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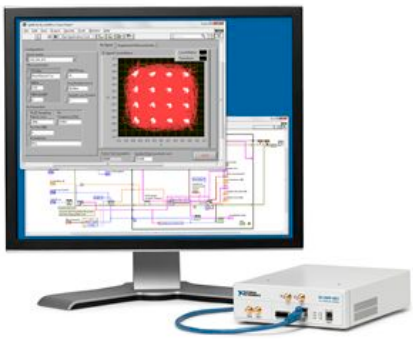
NI USRP-2920, NI USRP-2921

Universal Software Radio Peripherals



- Affordable, lab-ready solution
- Scalable solution for teaching and research
- Tunable RF transceivers cover 50 MHz to 2.2 GHz, 2.4 GHz/5.8 GHz
- Up to 20 MS/s baseband I/Q streaming for host-based processing with LabVIEW
- NI technical support and 1-year extendable warranty

Overview

NI USRP-292x software-programmable radio transceivers are designed for wireless communications teaching and research. National Instruments combines the power of NI LabVIEW software and USRP™ hardware to deliver an affordable and easy-to-use software-reconfigurable RF platform that works well for communications education, experimentation, research, and rapid prototyping. With wide frequency coverage and two RF configurations, the NI USRP platform helps you experiment and prototype physical layer host-based algorithms with live signals in the same bands as 802.11a/b/g/n and ZigBee. This functionality both enhances the depth of an educational experience and allows researchers to rapidly validate their work with real-world data.

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Requirements and Compatibility

OS Information
Windows 7 32-bit
Windows 7 64-bit
Windows Vista
Windows XP

Driver Information
NI-USRP

Software Compatibility
LabVIEW

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Comparison Tables

Model	Tunable Frequency	Transmit Power	Bands/Possible Applications
NI USRP-2920	50 MHz to 2.2 GHz	30 to 100 mW typical	Whitespace, broadcast FM, public safety, land-mobile, low-power unlicensed devices (ISM), sensor networks, cellphones, amateur radio, GPS
NI USRP-2921	2.4 to 2.5 GHz and 4.9 to 5.9 GHz	50 to 100 mW typical	2.45 GHz/5.8 GHz ISM bands, public safety, Japanese wireless

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Application and Technology

An Affordable Lab-Ready Solution

The NI USRP platform offers new opportunities for RF and communications education, which traditionally has been focused on mathematical theory. Students can use the platform with LabVIEW to link theory and practical implementation through hands-on execution and exploration of a working communications system using live signals.

Figure 1. The NI Digital Communications Bundle

The NI Digital Communications Bundle is an affordable turnkey solution that addresses both time and budget concerns. It includes a pair of NI USRP-2920 transceivers, which enables implementation of a live communication link at frequencies between 50 MHz and 2.2 GHz with up to a 25 MHz bandwidth. The bundle also features a laboratory manual, *Digital Wireless Communication: Physical Layer Exploration Lab Using the NI USRP*, by Dr. Robert Heath, a professor at The University of Texas at Austin Department of Electrical and Computer Engineering. This material covers each element of a modern digital communications system and culminates with the design of an OFDM radio. The course material includes a printed lab manual with background content, pre-lab exercises, step-by-step lab instructions, and LabVIEW VIs associated with each exercise.

Lab 1.1	AWGN Simulator
Lab 2.1	Modulation/Demodulation
Lab 2.2	Pulse Shaping
Lab 3	Energy Detection
Lab 4	Equalization
Lab 5	Frame Detection
Lab 6	Intro to OFDM
Lab 7	Frequency Correction and Synchronization
Lab 8	OFDM Channel Coding

Table 1. Topics Covered by Digital Wireless Communication: Physical Layer Exploration Lab Using the NI USRP

Communications Research

NI USRP hardware also works well for research, such as certain physical layer RF and communications research that requires a low-cost, flexible platform. Examples of research applications include decoding the beacon signal from Wi-Fi, performing whitespace spectral monitoring for dynamic spectrum access, prototyping a custom ZigBee-like protocol to determine the effects of channel impairments on bit error rate (BER), and maximizing throughput by modeling the nonlinear nature of RF analog front ends.

Hardware

The NI USRP connects to a host PC to act as a software-defined radio. Incoming signals attached to the standard SMA connector are mixed down from RF using a direct-conversion receiver (DCR) to baseband I/Q components, which are sampled by a 2-channel, 100 MS/s, 14-bit analog-to-digital converter (ADC). The digitized I/Q data follows parallel paths through a digital downconversion (DDC) process that mixes, filters, and decimates the input 100 MS/s signal to a user-specified rate. The downconverted samples are passed to the host computer at up to 20 MS/s over a standard Gigabit Ethernet connection.

For transmission, baseband I/Q signal samples are synthesized by the host computer and fed to a USRP-292x at up to 20 MS/s over Gigabit Ethernet. The USRP hardware interpolates the incoming signal to 100 MS/s using a digital upconversion (DUC) process and then converts the signal to analog with a dual-channel, 16-bit digital-to-analog converter (DAC). The resulting analog signal is then mixed up to the specified RF frequency.

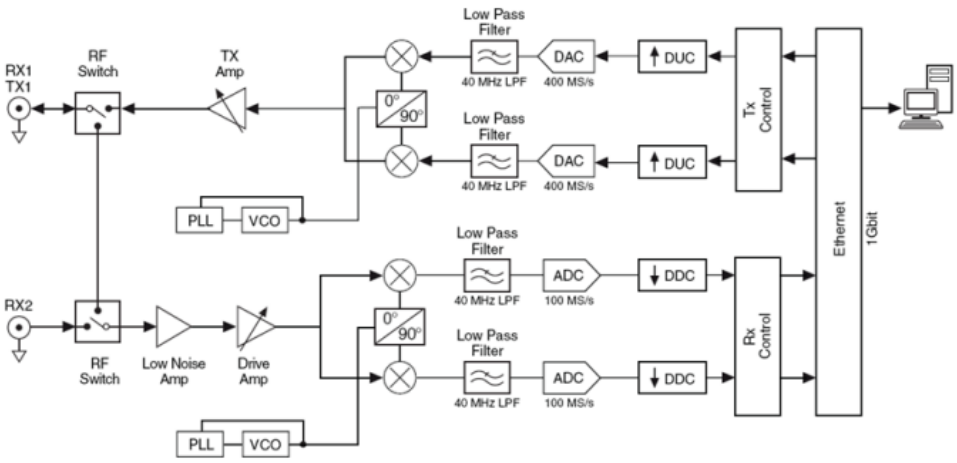

Figure 2. NI USRP-2920 System Block Diagram

LabVIEW Software and the NI-USRP Driver

The LabVIEW development system provides an ideal way to interface with NI USRP hardware for the development and exploration of communications algorithms that process received signals and synthesize signals for transmission. NI-USRP driver software provides functions (LabVIEW VIs) for the hardware/software configuration with tools for opening/closing sessions and performing read/write operations.

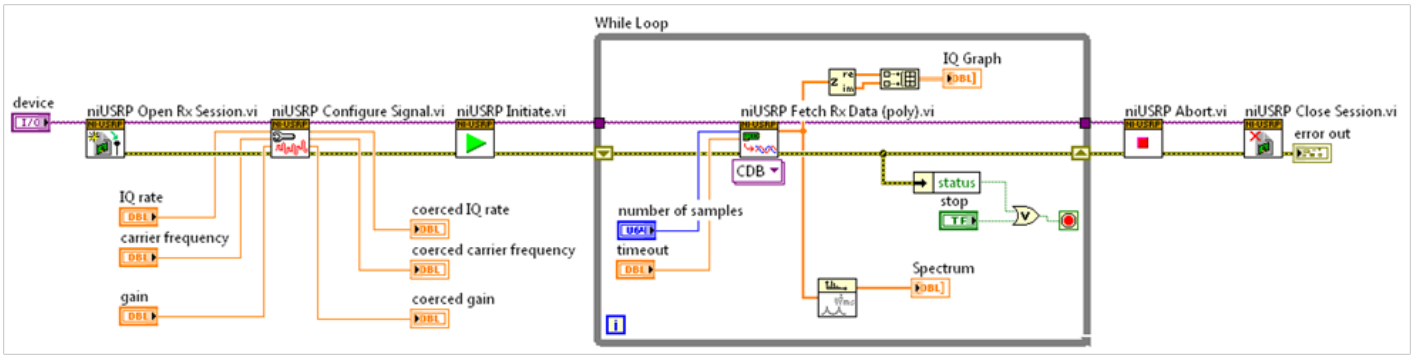

Figure 3. Continuous Receive Using NI-USRP Driver in LabVIEW Software

LabVIEW Modulation Toolkit

The LabVIEW Modulation Toolkit extends LabVIEW with VIs to rapidly develop communications systems for simulation or to operate on live signals associated with NI USRP hardware. On the transmit side, included VIs provide functionality for PN-sequence generation, channel coding, and baseband modulation. Receiver-side functionality encompasses demodulation, equalization, channel decoding, and more. With LabVIEW Modulation utilities, you can add baseband impairments, BER measurements, modulation domain measurements, and communications-oriented visualization. You also can simulate and analyze an entire communications system with channel impairments and then update the system to transmit/receive live signals.

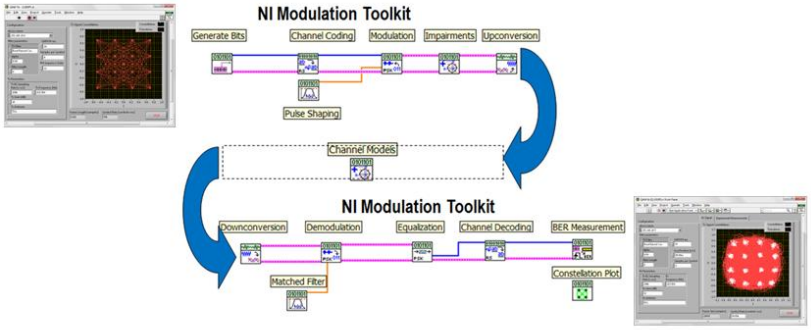

Figure 4. LabVIEW Modulation Toolkit

LabVIEW MathScript RT Module

With the LabVIEW MathScript RT Module, you can efficiently execute .m file syntax in a LabVIEW diagram to combine both graphical and textual models of computation. In addition, you can design and implement communications algorithms using the popular .m file script syntax.

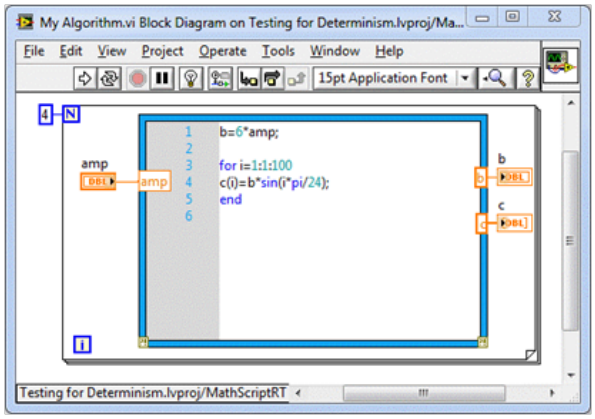

Figure 5. A LabVIEW MathScript RT Node Inside a LabVIEW For Loop

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Ordering Information

For a complete list of accessories, visit the product page on ni.com.

Products	Part Number	Recommended Accessories	Part Number
Optional Accessories			
MIMO Sync and Data Transfer Cable for NI USRP-292x, 0.5M	781916-01	No accessories required.	
VERT400: Tri-Band Vertical Antenna (144 MHz, 400 MHz, 1200 MHz)	781915-01	No accessories required.	

VERT2450: Dual-Band Vertical Antenna (2.4 GHz, 5 GHz)	781913-01	No accessories required.
Digital Communication Bundle		
NI Digital Communications Bundle: 2 NI USRP-2920 Kits With LabVIEW Add-Ons, MIMO Cable, and Ready-to-Use Courseware	781908-01	No accessories required.
NI USRP-292x Hardware Kits		
NI USRP-2920, 50 MHz to 2.2 GHz Software Radio Kit	781906-01	No accessories required.
NI USRP-2921, 2.4 AND 5 GHz Software Radio Kit	781907-01	No accessories required.

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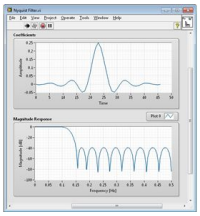
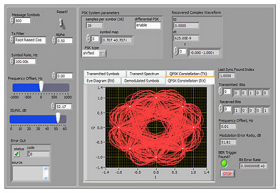
Software Recommendations

NI LabVIEW Digital Filter Design Toolkit



Floating- and fixed-point design with LabVIEW or ANSI C autocode generation
Digital filter design, analysis, and implementation within LabVIEW
Comprehensive tools that meet basic or advanced needs
Includes Digital Filter Design MathScript RT Module functions

NI Modulation Toolkit



Simulate and measure impairments including DC offset, I/Q gain imbalance, and quadrature skew
Handles standard and custom modulation formats(AM, FM, PM, ASK, FSK, MSK, GMSK, PSK, QPSK, PAM, QAM)
Measurements including bit error rate (BER), phase error, burst timing, and frequency deviation
Quality measurements including EVM, modulation error ratio (MER), and ρ (rho)
Powerful 3D eye diagrams enhance the suite of traditional 2D eye, trellis, and constellation plots
More than 100 source code example programs

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Support and Services

Technical Support

Get answers to your technical questions using the following National Instruments resources.

Support - Visit ni.com/support to access the NI KnowledgeBase, example programs, and tutorials or to contact our applications engineers who are located in NI sales offices around the world and speak the local language.
Discussion Forums - Visit forums.ni.com for a diverse set of discussion boards on topics you care about.
Online Community - Visit community.ni.com to find, contribute, or collaborate on customer-contributed technical content with users like you.

Repair

While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit ni.com/repair.

Training and Certifications

The NI training and certification program delivers the fastest, most certain route to increased proficiency and productivity using NI software and hardware. Training builds the skills to more efficiently develop robust, maintainable applications, while certification validates your knowledge and ability.

Classroom training in cities worldwide - the most comprehensive hands-on training taught by engineers.
On-site training at your facility - an excellent option to train multiple employees at the same time.
Online instructor-led training - lower-cost, remote training if classroom or on-site courses are not possible.
Course kits - lowest-cost, self-paced training that you can use as reference guides.
Training memberships and training credits - to buy now and schedule training later.

Visit ni.com/training for more information.

Extended Warranty

NI offers options for extending the standard product warranty to meet the life-cycle requirements of your project. In addition, because NI understands that your requirements may change, the extended warranty is flexible in length and easily renewed. For more information, visit ni.com/warranty.

OEM

NI offers design-in consulting and product integration assistance if you need NI products for OEM applications. For information about special pricing and services for OEM customers, visit ni.com/oem.

Alliance

Our Professional Services Team is comprised of NI applications engineers, NI Consulting Services, and a worldwide National Instruments Alliance Partner program of more than 700 independent consultants and integrators. Services range from start-up assistance to turnkey system integration. Visit ni.com/alliance.

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Detailed Specifications

All characteristics described in this document are based on the manufacturing design. *This equipment information is only for product description* and is not covered by warranty. This device is not calibrated.

Characteristics	NI USRP-2920	NI USRP-2921	NI USRP-2922	NI USRP-2930	NI USRP-2932
Transmitter					
Frequency Range	50MHz-2.2GHz	2.4GHz-2.5GHz 4.9GHz-5.9GHz	400MHz-4.4GHz	50MHz- 2.2GHz	400MHz-4.4GHz
SW Adjustable TX Frequency Step	< 1KHz				
MAX Output Power	15 dBm - 20 dBm				
TX Output Power Gain Range	0 dB - 31 dB				
SW Adjustable Output Power Step Size	1dB				
Instantaneous Real-Time Bandwidth	20MHz (16bit samples) 40MHz (8bit-samples)				
DAC (Digital to Analog Conversion)	2 channels, 400MS/s, 16 bit				
DAC SFDR (Spurious Free Dynamic Range)	80 dB				
Receiver					
Software Adjustable RX Frequency Step	< 1KHz				
Max Input Power (Pin)	0 dBm				
Noise Figure	5 to 7 dB				
Instantaneous Real-Time Bandwidth	20MHz (16bit samples) 40MHz (8bit-samples)				
ADC (Analog to Digital Conversion)	2 channels, 100MS/s, 14 bit				
ADC SFDR (Spurious Free Dynamic Range)	88 dB				

Reference Clock					
Clock Type	TCXO	TCXO	TCXO	OCXO	OCXO
GPS Disciplined	NO	NO	NO	YES	YES
Freq.Accuracy of 10MHz Ref (No GPS Antenna)	2.5ppm	2.5ppm	2.5ppm	2.5 ppb	2.5 ppb
Freq.Accuracy of 10MHz Ref (GPS Antenna)	NA	NA	NA	0.01 ppb	0.01 ppb

Shared Characteristics (Apply all NI-29xx devices)

Connections		Physical Specifications	
TX1 RX1, TX2 RX2, RX2 Ports	SMA	Enclosure Dimensions	6.25” Wide x 1.9” Tall x 8.35” Deep
Ethernet Connection	1 Gigabit Ethernet	Weight	2.63 lbs
Power Adapter	6VDC, 3A	Operating Temperature	23°C ±5°, Room Temperature
Ref Clock (10-Mhz external reference input)	SMA, 10 MHz		
PPS Input (Pulse Per Second reference input)	SMA, 3-5V TTL Compatible		
MIMO Expansion Port	High-Speed SerDes protocol		

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