



ООО «4ТЕСТ»

Телефон: +7 (499) 685-4444

info@4test.ru

[www.4test.ru](http://www.4test.ru)

## PRODUCT FLYER

# USRP Software Defined Radios

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# USRP Software Defined Radios

USRP-290x, USRP-292x, and USRP 293x; USRP-294x and USRP-295x; and USRP-2974



- **Software:** Includes API support for LabVIEW and the LabVIEW FPGA Module, shipping examples, and detailed help files; text-based languages are supported using the USRP Hardware Driver (UHD)
- Frequency ranges between 10 MHz and 6 GHz
- Up to 160 MHz instantaneous bandwidth
- GPS disciplined oscillator option
- Up to 2x2 transceiver channels or 4 receiver channels
- Reconfigurable FPGA on some models
- Onboard x86 processor option

## Software Defined Radios for Any Use Case

NI USRP devices are software defined radios (SDRs) that combine host-based processors, FPGAs, and RF front ends to help you rapidly design, prototype, and deploy wireless systems. The USRP product line offers a wide breadth of SDRs ranging from lower-cost options with fixed FPGA personalities to high-end radios with large, open FPGAs and up to 160 MHz of instantaneous bandwidth.

USRP SDRs are ideal for developing and prototyping complex wireless designs. After you design and simulate your digital signal processing (DSP) algorithms, you need to prototype in a real-world environment to ensure you deliver high-quality technology to market on time. The powerful processing capability of onboard FPGAs is especially beneficial for applications that require processing wide bandwidths of data in real time. USRP SDRs are also well suited for applications like spectral monitoring and direction finding because of their wide bandwidths and flexible RF front ends. On select models, an onboard x86 processor creates a complex yet powerful USRP that you can use as a stand-alone radio.

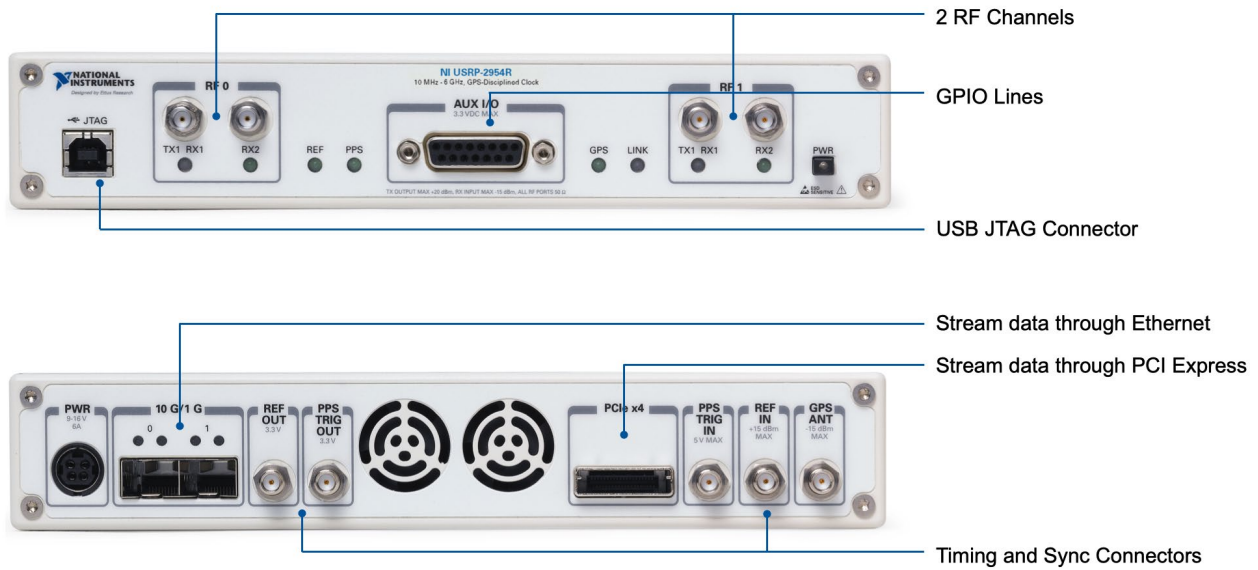
Table 1. Overview of Features for All NI USRP Models and Their Ettus Research Equivalents

NI Model	Frequency Range	Bandwidth	GPS Disciplined Oscillator	LabVIEW FPGA Support	Ettus Research Equivalent
USRP-2900	70 MHz–6 GHz	56 MHz			B200
USRP-2901	70 MHz–6 GHz	56 MHz			B210
USRP-2920	50 MHz–2.2 GHz	20 MHz			N210 + WBX
USRP-2922	0.4–4.4 GHz	20 MHz			N210 + SBX
USRP-2930	50 MHz–2.2 GHz	20 MHz	•		N210 + WBX + GPSDO
USRP-2932	0.4–4.4 GHz	20 MHz	•		N210 + SBX + GPSDO
USRP-2940	50 MHz–2.2 GHz	40 MHz/120 MHz		•	X310 + WBX
USRP-2942	0.4–4.4 GHz	40 MHz/120 MHz		•	X310 + SBX
USRP-2943	1.2–6 GHz	40 MHz/120 MHz		•	X310 + CBX
USRP-2944	30 MHz–6 GHz	160 MHz		•	X310 + UBX
USRP-2945	10 MHz–6 GHz	80 MHz		•	X310 + TwinRX
USRP-2950	50 MHz–2.2 GHz	40 MHz/120 MHz	•	•	X310 + WBX + GPSDO
USRP-2952	0.4–4.4 GHz	40 MHz/120 MHz	•	•	X310 + SBX + GPSDO
USRP-2953	1.2–6 GHz	40 MHz/120 MHz	•	•	X310 + CBX + GPSDO
USRP-2954	30 MHz–6 GHz	160 MHz	•	•	X310 + UBX + GPSDO
USRP-2955	10 MHz–6 GHz	80 MHz	•	•	X310 + TwinRX + GPSDO
USRP-2974*	10 MHz–6 GHz	160 MHz	•	•	USRP-2974

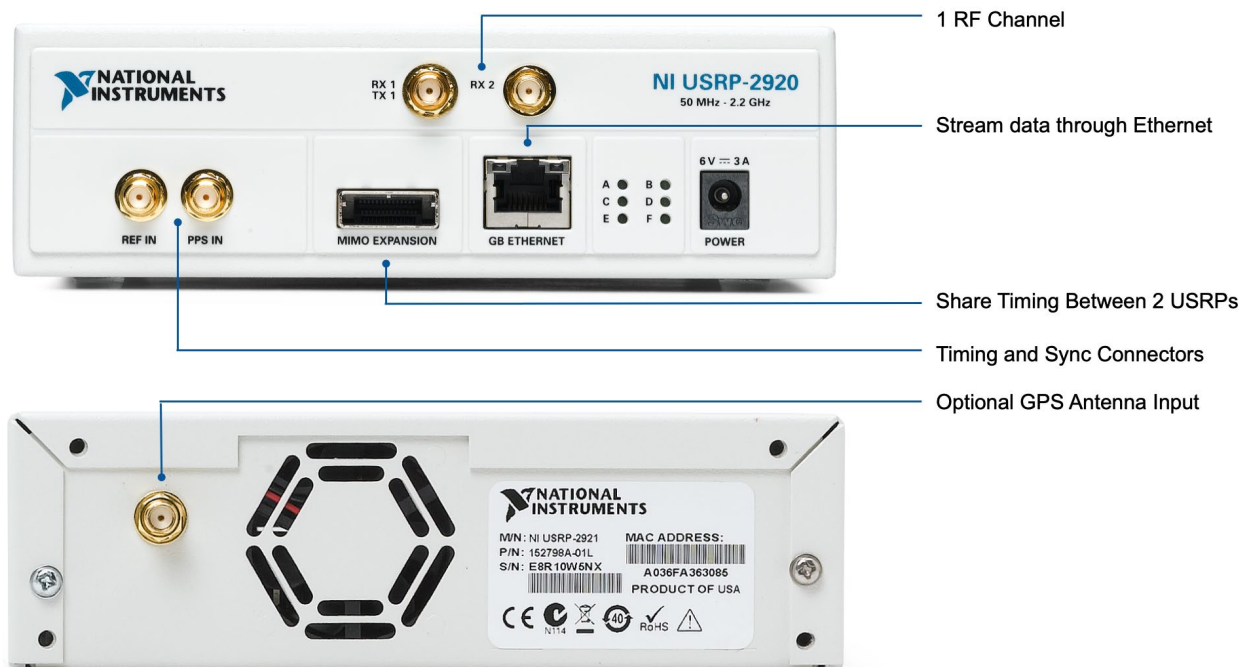
\*The USRP-2974 is a stand-alone device that includes an onboard Intel Core i7 processor.

NI offers a wide range of USRP SDRs. Table 1 provides an overview of the basic features of each version. The equivalent product from Ettus Research (a National Instruments Brand) is also included. All NI USRP SDRs are sold as fully assembled, tested, and enclosed units that are ready to run out of the box. All Ettus Research USRP SDRs are sold as components and require assembly by the end user. Additional USRP models are available from Ettus Research.

## Detailed View of the USRP-2944 10 MHz–6 GHz SDR



## Detailed View of the USRP-2920 50 MHz–2.2 GHz SDR



# Key Features

## Wide Selection of RF I/O

USRP SDRs offer the broadest selection of RF I/O of any commercial off-the-shelf SDR. With frequency ranges between 10 MHz and 6 GHz and instantaneous bandwidth up to 160 MHz, NI provides you with the relevant frequency bands to keep up with the latest industry standards, including the specifications to support emerging standards like 5G New Radio (NR).

## Scalable for Multichannel Operation

USRP SDRs feature a variety of synchronization options so you can easily expand your RF channel count for Massive MIMO applications. Choose between hardware synchronization using a shared reference clock and trigger or GPS synchronization using the GPS Disciplined Oscillator (GPSDO). Through the Ettus Research catalog, you also have the option for Ethernet-based synchronization using the White Rabbit standard for select models.

For tight, multidevice synchronization, you can share up to eight clocks using the 8-Channel Clock Distribution Accessory, or CDA-2990. This device accepts both an external 10 MHz clock and a pulse per second (PPS) input signal and then amplifies and distributes each to eight output ports, so you can synchronize multiple modules to a common timing source. For systems with even higher channel counts, you can cascade multiple CDA-2990 devices. Using this method, USRP users have built phase-coherent systems up to 128 channels.

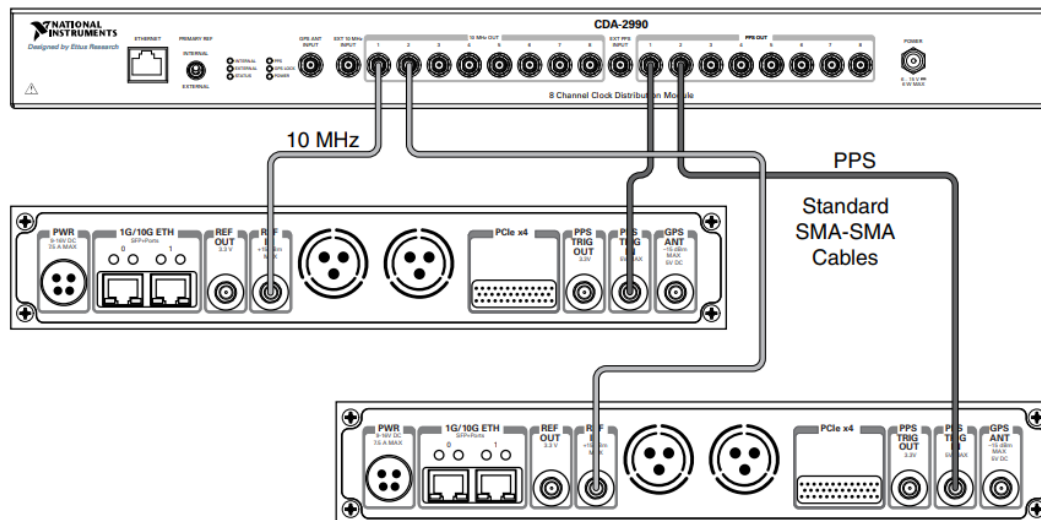


Figure 1. Synchronizing Multiple USRP Devices with the CDA-2990

## Your Choice of Development Software

No matter what your preferences are for development tools, USRP SDRs work with the broadest range of software workflows on the market. You can choose between two drivers, NI-USRP or UHD, based on your preferred development tools.

With NI-USRP, you can program your USRP SDR with LabVIEW, NI's flagship intuitive development environment, to rapidly develop measurement systems. Using the LabVIEW dataflow programming style, you can program both the host and FPGA in a single development environment. The abstracted design environment helps accelerate the design of wireless systems and makes FPGA programming accessible to those without HDL design expertise. If you have third-party IP that you want to incorporate, such as MathWorks MATLAB® or VHDL code, you can import this IP directly from LabVIEW. For a higher-level starting point, NI also offers LabVIEW Communications application frameworks for LTE, 802.11, and MIMO to accelerate application design.

UHD works with all USRP SDRs, and it is published by NI's R&D organization under open-source licenses. It facilitates application development on USRP SDRs in C/C++ and offers cross-platform support for several industry-standard development environments and frameworks, such as RFNoC, GNU Radio, Python, and MathWorks MATLAB and Simulink®. As an active leader in the open-source SDR communities such as the GNU Radio Foundation, NI consistently works to further wireless communications research through the open-source ecosystem.

Table 2. Overview of the Ettus Research USRP Hardware Driver (UHD) and NI-USRP Driver

	UHD	NI-USRP
OS	Windows Linux Mac OS	Windows NI Linux Real-Time
Host	GNU Radio C/C++ MATLAB®/Simulink® Python	LabVIEW 20XX LabVIEW NXG
FPGA	VHDL Verilog HDL Coder <a href="#">RFNoC (Open-Source FPGA Framework)</a>	LabVIEW FPGA Module LabVIEW NXG Module

## Easier FPGA Programming

As bandwidths widen and latency requirements grow more stringent, the ability to implement high-speed digital signal processing in real time is essential. The powerful processing capability of onboard FPGAs helps you meet these requirements, but the tools needed to design FPGA-based systems are notoriously complex for even the most competent scientists and engineers. USRP SDRs make FPGA programming easier by abstracting many of the low-level design tasks associated with custom hardware design.

You can program FPGAs more intuitively without HDL expertise using LabVIEW, which offers a graphical programming language that mirrors the parallelism of hardware. LabVIEW is a single development environment that can target multicore general-purpose processors, NI Linux Real-Time, and FPGAs while tightly integrating with SDR hardware.

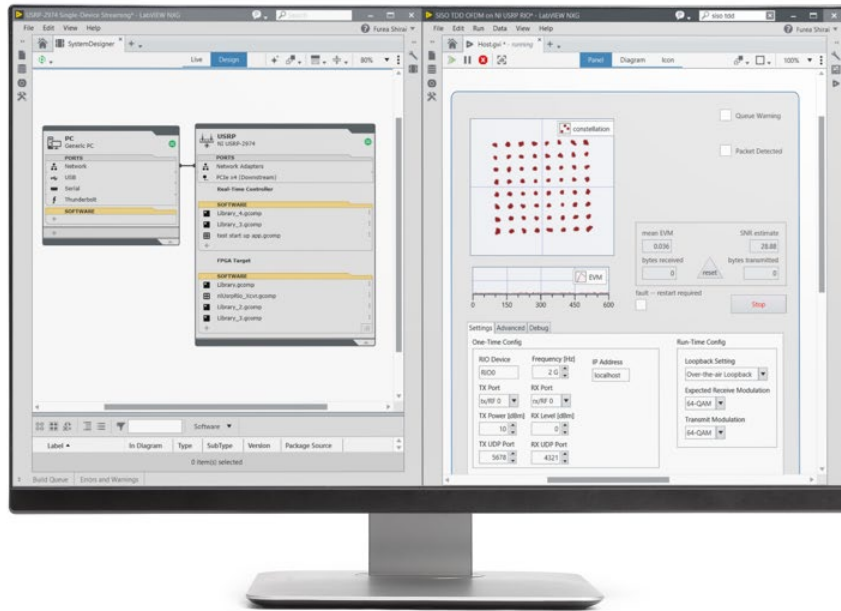


Figure 2. LabVIEW Communications System Design Suite

If you prefer traditional FPGA design languages, UHD includes free and open-source FPGA code for all USRP devices. An optional part of UHD is an FPGA framework called RF Network-on-Chip (RFNoC) that provides a consistent approach to implementing FPGA DSP code in an open-source environment.

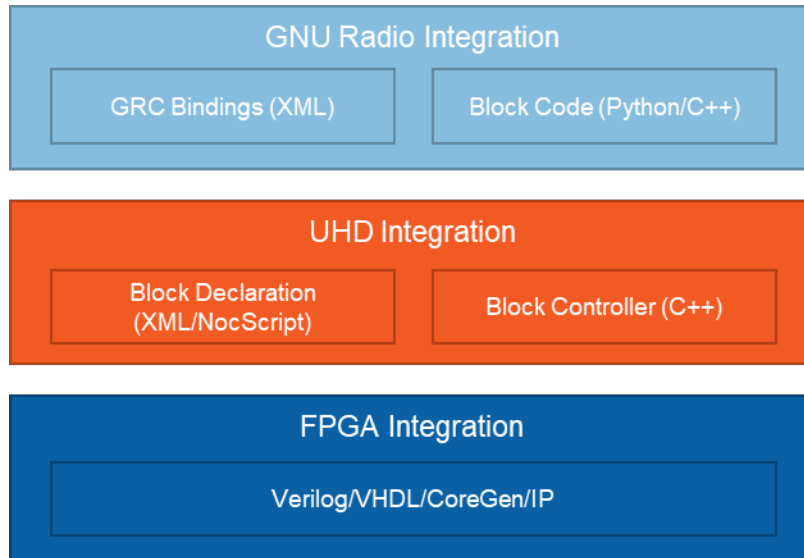


Figure 3. RFNoC Software Stack

## Best-in-Class Hardware Design

USRP SDRs have been trusted by more than 8,000 companies for industrial and commercial use for over a decade. More than 50,000 devices have been incorporated in labs, testbeds, and OEM deployments worldwide. USRP is considered the gold standard in SDRs because of the excellence of our hardware design practices. The assembled devices arrive precertified with CE and KC EMC certifications for conformity, so you can be confident that your devices meet EMC emissions requirements.

# NI-USRP Application Programming Interface for LabVIEW and LabVIEW Communications

The [NI-USRP driver](#) includes a best-in-class application programming interface (API) that works with LabVIEW, the LabVIEW FPGA Module, and the LabVIEW Communications System Design Suite. To ensure the long-term interoperability of USRP SDRs, the NI-USRP driver API is the same API used for all past and current NI USRP SDRs.\* The driver also provides access to help files, documentation, and dozens of ready-to-run shipping examples you can use as a starting point for your application.

\*NI USRP SDRs only. Not all Ettus Research USRP SDRs are supported by the NI-USRP driver. Please check the driver readme file for a complete list of supported devices.

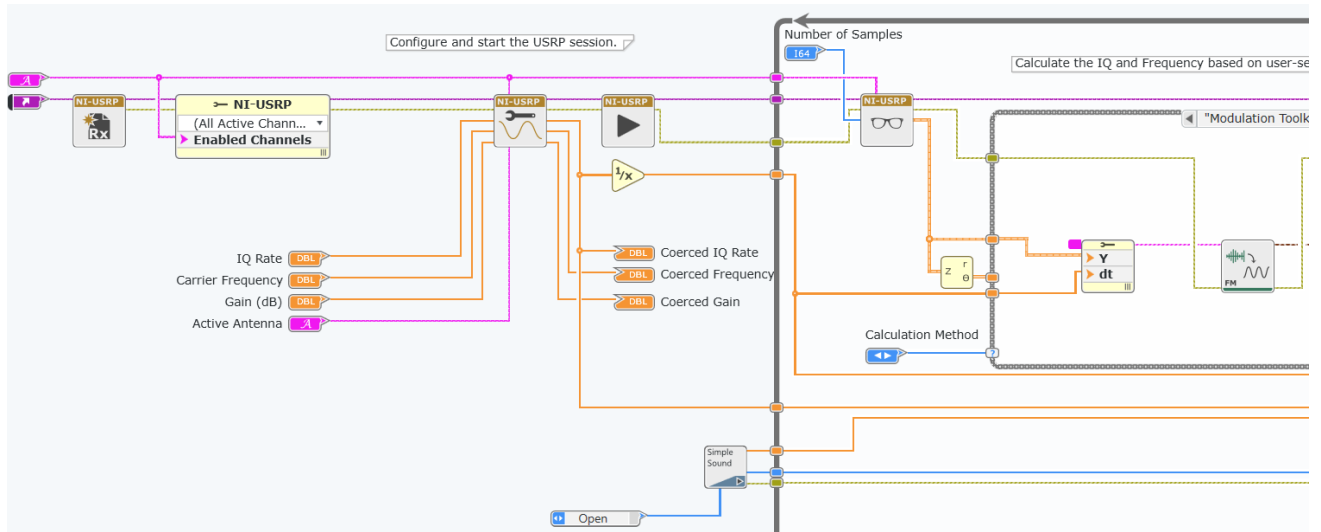


Figure 4. Graphical programming in the LabVIEW Communications System Design Suite.

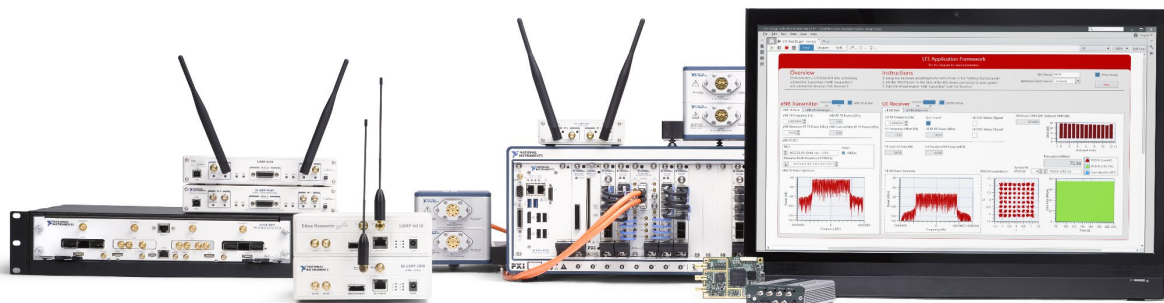


# Unparalleled Solutions for SDR

NI SDR hardware and software solutions drive productivity, shorten time to results, and empower engineers, scientists, and researchers to design next-generation wireless technologies.

The breadth and depth of NI's SDR offering are unrivaled. Scaling from small to massive, NI SDR tools, including those from Ettus Research, an NI company, can be used for a wide variety of applications including signals intelligence, military communications, radar, and communications research.

Across applications and industries like these, wireless researchers can leverage NI tools that scale from cost-effective single-user experimentation systems to densely packed Massive MIMO systems capable of accommodating hundreds of radios and antennas. And when it comes to software, NI provides unmatched flexibility and choice from the simplified FPGA programming of the LabVIEW Communications System Design Suite to a wide, vibrant community of open-source software contributors through GNU Radio.



*Figure 5. NI portfolio of software defined instruments*

# NI SDR Hardware

NI offers the most comprehensive range of SDR hardware in the world. With banded frequency options from DC to 71 GHz, up to 2 GHz 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



## N Series/USRP-292x

High-value Ethernet-connected USRP SDRs featuring superior RF performance, MIMO capability, and up to 100 MHz of bandwidth



## E Series

Portable and stand-alone wideband SDRs containing a Zynq SoC, a 2x2 MIMO transceiver, and 56 MHz of bandwidth



## 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



## mmWave Transceiver System

Advanced multi-FPGA solution for real-time 5G prototyping that features 2 GHz of bandwidth at the 28, 39, and 73 GHz bands



## ATCA-3671

Four Virtex-7 690T FPGAs in an ATCA form factor, dedicated internal serial links between each FPGA, and up to 160 GB/s of external digital connection



## 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

# 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.

	Standard	Premium	Description
Program Duration	1, 3, or 5 years	1, 3, or 5 years	Length of service program
Extended Repair Coverage	•	•	NI restores your device's functionality and includes firmware updates and factory calibration.
System Configuration, Assembly, and Test <sup>1</sup>	•	•	NI technicians assemble, install software in, and test your system per your custom configuration prior to shipment.
Advanced Replacement <sup>2</sup>		•	NI stocks replacement hardware that can be shipped immediately if a repair is needed.
System Return Material Authorization (RMA) <sup>1</sup>		•	NI accepts the delivery of fully assembled systems when performing repair services.
Calibration Plan (Optional)	Standard	Expedited <sup>3</sup>	NI performs the requested level of calibration at the specified calibration interval for the duration of the service program.

<sup>1</sup>This option is available only for PXI, CompactRIO, and CompactDAQ systems.

<sup>2</sup>This option is not available for all products in all countries. Contact your local NI sales engineer to confirm availability.

<sup>3</sup>Expedited calibration includes only traceable levels.

## 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.

## Technical Support

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](#).

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