USRP-2950/2952/2953

2022-07-11

Contents

USRP RIO Getting Started Guide

This document explains how to install, configure, and test the following USRP RIO devices:

- USRP-2950R Software Defined Radio Reconfigurable Device (USRP-2950)
- USRP-2952R Software Defined Radio Reconfigurable Device (USRP-2952)
- USRP-2953R Software Defined Radio Reconfigurable Device (USRP-2953)
- USRP-2954R Software Defined Radio Reconfigurable Device (USRP-2954)
- USRP-2955 Software Defined Radio Reconfigurable Device (USRP-2955)

The USRP RIO can send and/or receive signals for use in various communications applications. The device ships with the NI-USRP instrument driver, which you can use to program the device.

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.

Verifying the System Requirements

To use the NI-USRP instrument driver, your system must meet certain requirements.

Refer to the product readme, which is available online at ni.com/manuals, for more information about minimum system requirements, recommended system, and supported application development environments (ADEs).

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.

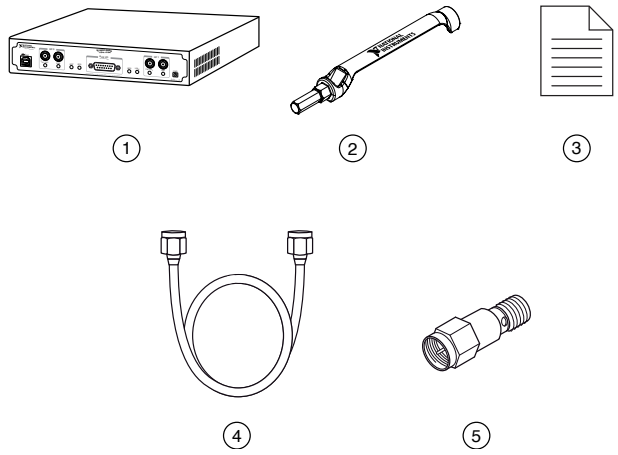
   > **Note** Do not install a device if it appears damaged in any way.

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. Kit Contents



1. USRP RIO Device
2. SMA Driver Bit (USRP-2955 Only)
3. Getting Started Guide (This Document)
4. SMA (m)-to-SMA (m) Cable
5. 30 dB SMA Attenuator (Not Included with USRP-2955)

Caution If you directly connect or cable a signal generator to your device, or if you connect multiple USRP RIO devices together, you must connect a 30 dB attenuator to the RF input (RX1 or RX2) of each receiving USRP RIO device.

Other Required Item(s)

In addition to the kit contents, you must provide the following additional item(s):

- An MXI Express interface card. You can purchase an MXI Express interface kit for your USRP RIO device, which contains an MXI Express interface card, at ni.com.

Optional Items

- LabVIEW Modulation Toolkit (MT), available for download at ni.com/downloads and included in LabVIEW Communications System Design Suite, which includes MT VIs and functions, examples, and documentation

> **Note** You must install the LabVIEW Modulation Toolkit for proper operation of the NI-USRP Modulation Toolkit example VIs.

- LabVIEW Digital Filter Design Toolkit, available for download at ni.com/downloads and included in LabVIEW Communications System Design Suite
- LabVIEW MathScript RT Module, available for download at ni.com/downloads
- Additional SMA (m)-to-SMA (m) cables to use the REF IN and PPS IN signals
- GPS antenna for devices with GPS disciplined oscillator (GPSDO) support
- PCIe - MXI Express Interface Kit for USRP RIO to connect to a desktop computer
- ExpressCard Slot - MXI Express Interface Kit for USRP RIO to connect to a laptop computer
- PXIe - MXI Express Interface Kit for USRP RIO to connect to a PXI Express chassis
- CDA-2990 Clock Distribution Device for synchronizing multiple devices
- CPS-8910 Switch Device for PCI Express for large multiple-input, multiple-output (MIMO) expansion configurations

Preparing the Environment

Ensure that the environment you are using the USRP RIO in meets the following specifications.

Ambient temperature range	0 °C to 55 °C
Operating temperature	23 °C ± 5 °C
Operating humidity	10% to 90% relative humidity, noncondensing

Pollution Degree	2
Maximum altitude	2,000 m

Indoor use only.

Caution Do not operate the USRP RIO in a manner not specified in this document. Product misuse can result in a hazard. You can compromise the safety protection built into the product if the product is damaged in any way. If the product is damaged, return it to NI for repair.

Installing the Software

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

1. Install an ADE, such as LabVIEW or LabVIEW Communications System Design Suite.
2. Visit ni.com/info and enter the Info Code usrpdriver to access the driver download page for the latest NI-USRP software.
3. Download the NI-USRP driver software.
4. 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.

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

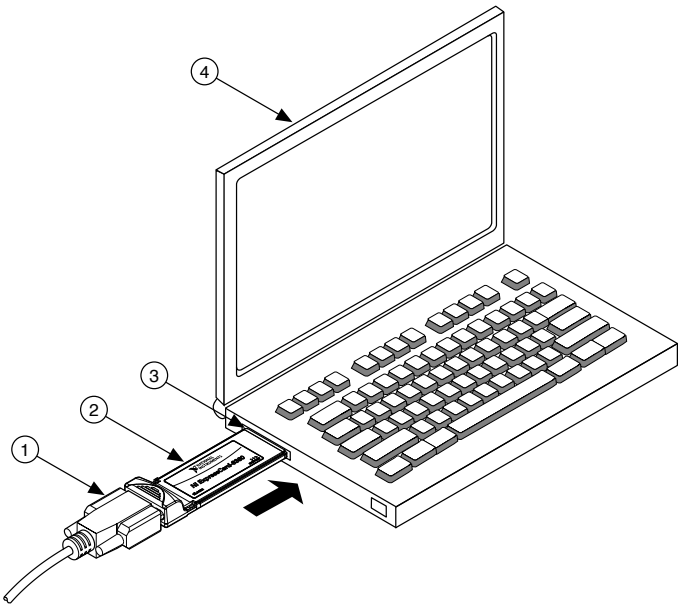
Installing USRP RIO Devices

Install all the software you plan to use before you install the hardware. Ensure that the USRP RIO device and computer are off before installing.

1. Attach the antenna or cable to the front panel terminals of the USRP RIO device as desired.

2. Use the MXI Express Interface Kit to connect the USRP RIO device to the computer.
    1. Identify which MXI Express Interface Kit you want to use.
        - If you are using the desktop connectivity kit or the PXI chassis connectivity kit, follow the installation instructions in the **Hardware Installation** section of the **Set Up Your MXI™ Express ×4 System** document included in that kit.
        - If you are using the laptop connectivity kit, touch the ExpressCard-8360 for USRP and outer metal case of the USRP RIO device simultaneously.
    2. Connect the MXI device to the USRP RIO device using the included cable.
       If you are using the laptop connectivity kit, refer to the following figure.

       Figure 2. Connecting the USRP RIO Device with a Laptop Connectivity Kit



        1. Cable Included with ExpressCard Interface Kit
        2. ExpressCard-8360 for USRP Device for PXI Remote Control
        3. ExpressCard Slot
        4. Laptop Computer
3. Connect the AC/DC power supply to the USRP RIO device.

4. Plug the power supply into a wall outlet. Press the PWR button.
5. Power on the computer.
   Windows automatically recognizes the USRP RIO device.

Related information

- Refer to the Set Up Your MXI™ Express ×4 System document for installation instructions.

Synchronizing Multiple USRP RIO Devices (Optional)

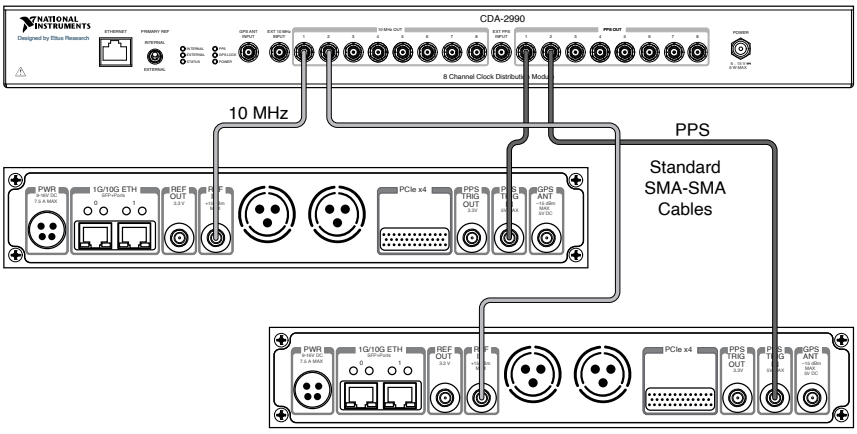
To set up a higher channel-count system, you can synchronize two or more USRP RIO devices so that they share clock and PPS signals.

Note Synchronizing multiple USRP RIO devices requires a CDA-2990 accessory.

Ensure that all hardware is set up as previously indicated.

1. Connect the REF IN port of the USRP RIO device to the first 10 MHz OUT port of the CDA-2990 using a standard SMA (m)-to-SMA (m) cable.
2. Connect the PPS TRIG IN port of the USRP RIO device to the PPS OUT port of the CDA-2990 using a standard SMA (m)-to-SMA (m) cable.
3. Repeat steps 1 and 2 to synchronize additional USRP RIO devices using the additional ports on the CDA-2990 (optional).
   The completed hardware setup for two USRP RIO devices is shown in the following figure.

Figure 3. Synchronizing Multiple USRP RIO Devices with the CDA-2990

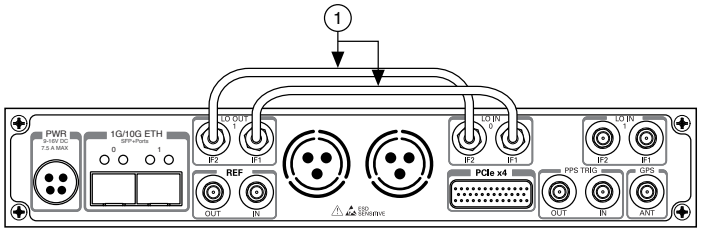


Preparing the USRP-2955 for LO Sharing (Optional)

Complete the following steps to prepare a single USRP-2955 device to share local oscillators (LOs) among all four channels in the device.

1. Connect the LO OUT 1 IF2 connector of the USRP-2955 back panel to the LO IN 0 IF2 connector of the same USRP-2955 back panel using an SMA(m)-to-SMA(m) cable.
2. Connect the LO OUT 1 IF1 connector of the USRP-2955 back panel to the LO IN 0 IF1 connector of the same USRP-2955 back panel using an SMA(m)-to-SMA(m) cable.
   The completed hardware setup is shown in the following figure.

   Figure 4. USRP-2955 Single Device LO Sharing



1. SMA(m)-to-SMA(m) Cables

Programming the USRP RIO

You can use the NI-USRP instrument driver to create communications applications for the USRP RIO.

USRP RIO devices are LabVIEW FPGA targets, which support creating custom FPGAs and configuring the device using Instrument Design Libraries. Use a sample project as a starting point for application development.

Note You must use the PCIe x4 connector if you want to program the FPGA. You cannot use the 1G/10G ETH connector to program the FPGA.

NI-USRP Instrument Driver

NI-USRP features a set of VIs and properties that exercise the functionality of the USRP RIO, including configuration, control, and other device-specific functions. Refer to the **NI-USRP Help** for information about using the instrument driver in your applications.

Software Options

NI provides two software options for programming the USRP RIO device: the NI-USRP API and the USRP RIO instrument design library (IDL).

Software Option	Description	Use Case	Palette Location
NI-USRP API	Provides an API for interacting with your USRP RIO device. Provides the standard, CPU-based host operation needed for most SDR applications.	Create custom measurements or applications that require in-phase/quadrature modulation (I/Q) data. Use with the Modulation Toolkit to develop SDR transmitters and receivers. Use with the Modulation Toolkit to create and generate modulated signals.	LabVIEW Communications System Design Suite: Diagram » Hardware Interfaces » NI-USRP LabVIEW: Functions » Instrument I/O » Instrument Drivers » NI-USRP
USRP RIO IDL	Allows you to interface with the FPGA of your USRP RIO device for advanced	Use with the LabVIEW FPGA Module to customize the behavior of the device FPGA to create	LabVIEW Communications System Design Suite: Diagram » Hardware Interfaces » USRP RIO

Software Option	Description	Use Case	Palette Location
	programming and digital signal processing (DSP). Uses the USRP RIO Sample Projects, which allow you to take common measurements with your device. USRP RIO Sample Projects are included in the installation.	application-specific instrument designs.	LabVIEW: Functions » Instrument I/O » Instrument Drivers » USRP RIO

Table 1. USRP RIO Software Options

Note You cannot use the USRP RIO IDLs with the NI-USRP API.

NI-USRP Sample Projects

The NI-USRP software contains sample projects that are a starting point for application development.

ADE	Instructions
LabVIEW Communications System Design Suite	Open the projects in LabVIEW Communications System Design Suite by selecting the Projects tab and choosing a USRP sample project from the array.
LabVIEW	Open the projects in LabVIEW by selecting File » Create Project » NI-USRP. You must install the LabVIEW FPGA Module to customize the behavior of the device FPGA.

Table 2. NI-USRP Sample Projects

NI-USRP Examples

The instrument driver examples are instructional tools that demonstrate some of the functionality of the USRP RIO. You can use these examples separately or integrate them into your systems. NI-USRP includes examples for getting started and other SDR functionality. You can access the NI-USRP examples from the following locations:

- In LabVIEW Communications System Design Suite at Learning » Examples » Hardware Input and Output.
- From the Start menu at Start » All Programs » National Instruments » NI-USRP » Examples.
- In LabVIEW from Functions » Instrument I/O » Instrument Drivers » NI-USRP » Examples palette.

You can access additional examples from the code sharing community at ni.com/usrp.

Note The NI Example Finder does not include NI-USRP examples.

Using LabVIEW Communications System Design Suite

Run a VI to confirm that the device transmits and receives signals and is connected correctly to the host computer.

1. Navigate to Learning » Examples » Hardware Input and Output to create an example.
2. Select the Single-Device Streaming project template for your device.
3. Run Tx and Rx Streaming (Host).gvi.
   If the device is transmitting and receiving signals, the front panel graphs display waveform data.
4. Click STOP to conclude the test.

Using LabVIEW

Run a VI to confirm that the device transmits and/or receives signals and is connected correctly to the host computer.

1. Create a sample project in LabVIEW by selecting File » Create Project » NI-USRP.
2. Select the NI-USRP Simple Streaming sample project template and click Next.
3. Run the appropriate streaming VI according to your USRP RIO device.

Device	VI
USRP-2950/2952/2953/2954	Tx and Rx Streaming Host VI
USRP-2955	Rx Streaming (Host) VI

If the device is transmitting and/or receiving signals, the front panel graphs display waveform data.

4. Click STOP to conclude the test.

Troubleshooting

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

Should I Update Device Firmware and FPGA Images?

USRP RIO devices ship with firmware and FPGA images compatible with NI-USRP driver software. You may need to update the device for compatibility with the latest version of the software.
The driver software media also includes the NI-USRP Configuration Utility, which you can use to update the devices.

Why Doesn't the Device Power On?

- Verify that the power supply is functional by substituting a different adapter.
- Verify that the power switch on the front of the device is engaged.

Why Doesn't the USRP Device Appear in the NI-USRP Configuration Utility?

Check the connection between the USRP device and the computer. Ensure that the USRP device is powered on and connected to a computer before you power on the computer.

Why Does USRP2 Appear Instead of USRP RIO in the NI-USRP Configuration Utility?

An incorrect IP address on the computer may cause this error. Check the IP address and run the NI-USRP Configuration Utility again.

An old FPGA or firmware image on the device may also cause this error. Upgrade the FPGA and firmware using the NI-USRP Configuration Utility.

Why Don't NI-USRP Examples Appear in the NI Example Finder?

NI-USRP does not install examples into the NI Example Finder.
You can access the NI-USRP examples from the following locations:

- In LabVIEW Communications System Design Suite at Learning » Examples » Hardware Input and Output.
- From the Start menu at Start » All Programs » National Instruments » NI-USRP » Examples.
- In LabVIEW from Functions » Instrument I/O » Instrument Drivers » NI-USRP » Examples palette.

Direct Connections to the USRP RIO

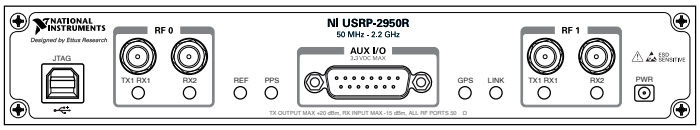
The USRP RIO is an RF instrument that is sensitive to ESD and transients. Ensure you take the following precautions when making direct connections to the USRP RIO to avoid damaging the device.

> **Caution** Apply external signals only while the USRP RIO is powered on. Applying external signals while the device is powered off may cause damage.

- Ensure you are properly grounded when manipulating cables or antennas connected to the USRP RIO TX 1 RX 1, RX 1, or RX 2 connector.
- 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 USRP RIO TX 1 RX 1, RX 1, or RX 2 connector, ensure that the device cannot generate signal transients greater than the RF and DC specifications of the USRP RIO TX 1 RX 1, RX 1, or RX 2 connector.

USRP-2950

Figure 5. USRP-2950 Front Panel



Connector		Use
JTAG		A USB port that connects the host computer to the device FPGA for recovery purposes. This port can be used with the Xilinx iMPACT configuration tool to temporarily load a new bitfile.
RF 0	TX1 RX1	Input and output terminal for the RF signal. TX1 RX1 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
	RX2	Input terminal for the RF signal. RX2 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input channel.
AUX I/O		General-purpose I/O (GPIO) port. AUX I/O is controlled by the FPGA.
RF 1	TX1 RX1	Input and output terminal for the RF signal. TX1 RX1 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
	RX2	Input terminal for the RF signal. RX2 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input channel.

Table 15. USRP-2950 Module Front Panel Connectors

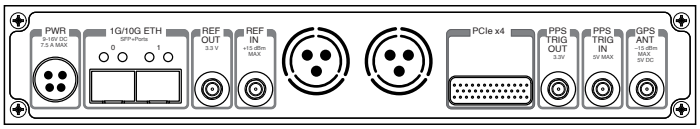
Note The LED indications described in the following table occur only when you use the NI-USRP API with the default API image. When you use LabVIEW FPGA, you customize the LED indications.

LED		Description	Color	State	Indication
RF 0	TX1 RX1	Indicates the transmit status of the module.	OFF	—	The module is not active.
			Red	Solid	The module is transmitting data.
			Green	Solid	The module is receiving data.
	RX2	Indicates the receive status of the module.	OFF	—	The module is not receiving.
			Green	Solid	The module is receiving.
REF		Indicates the status of the reference signal.	OFF	—	There is no reference signal, or the device is not locked to the reference signal.

LED		Description	Color	State	Indication
			Green	Blinking	The device is not locked to the reference signal.
				Solid	The device is locked to the reference signal.
PPS		Indicates the pulse per second (PPS).	OFF	—	There is no PPS timing reference signal, or the device is not locked to the reference signal.
			Green	Blinking	The device is locked to the PPS timing reference signal.
GPS		Indicates whether the GPSDO is locked.	OFF	—	There is no GPSDO or the GPSDO is not locked.
			Green	Solid	The GPSDO is locked.
LINK		Indicates the status of the link to a host computer.	OFF	—	There is no link to a host computer.
			Green, yellow, or red	Solid	The host is actively communicating with the device.
RF 1	TX1 RX1	Indicates the transmit status of the module.	OFF	—	The module is not active.
			Red	Solid	The module is transmitting data.
			Green	Solid	The module is receiving data.
	RX2	Indicates the receive status of the module.	OFF	—	The module is not receiving.
			Green	Solid	The module is receiving.

Table 16. USRP-2950 Module LEDs

Figure 6. USRP-2950 Module Back Panel



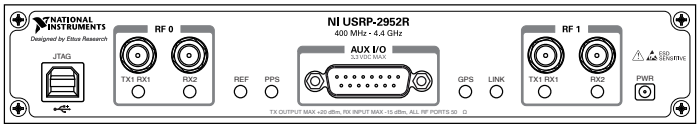
Connector	Use
PWR	Input that accepts a 9 V to 16 V, 6 A external DC power connector.
1G/10G ETH	Two SFP+ input terminals used for 1G ETH or 10G ETH connectivity with the host driver. Not currently supported in LabVIEW FPGA.

Connector	Use
REF OUT	Output terminal for an external reference signal for the LO on the device. REF OUT is a female SMA connector with an impedance of 50 Ω, and it is a single-ended reference output. The output signal at this connector is 10 MHz at 3.3 V.
REF IN	Input terminal for an external reference signal for the LO on the device. REF IN is a female SMA connector with an impedance of 50 Ω, and it is a single-ended reference input. REF IN accepts a 10 MHz signal with a minimum input power of 0 dBm (0.632 Vpk-pk) and a maximum input power of 15 dBm (3.56 Vpk-pk) for a square wave or sine wave.
PCIe x4	Port for a PCI Express Generation 1, x4 bus connection through an MXI Express four-lane cable.
PPS TRIG OUT	Output terminal for the pulse per second (PPS) timing reference. PPS TRIG OUT is a female SMA connector with an impedance of 50 Ω, and it is a single-ended input. The output signal is 0 V to 3.3 V TTL. You can also use this port as triggered output (TRIG OUT) that you program with the PPS Trig Out I/O signal.
PPS TRIG IN	Input terminal for pulse per second (PPS) timing reference. PPS TRIG IN is a female SMA connector with an impedance of 50 Ω, and it is a single-ended input channel. PPS TRIG IN accepts 0 V to 3.3 V TTL and 0 V to 5 V TTL signals. You can also use this port as a triggered input (TRIG IN) that you control using NI-USRP software.
GPS ANT	Input terminal for the GPS antenna signal. GPS ANT is a female SMA connector with a maximum input power of -15 dBm and an output of DC 5 V to power an active antenna. **Caution** Do not terminate the GPS ANT port if you do not use it.

Table 17. USRP-2950 Module Back Panel Connectors

USRP-2952

Figure 7. USRP-2952 Front Panel



Connector	Use
JTAG	A USB port that connects the host computer to the device FPGA for recovery purposes. This port can be used with the Xilinx iMPACT configuration tool to temporarily load a new bitfile.

Connector		Use
RF 0	TX1 RX1	Input and output terminal for the RF signal. TX1 RX1 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
	RX2	Input terminal for the RF signal. RX2 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input channel.
AUX I/O		General-purpose I/O (GPIO) port. AUX I/O is controlled by the FPGA.
RF 1	TX1 RX1	Input and output terminal for the RF signal. TX1 RX1 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
	RX2	Input terminal for the RF signal. RX2 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input channel.

Table 15. USRP-2952 Module Front Panel Connectors

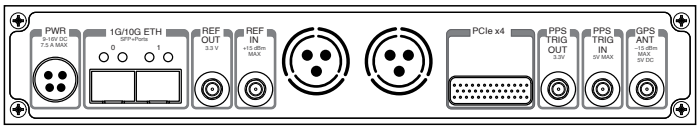
Note The LED indications described in the following table occur only when you use the NI-USRP API with the default API image. When you use LabVIEW FPGA, you customize the LED indications.

LED		Description	Color	State	Indication
RF 0	TX1 RX1	Indicates the transmit status of the module.	OFF	—	The module is not active.
			Red	Solid	The module is transmitting data.
			Green	Solid	The module is receiving data.
	RX2	Indicates the receive status of the module.	OFF	—	The module is not receiving.
			Green	Solid	The module is receiving.
REF		Indicates the status of the reference signal.	OFF	—	There is no reference signal, or the device is not locked to the reference signal.
			Green	Blinking	The device is not locked to the reference signal.
				Solid	The device is locked to the reference signal.
PPS		Indicates the pulse per second (PPS).	OFF	—	There is no PPS timing reference signal, or the device is not locked to the reference signal.
			Green	Blinking	The device is locked to the PPS timing reference signal.

LED		Description	Color	State	Indication
GPS		Indicates whether the GPSDO is locked.	OFF	—	There is no GPSDO or the GPSDO is not locked.
			Green	Solid	The GPSDO is locked.
LINK		Indicates the status of the link to a host computer.	OFF	—	There is no link to a host computer.
			Green, yellow, or red	Solid	The host is actively communicating with the device.
RF 1	TX1 RX1	Indicates the transmit status of the module.	OFF	—	The module is not active.
			Red	Solid	The module is transmitting data.
			Green	Solid	The module is receiving data.
	RX2	Indicates the receive status of the module.	OFF	—	The module is not receiving.
			Green	Solid	The module is receiving.

Table 16. USRP-2952 Module LEDs

Figure 8. USRP-2952 Module Back Panel



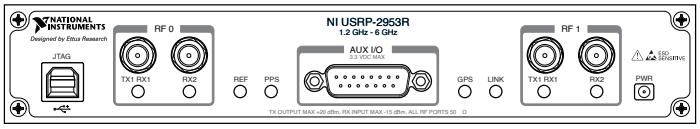
Connector	Use
PWR	Input that accepts a 9 V to 16 V, 6 A external DC power connector.
1G/10G ETH	Two SFP+ input terminals used for 1G ETH or 10G ETH connectivity with the host driver. Not currently supported in LabVIEW FPGA.
REF OUT	Output terminal for an external reference signal for the LO on the device. REF OUT is a female SMA connector with an impedance of 50 Ω, and it is a single-ended reference output. The output signal at this connector is 10 MHz at 3.3 V.
REF IN	Input terminal for an external reference signal for the LO on the device. REF IN is a female SMA connector with an impedance of 50 Ω, and it is a single-ended reference input. REF IN accepts a 10 MHz signal with a minimum input power of 0 dBm (0.632 Vpk-pk) and a maximum input power of 15 dBm (3.56 Vpk-pk) for a square wave or sine wave.
PCIe x4	Port for a PCI Express Generation 1, x4 bus connection through an MXI Express four-lane cable.
PPS TRIG OUT	Output terminal for the pulse per second (PPS) timing reference. PPS TRIG OUT is a female SMA connector with an impedance of 50 Ω, and it is a single-ended input.

Connector	Use
	The output signal is 0 V to 3.3 V TTL. You can also use this port as triggered output (TRIG OUT) that you program with the PPS Trig Out I/O signal.
PPS TRIG IN	Input terminal for pulse per second (PPS) timing reference. PPS TRIG IN is a female SMA connector with an impedance of 50 Ω, and it is a single-ended input channel. PPS TRIG IN accepts 0 V to 3.3 V TTL and 0 V to 5 V TTL signals. You can also use this port as a triggered input (TRIG IN) that you control using NI-USRP software.
GPS ANT	Input terminal for the GPS antenna signal. GPS ANT is a female SMA connector with a maximum input power of -15 dBm and an output of DC 5 V to power an active antenna. **Caution** Do not terminate the GPS ANT port if you do not use it.

Table 17. USRP-2952 Module Back Panel Connectors

USRP-2953

Figure 9. USRP-2953 Front Panel



Connector		Use
JTAG		A USB port that connects the host computer to the device FPGA for recovery purposes. This port can be used with the Xilinx iMPACT configuration tool to temporarily load a new bitfile.
RF 0	TX1 RX1	Input and output terminal for the RF signal. TX1 RX1 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
	RX2	Input terminal for the RF signal. RX2 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input channel.
AUX I/O		General-purpose I/O (GPIO) port. AUX I/O is controlled by the FPGA.
RF 1	TX1 RX1	Input and output terminal for the RF signal. TX1 RX1 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
	RX2	Input terminal for the RF signal. RX2 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input channel.

Table 15. USRP-2953 Module Front Panel Connectors

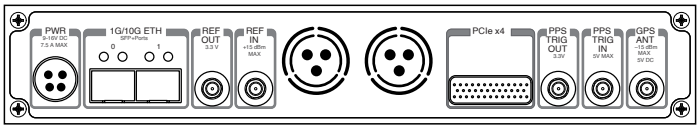
Note The LED indications described in the following table occur only when you use the NI-USRP API with the default API image. When you use LabVIEW FPGA, you customize the LED indications.

LED		Description	Color	State	Indication
RF 0	TX1 RX1	Indicates the transmit status of the module.	OFF	—	The module is not active.
			Red	Solid	The module is transmitting data.
			Green	Solid	The module is receiving data.
	RX2	Indicates the receive status of the module.	OFF	—	The module is not receiving.
			Green	Solid	The module is receiving.
REF		Indicates the status of the reference signal.	OFF	—	There is no reference signal, or the device is not locked to the reference signal.
			Green	Blinking	The device is not locked to the reference signal.
				Solid	The device is locked to the reference signal.
PPS		Indicates the pulse per second (PPS).	OFF	—	There is no PPS timing reference signal, or the device is not locked to the reference signal.
			Green	Blinking	The device is locked to the PPS timing reference signal.
GPS		Indicates whether the GPSDO is locked.	OFF	—	There is no GPSDO or the GPSDO is not locked.
			Green	Solid	The GPSDO is locked.
LINK		Indicates the status of the link to a host computer.	OFF	—	There is no link to a host computer.
			Green, yellow, or red	Solid	The host is actively communicating with the device.
RF 1	TX1 RX1	Indicates the transmit status of the module.	OFF	—	The module is not active.
			Red	Solid	The module is transmitting data.
			Green	Solid	The module is receiving data.
	RX2	Indicates the receive status of the module.	OFF	—	The module is not receiving.

LED		Description	Color	State	Indication
			Green	Solid	The module is receiving.

Table 16. USRP-2953 Module LEDs

Figure 10. USRP-2953 Module Back Panel



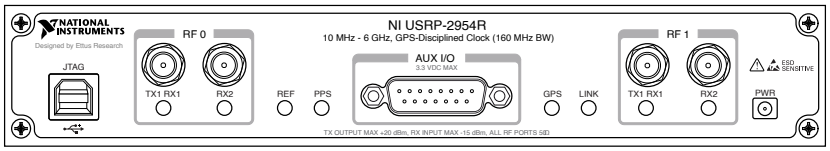
Connector	Use
PWR	Input that accepts a 9 V to 16 V, 6 A external DC power connector.
1G/10G ETH	Two SFP+ input terminals used for 1G ETH or 10G ETH connectivity with the host driver. Not currently supported in LabVIEW FPGA.
REF OUT	Output terminal for an external reference signal for the LO on the device. REF OUT is a female SMA connector with an impedance of 50 Ω, and it is a single-ended reference output. The output signal at this connector is 10 MHz at 3.3 V.
REF IN	Input terminal for an external reference signal for the LO on the device. REF IN is a female SMA connector with an impedance of 50 Ω, and it is a single-ended reference input. REF IN accepts a 10 MHz signal with a minimum input power of 0 dBm (0.632 Vpk-pk) and a maximum input power of 15 dBm (3.56 Vpk-pk) for a square wave or sine wave.
PCIe x4	Port for a PCI Express Generation 1, x4 bus connection through an MXI Express four-lane cable.
PPS TRIG OUT	Output terminal for the pulse per second (PPS) timing reference. PPS TRIG OUT is a female SMA connector with an impedance of 50 Ω, and it is a single-ended input. The output signal is 0 V to 3.3 V TTL. You can also use this port as triggered output (TRIG OUT) that you program with the PPS Trig Out I/O signal.
PPS TRIG IN	Input terminal for pulse per second (PPS) timing reference. PPS TRIG IN is a female SMA connector with an impedance of 50 Ω, and it is a single-ended input channel. PPS TRIG IN accepts 0 V to 3.3 V TTL and 0 V to 5 V TTL signals. You can also use this port as a triggered input (TRIG IN) that you control using NI-USRP software.
GPS ANT	Input terminal for the GPS antenna signal. GPS ANT is a female SMA connector with a maximum input power of -15 dBm and an output of DC 5 V to power an active antenna.

Connector	Use
	Caution Do not terminate the GPS ANT port if you do not use it.

Table 17. USRP-2953 Module Back Panel Connectors

USRP-2954

Figure 11. USRP-2954 Front Panel



Connector		Use
JTAG		A USB port that connects the host computer to the device FPGA for recovery purposes. This port can be used with the Xilinx iMPACT configuration tool to temporarily load a new bitfile.
RF 0	TX1 RX1	Input and output terminal for the RF signal. TX1 RX1 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
	RX2	Input terminal for the RF signal. RX2 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input channel.
AUX I/O		General-purpose I/O (GPIO) port. AUX I/O is controlled by the FPGA.
RF 1	TX1 RX1	Input and output terminal for the RF signal. TX1 RX1 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
	RX2	Input terminal for the RF signal. RX2 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input channel.

Table 15. USRP-2954 Module Front Panel Connectors

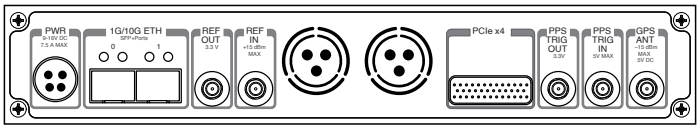
Note The LED indications described in the following table occur only when you use the NI-USRP API with the default API image. When you use LabVIEW FPGA, you customize the LED indications.

LED		Description	Color	State	Indication
RF 0	TX1 RX1	Indicates the transmit status of the module.	OFF	—	The module is not active.
			Red	Solid	The module is transmitting data.

LED		Description	Color	State	Indication
			Green	Solid	The module is receiving data.
	RX2	Indicates the receive status of the module.	OFF	—	The module is not receiving.
			Green	Solid	The module is receiving.
REF		Indicates the status of the reference signal.	OFF	—	There is no reference signal, or the device is not locked to the reference signal.
			Green	Blinking	The device is not locked to the reference signal.
				Solid	The device is locked to the reference signal.
PPS		Indicates the pulse per second (PPS).	OFF	—	There is no PPS timing reference signal, or the device is not locked to the reference signal.
			Green	Blinking	The device is locked to the PPS timing reference signal.
GPS		Indicates whether the GPSDO is locked.	OFF	—	There is no GPSDO or the GPSDO is not locked.
			Green	Solid	The GPSDO is locked.
LINK		Indicates the status of the link to a host computer.	OFF	—	There is no link to a host computer.
			Green, yellow, or red	Solid	The host is actively communicating with the device.
RF 1	TX1 RX1	Indicates the transmit status of the module.	OFF	—	The module is not active.
			Red	Solid	The module is transmitting data.
			Green	Solid	The module is receiving data.
	RX2	Indicates the receive status of the module.	OFF	—	The module is not receiving.
			Green	Solid	The module is receiving.

Table 16. USRP-2954 Module LEDs

Figure 12. USRP-2954 Module Back Panel

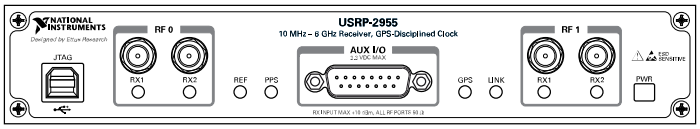


Connector	Use
PWR	Input that accepts a 9 V to 16 V, 6 A external DC power connector.
1G/10G ETH	Two SFP+ input terminals used for 1G ETH or 10G ETH connectivity with the host driver. Not currently supported in LabVIEW FPGA.
REF OUT	Output terminal for an external reference signal for the LO on the device. REF OUT is a female SMA connector with an impedance of 50 Ω, and it is a single-ended reference output. The output signal at this connector is 10 MHz at 3.3 V.
REF IN	Input terminal for an external reference signal for the LO on the device. REF IN is a female SMA connector with an impedance of 50 Ω, and it is a single-ended reference input. REF IN accepts a 10 MHz signal with a minimum input power of 0 dBm (0.632 Vpk-pk) and a maximum input power of 15 dBm (3.56 Vpk-pk) for a square wave or sine wave.
PCIe x4	Port for a PCI Express Generation 1, x4 bus connection through an MXI Express four-lane cable.
PPS TRIG OUT	Output terminal for the pulse per second (PPS) timing reference. PPS TRIG OUT is a female SMA connector with an impedance of 50 Ω, and it is a single-ended input. The output signal is 0 V to 3.3 V TTL. You can also use this port as triggered output (TRIG OUT) that you program with the PPS Trig Out I/O signal.
PPS TRIG IN	Input terminal for pulse per second (PPS) timing reference. PPS TRIG IN is a female SMA connector with an impedance of 50 Ω, and it is a single-ended input channel. PPS TRIG IN accepts 0 V to 3.3 V TTL and 0 V to 5 V TTL signals. You can also use this port as a triggered input (TRIG IN) that you control using NI-USRP software.
GPS ANT	Input terminal for the GPS antenna signal. GPS ANT is a female SMA connector with a maximum input power of -15 dBm and an output of DC 5 V to power an active antenna. **Caution** Do not terminate the GPS ANT port if you do not use it.

Table 17. USRP-2954 Module Back Panel Connectors

USRP-2955

Figure 13. USRP-2955 Front Panel



Connector		Use
JTAG		A USB port that connects the host computer to the device FPGA for recovery purposes. This port can be used with the Xilinx iMPACT configuration tool to temporarily load a new bitfile.
RF 0	RX1	Input terminal for the RF signal. RX1 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
	RX2	Input terminal for the RF signal. RX2 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input channel.
AUX I/O		General-purpose I/O (GPIO) port. AUX I/O is controlled by the FPGA.
RF 1	RX1	Input terminal for the RF signal. RX1 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
	RX2	Input terminal for the RF signal. RX2 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input channel.

Table 15. USRP-2955 Module Front Panel Connectors

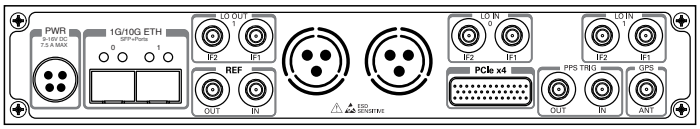
Note The LED indications described in the following table occur only when you use the NI-USRP API with the default API image. When you use LabVIEW FPGA, you customize the LED indications.

LED		Description	Color	State	Indication
RF 0	RX1	Indicates the receive status of the module.	OFF	—	The module is not receiving.
			Green	Solid	The module is receiving data.
	RX2	Indicates the receive status of the module.	OFF	—	The module is not receiving.
			Green	Solid	The module is receiving.
REF		Indicates the status of the reference signal.	OFF	—	There is no reference signal, or the device is not locked to the reference signal.
			Green	Blinking	The device is not locked to the reference signal.
				Solid	The device is locked to the reference signal.
PPS		Indicates the pulse per second (PPS).	OFF	—	There is no PPS timing reference signal, or the device is not locked to the reference signal.

LED		Description	Color	State	Indication
			Green	Blinking	The device is locked to the PPS timing reference signal.
GPS		Indicates whether the GPSDO is locked.	OFF	—	There is no GPSDO or the GPSDO is not locked.
			Green	Solid	The GPSDO is locked.
LINK		Indicates the status of the link to a host computer.	OFF	—	There is no link to a host computer.
			Green, yellow, or red	Solid	The host is actively communicating with the device.
RF 1	RX1	Indicates the receive status of the module.	OFF	—	The module is not active.
			Green	Solid	The module is receiving data.
	RX2	Indicates the receive status of the module.	OFF	—	The module is not receiving.
			Green	Solid	The module is receiving.

Table 16. USRP-2955 Module LEDs

Figure 14. USRP-2955 Module Back Panel



Connector	Use
PWR	Input that accepts a 9 V to 16 V, 6 A external DC power connector.
1G/10G ETH	Two SFP+ input terminals used for 1G ETH or 10G ETH connectivity with the host driver. Not currently supported in LabVIEW FPGA.
LO OUT 1 IF2	Output terminal for the IF LO signal exported by RF 1. LO OUT 1 IF2 is a female SMA connector with an impedance of 50 Ω.
LO OUT 1 IF1	Output terminal for the RF LO signal exported by RF 1. LO OUT 1 IF1 is a female SMA connector with an impedance of 50 Ω.
REF OUT	Output terminal for an external reference signal for the LO on the device. REF OUT is a female SMA connector with an impedance of 50 Ω, and it is a single-ended reference output. The output signal at this connector is 10 MHz at 3.3 V.
REF IN	Input terminal for an external reference signal for the LO on the device. REF IN is a female SMA connector with an impedance of 50 Ω, and it is a single-ended reference input. REF IN accepts a 10 MHz signal with a minimum input power of 0 dBm (0.632 Vpk-pk) and a maximum input power of 15 dBm (3.56 Vpk-pk) for a square wave or sine wave.

Connector	Use
LO IN 0 IF2	Terminal for an external signal to the IF LO input on the RF 0 daughterboard. This signal can be used as the LO source for an RF 0 channel by selecting external on that channel's LO source setting. LO IN 0 IF2 is a female SMA connector with an impedance of 50 Ω.
LO IN 0 IF1	Terminal for an external signal to the IF LO input on the RF 0 daughterboard. This signal can be used as the LO source for an RF 0 channel by selecting external on that channel's LO source setting. LO IN 0 IF1 is a female SMA connector with an impedance of 50 Ω.
PCIe x4	Port for a PCI Express Generation 1, x4 bus connection through an MXI Express four-lane cable.
LO IN 1 IF2	Terminal for an external signal to the IF LO input on the RF 0 daughterboard. This signal can be used as the LO source for an RF 0 channel by selecting external on that channel's LO source setting. LO IN 1 IF2 is a female SMA connector with an impedance of 50 Ω.
LO IN 1 IF1	Terminal for an external signal to the IF LO input on the RF 0 daughterboard. This signal can be used as the LO source for an RF 0 channel by selecting external on that channel's LO source setting. LO IN 1 IF1 is a female SMA connector with an impedance of 50 Ω.
PPS TRIG OUT	Output terminal for the pulse per second (PPS) timing reference. PPS TRIG OUT is a female SMA connector with an impedance of 50 Ω, and it is a single-ended input. The output signal is 0 V to 3.3 V TTL. You can also use this port as triggered output (TRIG OUT) that you program with the PPS Trig Out I/O signal.
PPS TRIG IN	Input terminal for pulse per second (PPS) timing reference. PPS TRIG IN is a female SMA connector with an impedance of 50 Ω, and it is a single-ended input channel. PPS TRIG IN accepts 0 V to 3.3 V TTL and 0 V to 5 V TTL signals. You can also use this port as a triggered input (TRIG IN) that you control using NI-USRP software.
GPS ANT	Input terminal for the GPS antenna signal. GPS ANT is a female SMA connector with a maximum input power of -15 dBm and an output of DC 5 V to power an active antenna. **Caution** Do not terminate the GPS ANT port if you do not use it.

Table 17. USRP-2955 Module Back Panel Connectors

GPIO Connector

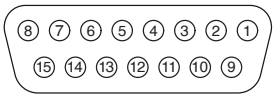
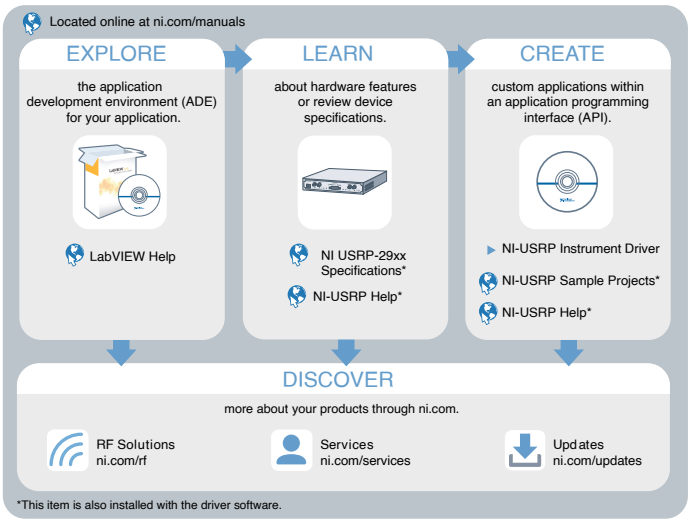
AUX I/O Connector	Pin	NI-USRP Terminal Name	USRP RIO (LV FPGA) IO Node Terminal Name
	1	3.3 V	3.3 V
	2	GPIO 0	AUX I/O 0
	3	GPIO 1	AUX I/O 1
	4	GPIO 2	AUX I/O 2
	5	GPIO 3	AUX I/O 3
	6	GPIO 4	AUX I/O 4
	7	GPIO 5	AUX I/O 5
	8	GPIO 6	AUX I/O 6
	9	GPIO 7	AUX I/O 7
	10	GPIO 8	AUX I/O 8
	11	GPIO 9	AUX I/O 9
	12	GPIO 10	AUX I/O 10
	13	GPIO 11	AUX I/O 11
	14	0 V	0 V
	15	0 V	0 V

Table 18. USRP RIO GPIO Connector Pin Assignments

Where to Go Next

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



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

Worldwide Support and Services

The NI 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 NI product. Product registration facilitates technical support and ensures that you receive important information updates from NI.

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