avoid damage.

PXIe-5654 Factory Calibration

NI performs calibration of the PXIe-5654 that is relative to an NIST-traceable standard over the specified operating temperature range. Every PXIe-5654 is individually calibrated at the factory for accurate frequency and amplitude response.

For frequency accuracy, the 100 MHz system clock is calibrated against an NIST-traceable rubidium clock at room temperature and over the PXIe-5654 operating temperature range. It is important that the PXIe-5654 temperature stabilizes before critical frequency accuracy measurements are taken. The PXIe-5654 uses a high quality oven-controlled crystal oscillator (OCXO) as a frequency reference, and because the OCXO is heated and operates at a temperature higher than the ambient air temperature, it is less susceptible to temperature variations.

For amplitude accuracy, the internal attenuators are calibrated over the entire specified temperature and amplitude range. The amplitude accuracy is calibrated against an NIST-traceable power meter for all power levels.

Note Refer to the ***PXIe-5654 Specifications*** document for detailed specifications.

Notice Opening the RF enclosure invalidates factory calibration. To preserve guaranteed calibration, do not disassemble the PXIe-5654 RF enclosure.

For more information about calibration, contact NI or visit ni.com/calibration.

PXIe-5696 Factory Calibration

NI performs calibration of the PXIe-5696 that is relative to an NIST-traceable standard over the specified operating temperature range. Every PXIe-5696 is individually calibrated at the factory for accurate amplitude response. Both amplifiers (low harmonic and high power), automatic leveling control (ALC), and attenuators are calibrated over the entire frequency range.

Note Refer to the ***PXIe-5654 Specifications*** document for detailed PXIe-5654 with PXIe-5696 specifications.

Notice Opening the RF enclosure invalidates factory calibration. To preserve guaranteed calibration, do not disassemble the PXIe-5654 or PXIe-5696 RF enclosure.

For more information about calibration, contact NI or visit ni.com/calibration.