Ettus USRP X440 Getting Started Guide

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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.

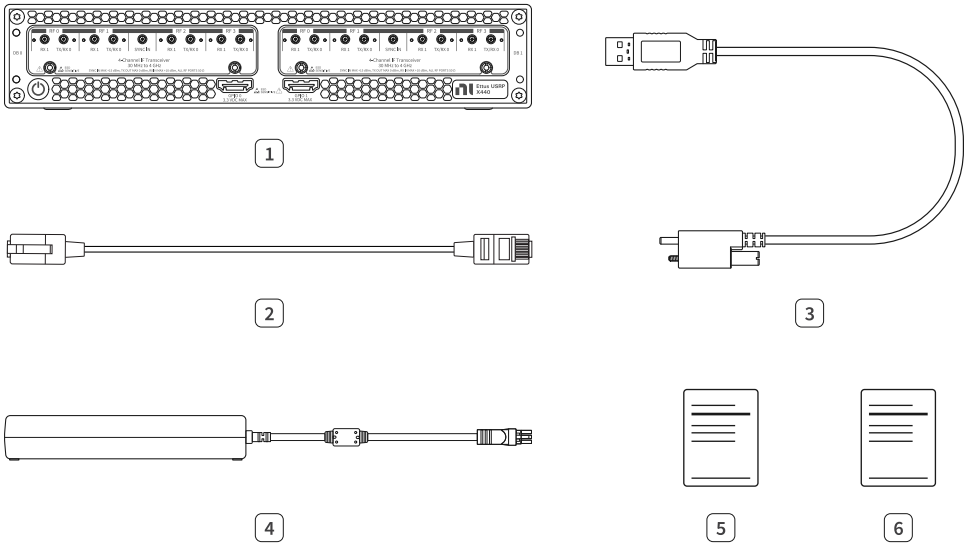
   > **Note** Do not install a device if it appears damaged in any way.

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. Ettus USRP X440
2. CAT 5E Ethernet Cable
3. USB-A (m) to USB-C (m) with Jack Screw Cable
4. Power Supply
5. Ettus USRP X440 Documentation Note
6. Ettus USRP X440 Safety, Environmental, and Regulatory Information

Additional Items for Device Setup

- Cables
  - QSFP28 to QSFP28 Ethernet cable
  - QSFP28 to 4xSFP28 Ethernet breakout cable
  - MMPX-to-MMPX cable or MMPX-to-SMA cable
- Host PC
- 10 Gb Ethernet network card or 100 Gb Ethernet network card

> **Tip** NI recommends using an Ethernet network card available in connectivity kits sold on `www.ettus.com` and `ni.com`.

- 30 dB attenuator

> **Note** If you directly connect or cable a signal generator to your device, or if you connect multiple devices together, use an attenuator to avoid damaging the device.

- Ettus USRP X4xx Mounting Kit (optional)

> **Note** Refer to the USRP X4xx Mount Dimensional Drawings to visualize how to set up your device(s) using this kit.

Verifying the System Requirements

To use UHD, your system must meet certain requirements.

Refer to your driver's readme for more information on minimum system requirements and supported application development environments (ADEs). The ***UHD Readme*** is available on The USRP Hardware Driver Repository.

Ettus USRP X440 Front Panel, Back Panel, and LEDs

Figure 2. Front Panel

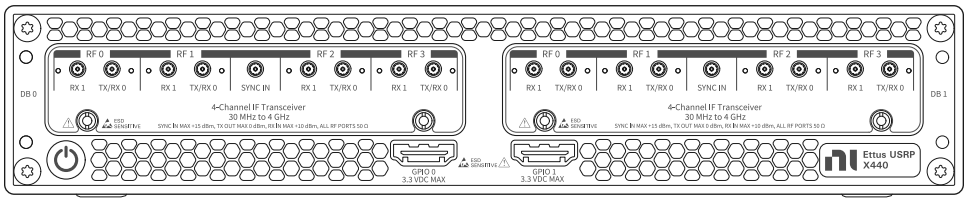


Table 1. Front Panel Connector Descriptions

Connector			Description
DB 0, DB 1	RF 0	RX 1	Input terminal for the RF signal. RX 1 is an MMPX (f) connector with an impedance of 50 Ω and is a single-ended input channel.
		TX/RX 0	Output and input terminal for the RF signal. TX/RX 0 is an MMPX (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
	RF 1	RX 1	Input terminal for the RF signal. RX 1 is an MMPX (f) connector with an impedance of 50 Ω and is a single-ended input channel.

Connector			Description
		TX/RX 0	Output and input terminal for the RF signal. TX/RX 0 is an MMPX (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
	SYNC IN		Input terminal for an external IF signal, which is distributed to all four ADCs. SYNC IN is an MMPX (f) connector. SYNC IN accepts signal frequencies up to 1.3 GHz and maximum input power of +15 dBm.
	RF 2	RX 1	Input terminal for the RF signal. RX 1 is an MMPX (f) connector with an impedance of 50 Ω and is a single-ended input channel.
		TX/RX 0	Output and input terminal for the RF signal. TX/RX 0 is an MMPX (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
	RF 3	RX 1	Input terminal for the RF signal. RX 1 is an MMPX (f) connector with an impedance of 50 Ω and is a single-ended input channel.
		TX/RX 0	Output and input terminal for the RF signal. TX/RX 0 is an MMPX (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
GPIO 0, GPIO 1			General Purpose Input/Output (GPIO) digital terminals. GPIO 0 and GPIO 1 are HDMI Type-A connectors. Output voltage can be configured per individual connector: 1.8 V (default), 2.5 V, or 3.3 V.

Figure 3. Back Panel

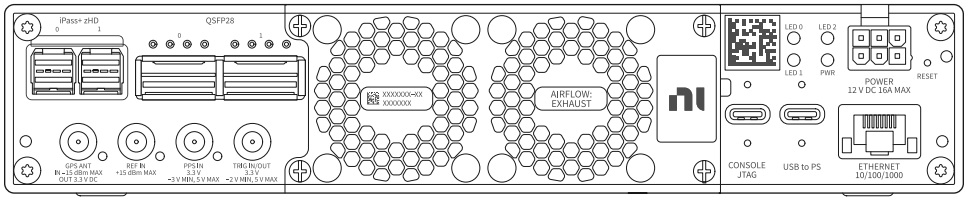


Table 2. Back Panel Connector Descriptions

Connector	Description
iPass+ zHD	This connector is currently unused.
QSFP28	Supports multiple configurations for streaming high-speed, low-latency data. Designed for speeds of up to 25 Gbps per lane with 4 lanes in each

Connector	Description
	connector and a bandwidth of up to 100 Gbps per connector.
GPS ANT	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 3.3 V DC to power an active antenna. **Notice** Do not terminate the GPS ANT port if your application does not make use of the port.
REF IN	Input terminal for an external reference signal to synchronize 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 IN	Input terminal for PPS timing reference. PPS IN is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input channel. PPS IN accepts 0 V to 3.3 V TTL and 0 V to 5 V TTL signals.
TRIG IN/OUT	Input/Output trigger terminal. This port can be used to output the PPS timing reference. TRIG IN/OUT is an SMA (f) connector with an impedance of 50 Ω and is a single-ended port. The output voltage is 0 V to 3.3 V TTL. You can also use this port as a triggered output (TRIG OUT).
POWER	Input that accepts a 12 V ± 5%, 16 A external DC power connector.
CONSOLE JTAG	A USB Type-C port that connects the host computer to the device for development and debugging. This port provides access to the JTAG, the PS serial console, and the SCU serial console. It should be used with the 115200 baud, 8 data bits, 1 stop bit, no parity.
USB to PS	A USB Type-C 2.0 port that can be used to connect peripheral devices to the processing system (PS), such as a USB mass storage device. May also be used to complete functions such as writing a new file system to the internal storage.
ETHERNET	A 1 gigabit Ethernet Connection that interfaces with the onboard PS. Can be used to connect to the PS through SSH. Can be used for UHD management traffic in Network Mode. By default, the 1 Gb Ethernet connection is configured to use a DHCP-assigned IP address.

Table 3. Back Panel LEDs

Note This table describes default LED settings. LED functionality can be changed in software.

LED	Description	Color	State	Indication
LED 0	Indicates the status of the PS.	—	OFF	The processor is powered off.
		Green	Blinking	The frequency of blinks is proportional to the CPU load.
			Solid	The processor is powered on.
LED 1	Indicates the status of the Programmable Logic (PL).	—	OFF	The PL is not loaded.
		Green	Solid	The PL is loaded.
LED 2	Indicates the status of the onboard eMMC storage activity.	—	OFF	The eMMC is idle.
		Green	Blinking	There is read or write activity on the eMMC.
			Solid	There is read or write activity on the eMMC.
PWR	Indicates the power state of the device.	—	OFF	The device is powered off.
		Green	Solid	The device is powered on and the power is good.
		Red	Solid	The device is in a power error state.
		Amber	Solid	The device is powered off and the power is good.

USRP Hardware Driver

The USRP Hardware Driver™ (UHD) software API supports application development using the Ettus USRP X440.

UHD uses a common, open-source software interface that increases code portability, allowing applications to transition to other USRP SDR platforms when development requirements expand or new platforms are available. UHD offers cross-platform support for multiple industry-standard development environments and frameworks, including GNU Radio and MATLAB/Simulink.

Table 4. UHD Features

Feature	**UHD**
Distribution Form	Open-Source
Host OS	Windows Linux Mac OS
Host ADE	GNU Radio C/C++ MATLAB/Simulink Python
FPGA Development Environment	VHDL Verilog HDL Coder RFNoC
Earliest Version with Ettus USRP X440 Support	4.5.0.0
Streaming/Host Interface Support	10 Gb Ethernet 100 Gb Ethernet

Setting Up the Device

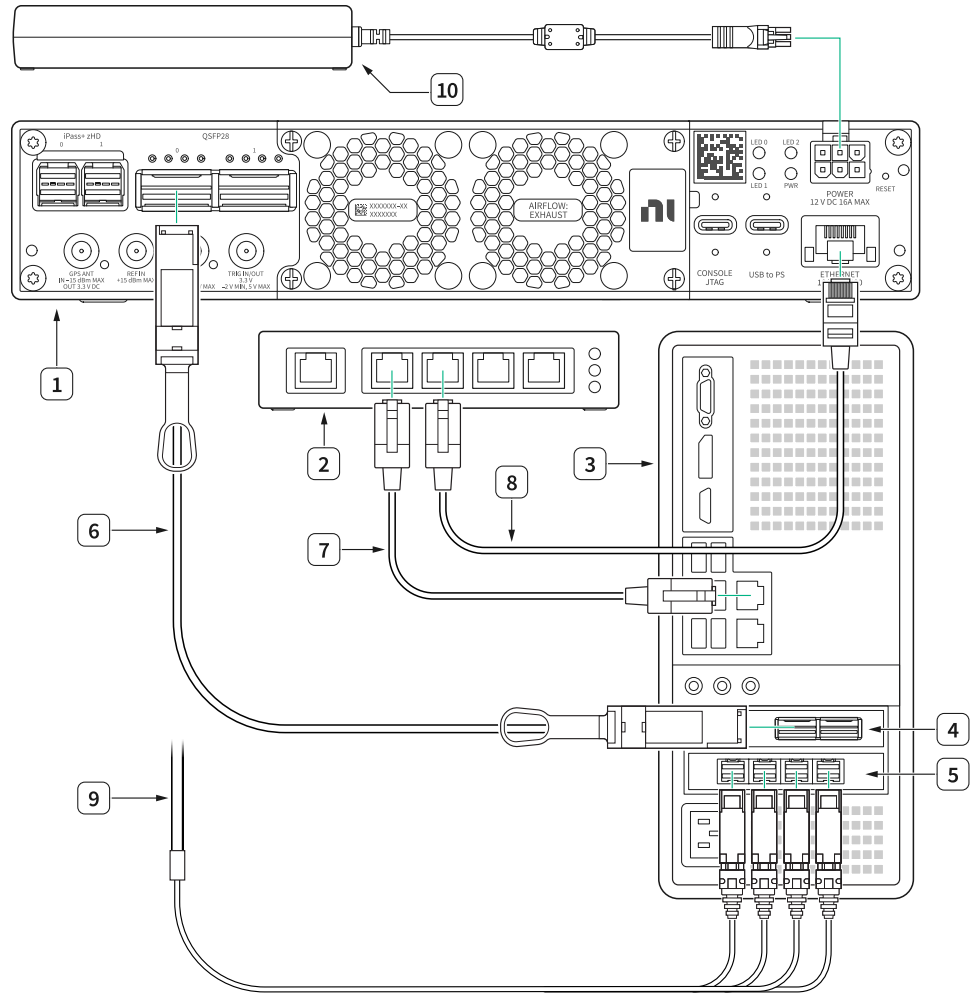
Ensure that all of your hardware components are powered off before installing.

1. Verify that you have all items included in your device kit and the following additional items.
   - Host PC
   - Network switch
   - CAT 5E Ethernet Cable (optional)
   - One of the following:
     - QSFP28 to QSFP28 Ethernet cable and 100 Gb Ethernet network card
     - QSFP28 to 4xSFP28 Ethernet breakout cable and 10 Gb Ethernet network card
2. Set all items on a flat surface near power outlets and a modem or router.
3. Follow the instructions included with your network switch to connect it to a modem or router.
4. Follow the instructions included with your host PC to connect it to power and complete your computer setup.
5. Connect any additional attachments required for your project to the front panel terminals of the Ettus USRP X440.

Connecting the Device (UHD)

This process describes a hardware configuration option. Other configurations are possible.

Connect your hardware as shown in the following diagram.



1. Ettus USRP X440
2. Network Switch (optional)
3. Host PC
4. 100 G Ethernet Network Card
5. 10 G Ethernet Network Card
6. QSFP28 to QSFP28 Ethernet Cable (optional)
7. CAT 5E Ethernet Cable (optional)
8. CAT 5E Ethernet Cable (optional)
9. QSFP28 to 4xSFP28 Ethernet Breakout Cable (optional)
10. Power Supply

Table 5. Ettus USRP X440 Connections (UHD)

Connector Type	Connection 1	Connection 2	Label in Figure
QSFP28 to QSFP28 Ethernet Cable	Ettus USRP X440, QSFP28, 0 Port	100 G Ethernet Network Card	6

Connector Type	Connection 1	Connection 2	Label in Figure
CAT 5E Ethernet Cable	Host PC	Network Switch	7
CAT 5E Ethernet Cable	Network Switch	Ettus USRP X440 ETHERNET Port	8
QSFP28 to 4xSFP28 Ethernet Breakout Cable	Ettus USRP X440, QSFP28, 0 Port	10 G Ethernet Network Card	9
Power Supply	—	Ettus USRP X440 POWER Port	10

Note If you choose not to use the optional network switch, use one CAT 5E Ethernet cable to connect the Ettus USRP X440 to the Host PC. This hardware setup requires additional configuration in software. Either set a DHCP server on the Host PC or set a static IP address on the Ettus USRP X440.

Powering on the Device

1. Connect the power supply to the Ettus USRP X440.
2. Plug the power supply into a wall outlet. Press the power button on the front of your device.
3. Power on the host PC and network switch.

Installing the Software

To program your device with UHD, install UHD on your host computer.

Navigate to the installation guide that applies to your operating system.

- Linux: ni.com/r/linuxuhdinstall
- OS X: ni.com/r/osxuhdinstall
- Windows: ni.com/r/windowsuhdinstall

Note The Ettus USRP X440 requires UHD version 4.5.0.0 or later. If you are using a host machine, the versions of UHD on the host machine and device must match.

Programming the Device

For detailed information on programming your device with UHD, navigate to ni.com/r/uhdx440gettingstarted.
There, you can read about how to:

- Utilize the eMMC storage
- Update your file system
- Update your FPGA
- Update your security settings
- Establish a serial connection
- Establish an SSH connection
- Customize LED behavior

UHD Examples

Various C++, Python, and RFNoC examples for using the UHD API are provided in the Ettus Research GitHub Repository, at **host » examples**. These examples are installed with UHD and will be located at the **$prefix » lib » uhd » examples** directory of your system (for instance, `/usr/lib/uhd/examples`).