

GETTING STARTED GUIDE

NI USRP-2950R/2952R/2953R/ 2954R

Universal Software Radio Peripheral

This document explains how to install, configure, and test the National Instruments universal software radio peripheral (USRP) 2950R, 2952R, 2953R, or 2954R (NI 295x) device. The NI 295x can send and receive signals for use in various communications applications. This device ships with the NI-USRP instrument driver, which you can use to program the device.

To access NI 295x documentation, navigate to **Start»All Programs»National Instruments»NI-USRP»Documentation**.

Contents

Electromagnetic Compatibility Guidelines.....	2
Verifying the System Requirements.....	2
Unpacking the Kit.....	3
Verifying the Kit Contents.....	3
Preparing the Environment.....	4
Installing the Software.....	5
Installing NI 295x Devices.....	5
Synchronizing Multiple NI 295x Devices (Optional).....	6
Programming the NI 295x.....	7
NI-USRP Instrument Driver.....	7
NI-USRP Sample Projects.....	7
NI-USRP Examples.....	7
Testing the Device (Optional).....	8
Troubleshooting.....	8
Should I Update Device Firmware and FPGA Images?.....	8
Why Doesn't the Device Power On?.....	8
Installing the Software.....	8
Why Doesn't the USRP Device Appear in the NI-USRP Configuration Utility?.....	9
Why Does USRP2 Appear Instead of NI 295x in the NI-USRP Configuration Utility?.....	9
Why Don't NI-USRP Examples Appear in the NI Example Finder?.....	9
Front Panels, Back Panels, and Connectors.....	9
Direct Connections to the NI 295x.....	9
NI USRP-2950R.....	10
NI USRP-2952R.....	13

NI USRP-2953R.....	17
NI USRP-2954R.....	21
GPIO Connector.....	26
Where to Go Next.....	27
Worldwide Support and Services.....	27

Electromagnetic Compatibility Guidelines

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

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

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



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



Caution To ensure the specified EMC performance, the length of all I/O cables except those connected to the Ethernet and GPS antenna ports must be no longer than 3 m (10 ft).



Caution To ensure the specified EMC performance, install snap-on, ferrite bead(s) (National Instruments part number 781233-01) in accordance with the included Note to Users regarding ferrite installation.



Caution This product is not approved or licensed for transmission over the air using an antenna. As a result, operating this product with an antenna may violate local laws. Ensure that you are in compliance with all local laws before operating this product with an antenna.

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 at **Start»All Programs»National Instruments»NI-USRP»Documentation** or 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.

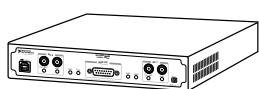


Note Do not install a device if it appears damaged in any way.

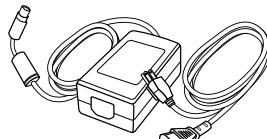
3. Unpack any other items and documentation from the kit.

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

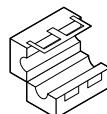
Verifying the Kit Contents



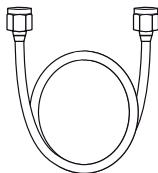
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1. NI 29xx Device
2. AC/DC Power Supply and Power Cable
3. Ferrite Bead
4. SMA (m)-to-SMA (m) Cable
5. 30 dB SMA Attenuator
6. Getting Started Guide (This Document)



Caution If you directly connect or cable a signal generator to your device, or if you connect multiple USRP devices together, you must connect a 30 dB attenuator to the RF input (RX1 or RX2) of each receiving USRP 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 USRP RIO, which contains an MXI Express interface card, at ni.com.



Caution This product is not approved or licensed for transmission over the air using an antenna. As a result, operating this product with an antenna may violate local laws. Ensure that you are in compliance with all local laws before operating this product with an antenna.

Optional Items

- LabVIEW Modulation Toolkit (MT), included on the driver software media, 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, included on the driver software media
- LabVIEW MathScript RT Module, included on the driver software media
- 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
- NI PCIe - MXI Express Interface Kit for USRP RIO to connect to a desktop computer
- NI ExpressCard Slot - MXI Express Interface Kit for USRP RIO to connect to a laptop computer
- NI PXIE - MXI Express Interface Kit for USRP RIO to connect to a PXI Express chassis
- CDA-2990 clock distribution accessory for synchronizing multiple devices

Preparing the Environment

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

Operating temperature	$23 \pm 5^{\circ}\text{C}$
Operating humidity	10% to 90% relative humidity, noncondensing
Pollution Degree	2
Maximum altitude	2,000 m

Indoor use only.



Note Refer to the USRP device specifications at ni.com/manuals for complete specifications.



Caution Do not operate the NI 295x 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.
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.

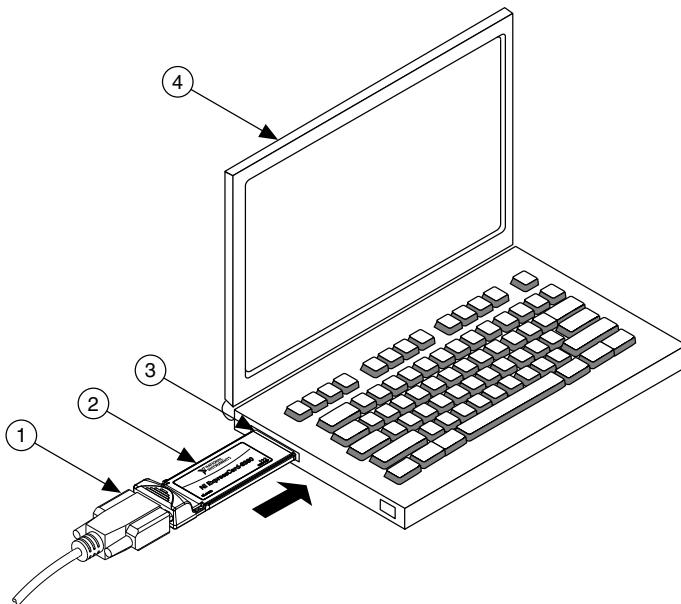
5. When the installer completes, select **Restart** in the dialog box that prompts you to restart, shut down, or restart later.

Installing NI 295x Devices

Install all the software you plan to use before you install the hardware.

1. Power off the computer and the USRP device. Power on the USRP device before powering on your computer.
2. Attach the antenna or cable to the front panel terminals of the USRP device as desired.
3. Use the MXI Express Interface Kit to connect the USRP device to the computer.
 - a) 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 MXT™ Express ×4 System* document included in that kit.
 - If you are using the laptop connectivity kit, touch the NI ExpressCard-8360B and outer metal case of the USRP device simultaneously.
 - b) Connect the MXI device to the USRP device using the included cable.

If you are using the laptop connectivity kit, refer to the following figure.



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- | | |
|--|---------------------|
| 1. Cable Included with ExpressCard Interface Kit | 3. ExpressCard Slot |
| 2. NI ExpressCard-8360B | 4. Laptop Computer |
4. Connect the AC/DC power supply to the USRP device.
 5. Plug the power supply into a wall outlet. Press the PWR button.
 6. Power on the computer.

Windows automatically recognizes the USRP device.

Related Information

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

Synchronizing Multiple NI 295x Devices (Optional)

To set up a higher channel-count system, you can synchronize two or more NI 295x devices so that they share clock and PPS signals.

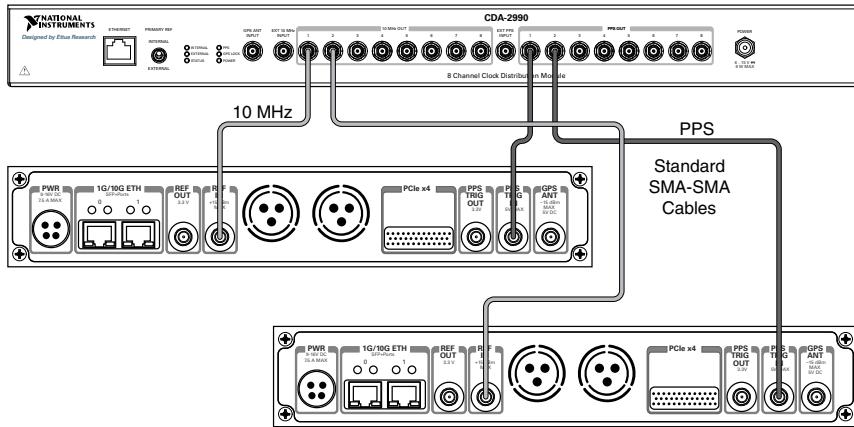


Note Synchronizing multiple NI 295x devices requires a CDA-2990 device.

Ensure that all hardware is set up as previously indicated.

1. Connect the REF IN port of the NI 295x device to the first 10 MHz OUT port of the CDA-2990 device using a standard SMA (m)-to-SMA (m) cable.
2. Connect the PPS TRIG IN port of the NI 295x device to the PPS OUT port of the CDA-2990 device using a standard SMA (m)-to-SMA (m) cable.
3. Repeat steps 1 and 2 for any additional NI 295x devices using the additional ports on the CDA-2990 (optional). Refer to the following figure.

Figure 1. Synchronizing Multiple NI 295x Devices with the CDA-2990



Programming the NI 295x

You can use the NI-USRP instrument driver to create communications applications for the NI 295x.

NI 295x 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 NI 295x, including configuration, control, and other device-specific functions. Refer to the *NI-USRP Help* for information about using the instrument driver in your applications.

NI-USRP Sample Projects

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

NI-USRP Examples

The instrument driver examples are instructional tools that demonstrate some of the functionality of the NI 295x. 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:

- 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.

Testing the Device (Optional)

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

1. Create a sample project using the NI-USRP sample project template in LabVIEW by selecting **File»Create Project»NI-USRP**.
2. Run the Full Duplex Streaming (Host) VI.

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

3. 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?

NI 295x 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.

Installing the Software

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

1. Install an ADE, such as LabVIEW.
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.

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 NI 295x 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:

- 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.

Front Panels, Back Panels, and Connectors

Direct Connections to the NI 295x

The NI 295x is a precision RF instrument that is sensitive to ESD and transients. Ensure you take the following precautions when making direct connections to the NI 295x to avoid damaging the device.



Caution Apply external signals only while the NI 295x 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 NI 295x TX1 RX 1 or RX2 connector.
- If you are using noninsulated devices, such as a noninsulated RF antenna, ensure the devices are maintained in a static-free environment.
- If you are using an active device, such as a preamplifier or switch routed to the NI 295x TX1 RX 1 or RX2 connector, ensure that there are no signal transients greater than the RF and DC specifications for the device that are being generated and sourced to the NI 295x TX1 RX 1 or RX2 connector.

NI USRP-2950R

Figure 2. NI USRP-2950R Front Panel

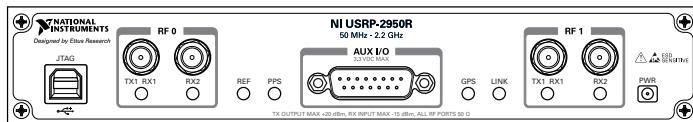


Table 1. NI USRP-2950R Module Front Panel Connectors

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.



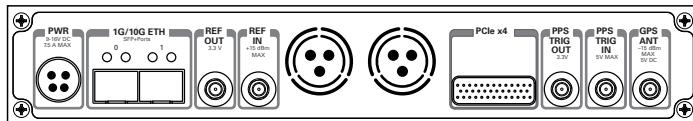
Note The LED indications described in the following table occur only when you use the NI-USRP API with the default API image. When you use LabVIEW FPGA, you customize the LED indications.

Table 2. NI USRP-2950R Module LEDs

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.
REF	RX2	Indicates the receive status of the module.	OFF	—	The module is not receiving.
			Green	Solid	The module is receiving.
			OFF	—	There is no reference signal, or the device is not locked to the reference signal.
PPS	REF	Indicates the status of the reference signal.	Green	Blinking	The device is not locked to the reference signal.
			Green	Solid	The device is locked to the reference signal.
			OFF	—	There is no PPS timing reference signal, or the device is not locked to the reference signal.
GPS	PPS	Indicates the pulse per second (PPS).	Green	Blinking	The device is not locked to the PPS timing reference signal.
			Green	Solid	The device is locked to the PPS timing reference signal.
GPS	GPS	Indicates whether the GPSDO is locked.	OFF	—	There is no GPSDO or the GPSDO is not locked.
			Green	Solid	The GPSDO is locked.

Table 2. NI USRP-2950R Module LEDs (Continued)

LED		Description	Color	State	Indication
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.

Figure 3. NI USRP-2950R Module Back Panel**Table 3.** NI USRP-2950R Module Back Panel Connectors

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.

Table 3. NI USRP-2950R Module Back Panel Connectors (Continued)

Connector	Use
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 $50\ \Omega$, and it is a single-ended reference input. REF IN accepts a 10 MHz signal with a minimum input power of 0 dBm ($0.632\ V_{pk-pk}$) and a maximum input power of 15 dBm ($3.56\ V_{pk-pk}$) 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 $50\ \Omega$, 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 $50\ \Omega$, 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.

NI USRP-2952R

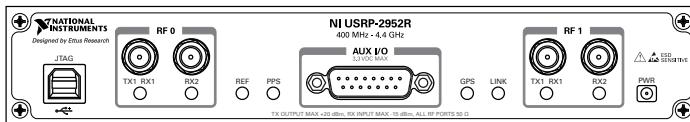
Figure 4. NI USRP-2952R Front Panel

Table 4. NI USRP-2952R Module Front Panel Connectors

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 50Ω 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 50Ω 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 50Ω 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 50Ω and is a single-ended input channel.



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.

Table 5. NI USRP-2952R Module LEDs

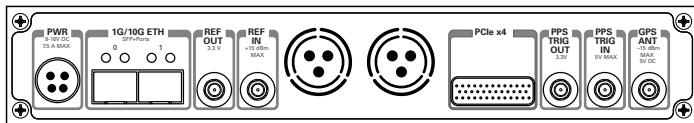
LED		Description	Color	State	Indication
RF 0	TX1 RX1	Indicates the transmit status of the module.	OFF	—	The module is not active.
			Red	Solid	The module is transmitting data.
			Green	Solid	The module is receiving data.
	RX2	Indicates the receive status of the module.	OFF	—	The module is not receiving.
			Green	Solid	The module is receiving.

Table 5. NI USRP-2952R Module LEDs (Continued)

LED	Description	Color	State	Indication
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 not locked to the PPS timing reference signal.
			Solid	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.

Table 5. NI USRP-2952R Module LEDs (Continued)

LED		Description	Color	State	Indication
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.

Figure 5. NI USRP-2952R Module Back Panel**Table 6.** NI USRP-2952R Module Back Panel Connectors

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 $50\ \Omega$, 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 $50\ \Omega$, and it is a single-ended reference input. REF IN accepts a 10 MHz signal with a minimum input power of 0 dBm ($0.632\text{ V}_{\text{pk-pk}}$) and a maximum input power of 15 dBm ($3.56\text{ V}_{\text{pk-pk}}$) 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.

Table 6. NI USRP-2952R Module Back Panel Connectors (Continued)

Connector	Use
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 $50\ \Omega$, 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 $50\ \Omega$, 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.

NI USRP-2953R

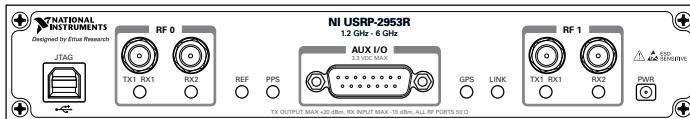
Figure 6. NI USRP-2953R Front Panel

Table 7. NI USRP-2953R Module Front Panel Connectors

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 50Ω 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 50Ω 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 50Ω 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 50Ω and is a single-ended input channel.



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.

Table 8. NI USRP-2953R Module LEDs

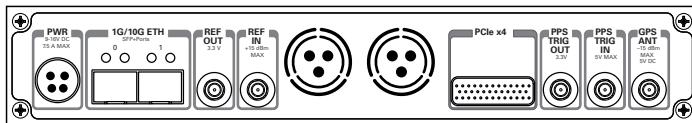
LED	Description	Color	State	Indication	
RF 0	TX1 RX1	Indicates the transmit status of the module.	OFF	—	The module is not active.
			Red	Solid	The module is transmitting data.
			Green	Solid	The module is receiving data.
	RX2	Indicates the receive status of the module.	OFF	—	The module is not receiving.
			Green	Solid	The module is receiving.

Table 8. NI USRP-2953R Module LEDs (Continued)

LED	Description	Color	State	Indication
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 not locked to the PPS timing reference signal.
			Solid	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.

Table 8. NI USRP-2953R Module LEDs (Continued)

LED		Description	Color	State	Indication
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.

Figure 7. NI USRP-2953R Module Back Panel**Table 9.** NI USRP-2953R Module Back Panel Connectors

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 V _{pk-pk}) and a maximum input power of 15 dBm (3.56 V _{pk-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.

Table 9. NI USRP-2953R Module Back Panel Connectors (Continued)

Connector	Use
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 $50\ \Omega$, 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 $50\ \Omega$, 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.

NI USRP-2954R

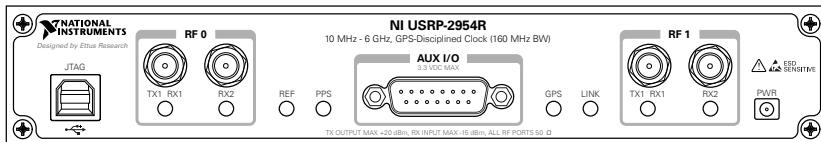
Figure 8. NI USRP-2954R Front Panel

Table 10. NI USRP-2954R Module Front Panel Connectors

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 50Ω 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 50Ω 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 50Ω 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 50Ω and is a single-ended input channel.



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.

Table 11. NI USRP-2954R Module LEDs

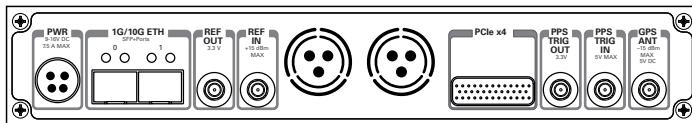
LED		Description	Color	State	Indication
RF 0	TX1 RX1	Indicates the transmit status of the module.	OFF	—	The module is not active.
			Red	Solid	The module is transmitting data.
			Green	Solid	The module is receiving data.
	RX2	Indicates the receive status of the module.	OFF	—	The module is not receiving.
			Green	Solid	The module is receiving.

Table 11. NI USRP-2954R Module LEDs (Continued)

LED	Description	Color	State	Indication
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 not locked to the PPS timing reference signal.
			Solid	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.

Table 11. NI USRP-2954R Module LEDs (Continued)

LED		Description	Color	State	Indication
RF 1 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.

Figure 9. NI USRP-2954R Module Back Panel**Table 12.** NI USRP-2954R Module Back Panel Connectors

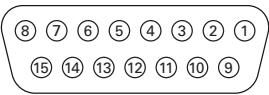
Connector	Use
PWR	Input that accepts a 9 V to 16 V, 6 A external DC power connector.
1G/10G ETH	Two SFP+ input terminals used for 1G ETH or 10G ETH connectivity with the host driver. Not currently supported in LabVIEW FPGA.
REF OUT	Output terminal for an external reference signal for the LO on the device. 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 V _{pk-pk}) and a maximum input power of 15 dBm (3.56 V _{pk-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.

Table 12. NI USRP-2954R Module Back Panel Connectors (Continued)

Connector	Use
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 $50\ \Omega$, 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 $50\ \Omega$, 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	<p>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.</p> <p> Caution Do not terminate the GPS ANT port if you do not use it.</p>

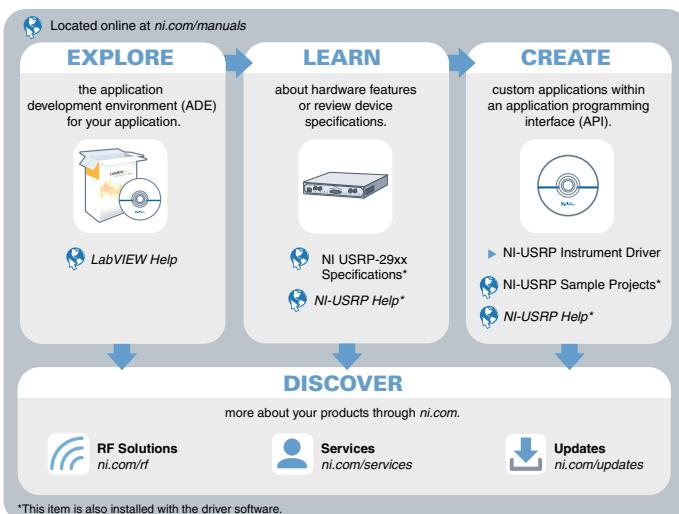
GPIO Connector

Table 13. NI 295x GPIO Connector Pin Assignments

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

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.

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