

Software Defined Radios

NI Ettus USRPs



ni.com



Software Defined Radios for Any Use Case

The NI USRP (Universal Software Radio Peripheral) is a suite of fully user-programmable software defined radios (SDRs) that combine general-purpose processors, Field Programmable Gate Arrays (FPGAs), and RF front-ends so that you rapidly can design, prototype, and deploy wireless systems. From low-cost, to high-performance, to rugged-deployable, to multichannel, the NI USRP is the most popular and versatile SDR available.

Software is central to SDRs, and the NI USRP product line's roots lie in the designs of Ettus Research, an NI brand since 2010. Whether you are a long-time LabVIEW programmer or you prefer open-source development tools, use the NI USRP product line to rapidly get up and going to build your custom wireless application. The NI USRP supports the popular GNU Radio framework with its open-source driver, USRP Hardware Driver (UHD).

Beyond software flexibility, with the NI USRP product line, you can take simulated inline digital signal processor (DSP) code and target it to the FPGA for real-time processing. You're able to do this with a prebuilt digital infrastructure using both LabVIEW FPGA and the powerful RF Network-on-Chip (RFNoC) framework compatible with popular open-source workflows.

Hardware Features

Take advantage of these powerful hardware features:

RF Performance

- 1 MHz to 7.2 GHz frequency ranges
- Up to 400 MHz instantaneous bandwidth
- Up to four transmit and four receive channels per radio
- Up to 128 x 128 multichannel synchronized systems
- Local oscillator import/export synchronization
- GPS disciplined oscillator (GPSDO)

Digital Performance

- Onboard Arm and x86 processor available on some models
- USB, 1 Gigabit Ethernet, 10 Gigabit Ethernet, 100 Gigabit Ethernet, and PCI Express communication interfaces

Software Features

Utilize flexibility with these software components:

Host Development Tools

- LabVIEW, open-source UHD, GNU Radio, MathWorks MATLAB® software

OS Support

- Windows, Linux, OS X

FPGA Development Tools

- LabVIEW FPGA, RFNoC framework

Rapidly Deployed Mission-Critical Applications

NI USRP SDRs are highly portable, high-performance, and highly deployable. With a completely open software driver and FPGA framework, USRP users quickly can take ideas from concept to prototype to field-deployed. USRP's flexibility makes it ideal for emerging defense applications such as drone defense.



FIG 1 SkySafe Defeats Commercial Drone Threats with NI Open-Source SDR

The NI USRP X310 is the only commercially available SDR with the openness and raw RF and DSP capabilities to meet the needs of this rapidly evolving drone threat.

Scott Torborg
CTO, SkySafe

Scalable Multichannel Synchronized Systems

With the NI USRP synchronization features, you can expand your RF channel count for phase-synchronous and massive multiple-input, multiple-output (MIMO) applications. Configure your multichannel system with shared reference clocks, triggers, and GPS synchronization using the GPSDO available on many units. Many models also have the option of Ethernet-based synchronization using the 'White Rabbit' standard. Or, design a more advanced system for true phase-coherent operation using USRP N320/N321 local oscillator export, distribution, and import features.



FIG 2 University of Bristol Massive MIMO Testbed

With the NI MIMO Prototyping System, we were able to alleviate some of the pain of this development through an integrated hardware and software platform.

Paul Harris
University of Bristol

The NI USRP Family

Let's Talk Development Tools

Open-source or LabVIEW—you decide. Program the FPGA with Xilinx Vivado using the RFNoC framework or benefit from the abstraction of LabVIEW FPGA

Let's Talk Radio Hardware

Choose from stand-alone, host-connected, FPGA-enabled, low-size, weight, and power (SWAP), and embedded deployable options.

Let's Talk Applications

From 5G New Radio-ready, to MIMO-ready, to Long-Term Evolution, IEEE 802.11, digital modulation, radar, communications, or EW—you're covered.

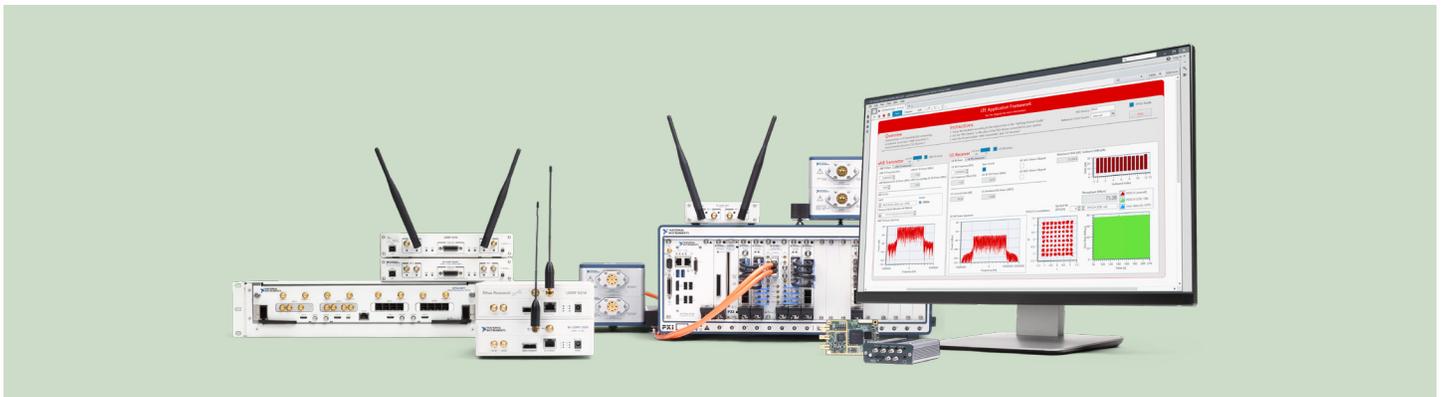


FIG 3 NI USRP Devices

| NI/ETTUS RESEARCH USRP MODEL | FREQUENCY RANGE | BANDWIDTH | TRANSMITTER/RECEIVER CHANNELS | BUS | FEATURES |
|------------------------------|------------------|-----------|-------------------------------|--|------------------------------------|
| USRP X410 | 1 MHz to 7.2 GHz | 400 MHz | 4 TX/4 RX | 100 Gigabit Ethernet, 10 Gigabit Ethernet, PCI Express | Zynq UltraScale+ RFSoc, UHD, GPSDO |
| USRP-2974 | 10 MHz to 6 GHz | 160 MHz | 2 TX/2 RX | 10 Gigabit Ethernet | x86, Stand-Alone |
| USRP N320 | 3 MHz to 6 GHz | 200 MHz | 2 TX/2 RX | 10 Gigabit Ethernet | 128 Channels, Zynq |
| USRP N321 | 3 MHz to 6 GHz | 200 MHz | 2 TX/2 RX | 10 Gigabit Ethernet | 128 Channels, Zynq |
| USRP N310 | 10 MHz to 6 GHz | 100 MHz | 4 TX/4 RX | 10 Gigabit Ethernet | Zynq |
| USRP E320 | 70 MHz to 6 GHz | 56 MHz | 2 TX/2 RX | 10 Gigabit Ethernet | CC, GPSDO, Zynq |
| USRP E31X | 70 MHz to 6 GHz | 56 MHz | 2 TX/2 RX | 1 Gigabit Ethernet | CC, Zynq |
| USRP-2955 (X310) | 10 MHz to 6 GHz | 80 MHz | 4 RX | 10 Gigabit Ethernet, PCI Express | GPSDO |
| USRP-2954 (X310) | 30 MHz to 6 GHz | 160 MHz | 2 TX/2 RX | 10 Gigabit Ethernet, PCI Express | GPSDO |
| USRP-2932 (N210) | 4 GHz to 4.4 GHz | 20 MHz | 1 TX/1 RX | 1 Gigabit Ethernet | GPSDO |
| USRP-2901 (B210) | 70 MHz to 6 GHz | 56MHz | 2 TX/2 RX | USB | GPSDO |
| USRP B200mini | 70 MHz to 6 GHz | 56MHz | 1 TX/1 RX | USB | Low-SWaP |

TBL 1 NI/Ettus Research USRP Products

To view all models, visit ni.com/sdr and ettus.com. Or contact NI sales for help in choosing your USRP.

NI SDR Hardware

From DC to 7.2 GHz, up to 400 MHz of real-time bandwidth, powerful DSP-focused FPGAs, and form factors ranging from handheld devices to high-channel-count systems, NI SDRs can meet your needs from design to deployment.

B Series/ USRP 290x

Cost-effective USB SDRs with a wide frequency range, a compact form factor, and up to 15 MHz of streaming bandwidth. Supports LabVIEW and open-source software.



X Series/ USRP RIO

High-performance PCI Express, 10 Gigabit Ethernet devices that include a powerful Kintex-7 FPGA, a 2x2 MIMO transceiver, and up to 160 MHz of bandwidth. Supports LabVIEW and open-source software.



NI Ettus USRP X410

The latest and highest performance X Series USRP yet contains a Zynq UltraScale+ RFSoc, 4x4 MIMO, and 400 MHz of bandwidth. Supports LabVIEW and open-source software.



E Series

Conduction-cooled, portable, and stand-alone SDRs containing a Zynq System-on-Chip (SoC), a 2x2 MIMO transceiver, and 56 MHz of bandwidth. Open-source software only.



N Series

High-performance, stand-alone SDR containing a Zynq SoC, 2x2 MIMO, and up to 128 x 128 phase synchronous systems. 200 MHz of bandwidth. Open-source software only.



Stand-Alone SDR

High-performing SDRs with an onboard processor and FPGA for stand-alone applications, up to 160 MHz of bandwidth, and MIMO capability. Supports LabVIEW and open-source software.



Find detailed product information for B Series, N Series, E Series, and X Series devices at ettus.com.

Your Choice of Development Software

Programming the Host

The NI USRP product family works with the broadest range of software workflows on the market. You can choose between NI USRP and USRP RIO drivers based on LabVIEW or the flexible, open-source tools with the UHD with GNU Radio, Python, and C++.

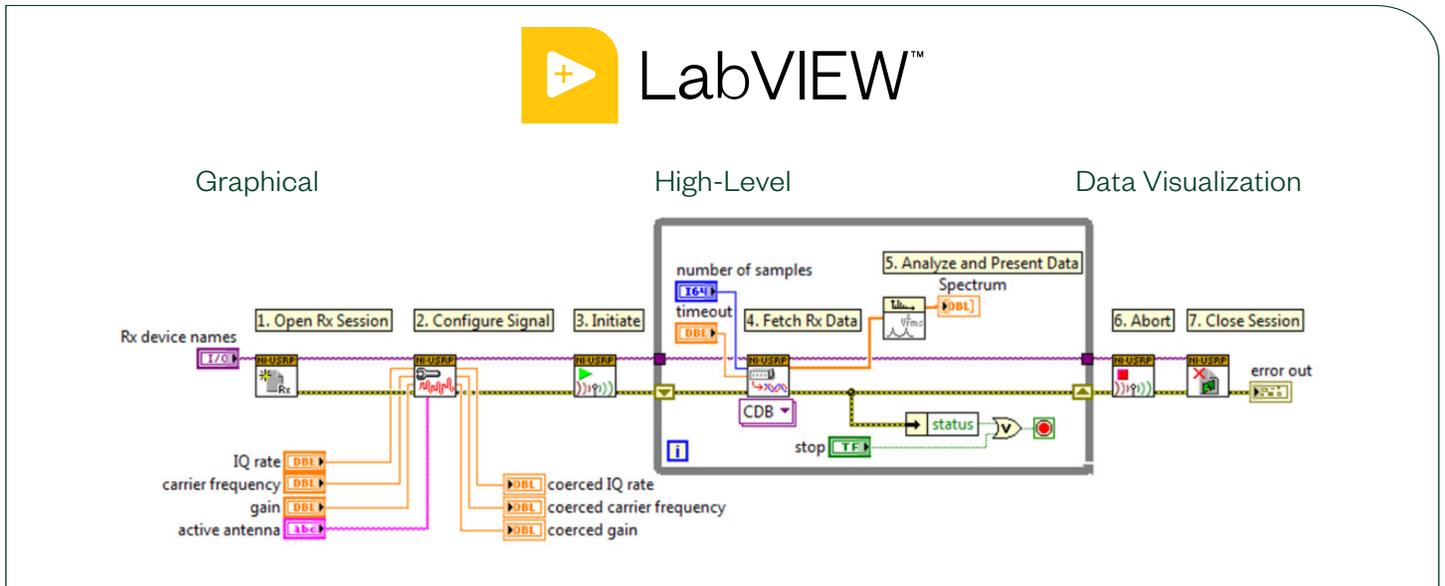


FIG 5 An Example of Programming in LabVIEW

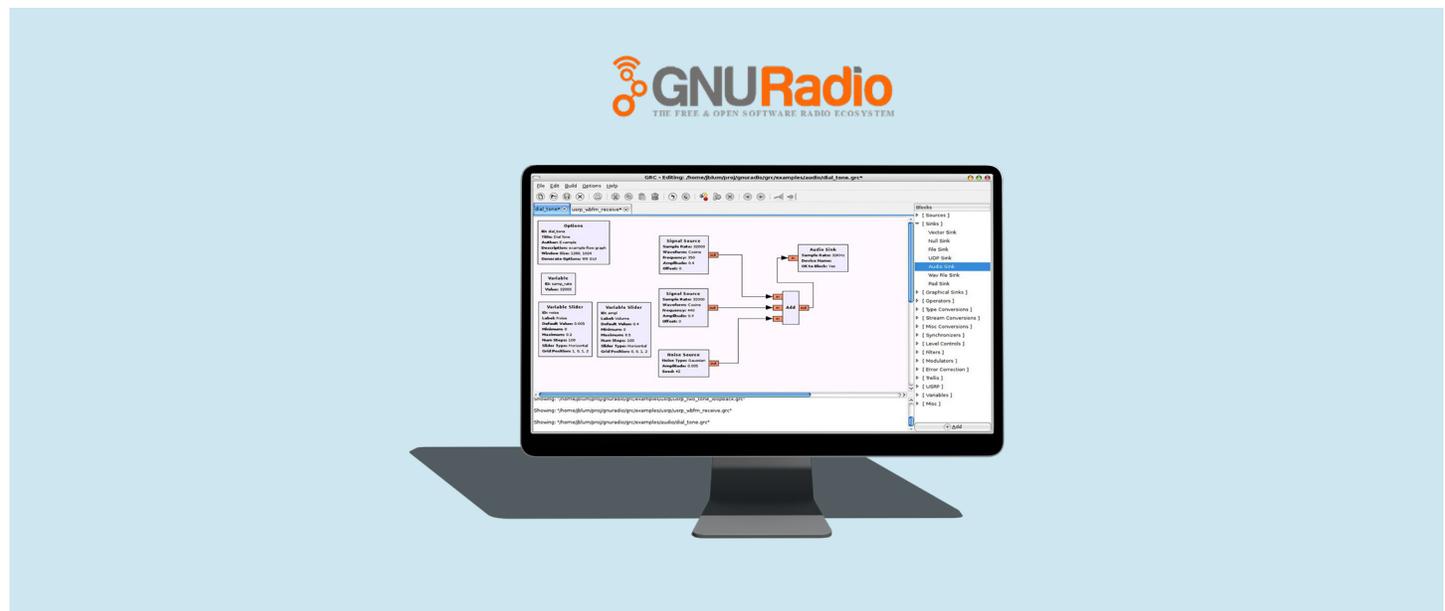


FIG 5 An Example of Programming with GNU Radio gnuradio.org

Let's Take Advantage of the Power of FPGA Processing

Programming the FPGA with LabVIEW and USRP RIO

Many NI USRP models feature a large user-programmable FPGA for those wireless applications that require the highest-performance SDR. The NI USRP gives you multiple options to take advantage of the power of FPGA programming for high-speed signal processing such as inline fast Fourier transforms (FFTs) or finite impulse response filters. Using LabVIEW, program your USRP with the LabVIEW FPGA and the USRP RIO driver for certain models.

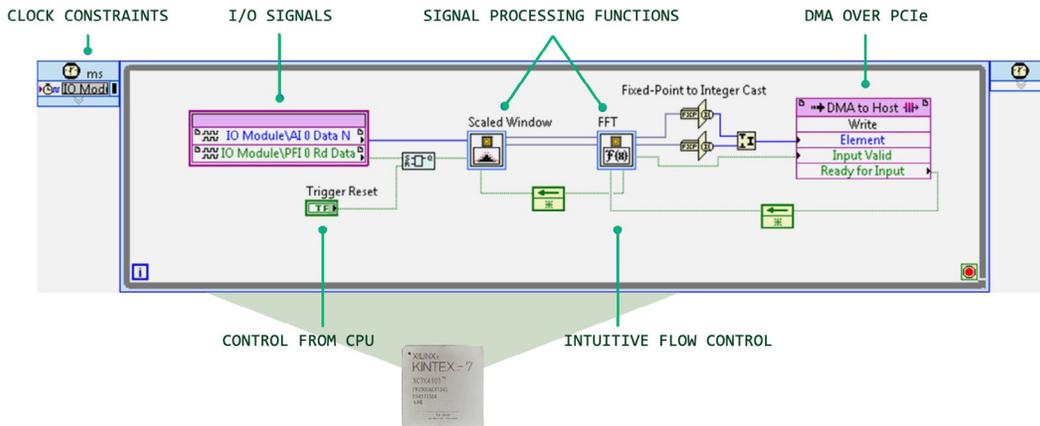


FIG 6 LabVIEW FPGA Graphical Abstraction of FPGA IP Integration

Open Source with GNU Radio, C++, and Python

Get the most out of your USRP with the RF Network on Chip (RFNoC) framework: A prebuilt framework that gives you the infrastructure you need to build an SDR application with the FPGA—without having to build the digital infrastructure—all programmed with VHSIC Hardware Description Language and Verilog Hardware Description Languages with plugins for GNU Radio.

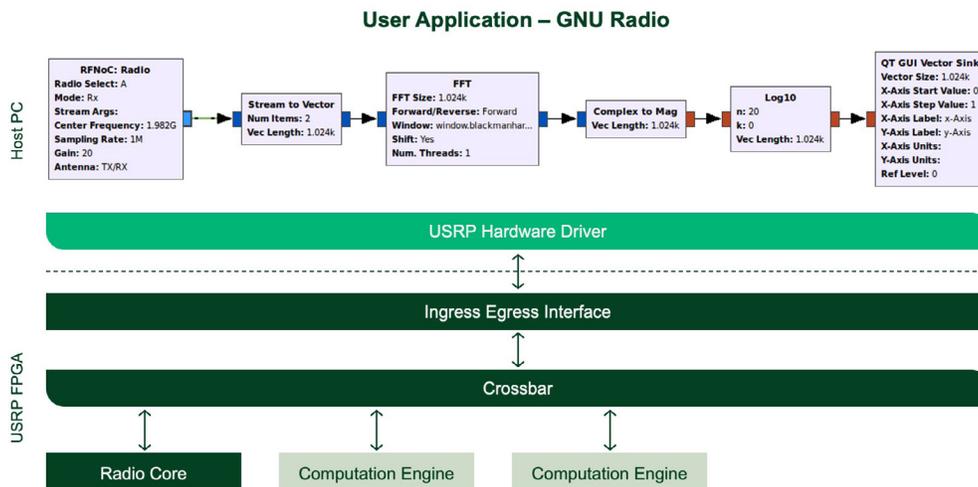


FIG 7 NI USRP RFNoC Framework



The USRP X410: The Most Advanced Commercial-Off-the-Shelf SDR

Built on the Xilinx Zynq UltraScale+ Radio Frequency System-on-Chip (RFSoc), the USRP X410 is the most advanced SDR yet.

Key Features

- Most FPGA resources of any USRP
- Quad-core Arm SoC application processor
- Dual QSFP28 (100 Gigabit Ethernet, Aurora)
- PCI Express Gen 3 x8 data interface
- Built-in Soft-Decision Forward-Error Correction IP core

RF Specifications

- Frequency: 1 MHz to 7.2 GHz
- Bandwidth: 400 MHz
- Channels: 4 RX/4 TX
- Maximum TX Power: 22 dBm
- Maximum RX Power: 0 dBm

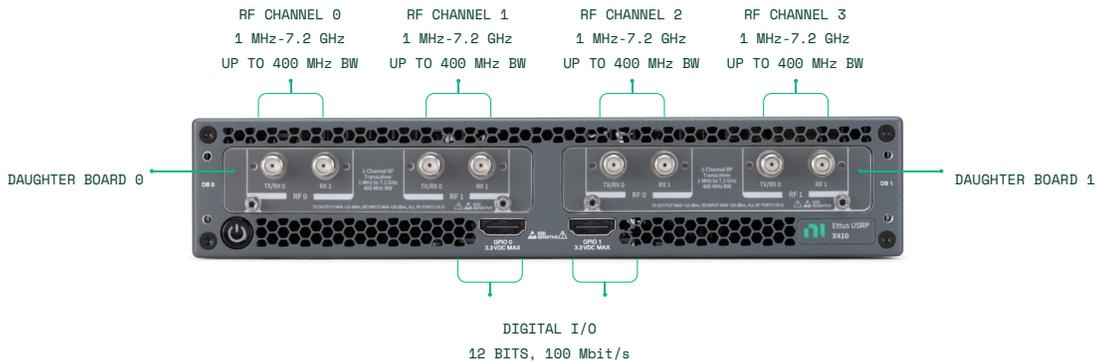


FIG 8 NI USRP X410 Front Panel

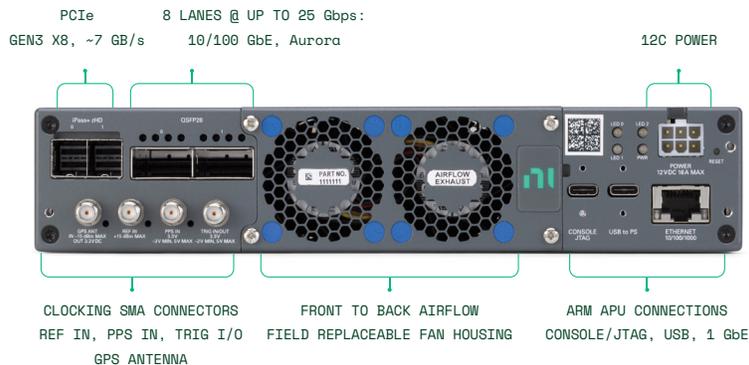


FIG 9 NI USRP X410 Back Panel

Hardware Services

All NI hardware features a one-year warranty for basic repair coverage in adherence to NI specifications prior to shipment. NI offers additional entitlements to improve uptime and lower maintenance costs with service programs for hardware. Learn more at ni.com/services/hardware.

| | STANDARD | PREMIUM | DESCRIPTION |
|--|------------------|------------------|---|
| PROGRAM DURATION | 1, 3, or 5 years | 1, 3, or 5 years | NI offers several service-program lengths. |
| EXTENDED REPAIR COVERAGE | . | . | NI restores your device's functionality and includes firmware updates and factory calibration. |
| SYSTEM CONFIGURATION, ASSEMBLY, AND TEST | . | . | NI technicians assemble, install software in, and test your system per your custom configuration prior to shipment. |
| ADVANCED REPLACEMENT | . | . | NI stocks replacement hardware that can ship immediately if a repair is needed. |
| SYSTEM RETURN MATERIAL AUTHORIZATION | . | . | NI accepts the delivery of fully assembled systems when performing repair services. |

TBL
2 | NI Service Program Offerings

SDR Technical Support and Training

Every NI system includes a 30-day trial for phone and email support from NI engineers that you can extend through a Standard Service Program (SSP) membership. NI has more than 400 engineers around the globe to provide local support in more than 30 languages. Additionally, you can take advantage of NI's award-winning online resources and communities.

Open-Source Support

In addition to standard NI support, you can find additional resources at ettus.com/support, including user manuals, an extensive Knowledge Base, and help with ordering.

New to open-source SDR? Take the "Using Open-Source Tools with USRP Hardware for SDR Applications" course at learn.ni.com.

PremiumPlus Service Program

NI can customize the offerings listed above or offer additional entitlements such as on-site calibration, custom sparring, and life-cycle services through a PremiumPlus Service Program. Contact your NI sales engineer to learn more.

To learn how you can leverage USRP technology to accelerate your wireless project, contact your account manager or NI at (888) 280-7645 or info@ni.com.

