

## GETTING STARTED GUIDE

# USRP-2900/2901

## Universal Software Radio Peripheral

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

- USRP-2900 Software Defined Radio (USRP-2900)
- USRP-2901 Software Defined Radio (USRP-2901)

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## Electromagnetic Compatibility Guidelines

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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** 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

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

Refer to the product readme, which is available on the driver software media or online at [ni.com/manuals](http://ni.com/manuals), for more information about minimum system requirements, recommended system, and supported application development environments (ADEs).

## Unpacking the Kit

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**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.



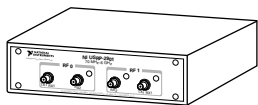
**Note** Do not install a device if it appears damaged in any way.

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

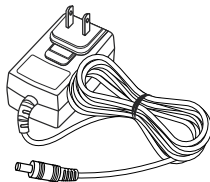
Store the device in the antistatic package when the device is not in use.

# Verifying the Kit Contents

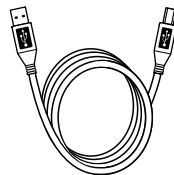
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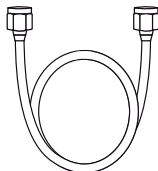
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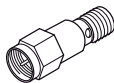
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|---|---|
| 1. USRP-2900/2901 Device                                | 5. 30 dB SMA Attenuator                                 |
| 2. AC/DC Power Supply (Included Only in USRP-2901 Kits) | 6. Driver Software Media                                |
| 3. USB 3.0 Cable  | 7. USRP-2900/2901 Getting Started Guide (This Document) |
| 4. SMA (m)-to-SMA (m) Cable                             |   |
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**Note** The driver software media installs the NI-USRP driver software and electronic documentation, including the *NI-USRP Help*, the *NI-USRP Readme*, and device specifications. After installation, you can access USRP-2900/2901 documentation at **Start»All Programs»National Instruments»NI-USRP»Documentation**.

## Other Required Items

In addition to the kit contents, you must provide the following additional items:

- Computer with available USB 3.0 or USB 2.0 interface.



**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

- Additional SMA (m)-to-SMA (m) cables to connect both channels with external devices or to use the REF IN and PPS IN signals
- 6 V, 3 A external DC power connector

## Preparing the Environment

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Ensure that the environment you are using the USRP-2900/2901 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-2900/2901 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

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

1. Install an ADE, such as LabVIEW or LabVIEW Communications System Design Software.
2. Visit [ni.com/info](https://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-2900/2901 Devices

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Install LabVIEW Communications System Design Software and NI-USRP before you install the hardware.



**Note** The USRP-2900/2901 device connects to a host computer using a standard USB connector and USB cable.

1. Power on the computer.
2. Attach the antenna or cable to the front panel terminals of the USRP-2900/2901 device as needed for your application.
3. Use the USB cable to connect the USRP device to the computer.



**Note** You can connect the USRP device to either a USB 3.0 or a USB 2.0 port. If you use a USB 2.0 port, the maximum achievable sample rate may be reduced to 8 MS/s or less.



**Note** NI recommends that you connect the device to an external power supply when you use USB 2.0.

4. (Optional) Connect the AC/DC power supply to the PWR connector on the back panel of the USRP device, and plug the power supply into a wall outlet.



**Note** NI recommends that you connect the device to an external power supply if you plan to use both channels of the USRP device. However, if you plan to use only one channel, bus power may be acceptable.

You can connect and synchronize multiple USRP-2900/2901 devices using an external Reference Clock distribution system such as the CDA-2990 Clock Distribution Device. However, USB performance varies when multiple devices stream through the same controller. Consider using a USRP RIO device if you need to build a high-channel count system.

## Configuring USRP-2900/2901 Devices

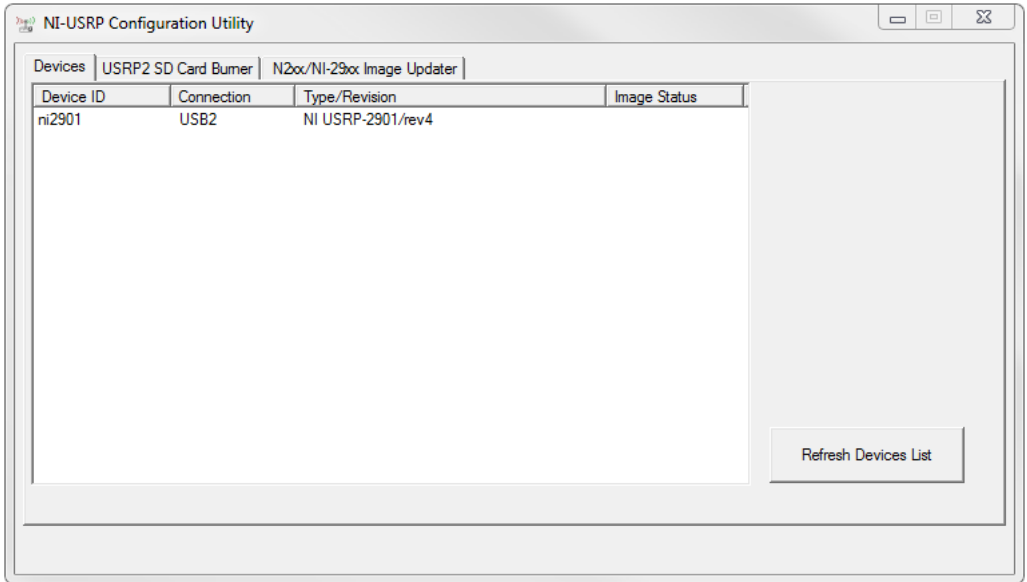
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### Confirming USB Connection

1. Select **Start»All Programs»National Instruments»NI-USRP»NI-USRP Configuration Utility** to open the NI-USRP Configuration Utility.
2. Select the **Devices** tab of the utility.

Your device should appear in the list on the left side of the tab, similar to the following figure.

**Figure 1.** Confirming USB Connection



**Note** If your device is not listed, verify that your device is powered on and correctly connected, then click the Refresh Devices List button to scan for USRP devices.

## Changing the Device ID

To change the USRP-2900/2901 device ID, you must know the current address of the device.

1. Verify that your device is powered on and connected to your computer using the USB 3.0 or 2.0 interface.
2. Select **Start»All Programs»National Instruments»NI-USRP»NI-USRP Configuration Utility** to open the NI-USRP Configuration Utility.
3. Select the **Devices** tab of the utility.

Your device should appear in the list on the left side of the tab.

4. In the list, select the device for which you want to change the device ID.

If you have multiple devices, verify that you selected the correct device.

The device ID of the selected device displays in the **Selected Device ID** textbox.

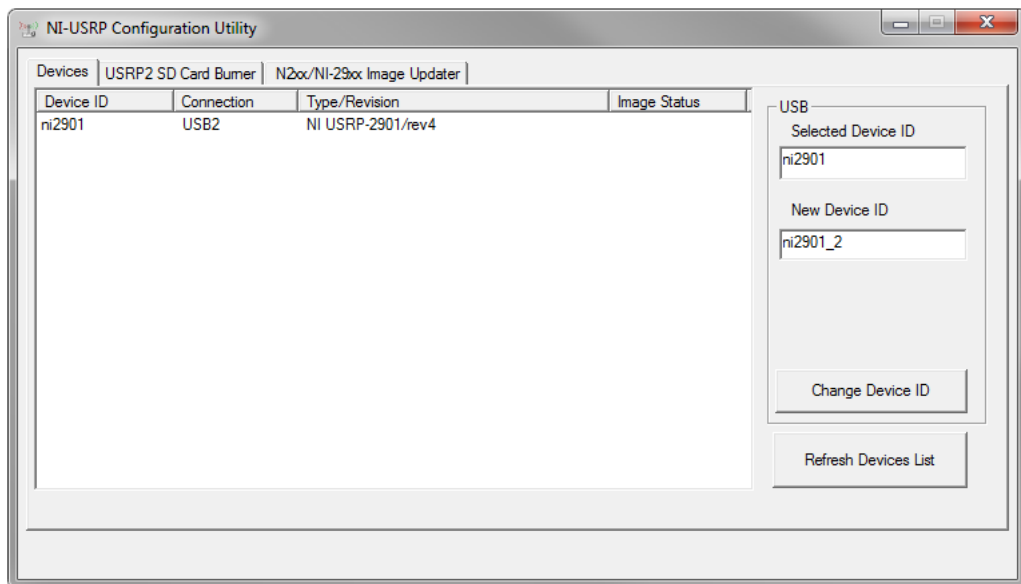
5. Enter the device ID for the device in the **New Device ID** textbox.



**Note** The device ID cannot contain spaces or special characters.

The utility should appear similar to the following figure.

**Figure 2.** Changing the Device ID



6. Click the **Change Device ID** button or press <Enter> to change the device ID.
7. The utility prompts you to confirm your selection. Click **OK** if your selection is correct; otherwise, click **Cancel**.
8. The utility displays a confirmation to indicate the process is complete. Click **OK**.
9. Power cycle the device to apply the changes.



**Note** After you change the device ID, you must power cycle the device and click **Find Devices** in the utility to update the list of devices.

## Configuring Multiple Devices with USB

You can connect multiple devices in the following ways:

- Multiple USB 2.0 or 3.0 interfaces—One device for each interface
- Single USB 2.0 or 3.0 interface—Multiple devices connected to a USB 2.0 or 3.0 hub



**Tip** Sharing a single USB 2.0 or 3.0 controller interface on your host computer among multiple devices may reduce overall signal throughput. For maximum signal throughput, NI recommends that you connect no more than one device per USB interface.

To configure multiple devices connected to either separate USB 2.0 or 3.0 interfaces or to a USB hub, assign a different device ID to each USRP device. Because each USRP-2900/2901 device has the same default device ID, you must change the device ID for each USRP device before you connect an additional device to the host computer.

# Programming the USRP-2900/2901

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## NI-USRP Instrument Driver

NI-USRP features a set of VIs and properties that exercise the functionality of the USRP-2900/2901, 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 Examples

The instrument driver examples are instructional tools that demonstrate some of the functionality of the USRP-2900/2901. 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 Software 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](https://ni.com/usrp).



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

## Verifying the Device Connection (Optional)

### Using LabVIEW Communications System Design Software

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

Perform a loopback test to confirm that the device transmits and receives signals and is connected correctly to the host computer.

1. Attach the included 30 dB attenuator to one end of the SMA (m)-to-SMA (m) cable.
2. Connect the 30 dB attenuator to the RX 2 TX 2 connector on the front panel of the USRP device, and connect the other end of the SMA (m)-to-SMA (m) cable to the RX 1 TX 1 port.



3. On the host computer, open the niUSRP EX Tx Continuous Async example VI and run it.  
If the device is transmitting signals, the IQ graph displays I and Q waveforms.
4. Open the niUSRP EX Rx Continuous Async example VI and run it.  
If the device is receiving signals, the IQ graph displays I and Q waveforms.

## Troubleshooting

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If an issue persists after you complete a troubleshooting procedure, contact NI technical support or visit [ni.com/support](http://ni.com/support).

### Why Doesn't the USRP Device Appear in MAX?

MAX does not support USRP-2900/2901 devices. Use the NI-USRP Configuration Utility instead. Open the NI-USRP Configuration Utility from the Start menu at **Start»All Programs»National Instruments»NI-USRP»NI-USRP Configuration Utility**.

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

1. Verify that the latest NI-USRP drivers are installed by running NI Update Service, available from the Start menu at **Start»All Programs»National Instruments»NI Update Service**.
2. Check the LED status to ensure the device is powered correctly. If the LED is blue, the device is powered correctly using USB. If the LED is orange, the device is powered correctly using external power.
3. Connect the device to a different USB port of the host computer, if one is available.
4. Ensure that the latest drivers are installed for your USB controller.

## Front Panels and Connectors

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### Direct Connections to the USRP-2900/2901

The USRP-2900/2901 is an RF instrument that is sensitive to ESD and transients. Ensure you take the following precautions when making direct connections to the USRP-2900/2901 to avoid damaging the device.

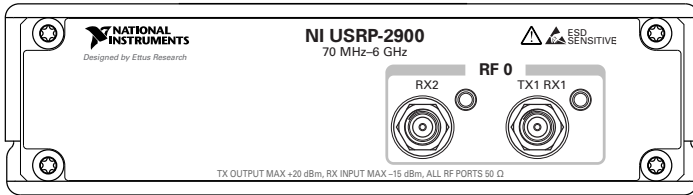


**Caution** Apply external signals only while the USRP-2900/2901 is powered on. Applying external signals while the device is powered off may cause damage.

- Ensure you are properly grounded when manipulating cables or antennas connected to the USRP-2900/2901 TX1 RX 1 or RX2 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-2900/2901 TX1 RX 1 or RX2 connector, ensure that the device cannot generate signal transients greater than the RF and DC specifications of the USRP-2900/2901 TX1 RX 1 or RX2 connector.

# USRP-2900 Connectors and LEDs

**Figure 3. USRP-2900 Front Panel**



**Table 1. Device Front Panel Icon Definitions**

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

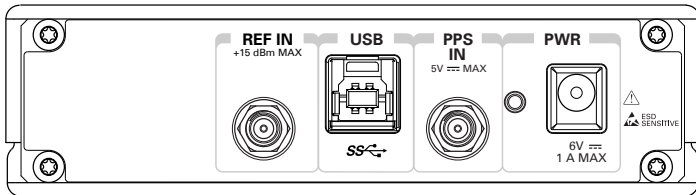
**Table 2. USRP-2900 Module Front Panel Connectors**

Connector	Use
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.
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.

**Table 3. USRP-2900 Module LEDs**

LED		Description	Color	Indication
RF 0	RX2	Indicates the receive status of the device.	Off	The device is not active.
			Green	The device is receiving data.
	TX1 RX1	Indicates the transmit status of the device.	Off	The device is not active.
			Green	The device is receiving data.
		Red	The device is transmitting data.	
			Orange	The device is switching between transmitting and receiving data.

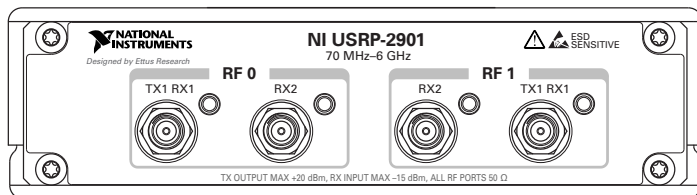
**Figure 4. USRP-2900 Module Back Panel Connectors**



Connector	Use
REF IN	Input terminal for an external reference signal for the local oscillator (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 <sub>pk-pk</sub> ) and a maximum input power of 15 dBm (3.56 V <sub>pk-pk</sub> ) for a square wave or sine wave.
USB	Input that accepts a standard USB cable. A suitable USB cable is included in the hardware kit.
PPS IN	Input terminal for pulse per second (PPS) timing reference. PPS IN is a female SMA connector with an impedance of 50 Ω, and it is a single-ended input channel. PPS IN accepts 0 V to 3.3 V TTL and 0 V to 5 V TTL signals.
PWR	Input that accepts a 6 V, 3 A external DC power connector.

# USRP-2901 Connectors and LEDs

**Figure 5. USRP-2901 Front Panel**



**Table 4. USRP-2901 Module Front Panel Connectors**

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.
RF 1	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.
	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.

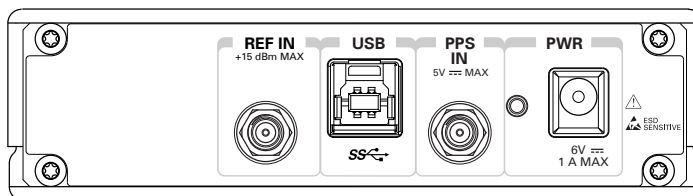
**Table 5. USRP-2901 Module LEDs**

LED	Description	Color	Indication	
RF 0	TX1 RX1	Indicates the transmit status of the device.	Off	The device is not active.
		Green	The device is receiving data.	
		Red	The device is transmitting data.	
		Orange	The device is switching between transmitting and receiving data.	
RX2	Indicates the receive status of the device.	Off	The device is not active.	
		Green	The device is receiving data.	

**Table 5. USRP-2901 Module LEDs (Continued)**

LED		Description	Color	Indication
RF 1	RX2	Indicates the receive status of the device.	Off	The device is not active.
			Green	The device is receiving data.
	TX1 RX1	Indicates the transmit status of the device.	Off	The device is not active.
			Green	The device is receiving data.
		Red	The device is transmitting data.	
			Orange	The device is switching between transmitting and receiving data.

**Figure 6. USRP-2901 Module Back Panel Connectors**



Connector	Use
REF IN	Input terminal for an external reference signal for the local oscillator (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 <sub>pk-pk</sub> ) and a maximum input power of 15 dBm (3.56 V <sub>pk-pk</sub> ) for a square wave or sine wave.
USB	Input that accepts a standard USB cable. A suitable USB cable is included in the hardware kit.
PPS IN	Input terminal for pulse per second (PPS) timing reference. PPS IN is a female SMA connector with an impedance of 50 $\Omega$ , and it is a single-ended input channel. PPS IN accepts 0 V to 3.3 V TTL and 0 V to 5 V TTL signals.
PWR	Input that accepts a 6 V, 3 A external DC power connector.

# Worldwide Support and Services

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The NI website is your complete resource for technical support. At [ni.com/support](http://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](http://ni.com/services) for NI Factory Installation Services, repairs, extended warranty, and other services.

Visit [ni.com/register](http://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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376357B-01 Dec16