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USRP-2974

GETTING STARTED GUIDE

USRP-2974

10 MHz to 6 GHz, x86 Processor, GPS-Disciplined OCXO, USRP
Software Defined Radio Stand-Alone Device

This document explains how to install, configure, and test the USRP-2974 Software Defined Radio Stand-Alone Device.

The USRP-2974 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.

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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 on the driver software media or online at ni.com/manuals, for more information about minimum system requirements, recommended system, and supported application development environments (ADEs).

Unpacking the Kit



Notice To prevent electrostatic discharge (ESD) from damaging the device, ground yourself using a grounding strap or by holding a grounded object, such as your computer chassis.

1. Touch the antistatic package to a metal part of the computer chassis.
2. Remove the device from the package and inspect the device for loose components or any other sign of damage.



Notice Never touch the exposed pins of connectors.



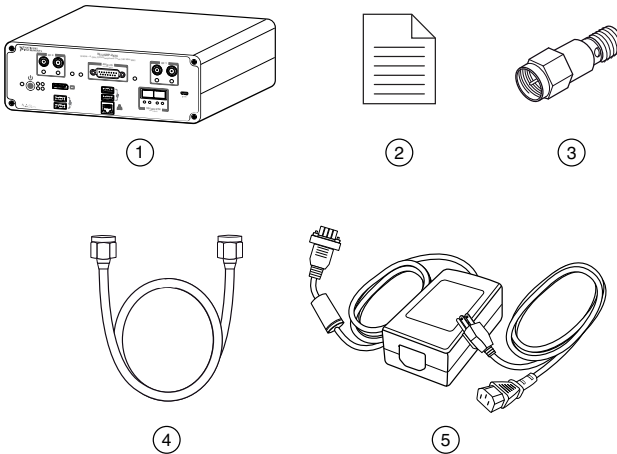
Note Do not install a device if it appears damaged in any way.

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

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

Verifying the Kit Contents

Figure 1. Kit Contents



-
- | | |
|------------------------------------------|-----------------------------|
| 1. USRP-2974 | 4. SMA (m)-to-SMA (m) Cable |
| 2. Getting Started Guide (This Document) | 5. Power Supply |
| 3. 30 dB SMA Attenuator | |
-



Notice If you directly connect or cable a signal generator to your device, or if you connect multiple devices together, you must connect a 30 dB attenuator to the RF input (RX1 or RX2) of each receiving USRP-2974.

Optional Items

- Additional SMA (m)-to-SMA (m) cables to use the REF IN and PPS IN signals
- 1 G or 10 G Ethernet cable
- CDA-2990 Clock Distribution Device for synchronizing multiple devices
- GPS antenna
- 10 G Ethernet card for desktop



Tip NI recommends using the Ettus 10 Gigabit Ethernet Card for Desktop, available at www.ettus.com.

Installing the Software

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

Ensure that you have installed the latest version of NI Package Manager. To access the download page for NI Package Manager, go to ni.com/info and enter Info Code NIPMDownload.

1. Install LabVIEW Communications System Design Suite.
2. Install the latest NI-USRP instrument driver using NI Package Manager.
3. Follow the instructions in the installation prompts.



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

Connecting to a Computer

For most applications, the USRP-2974 must be connected either to a desktop computer or a laptop computer.

Install any software you plan to use on the desktop computer or laptop computer before you connect the hardware.

1. (Optional) Connect any additional attachments required for your project to the front panel or back panel terminals of the USRP-2974.
2. Connect the USRP-2974 to an Ethernet port on the local subnet or directly to the computer using an Ethernet cable.

Connection Action

1G ETH	Connect the RJ45 connector of the USRP-2974 front panel to the Ethernet port of the computer.
---------------	-----------------------------------------------------------------------------------------------

Connection Action

10G ETH Connect the SFP+ Port 0 connector of the USRP-2974 front panel to the Ethernet port of the computer.



Note The USRP-2974 automatically attempts to connect to the network using dynamic host configuration protocol (DHCP). If DHCP is not available, the USRP-2974 connects to the network with a link-local IP address with the form 169.254.x.x.



Tip Use an Ethernet router to connect multiple USRP-2974 devices to the computer.

Related Information

[How Do I Change My IP Address Using My Computer?](#) on page 9

Powering on the Device

1. Connect the power supply to the USRP-2974.
2. Plug the power supply into a wall outlet. Press the power button.
3. Power on the computer or laptop.

Programming the Device

You can use the NI-USRP instrument driver to create communications applications for the USRP-2974.

The USRP-2974 contains a controller that runs NI Linux Real-Time. It also contains a LabVIEW FPGA target, which supports the creation of custom FPGAs and configuration of the device using Instrument Design Libraries (IDLs).

NI-USRP Instrument Driver

The NI-USRP instrument driver features a set of functions and properties that exercise the capabilities of the USRP-2974, including configuration, control, and other device-specific functions.

Refer to the [NI-USRP Manual](#) for information about using the instrument driver in your applications.

Software Options

You must use the USRP RIO IDL when programming the USRP-2974.



Note The NI-USRP API is not supported when programming the USRP-2974.

- Description:
 - Allows you to interface with the FPGA of your USRP-2974 for advanced 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.
- Use Case: Use with LabVIEW Communications System Design Suite to customize the behavior of the device FPGA to create application-specific instrument designs.
- Location:
 - (LabVIEW Communications System Design Suite 2.1 to Current) On the **Diagram** tab, select **Hardware Interfaces»Wireless Design and Test»USRP RIO** from the palette.
 - (LabVIEW Communications System Design Suite 2.0) On the **Diagram** tab, select **Hardware Interfaces»USRP RIO** from the palette.

NI-USRP Sample Project

NI-USRP includes a sample project that serves as a starting point to build a USRP RIO streaming application.

- LabVIEW NXG 2.1 to Current or LabVIEW Communications System Design Suite 2.1 to Current: From the **Projects** tab, select **USRP RIO** and choose the applicable sample project for your device and setup.
- LabVIEW Communications System Design Suite 2.0: From the **Projects** tab, choose the applicable sample project for your device and setup.

Using Your Device with Software

You can view and manage your device using SystemLink or LabVIEW Communications System Design Suite.



Note SystemLink is not supported when using LabVIEW Communications System Design Suite 2.0.

Related Information

Refer to the [SystemLink Manual](#) to learn more about using your device with SystemLink.

Refer to the [LabVIEW Communications System Design Suite Manual](#) for information on using a real-time target, such as connecting to a real-time controller, testing a VI, and deploying and running an application.

Adding Hardware to LabVIEW Communications System Design Suite

You must add your USRP-2974 to LabVIEW Communications System Design Suite before you can use it to run code.

Related Information

[Why Can't I Detect My Device in LabVIEW Communications System Design Suite?](#) on page 9

[What is the IP Address of My Device?](#) on page 9

Adding Hardware to LabVIEW Communications System Design Suite 2.1 to Current

1. Open LabVIEW Communications System Design Suite and select the **Hardware** button to open SystemDesigner.
2. Right-click anywhere in SystemDesigner and select **Add hardware**. Alternatively, select the + button.
3. In the **Discovered hardware** tab, select the USRP-2974 you want to register. Click **Add**.



Note If your device is not listed in the **Discovered hardware** tab, open the **Add hardware by address** tab and type the IP address or hostname of your device in the **IP address/hostname** field. Click **Connect**.



Note By default, the user name is `root`, and the password is blank.

4. Click **Close**.

Adding Hardware to LabVIEW Communications System Design Suite 2.0

1. Open LabVIEW Communications System Design Suite and select the **Hardware** tab.
2. Select **Network Systems** to display USRP-2974 devices that you can reserve to use in projects on the computer.

The device and the computer must be connected to the same local network.

3. In the **Unregistered Systems** category, select the icon of the USRP-2974 you want to register.
4. Click **Register**.



Note If your USRP-2974 does not appear in the **Unregistered Systems** category, type the IP address or hostname in the **Register by IP or Hostname** field.

5. Add or verify the **Hostname or IP Address**, **User name**, and **Password**.



Note By default, the user name is `root`, and the password is blank.

6. Click **Register**.

Adding Hardware to SystemLink

Connect your SystemLink Server to a target with LabVIEW Communications Real-Time Image installed to manage your device.



Note SystemLink Client is automatically installed with the LabVIEW Communications Real-Time Image.

1. Launch and log in to NI SystemLink Web Application.
2. Click **Systems Manager »Discovered Systems** . Since SystemLink Client is already installed on the target, your server automatically detects it.
3. Select the target and click **Add Selected** to register it as a managed system.

Related Information

For SystemLink Server setup instructions, refer to the SystemLink Manual.

Adding Your Device to a Project

Register your device with SystemLink or LabVIEW Communications System Design Suite before adding it to a project.

1. In LabVIEW Communications System Design Suite, create a new project or open an existing sample project.
2. In the SystemDesigner palette, navigate to the location appropriate for your version of LabVIEW Communications System Design Suite.

Version	Step
2.0	Software Defined Radio»USRP RIO»NI USRP-2974
2.1 to Current	PC»Devices»Software Defined Radio»USRP RIO»NI USRP-2974

3. Select the **NI USRP-2974** target and place it on the diagram.
4. In the Configuration pane, take the action appropriate for your version of LabVIEW Communications System Design Suite.

Version	Step
2.0	Select NI USRP-2974 from the Mapped To dropdown menu.
2.1 to Current	Click Hostname to choose a controller that has already been registered or to change the hostname of your controller.



Note If there is an external USRP RIO device connected to the PCIe x4 port of the USRP-2974 back panel, you must repeat steps 2 through 4 to map to the corresponding USRP RIO device in the Configuration pane.

Verifying the Device Connection

Run `Tx and Rx Streaming (Host).gvi` to confirm that the device transmits and receives signals and is connected correctly to the host computer.

1. In LabVIEW Communications System Design Suite, navigate to **Projects**.
2. Select **USRP-2974 Single-Device Streaming**. Click **Create**.
3. Add the USRP-2974 device to the project as described in [Adding Your Device to a Project](#).
4. Run `Tx and Rx Streaming (Host).gvi`.

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

5. 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.

Device Troubleshooting

Should I Update Device Firmware and FPGA Images?

Your device ships with firmware and FPGA images compatible with the NI-USRP driver software. You may need to update the device for compatibility with the latest version of the software.

Why Doesn't the Device Power On?

Verify that the power supply is functional by substituting a different adapter.

Network Troubleshooting

Why Doesn't the Device Respond to a Ping (ICMP Echo Request)?

The device should reply to an internet control message protocol (ICMP) echo request.

To ping the device, open a Windows command prompt and enter `ping <IP address>`, where `<IP address>` is the IP address for your USRP device. If you do not receive a response, verify that the host network interface card is set to a static IP address corresponding to the same subnet as the IP address of the corresponding device. Also verify that the device IP address is set properly.

Why Can't I Detect My Device in LabVIEW Communications System Design Suite?

Complete one or more of the following options to detect your device in LabVIEW Communications System Design Suite:


- Ensure that the device is powered on and has a valid IP address.
- Refer to the *NI-USRP Readme* to verify that your version of the NI-USRP instrument driver supports the USRP-2974.
- Visit ni.com/info and enter the Info Code `bxpssse` to access the *Provisioning a Real-Time Controller or USRP Stand-Alone Device for LabVIEW Communications* tutorial.

What is the IP Address of My Device?

The device acquires an IP address when connected to the network for the first time. You can discover this IP address by using Linux commands while connected to the device.

1. Connect the USRP-2974 to a monitor, keyboard, and mouse.
2. Enter your login credentials.
3. Use the Linux command `ifconfig` to view the IP address for the following Ethernet ports:

Table 1. Ethernet Port Addressing

Ethernet Port Addressing	Port Description
eth0	1G ETH RJ45
eth1	Internal 10G ETH
eth2	External SFP+ 1G/10G ETH 0
	 Note The external SFP+ 1G/10G ETH 1 port does not have access to the system on module (SoM).



Tip You can limit the results by adding the Ethernet port after the Linux command `ifconfig`. For example, the Linux command `ifconfig eth0` provides the IP address for the 1G ETH RJ45 port.

How Do I Change My IP Address Using My Computer?


1. Open or create a project including the USRP-2974 as described in [Adding Your Device to a Project](#).



Note If the device cannot be connected in SystemDesigner due to an incorrect or unknown IP address, set up a temporary IP address for the device as described in [How Do I Change My IP Address without Using My Computer?](#).

2. Select **Network Adapters** on the target in SystemDesigner.
3. Select **Configure Network Settings** on the Configuration pane.
4. Select the network adapter that you want to change the settings for using the addresses defined in the following table.

Table 2. Ethernet Port Addressing


Ethernet Port Addressing	Port Description
eth0	1G ETH RJ45
eth1	Internal 10G ETH
eth2	External SFP+ 1G/10G ETH 0  Note The external SFP+ 1G/10G ETH 1 port does not have access to the system on module (SoM).

5. Set the mode.
6. Set the address if the mode is static.
7. Click **Apply**.

How Do I Change My IP Address without Using My Computer?

1. Connect the USRP-2974 to a monitor, keyboard, and mouse.
2. Enter your login credentials.
3. Use the Linux command `ifconfig <Port> <IP Address>`, where `<Port>` is one of the following Ethernet ports, and `<IP Address>` is the new IP address.

Table 3. Ethernet Port Addressing

Ethernet Port Addressing	Port Description
eth0	1G ETH RJ45
eth1	Internal 10G ETH
eth2	External SFP+ 1G/10G ETH 0  Note The external SFP+ 1G/10G ETH 1 port does not have access to the system on module (SoM).

For example, if you would like to change the IP address of the 1G ETH RJ45 port, use the Linux command `ifconfig eth0 <IP Address>`.



Notice This change is lost once the device is turned off. Once the device is accessible from your computer, change the IP address using your computer as described in [How Do I Change My IP Address Using My Computer?](#) to ensure the IP address is set indefinitely.

Why Does the Device Not Connect to the Host Interface?

Ensure the connection between the host network interface card and the device cable connection is valid and both the device and computer are powered on.

A lit green LED in the upper left corner of the gigabit Ethernet connection port on the device front panel indicates a gigabit Ethernet connection.

Front Panel, Back Panel, and Connectors

Direct Connections to the USRP-2974

The USRP-2974 is an RF instrument that is sensitive to ESD and transients. Ensure you take the following precautions when making direct connections to the USRP-2974 to avoid damaging the device.

- !** **Notice** Apply external signals only while the USRP-2974 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-2974 TX 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-2974 TX 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-2974 TX 1 RX 1 or RX 2 connector.

USRP-2974 Front Panel, Back Panel, and LEDs

Front Panel

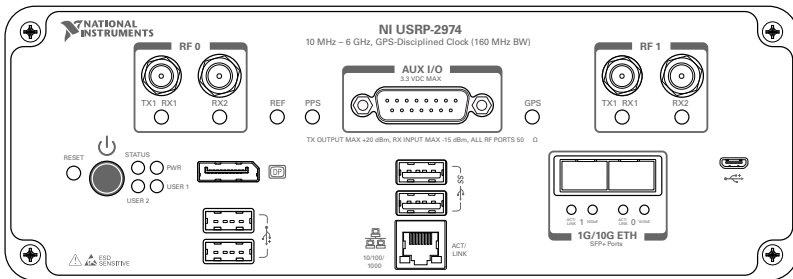


Table 4. Connector Descriptions

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.
DP		DisplayPort connector to connect one monitor for your controller.
USB2.0		USB ports that support common USB peripheral devices such as flash drives, hard drives, keyboards, and mice.
USB3.0		USB ports that support common USB peripheral devices such as flash drives, hard drives, keyboards, and mice.
1G ETH		RJ45 port used for 1G ETH connectivity to other ethernet devices.
μ USB		USB port used for UART connectivity to the controller.
1G/10G ETH 0		SFP+ port used for 10G ETH connectivity to other ethernet devices. Connects to the embedded Linux computer for communication with LabVIEW RT.
1G/10G ETH 1		SFP+ port used for 1G/10G ETH connectivity to other ethernet devices. Connects to the FPGA. Not currently supported in LabVIEW Communications System Design Suite.

Table 5. LEDs

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 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.

Table 5. LEDs (Continued)

LED	Description	Color	State	Indication
STATUS	Indicates the status of the device.	OFF	—	The device initialized successfully and is ready for use.
		Red	Blinking	Hardware error. An internal power supply has failed. Check front-panel I/O connections for shorts. Remove any shorts and cycle power to the USRP-2974. Contact NI if the problem persists.
PWR	Indicates the power status of the device.	OFF	—	The device is powered off.
		Green	Solid	The device is powered on.
10/100/1000	Indicates the speed of the Gigabit Ethernet link.	OFF	—	No link, or 10 Mbps link.
		Green	Solid	100 Mbps link.
		Amber	Solid	1,000 Mbps link.
ACT/LINK	Indicates the Gigabit Ethernet link activity or status.	OFF	—	No link has been established.
		Green	Solid	A link has been negotiated.
		Blinking		Activity on the link.

Table 5. LEDs (Continued)

LED		Description	Color	State	Indication
1G/10G ETH 0	ACT/ LINK	Indicates the status of the SFP+ port.	OFF	—	The link is down.
			Green	Solid	The link is up.
				Blinking	The link is active (transmitting and receiving).
	10GbE	Indicates the status of the 10G ETH link.	OFF	—	The 10G ETH link is down.
			Green	Solid	The 10G ETH link is up.
1G/10G ETH 1 10GbE		Indicates the status of the 10G ETH link.	OFF	—	The 10G ETH link is down.
			Green	Solid	The 10G ETH link is up.

Back Panel

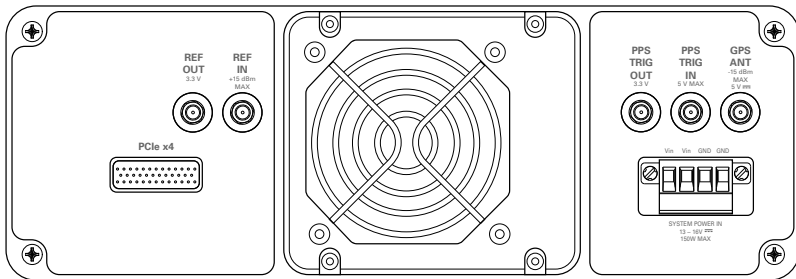

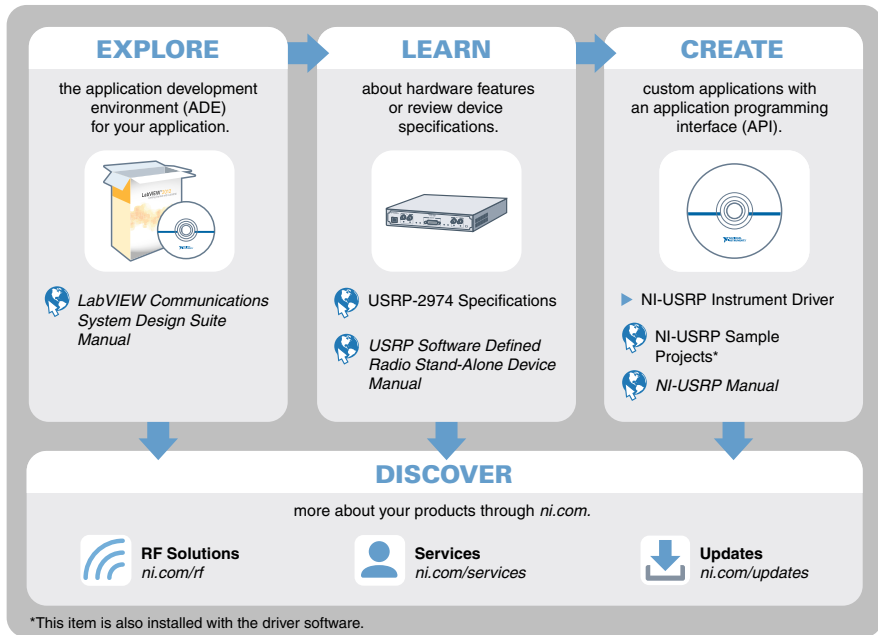


Table 6. Connector Descriptions

Connector	Use
REF OUT	Output terminal for an external reference signal for the LO on the device. REF OUT is an SMA (f) 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 an SMA (f) 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.
PPS TRIG OUT	Output terminal for the PPS timing reference. PPS TRIG OUT is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input. The output signal is 0 V to 3.3 V TTL. You can also use this port as a triggered output (TRIG OUT) that you program with the PPS Trig Out I/O signal.
PPS TRIG IN	Input terminal for PPS timing reference. PPS TRIG IN is an SMA (f) connector with an impedance of 50 Ω and 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 an SMA (f) connector with a maximum input power of -15 dBm and an output of 5 V DC to power an active antenna.</p> <p> Notice Do not terminate the GPS ANT port if you do not use it.</p>
PCIe x4	Port for a PCI Express Generation 2, x4 bus connection through an MXI Express four-lane cable. Can be used to connect an external USRP device or external chassis.
SYSTEM POWER IN	Input that accepts a 15 V \pm 5%, 10 A external DC power connector.

Where to Go Next

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



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 information about the services NI offers.

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377416C-01 May 16, 2019