USRP X300 and X310 Configuration Guide

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The Ettus Research USRP X300/X310 is a high-performance, modular software defined radio (SDR) platform that combines two extended-bandwidth daughterboard slots covering DC ? 6 GHz with up to 120 MHz bandwidth, multiple high-speed interface options (PCIe, dual GigE, dual GigE), and a large user-programmable Kintex-7 FPGA in a convenient desktop or rack-mountable half-wide 1U form factor. These features are provided in a flexible product that can be configured to meet to specific requirements of your application. This document can be used as a guide as you select the most ideal options.

Ettus Research recommends using the flowchart and table below to guide you through the decision making process. It highlights each decision point to be made as you configure a USRP X300/X310. A general recommendation is made for each decision point, based on high-level application criteria. Additional information for each decision point is also is also provided in this document.

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* Figure 1 - USRP X300/X310 Configuration Flow

Table 1 - USRP X300/X310 Configuration Matrix

Decision Point	Options	Recommendation	Your Choice
USRP ? X300 or X310?	USRP X300	USRP X310 for larger FPGA (XC7K410T)	
	USRP X310		
Interface Type	1 GigE	Max throughput(Desktop) -> 10 GigE	
	10 GigE	Minimum Latency ->PCIe	
		Min Latency (Laptop) -> ExpressCard	
	PCIe		
	ExpressCard	Provided with X3xx -> 1 GigE	
RF Daughterboard	WBX-120	Choose by frequency:	Daughterboard A:
	SBX-120	50 MHz ? 2.2 GHz -> WBX-120	
		400 MHz ? 4.4 GHz -> SBX-120	
	CBX-120	1.2 GHz ? 6 GHz -> CBX-120	
	Legacy DBs	DC ? 30 MHz -> LFRX/LFTX	Daughterboard B:
Power Cords	Yes/No	Outside the US/Japan?	
		Purchase a International Power Cord Kit	
High-Accuracy GPSDO	Yes/No	Purchase GPSDO for high-accuracy clocking	
GPSDO Antenna Kit	Yes/No	Purchase GPS Antenna for best clock accuracy and global timing alignment	
GPIO Kit	Yes/No	Purchase GPIO Kit for external control& debug functionality	
MIMO Components	OctoClock/	OctoClock if using an external 10 MHz/PPS source	
	OctoClock-G	OctoClock-G for fully integrated system with internal 10 MHz/PPS source	
Rackmount	Yes/No	Desktop setup: No	

In terms of host bandwidth, interface options, and all other hardware features the USRP X300 and USRP 310 are identical. However, the USRP X310 provides a larger FPGA, a Xilinx XC7K410T, as opposed to XC7K325T. While both options provide a significant amount of free resources for custom FPGA development, the XC7K410T provides additional design margin, which translates to ease of development and future expandability. Most users choose the USRP X310 for their development.

USRP X300 and X310 FPGA Resource Summary

Resource Type	USRP X300 (XC7K325T) Count	USRP X310 (XC7K410T) Count
DSP48 Blocks	840	1540
Block Rams (18kB)	890	1590
Logic Cells	326,080	406,720

Slices (logic)	50,950	63,550

For up-to-date information on FPGA resource utilization in the stock FPGA design, please see "USRP 300/X310 FPGA Resources" in the Ettus Research knowledge base (ettus.com/kb).

With the increased sample rates used by the USRP X300 and USRP X310, these new device can support extended-bandwidth daughterboards. The WBX-120, SBX-120, and CBX-120 are recommended to take advantage of the full bandwidth capability of the USRP X300 and X310. The WBX-120, SBX-120, and CBX-120 have been upgraded from their predecessors (40 MHz) to use 120 MHz baseband filters. You can select your daughterboard based on the center frequency of your primary application.

Daughterboard	Frequency Range	Bandwidth
WBX-120	50 MHz - 2200 MHz	120 MHz
SBX-120	400 MHz - 4400 MHz	120 MHz
CBX-120	1200 MHz - 6000 MHz	120 MHz

If your application is in the HF frequency range, the LFRX and LFTX are recommended for up to 30 MHz of bandwidth per channel. The BasicRX and BasicTX are ideal for configurations that use an external frontend for tuning and filtering with either an IF or baseband interface.

The USRP X300 and X310 are backward compatible with legacy daughterboards except for the RFX Series and XCVR2450. Please note, while there are two daughterboard slots, the USRP X300/X310 can only support a single TVRX2.

If you plan to transmit or receive over the air, you should also purchase an antenna.

The USRP X300/X310 provide three interface options ? 1 Gigabit Ethernet (1 GigE), 10 Gigabit Ethernet (10 GigE), and PCI-Express (PCIe). Generally, Ettus Research recommends using 10 GigE to achieve the maximum throughput available from the USRP X300/X310. PCIe is recommended for applications that require the lowest possible latency, which is a desirable characteristic for PHY/MAC research. If your application does not require the full bandwidth of the USRP ? X300 and X310, the 1 GigE interface serves as a cost-effective fall-back option. Ettus Research provides a complete interface kit for each of these options, which is also shown in Table 3.

Table 3 - Interface Performance Summary

Interface	Throughput (MS/s @ 16-bit)	Target	Recommended Kit
1 Gigabit	25 MS/s	Desktop/Laptop	Components provided with USRP X300/X310 kit. For additional connections, purchase the following: SFP Adapter + GigE Cable
10 Gigabit	200 MS/s	Desktop	10 GigE Interface Kit
PCI-Express (PCIe, 4 lane)	200 MS/S	Desktop	PCI-Express Desktop Kit
Express Card (PCIe, 1 lane)	50 MS/s	Laptop	ExpressCard Kit

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Figure 2 - Host Interface Options

The power supply provided with the USRP X300/X310 kit is packaged with a power cord that is compatible with power outlets in the US/Japan. If you are not using the USRP X300/X310 in the US/Japan, we recommend purchasing the International USRP X300/X310 Power Cord set.

The USRP X300 and USRP X310 provide the option to integrate a high-accuracy GPS-disciplined oscillator (GPSDO). The GPSDO improves the accuracy of the internal frequency reference to 20 ppb, or 0.1 ppb if the GPS is synchronized to the GPS constellation. When synchronized to the GPS constellation, all USRP ? devices will also be synchronized in time within 50 ns.

	Internal TCXO	GPS-Disciplined Clock
Frequency Reference	TCXO	OCXO
Frequency Accuracy	± 2.5ppm	± 20 ppb
	± 2,500 Hz @ 1 GHz	± 20 Hz @ 1 GHz
Frequency Accuracy		± 0.01ppb
(GPS-Disciplined)		~ ± 0.01 Hz @ 1 GHz
GPS Time Sync Accuracy		±50ns to UTC Time**
10 MHz Reference Phase Drift with GPS Sync		<±20ns After 1 Hour**

The GPSDO Mini Kit will improve the accuracy of the USRP reference clock, even if it does not receive signals from the GPS Constellation. However, to achieve the best accuracy possible, and to achieve global timing alignment across multiple USRPs, Ettus Research recommends the GPSDO Mini Antenna Kit.

The USRP X300 and X310 include a DB15 connector on the front panel that provides convenient access to GPIO signals. Each pin can be configured as an input or output, uses 3.3V-level logic, and is protected with basic anti-static circuitry. These pins can be used to control external devices like RF switches and amplifiers, trigger software events on the host, or even provide basic debugging functionality. The USRP GPIO Kit is an affordable option that provides access to these signals with a DB15 cable and a breakout board. The breakout board allows the user to connect external devices through a terminal block. The user can also solder wires and components into the dedicated prototyping area.

Multiple USRP X300/X310s can be synchronized for coherent operation by sharing a common 10 MHz and 1 PPS signal. We recommend using a star-distribution topology with an OctoClock or OctoClock-G, as seen in Figure 4. This requires matched length cables to be used for both 10 MHz and 1 PPS.

For more information about MIMO operation, please see the MIMO and Synchronization Application Note.

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Figure 4 - Star-Distribution of 10 MHz/PPS Signals with OctoClock

The USRP X300/X310 was designed to use a convenient half-wide 1U rack-mount form factor. This allows developers to build high-density MIMO systems in a neat and well organized setup. If the user will be developing in a lab environment, or building a high-channel count system, the 1U Rackmount Assembly is recommended. However, if the user plans to work with the USRP X300/X310 on a desk, the rackmount is not required. Rubber standoffs are mounted on the USRP X300/X310 to avoid direct contact and surface scratching.