

NI PXIe-5665 3.6 GHz Vector Signal Analyzer MIMO Platform

This document describes the proper slot placement and module connections needed for a phase-coherent multiple input, multiple output (MIMO) system with the NI PXIe-5665 3.6 GHz (NI 5665) vector signal analyzer (VSA).

The NI 5665 comprises the following modules:

- NI PXIe-5603 (NI 5603) RF downconverter
- NI PXIe-5653 (NI 5653) LO module
- NI PXIe-5622 (NI 5622) IF digitizer

Preconfigured NI MIMO test systems that include these modules, a chassis, controller, software, and accessories are available for purchase at ni.com/mimo.

This document also describes how to correctly configure the devices in Measurement & Automation Explorer (MAX) and how to associate the modules. Refer to the *NI PXIe-5665 Getting Started Guide* and the *NI PXIe-5665 Specifications*, available at ni.com/manuals, for more information about device specifications, maintenance, and safety information.



Note The *master* NI 5665 is the RF signal analyzer that receives the LO signal directly from the NI 5653 module. *Slave* NI 5665 devices refer to the additional analyzer channels that receive daisy-chained LO and Reference Clock signals.

Installing the Modules

The NI 5665 MIMO test system equipment setup requires you to install a master NI 5665 and additional NI 5665 slave devices in your PXI Express chassis.



Note The following installation instructions use semi-rigid cables when making some module connections. The semi-rigid cables restrict slot placement because they require you to place certain modules next to each other in the chassis.

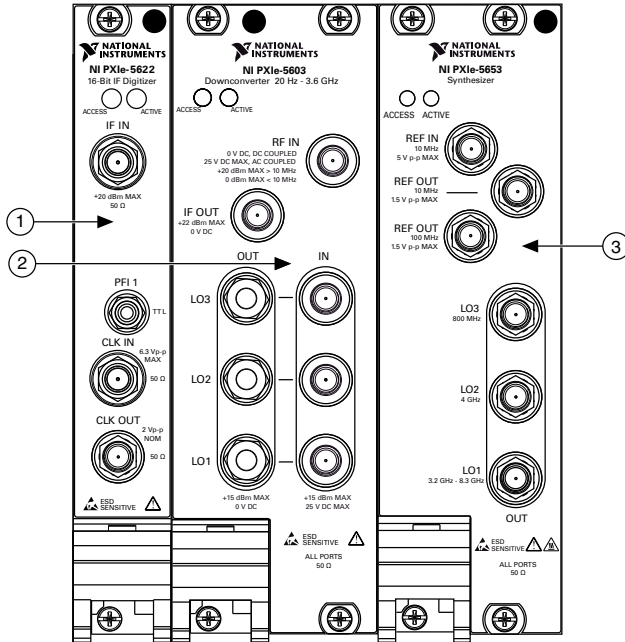
1. Install the NI 5665 master device in your chassis. To use the cables included with your module kit, install the NI 5622 IF digitizer module immediately to the left of the NI 5603 RF downconverter module, and install the NI 5653 LO module immediately to the right of the NI 5603.

The following figure illustrates the correct placement of the three modules that comprise the NI 5665.



Tip Install the master NI 5665 modules in the chassis with enough room to install your slave NI 5665 devices to the left of the master device.

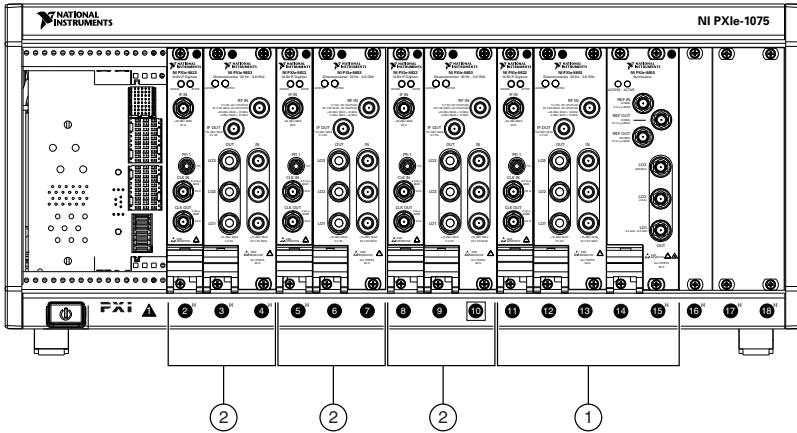
Figure 1. NI 5665 3.6 GHz VSA Master Module Placement



1. NI 5622
 2. NI 5603
 3. NI 5653
2. Install the slave NI 5665 device in your chassis to the left of the master NI 5665 device. You can install multiple NI 5665 devices to the left of the master NI 5665, depending on your application requirements.

The following figure illustrates the correct placement of the slave devices in a chassis.

Figure 2. NI 5665 3.6 GHz VSA Slave Module Placement



1. Master NI 5665 3.6 GHz VSA
2. Slave NI 5665 3.6 GHz VSA

Interconnecting the Modules

This section describes how to interconnect the master NI 5665 modules and how to connect the slave NI 5665 modules to the master NI 5665 modules.



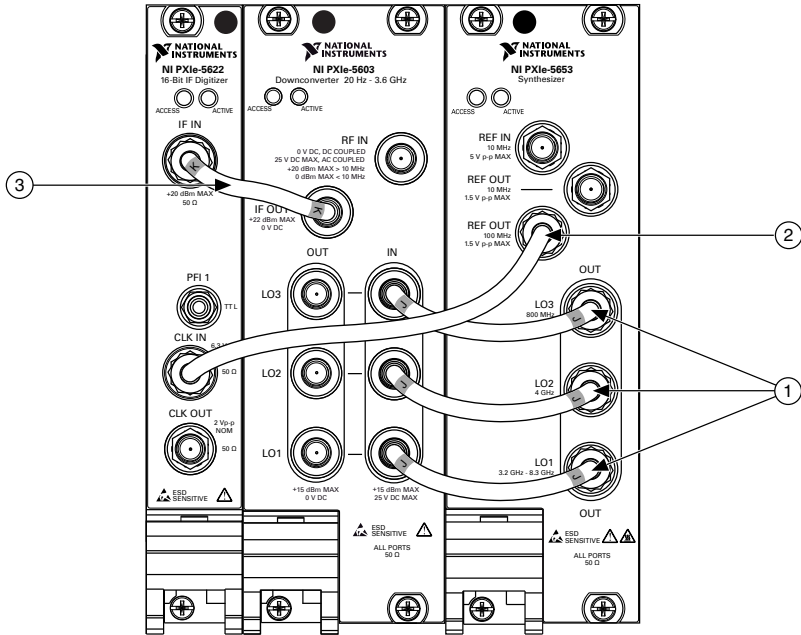
Note This module configuration frequency-locks to the NI 5653 100 MHz onboard Reference Clock by daisy chaining the 100 MHz Reference Clock to slave digitizer modules. To frequency-lock to the PXI backplane, the NI 5653 requires an OCXO-quality timebase source present on the PXI backplane.

For the best long-term phase stability over temperature, use the PXI backplane as the Reference Clock source, but override the native PXI chassis backplane clock with an OCXO-quality timebase that meets the requirements listed in the *NI PXIe-5665 Specifications*. The NI 5665 cannot lock to the native PXI chassis backplane clock, and attempting to do so without overriding it with an OCXO timebase results in phase-locked loop (PLL) lock errors. The NI PXIe-6674T Timing and Multichassis Synchronization module is an option for synchronizing multiple digitizer clocks.

The NI 6674T 10 MHz clock can be driven onto the PXI backplane when placed in the chassis System Timing Slot, also known as the Star Trigger Controller Slot. You can also connect the output of the NI 6674T 10 MHz clock to the 10 MHz BNC IN terminal on the back of the PXI chassis from any PXI chassis slot using an SMA-to-BNC cable.

Interconnecting the Master NI 5665 Modules

Figure 3. NI 5665 3.6 GHz VSA Cable Configuration



1. Medium, Semi-Rigid SMA-to-SMA Cables, Labeled J
2. Flexible SMA-to-SMA Cable
3. Short, Semi-Rigid SMA-to-SMA Cable, Labeled K

1. Using the three medium semi-rigid SMA-to-SMA cables (labeled J), connect the LO1, LO2, and LO3 connectors on the NI 5653 front panel to the associated LO1 IN, LO2 IN, and LO3 IN connectors on the NI 5603 front panel.
2. Using the flexible SMA-to-SMA cable, connect the REF OUT 100 MHz connector on the NI 5653 front panel to the CLK IN connector on the NI 5622 front panel.
3. Using the short semi-rigid SMA-to-SMA cable (labeled K), connect the IF OUT connector on the NI 5603 front panel to the IF IN connector on the NI 5622 front panel.
4. Hand-tighten all SMA cable ends on the SMA connectors 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 reconnect the cable center pin on the SMA cable to the SMA connector.
5. Carefully complete tightening all SMA connectors to $1 \text{ N} \cdot \text{m}$ using an appropriate torque wrench (not included) or torque screwdriver and SMA driver bit. Tighten only until the wrench clicks.



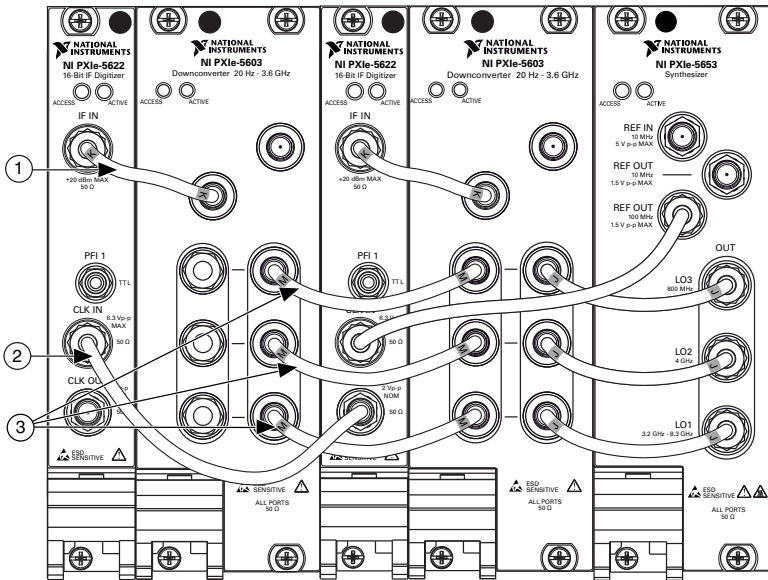
Caution Incorrect torque at SMA connections can degrade signal fidelity and phase-locked loop (PLL) performance and may cause insertion loss. Use an appropriate torque wrench or torque screwdriver and SMA driver bit to ensure all SMA connections are properly torqued. SMA connectors for connections to external equipment may require torque different from 1 N · m, depending on the connector type, material, and manufacturer.

Interconnecting the Slave NI 5665 Modules

The NI 5665 MIMO test system includes the following cables to interconnect additional modules:

- Semi-rigid SMA-to-SMA cable (labeled M), (x3)
- Short, semi-rigid SMA-to-SMA cable (labeled K)
- Flexible SMA-to-SMA cable

Figure 4. NI 5665 3.6 GHz VSA Slave Module Cable Configuration



1. Short, Semi-Rigid SMA-to-SMA Cable, Labeled K
2. Flexible SMA-to-SMA Cable
3. Medium, Semi-Rigid SMA-to-SMA Cables, Labeled M

1. Using the short, semi-rigid SMA-to-SMA cable (labeled K), connect the IF OUT connector on the slave NI 5603 front panel to the IF IN connector on the slave NI 5622 front panel.
2. Using the flexible SMA-to-SMA cable, connect the CLK OUT connector from the preceding NI 5622 front panel to the CLK IN connector on the next NI 5622 front panel. This cable passes the 100 MHz Reference Clock from the preceding NI 5622 to the CLK IN connector of the next NI 5622.

3. Using the three medium, semi-rigid SMA-to-SMA cables (labeled M), connect the LO1 OUT, LO2 OUT, and LO3 OUT connectors on the preceding NI 5603 front panel to the associated LO1 IN, LO2 IN, and LO3 IN connectors on the next NI 5603 front panel.
4. Hand-tighten all SMA cable ends on the SMA connectors 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 reconnect the cable center pin on the SMA cable to the SMA connector.
5. Carefully complete tightening all SMA connectors to $1 \text{ N} \cdot \text{m}$ using an appropriate torque wrench (not included) or torque screwdriver and SMA driver bit. Tighten only until the wrench clicks.



Caution Incorrect torque at SMA connections can degrade signal fidelity and phase-locked loop (PLL) performance and may cause insertion loss. Use an appropriate torque wrench or torque screwdriver and SMA driver bit to ensure all SMA connections are properly torqued. SMA connectors for connections to external equipment may require torque different from $1 \text{ N} \cdot \text{m}$, depending on the connector type, material, and manufacturer.

Configuring the NI 5665 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-RFSA.

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



Note If you are using the NI 5665 with the LabVIEW Real-Time Module, expand **Remote Systems**. Find your target IP address or name, expand it, and then expand **Devices and Interfaces**.

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 5665.
5. Associate the hardware modules that comprise the master and slave NI 5665.
 - a) Select the master NI 5603 module that is identified as not configured in the configuration tree.
 - b) In the Associated Devices section, select the appropriate module from each system component drop-down listbox.

For the master NI 5665, you must associate the NI 5622 IF digitizer module and the NI 5653 LO source module.

- c) Select the slave NI 5603 module that is identified as not configured in the configuration tree.
- d) In the Associated Devices section, select the appropriate module from each system component drop-down listbox.

For the slave NI 5665, you must associated the NI 5622 IF digitizer module and you must select **External** as the LO source for each slave device because the LO signals are shared by all NI 5665 devices.

- e) Click **Save** in the MAX toolbar.



Note Module associations may be lost when you move the modules to different chassis slots.

6. Self-test the device modules by selecting the modules in the configuration tree, and clicking **Self-Test** in the MAX toolbar. Repeat this step for all modules in your NI 5665 system.

The MAX self-test performs a basic verification of hardware resources.

Where Do I Go from Here?

Now that you have installed your hardware, interconnected the modules, and configured the modules in MAX, you can begin programming your hardware using the NI-RFSA instrument driver.

Visit ni.com/mimo for more information about how to start creating your MIMO application. This web site provides many useful MIMO articles, videos, and example programs.

The following documents provide more information that you may need as you create your MIMO application:

- *RF Multichannel Community*—Visit ni.com/info and enter the Info Code `exvi3p` to access the latest RF multi-channel reference software in LabVIEW for phase-coherent and non-phase-coherent hardware configurations.
- *NI RF Vector Signal Analyzers Help*—Use this help file, located at **Start»All Programs»National Instruments»NI-RFSA»Documentation**, to learn how to operate the NI 5665. This help file also includes hardware information and detailed programming references.
- *NI PXIe-5665 Specifications*—This document, located at **Start»All Programs»National Instruments»NI-RFSA»Documentation**, provides additional hardware information.
- *NI PXIe-5665 Getting Started Guide*—This printed document is included in your hardware kit and provides additional hardware configuration information.

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.

Refer to the *NI Trademarks and Logo Guidelines* at ni.com/trademarks for information on National Instruments trademarks. Other product and company names mentioned herein are trademarks or trade names of their respective companies. For patents covering National Instruments products/technology, refer to the appropriate location: **Help»Patents** in your software, the `patents.txt` file on your media, or the *National Instruments Patent Notice* at ni.com/patents. You can find information about end-user license agreements (EULAs) and third-party legal notices in the readme file for your NI product. Refer to the *Export Compliance Information* at ni.com/legal/export-compliance for the National Instruments global trade compliance policy and how to obtain relevant HTS codes, ECCNs, and other import/export data. NI MAKES NO EXPRESS OR IMPLIED WARRANTIES AS TO THE ACCURACY OF THE INFORMATION CONTAINED HEREIN AND SHALL NOT BE LIABLE FOR ANY ERRORS. U.S. Government Customers: The data contained in this manual was developed at private expense and is subject to the applicable limited rights and restricted data rights as set forth in FAR 52.227-14, DFAR 252.227-7014, and DFAR 252.227-7015.

© 2012—2014 National Instruments. All rights reserved.

373727C-01 Oct14