Ettus USRP X410 Specifications

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Contents

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Key Specifications

RF capabilities	4 TX, 4 RX, independently tunable Superheterodyne architecture 1 MHz to 7.2 GHz, tunable up to 8 GHz Up to 400 MHz bandwidth per channel
Processing system (PS)	Quad Core ARM Cortex-A53 (1200 MHz) 4 GB DDR4
Programmable logic (PL)	FPGA: RFSoC ZU28DR 2 × 4 GB DDR4
Software	UHD version 4.1 or later RFNoC GNU Radio C/C++ Python OpenEmbedded Linux on A53 NI-USRP 20.8 or later LabVIEW 2020 or later LabVIEW FPGA 2020 or later

Synchronization	REF IN (clock reference input) PPS IN (PPS time reference) TRIG IN/OUT GPSDO included OCXO included
Digital interfaces	2 QSFP28 (10/100 GbE, Aurora)[1] 2 iPass+ zHD (cabled PCIe Gen3 x8)[2] Ethernet (1 GbE to PS) 2 USB-C (USB to PS, Console/JTAG) 2 HDMI (GPIO)
Power, form factor	12 V DC, 16 A maximum Half-wide RU 28.5 cm × 22.2 cm × 4.4 cm

Definitions

Warranted specifications describe the performance of a model under stated operating conditions and are covered by the model warranty.

Characteristics describe values that are relevant to the use of the model under stated operating conditions but are not covered by the model warranty.

1. 100 GbE is supported in the UHD Toolflow. Aurora streaming is supported in the LabVIEW FPGA Toolflow. Support for these capabilities is not available in UHD 4.1. It will be added in a subsequent release.
2. This feature is supported in the LabVIEW FPGA Toolflow.

- ***Typical*** specifications describe the performance met by a majority of models.
- ***Nominal*** specifications describe an attribute that is based on design, conformance testing, or supplemental testing.

Specifications are ***Characteristics*** unless otherwise noted.

Conditions

Specifications are valid at 23 °C ± 5 °C unless otherwise noted.

Ettus USRP X410 Pinout

Figure 3. Front Panel

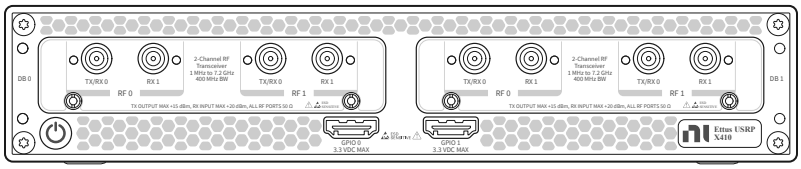


Table 1. Front Panel Connector Descriptions

Connector			Description
DB 0, DB 1	RF 0	TX/RX 0	Output and input terminal for the RF signal. TX/RX 0 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
		RX 1	Input terminal for the RF signal. RX 1 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input channel.
	RF 1	TX/RX 0	Output and input terminal for the RF signal. TX/RX 0 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input or output channel.
		RX 1	Input terminal for the RF signal. RX 1 is an SMA (f) connector with an impedance of 50 Ω and is a single-ended input 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, either 1.8 V (default), 2.5 V, or 3.3 V.

Controller

Processing System

CPU	Quad Core ARM Cortex-A53 (1200 MHz)
Memory	4 GB DDR4, 2.4 GT/s
NVM[3]	32 GB eMMC (Pseudo SLC)
RJ45	1 GbE host connection
USB-C	USB to PS (USB 2.0) USB Console/JTAG

Programmable Logic

FPGA	Xilinx RFSoC XCZU28DR Speed Grade -1
Memory	2 × 4 GB DDR4, 2.4 GT/s
SD-FEC	8 dedicated SD-FEC cores
QSFP28	2 × 4 lanes 10/100 GbE, Aurora[4]

3. Module assembly H and earlier has an NVM of 16 GB. All other module assemblies have an NVM of 32 GB.

iPass+ zHD	2 × 4 lanes PCIe Gen3x8[5]
GPIO	2 HDMI 12 I/O lines per connector Maximum data rate 100 Mbps Selectable I/O voltage (3.3 V, 2.5 V, or 1.8 V)
Trigger	SMA: Trigger In/Out (3.3 V I/O voltage)

Baseband

Maximum I/Q sample rates[6]	491.52 MSps 500.00 MSps
Number of available channels	4
ADC resolution	12 bit
DAC resolution	14 bit

4. 100 GbE is supported in the UHD Toolflow. Aurora streaming is supported in the LabVIEW FPGA Toolflow. Support for these capabilities is not available in UHD 4.1. It will be added in a subsequent release.
5. This feature is supported in the LabVIEW FPGA Toolflow.
6. The applicable maximum value depends on the sample rate selected in software.

RF

Transmitter

Number of channels	4
Frequency range	1 MHz to 7.2 GHz, tunable up to 8 GHz
Frequency step	<1 Hz
Maximum output power[7]	<23 dBm
TX/RX settling time	0.3 µs [8]
TX gain settling time	1 µs
Gain range[9]	60 dB, nominal
Gain step	1 dB, nominal
TX phase noise, 1 GHz carrier frequency, 23 °C, nominal	
1 kHz offset	-91 dBc/Hz
10 kHz offset	-101 dBc/Hz

7. Maximum output power varies by frequency. See the subsequent TX Measurements section for additional information.
8. This settling time applies to the TX/RX switch.
9. The output power resulting from the gain setting varies over the frequency band and among devices.

100 kHz offset	-103 dBc/Hz
Maximum instantaneous real-time bandwidth	400 MHz
Average noise density (23 °C, 10 MHz to 8 GHz)[10]	-146 dBm/Hz

TX Measurements

Figure 4. TX EVM Bathtub Curves: 5GNR, UL, FDD, SISO, 100 MHz BW, 30 kHz SCS, 256 QAM, 23 °C± 5 °C

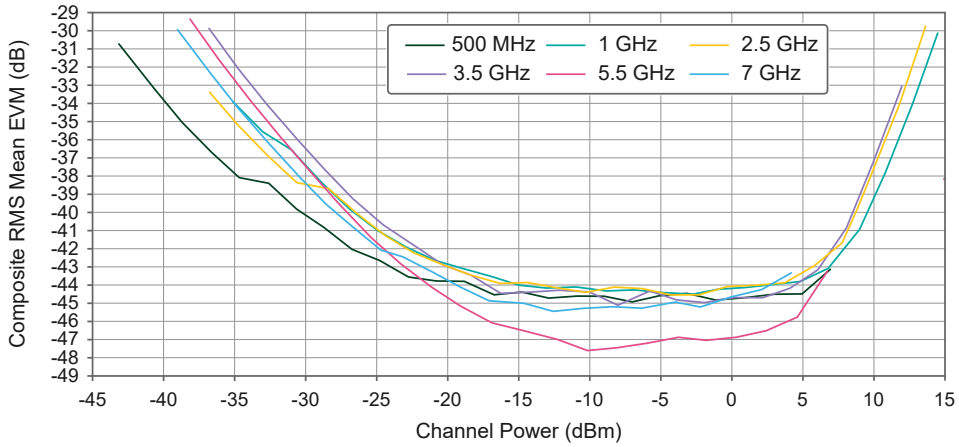
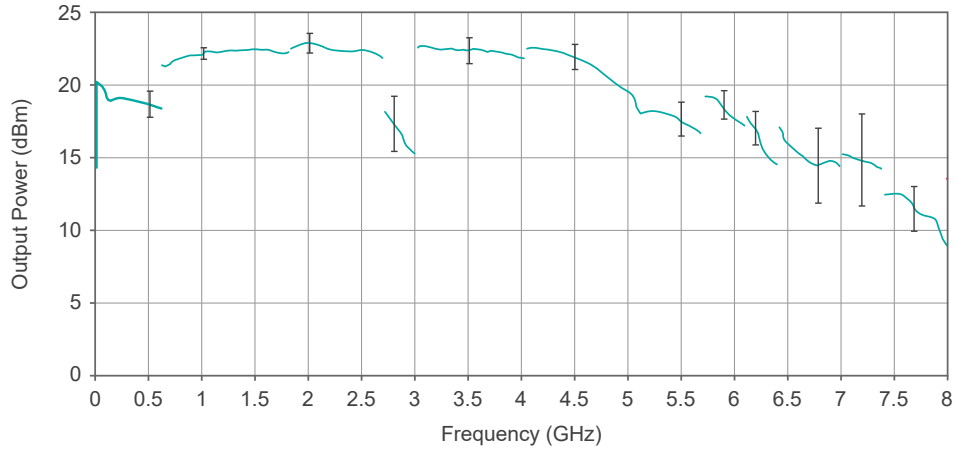


Figure 5. TX Maximum Output Power: 0 dBFS CW, Maximum Gain Setting, 23 °C± 5 °C



Note The previous figure depicts the average TX maximum output power based on 4 units with 16 channels total measured at 18 °C, 23 °C, and 28 °C. The bars represent 80% confidence intervals at selected frequencies.

10. Measured at the TX gain setting required to reach 0 dBm output power with 0 dBFS baseband signal.

Receiver

Number of channels	4
Frequency range	1 MHz to 7.2 GHz, tunable up to 8 GHz
Frequency step	<1 Hz
Gain range[11]	
≤500 MHz	38 dB, nominal
>500 MHz	60 dB, nominal
Gain step	1 dB, nominal
Maximum input power, damage level	
≤3 GHz	+14 dBm continuous
>3 GHz	+17 dBm continuous, +20 dBm for up to 5 minutes
Maximum operating power	0 dBm

Notice It is sometimes necessary to use attenuation when connecting multiple Ettus USRP X410 devices or when creating a loopback connection to avoid damaging the hardware.

11. The received signal amplitude resulting from the gain setting varies over the frequency band and among devices.

RX gain settling time	0.3 µs
Noise figure	
500 MHz to 3.1 GHz	8 dB
3.1 GHz to 6 GHz	6.5 dB
6 GHz to 8 GHz	9 dB
Input IP3, 0 dBm input, full scale	+12 dBm
Maximum instantaneous real-time bandwidth	400 MHz

RX Measurements

Figure 6. RX EVM Bathtub Curves: 5GNR, UL, FDD, SISO, 100 MHz BW, 30 kHz SCS, 256 QAM, 23 °C± 5 °C

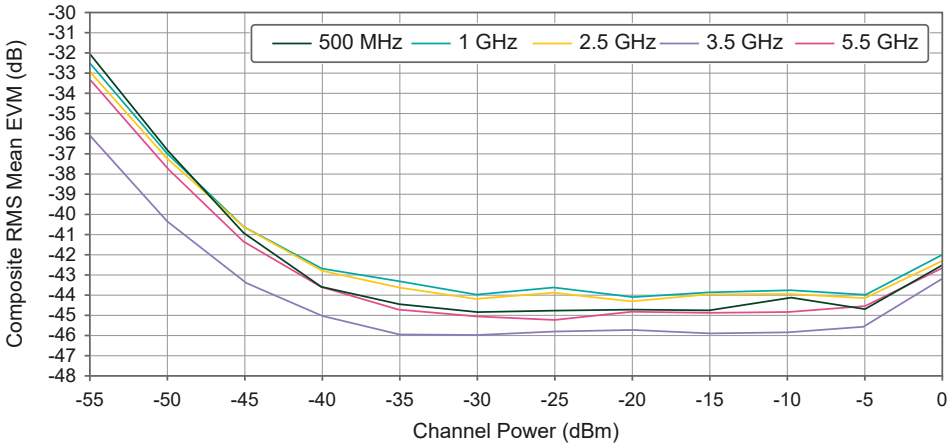
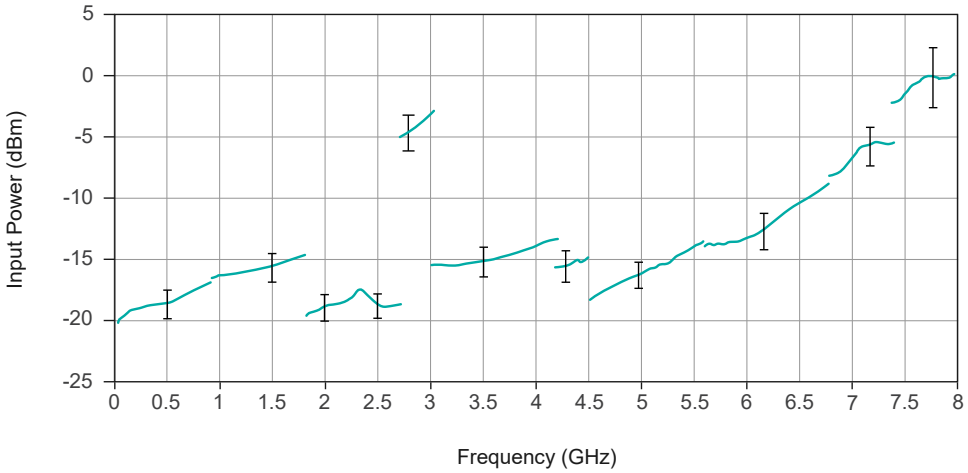


Figure 7. RX Input Power to Reach 0 dBFS: CW Input, 30 dB Gain Setting, 23 °C± 5 °C



Note The previous figure depicts the average RX input power to reach 0 dBFS based on 4 units with 16 channels total measured at 18 °C, 23 °C, and 28 °C. The bars represent 80% confidence intervals at selected frequencies.

GPS Disciplined Oscillator (GPSDO)

Frequency accuracy[12]	
OCXO (not locked to GPS)[13]	2.5 ppm
OCXO (locked to GPS)	5 ppb
Active antenna	
Voltage	3.3 V
Power	0.19 W

12. ***Frequency accuracy*** is based on oven-controlled crystal oscillator (OCXO) vendor specifications and is not measured. Alternatively, you can incorporate an external reference source to provide a more precise frequency Reference Clock and to achieve better frequency accuracy.
13. Factory default accuracy. Contact NI if your application requires tuning the OCXO output frequency.

Frequency band(s)	L1, C/A 1.574 GHz

Power

Notice The protection provided by this product may be impaired if it is used in a manner not described in this document.

Voltage rating	12 V
Frequency rating	DC
Current/power rating	7 A to 16 A (bitfile dependent)
Power supply	190 W, minimum

Caution The product must be powered with an AC adapter offered by NI that meets the power requirements for the product and has appropriate safety certification marks for country of use.

Physical Characteristics

Dimensions

Enclosure	26.7 cm × 22.2 cm × 4.4 cm (10.5 in. × 8.7 in. × 1.7 in.)
Enclosure and connectors	28.5 cm × 22.2 cm × 4.4 cm (11.2 in. × 8.7 in. × 1.7 in.)
Weight	2.7 kg (6 lb)

Ventilation Clearance and Cooling

This product is designed to operate on a bench or in an instrument rack. Fan vents are located at the back of the product. Standard airflow provision of the product is set up as front to back cooling with option to change the airflow direction in the interest for

directing back to front cooling using a fan cartridge accessory.

Adequate clearance is required at the front and back of the product and surrounding equipment, inclusive of indiscriminate heat generating devices, and any potential air flow blockages must be maintained to ensure proper cooling.

Minimum cooling clearances	51 mm (2 in.) at the front and back

Note Benchtop and rack mount applications may require additional cooling clearances for optimal airflow and to reduce any unexpected hot air recirculation in either direction of the air inlet fans.

Environment

Environmental Characteristics

Operating temperature range	0 °C to 55 °C
Storage temperature range	-40 °C to 71 °C
Maximum altitude	2,000 m (800 mbar) (at 25 °C ambient temperature)
Operating humidity range	10% to 90%, noncondensing
Storage humidity range	5% to 95%, noncondensing
Pollution Degree	2

Indoor use only.

Environmental Standards

This product meets the requirements of the following environmental standards for electrical equipment.

- IEC 60068-2-1 Cold
- IEC 60068-2-2 Dry heat
- IEC 60068-2-78 Damp heat (steady state)

- IEC 60068-2-64 Random vibration
- IEC 60068-2-27 Shock

Note To verify marine approval certification for a product, refer to the product label or visit ***ni.com/certification*** and search for the certificate.

Shock and Vibration

Operating vibration	5 Hz to 500 Hz, 0.3 g RMS
Non-operating vibration	5 Hz to 500 Hz, 2.4 g
RMS operating shock	30 g, half-sine, 11 ms pulse
Non-operating shock	50 g, half-sine, 11 ms pulse