

What's New in RF Hardware and Software?

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Staff Product Manager

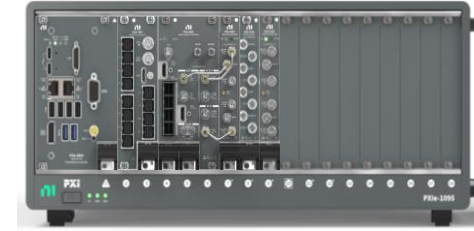
NI's RF Portfolio



Low SWaP-C Prototyping with Universal Software Radio Peripherals (USRPs)

Differentiators:

- Broad portfolio of low-cost <\$30k COTS SDRs
- Integration of RF with baseband and digital
- Open-source software, wide toolchain adoption
- Enables software migration to tactical hardware



High-performance Prototyping, Validation, and Production with PXI RF

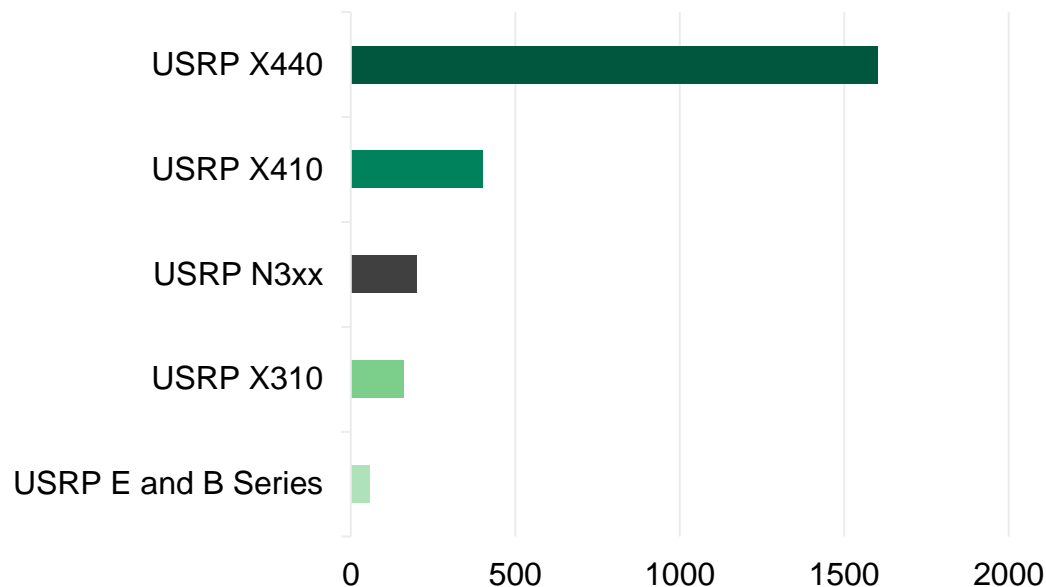
Differentiators:

- One instrument for all FR1, FR2, and FR3 frequency ranges up to 54GHz
- Lab-graded instrument with latest ADC/DAC and RF technologies
- Native mixed-signal capability (Digital, RF, Analog, etc.)
- Modularity and scalability supporting high channel counts
- Hardened infrastructure for data streaming, real-time processing, and storage

What's New in the USRP Platform?

NI Ettus USRP X440 | Wide Instantaneous Bandwidth and High Channel Density

Instantaneous Bandwidth of NI Ettus USRP Models (MHz)



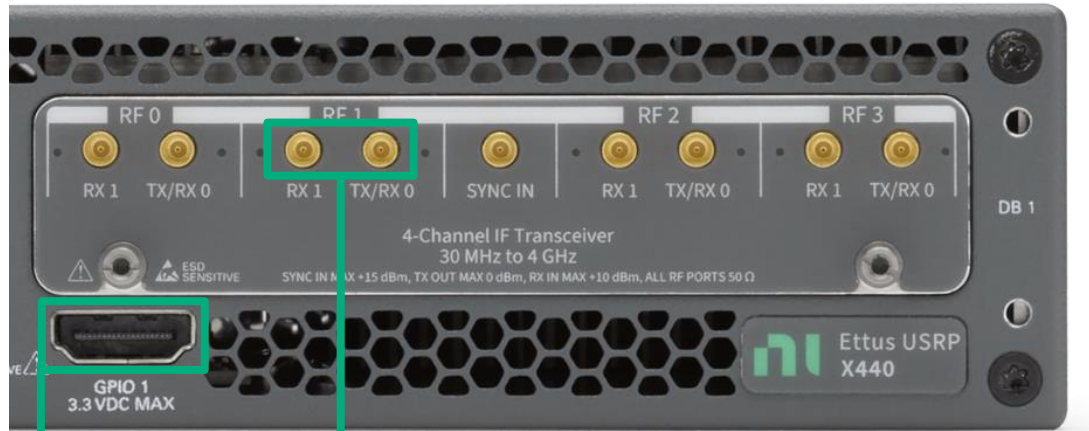
Hardware Specifications of the USRP X440:

- IF Range: 30 MHz – 4 GHz*
- 1.6 GHz* of instantaneous bandwidth (IBW)
- Up to 3.2 GHz of IBW in aggregate
- 8 Tx / 8 Rx channels (or 8 TRx)

Benefits of wide IBW & high channel count instrumentation:

- Improved scan rate in spectrum monitoring applications
- Exploration of broad frequency ranges and modulation schemes for research and prototyping
- Enhanced range and resolution capabilities for radar applications

NI Ettus USRP X440 | Direct Sampling Architecture



Front-end connectors are
Balun-coupled MMPX

GPIO control to an RF front-end
via UHD API or the FPGA

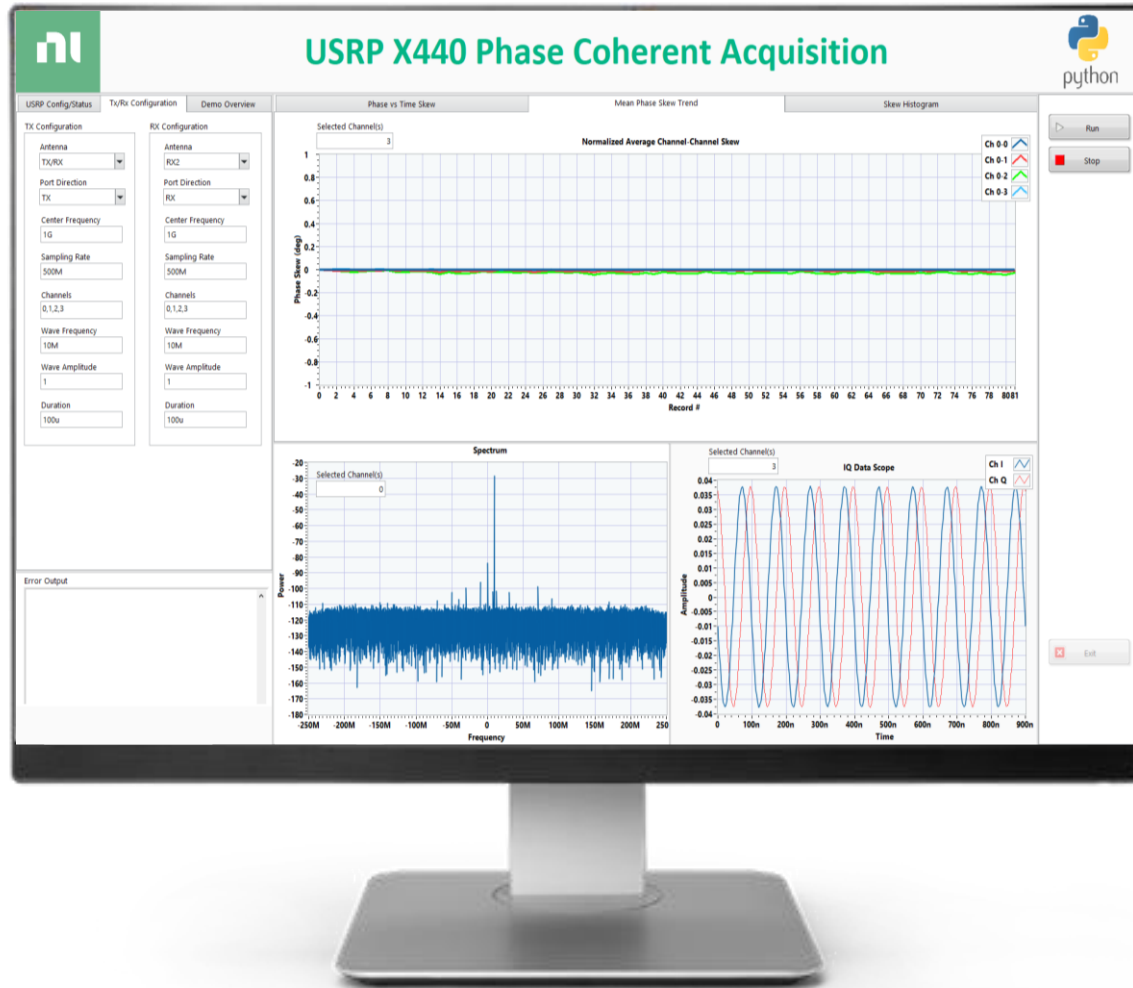
Hardware Specifications of the USRP X440:

- CPU: Built in quad-core ARM processor
- FPGA: Xilinx Zynq UltraScale+ RFSoc ZU28DR-2
- GPIO: Two 12-lane HDMI ports with SPI protocol support
- Direct Sampling: Flexible up to 4 GSps

Benefits of a direct sampling architecture:

- Direct access to the ADCs and DACs on the RFSoc
- Support versatile modulation schemes and signal types for diverse communication and radar systems
- Improved signal fidelity for spectrum monitoring applications

NI Ettus USRP X440 | Phase Coherent on Eight Channels



Hardware Specifications of the USRP X440:

- Phase coherency is sample based
 - Phase Stability (within device): $< 1^\circ$ RMS
 - Phase Repeatability (within device): $< 3^\circ$ Pk-Pk
 - Phase Stability (device-to-device): $< 2^\circ$ RMS
- Tx Output Level: < 0 dBm full scale
- Rx Output Level: 10 dBm full scale

Benefits of a phase coherent USRP:

- Easier to synchronize and phase-align multiple channels for MIMO systems and beamforming applications
- Enable accurate phase measurements, Doppler shift calculations, and precise direction determination in radar and direction-finding systems

For More Information

What is a USRP Device?

- Visit ni.com/usrp or scan the QR code below



Learn More About Sampling Rates and Master Clock Rates

- Read the application note [About Sampling Rates and Master Clock Rates for the USRP X440 - Ettus Knowledge Base](#) or scan the QR code below

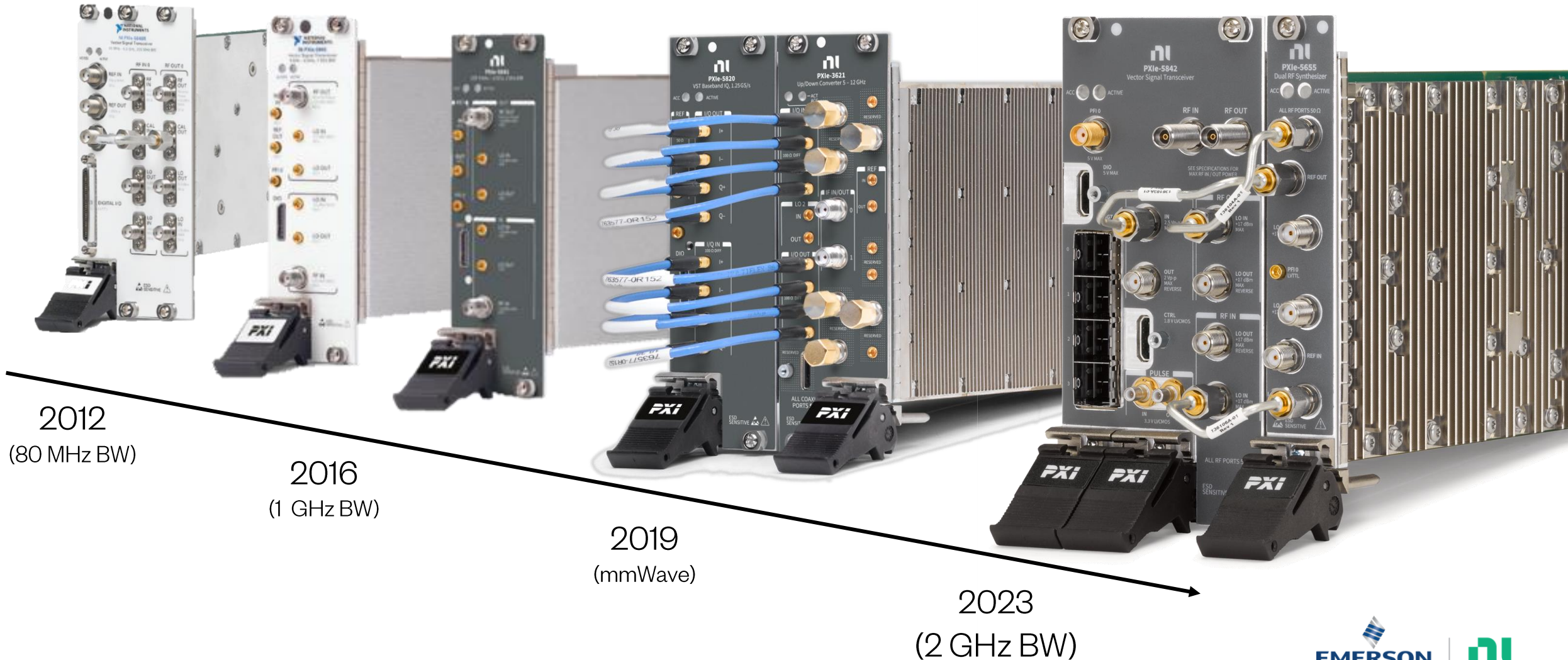


What's New in the PXI RF Platform?

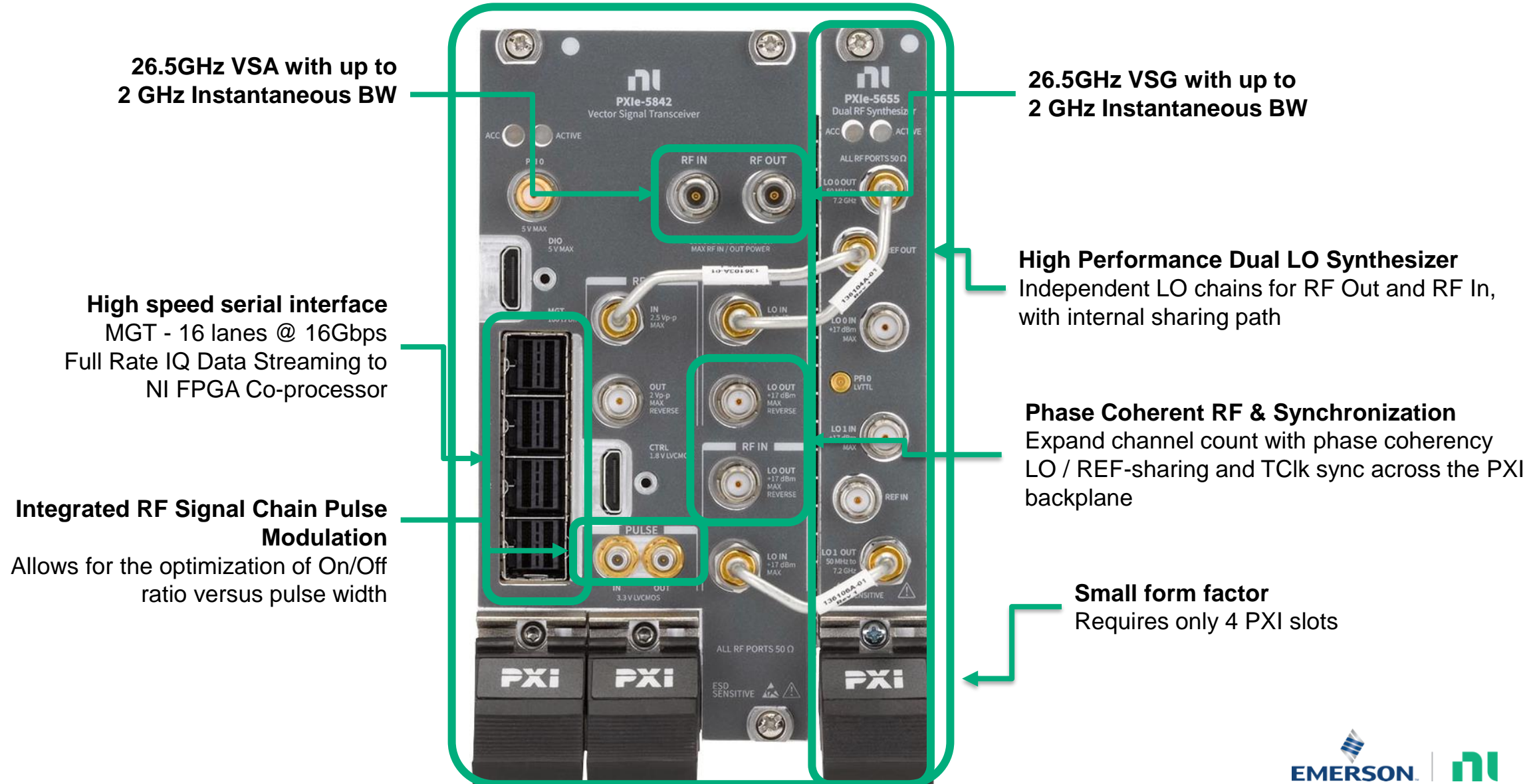
What is a PXI Vector Signal Transceiver?



NI VST – Over a Decade of Ambitious Engineering



PXIe-5842 | Most Versatile & Capable PXI VST



PXIe-5842 | Single-Channel Configuration

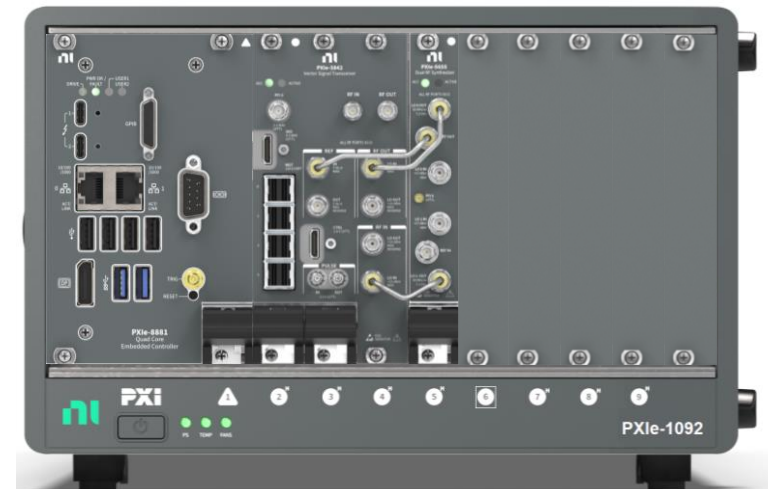
Improved density for wide frequency applications

PXIe-5841 + PXIe-5655 + PXIe-5830
1x1 Channel Configuration



7 Slots per Channel

PXIe-5842 VST
1x1 Channel Configuration

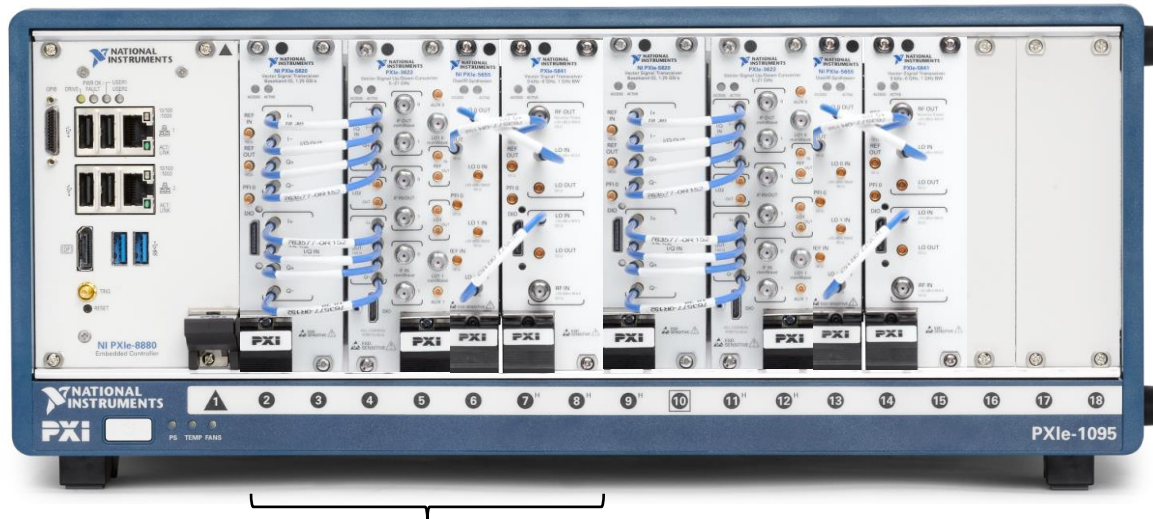


4 Slots per Channel

PXIe-5842 | Multi-Channel System

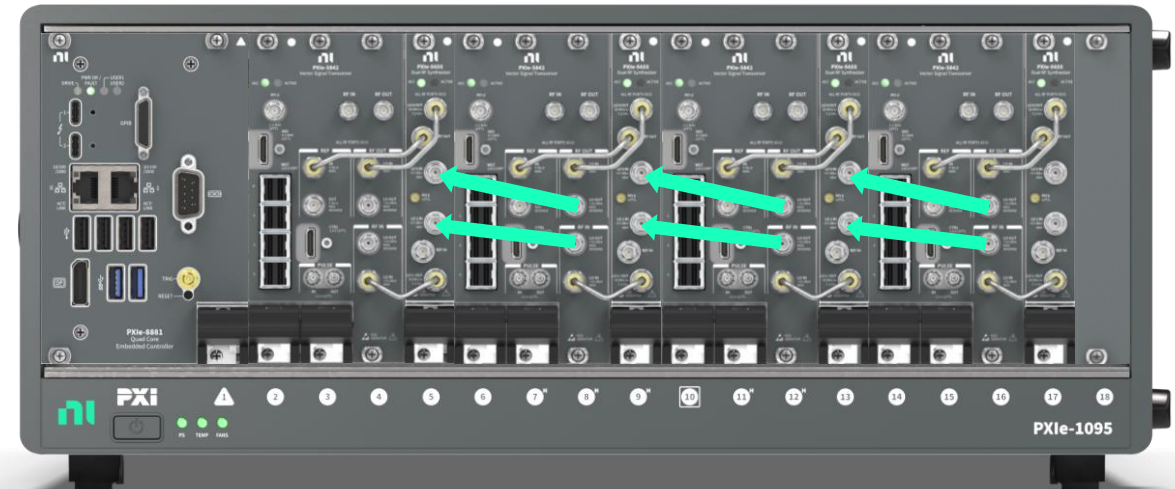
Improved density for wide frequency applications

PXIe-5841 + PXIe-5655 + PXIe-5830
2x2 Channel Configuration



7 Slots per Channel

PXIe-5842 VST
4x4 Channel Configuration



4 Slots per Channel

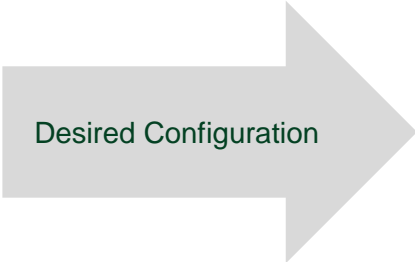
Shared LOs for MIMO
Configurations

PXIe-5842 | Configurations & Options

Scalable value at a scalable price, with no tradeoff on core performance

PXIe-5842 Fixed Configurations

Direction	Configuration
Analysis and Generation	8 GHz, 1 GHz BW
Analysis and Generation	12 GHz, 2 GHz BW
Analysis and Generation	23 GHz, 2 GHz BW



PXIe-5842 Hardware Options

Direction
Analysis and Generation
Analysis Only
Generation Only
Frequency Range
30 MHz – 8 GHz
30 MHz – 12 GHz
30 MHz – 18 GHz
30 MHz – 26.5 GHz
Bandwidth
500 MHz BW
1 GHz BW
2 GHz BW

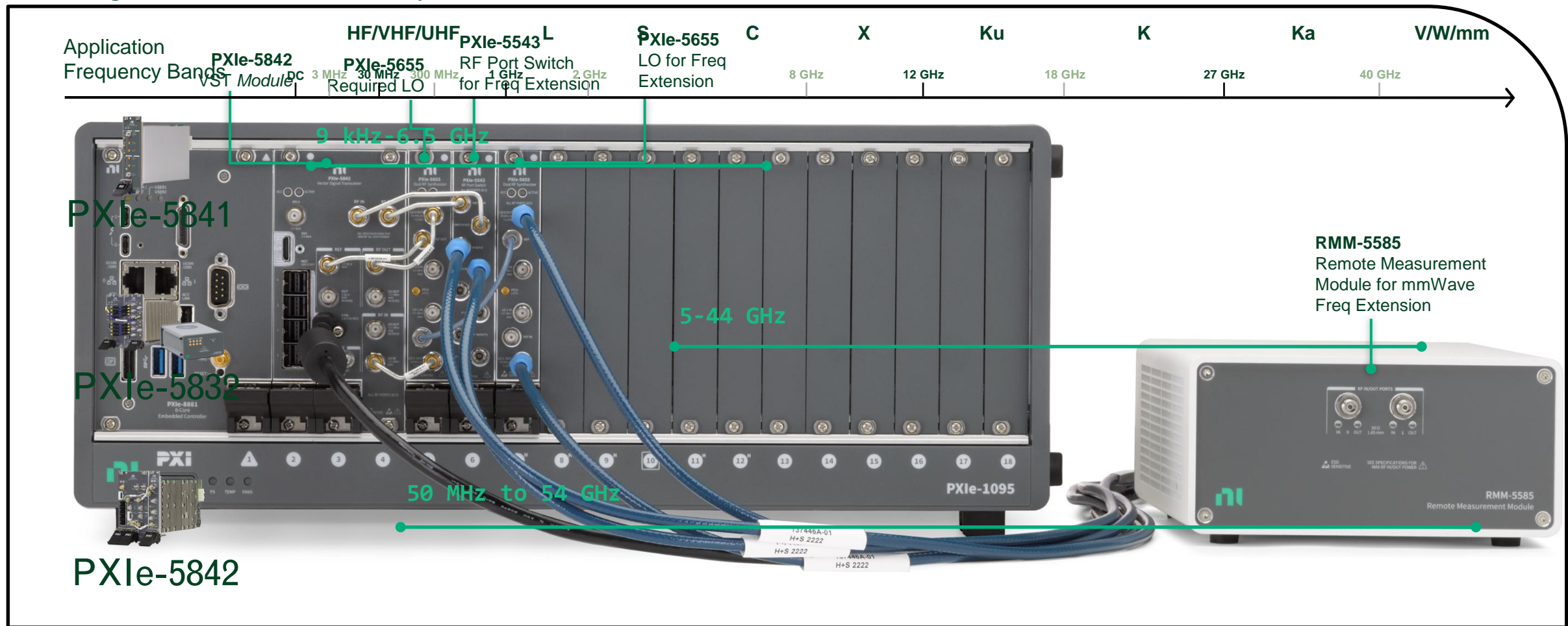
Choose Direction

Choose Frequency Range

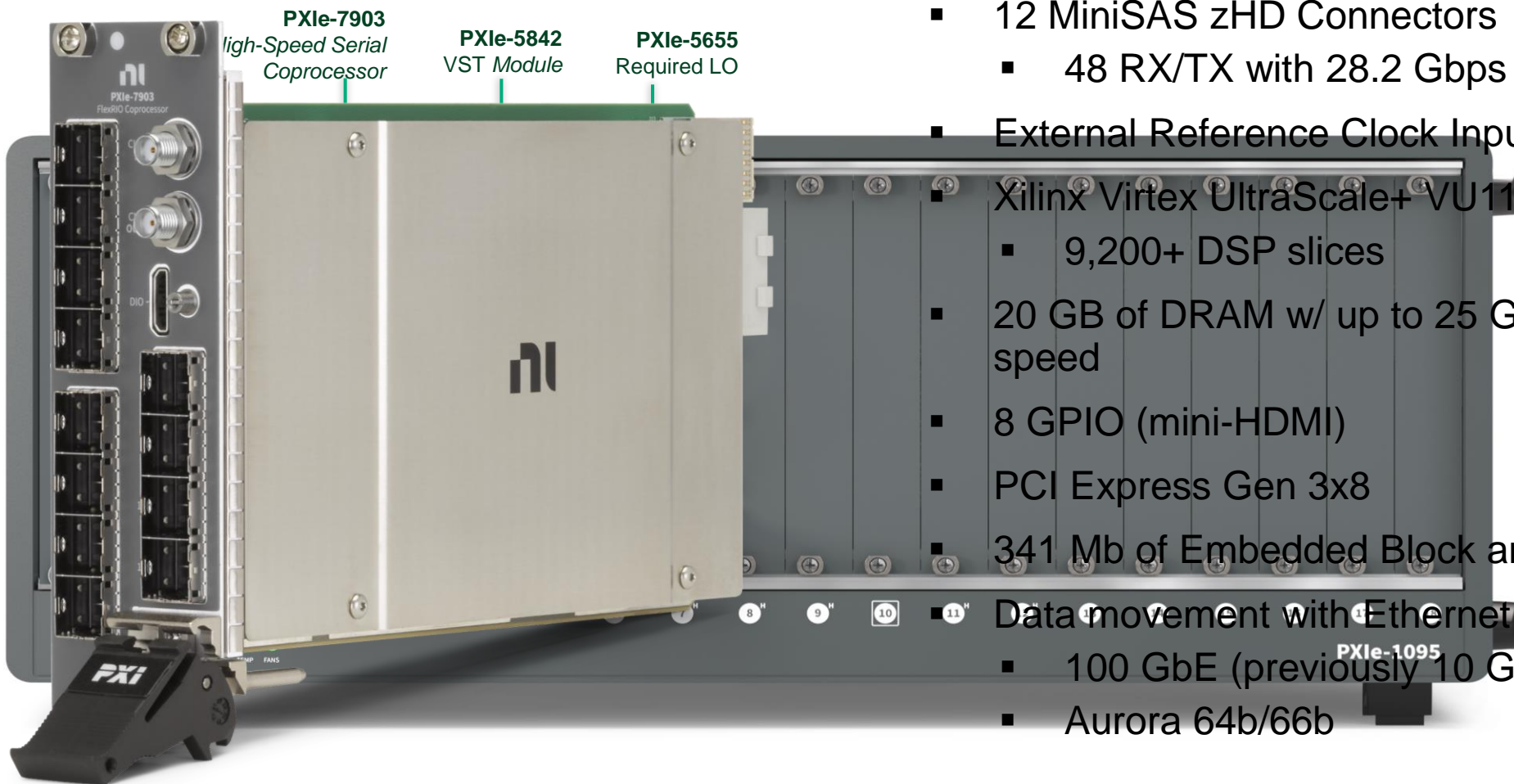
Choose Bandwidth

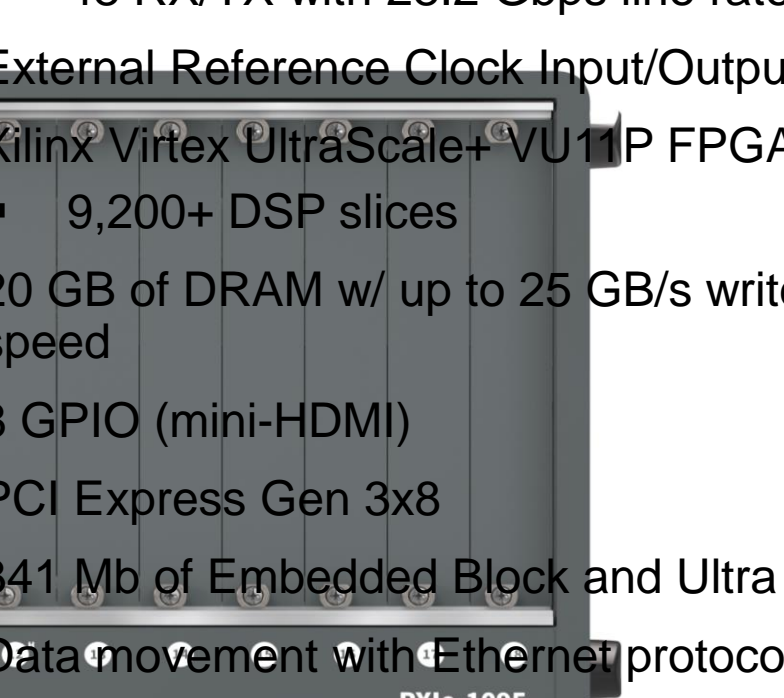
PXle-5842 | 54 GHz mmWave Frequency Extension

Vector Signal Transceiver Product Family

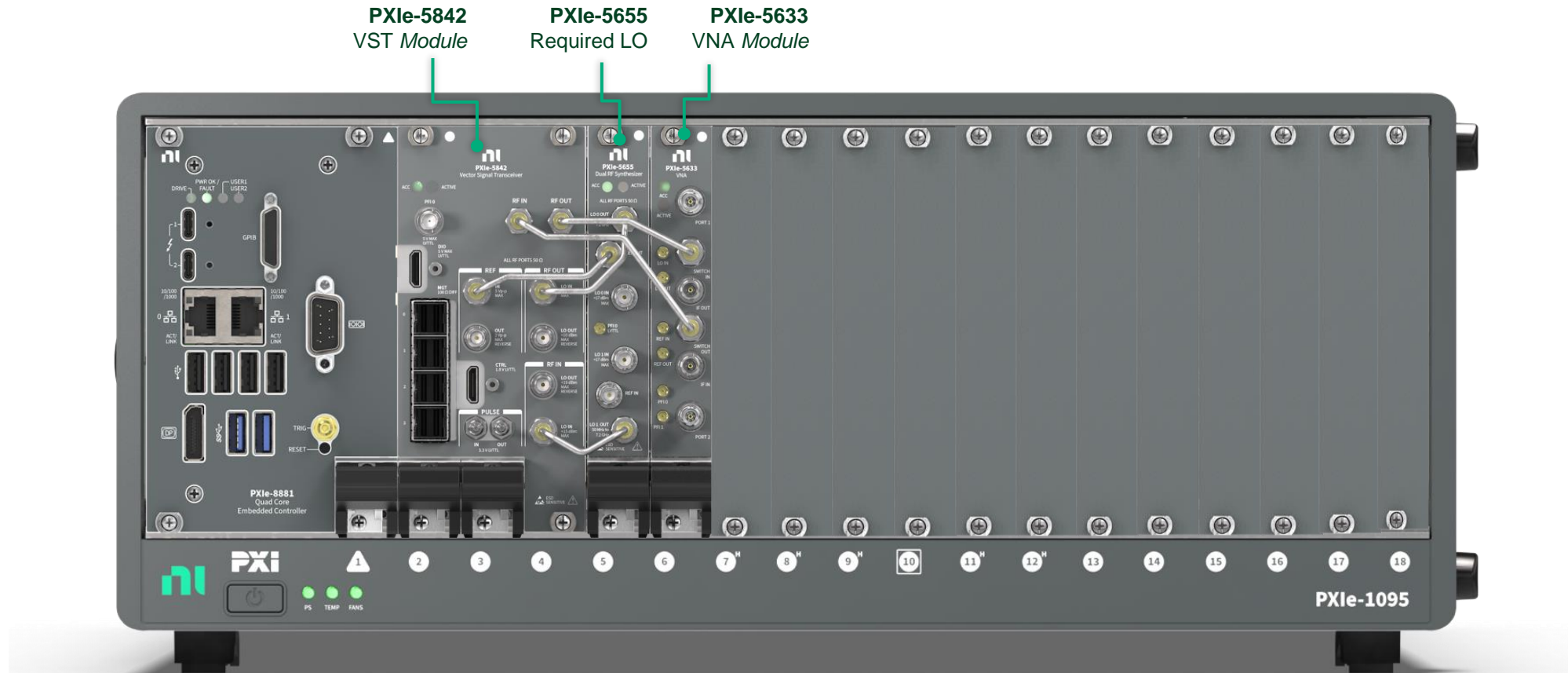


PXle-7903 | High-Speed Serial Coprocessor



- 
- 12 MiniSAS zHD Connectors
 - 48 RX/TX with 28.2 Gbps line rate
 - External Reference Clock Input/Output
 - Xilinx Virtex UltraScale+ VU11P FPGA
 - 9,200+ DSP slices
 - 20 GB of DRAM w/ up to 25 GB/s write speed
 - 8 GPIO (mini-HDMI)
 - PCI Express Gen 3x8
 - 341 Mb of Embedded Block and Ultra RAM
 - Data movement with Ethernet protocols
 - 100 GbE (previously 10 GbE was limit)
 - Aurora 64b/66b

PXIe-5633 | Adding S-parameters to the PXIe-5842



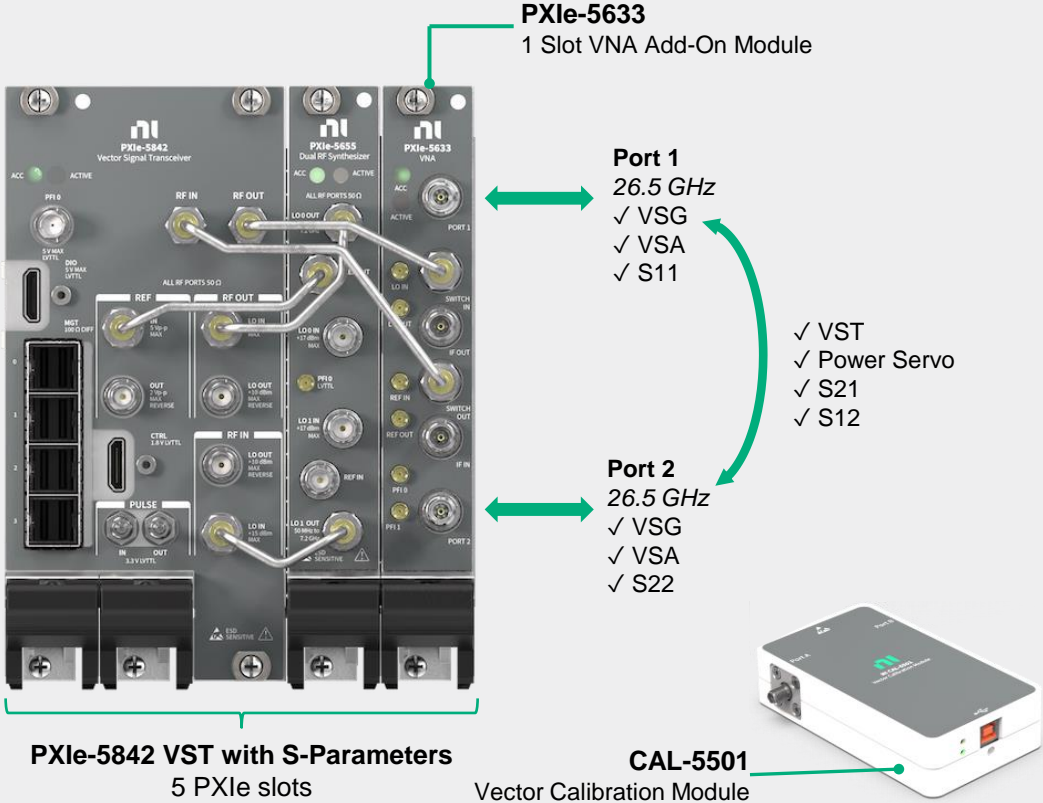
PXle-5633 Vector Network Analyzer

PXle-5633 Key Features

- 1 slot VNA add-on module to PXle-5842 VST
- 2 bidirectional RF Ports covering up to 26.5 GHz in VSG, VSA or VNA mode
- Combined VST+VNA simplifies large and small signal testing to one test insertion
- Software support with RFmx VNA and InstrumentStudio
- Vector Calibration Module for Automated SOLT calibration

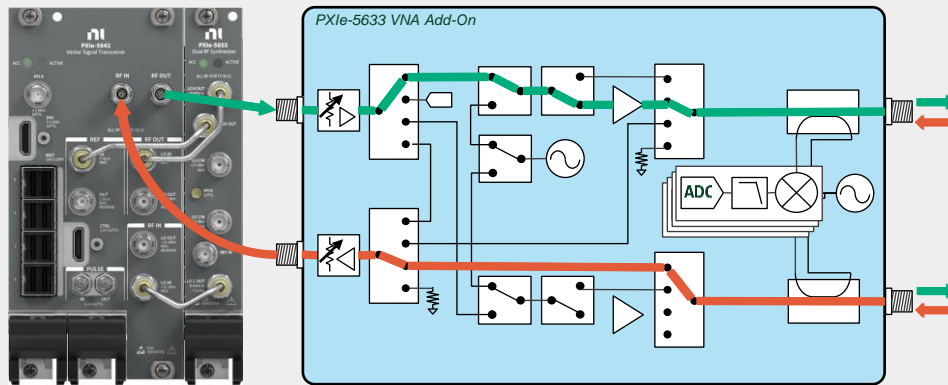
Parameter	Specification*	Parameter	Specification*
S-Parameters (2 ports)		Modulated (on either port)	
Frequency Range	50 MHz– 26.5 GHz	Frequency Range	30 MHz – 26.5 GHz
Dynamic Range	>134 dB (300 MHz – 22 GHz)	Bandwidth	Up to 2 GHz
Source Power	15 dBm (12 GHz)	RF In / Out Abs. Accuracy	±0.45 dB / ±0.7 dB (12 GHz, typ)
Directivity (Raw / Corrected)	> 13 dB, > 41 dB (12 GHz)	Max Unleveled TX Power	+22 dBm (12 GHz)
Measurement speed	< 100 µs per point	802.11ax EVM	Better than -53 dB

*Specifications subject to change



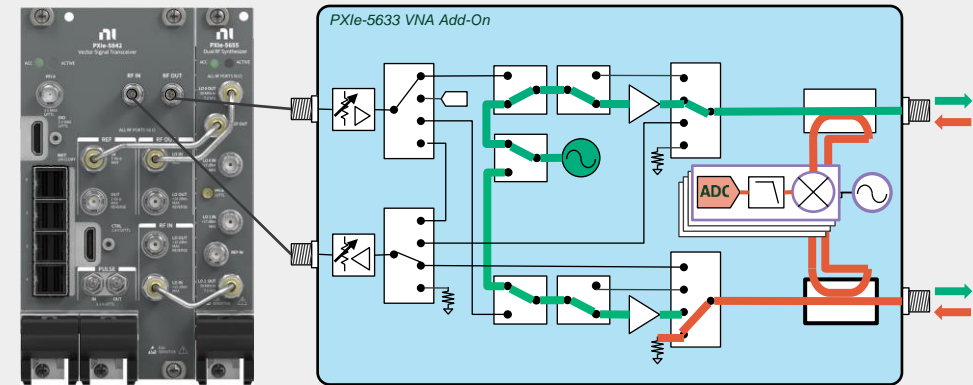
Single Port VSG, VSA, and S-parameter Testing

26.5 GHz VST and VNA Measurements On Common I/O Ports



VST Through VNA Mode

- Replicates PXIe-5842 Functionality (VSG and VSA) at PXIe-5633 ports
- Bi-directional ports: Source and measure on both ports
- Similar-to-VST performance with through path signal conditioning
- Behaves like a VST – driver abstraction and self-calibration

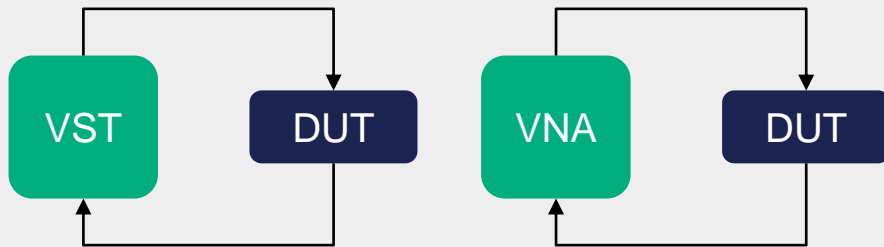


VNA Mode

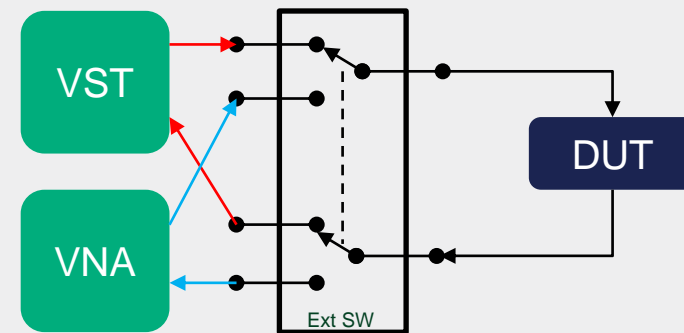
- Dedicated onboard synthesizers and receivers used for S-parameter testing
- Fully calibrated auto-reversing two port S-parameter measurements
- Excellent directivity, high dynamic range, and low source harmonics
- Ready for system-level integration

Benefits of PXIe-5842 VST + S-parameters

- S-parameters measurements are important in fully characterizing RF devices
- Most Vector Signal Transceiver customers need some S-parameter test capability
- Testing With Individual VST and VNA Instruments can be complex and problematic
 - Dual Insertion: Using expensive separate test stations to cover both VST and S-parameter tests
 - Single Insertion: Complex setup to externally switch the DUT between test instruments



Dual Insertion



Single Insertion

For More Information

What is a Vector Signal Transceiver?

- Visit ni.com/vst or scan the QR code below



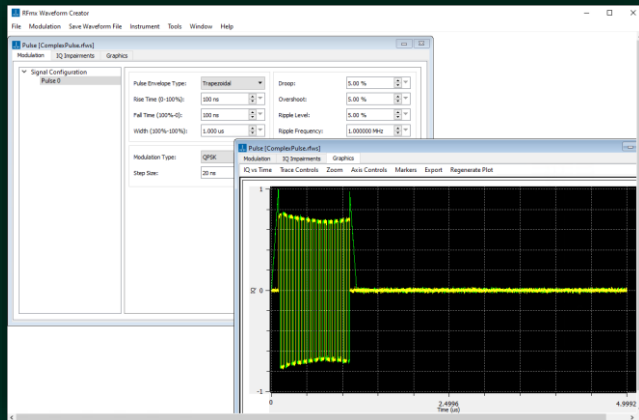
What is a Vector Network Analyzer?

- Visit ni.com/vna or scan the QR code below



Automate Signal Generation and Measurement

GENERATE



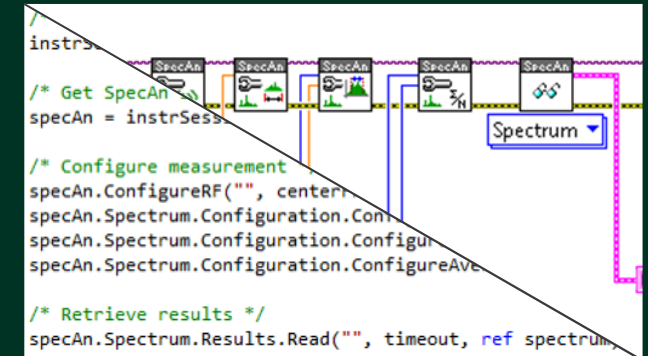
RFmx
Waveform Creator

MEASURE



RFmx
InstrumentStudio

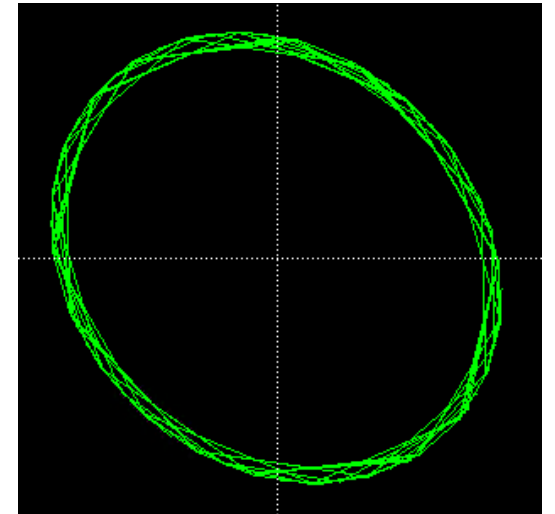
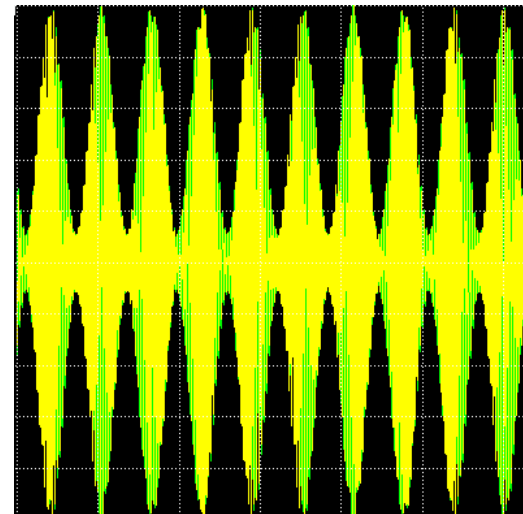
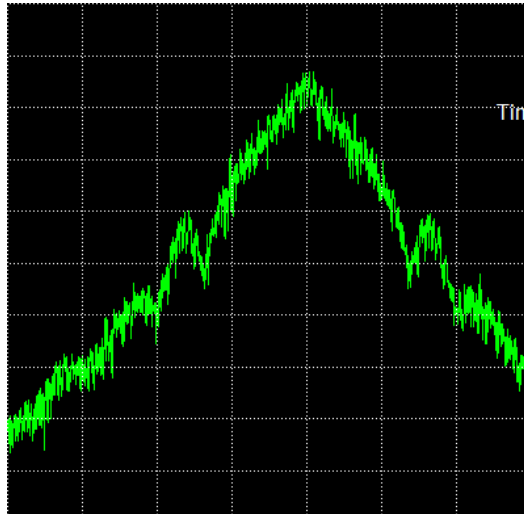
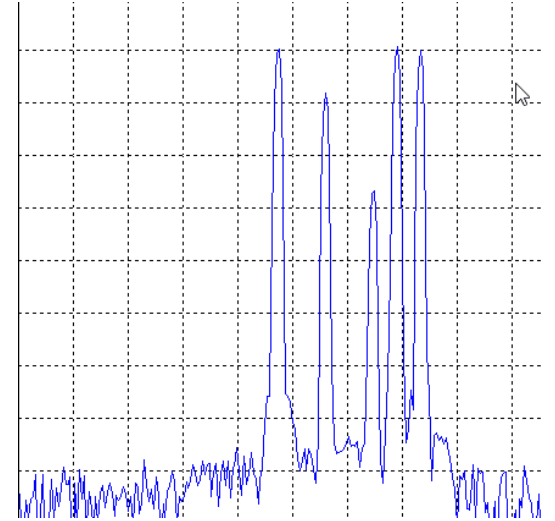
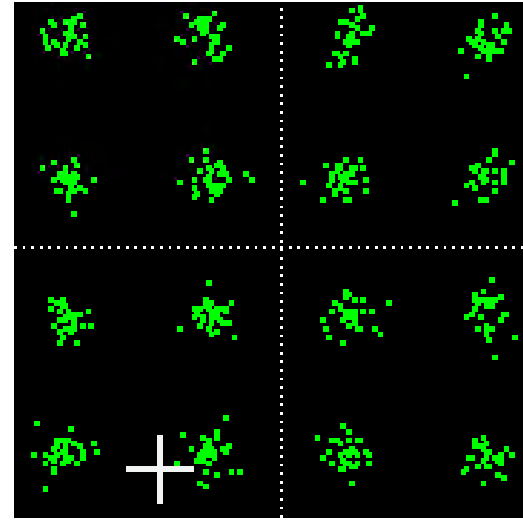
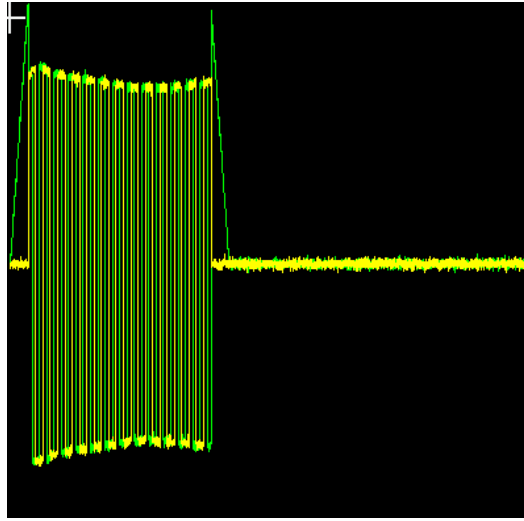
AUTOMATE



RFSG / RFmx API

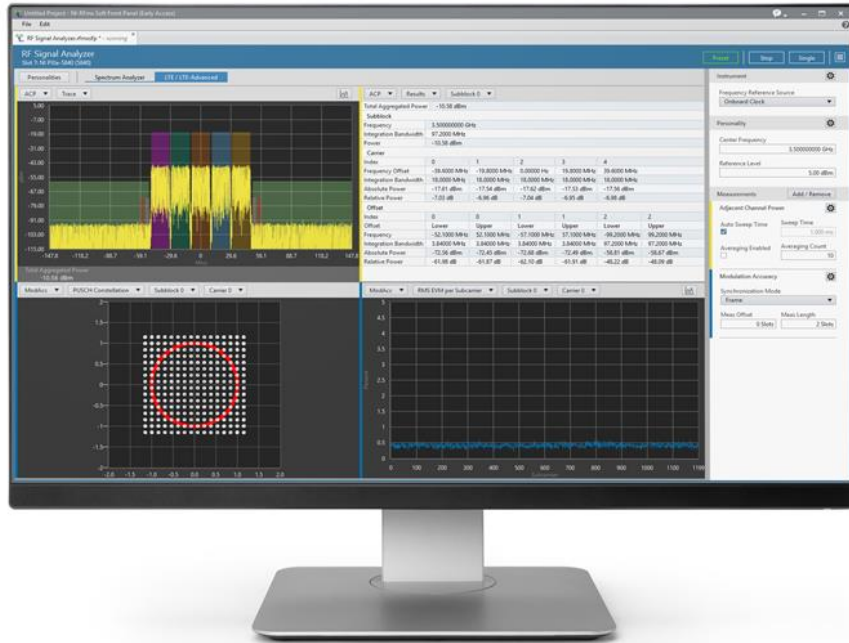
RFmx Waveform Creator

- Waveform file creation and integrated hardware generation in a single experience.
- User Data
- Custom Filters
- Standards
- Pulse
- Generic Modulation
 - QAM/FSK/etc.



RFmx

Signal generation and measurement for general-purpose, cellular, connectivity, and aerospace/defense test applications.



Comprehensive System—RFmx and NI PXI instrumentation, software and hardware connect for seamless signal generation and analysis.

General-Purpose—Gain insight into a wide range of general-purpose signals quickly and easily. Perform conventional spectrum analysis and interact with a variety of modulated signals.

Standard Compliant—Test multiple wireless standards for cellular, connectivity and IoT signals. Select the personality of RFmx for your specific application and testing needs.

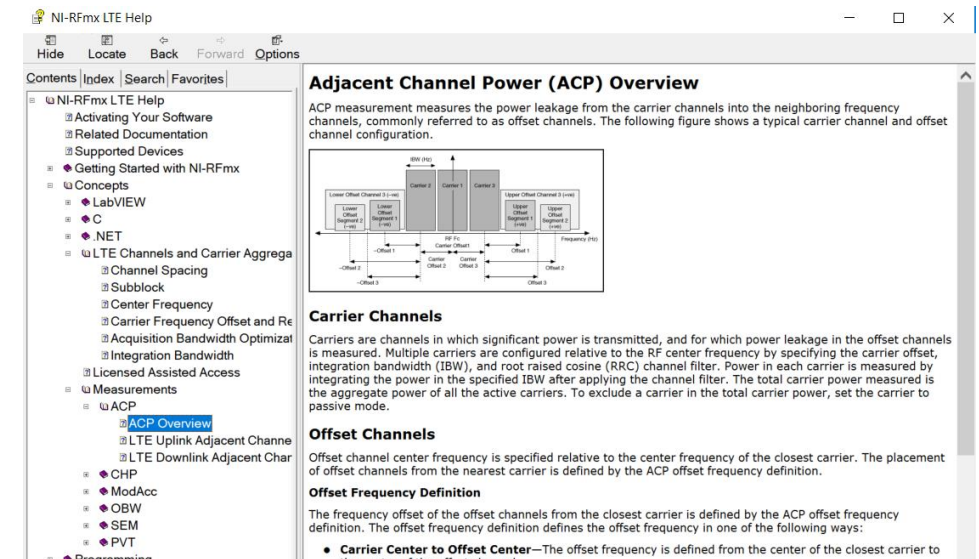
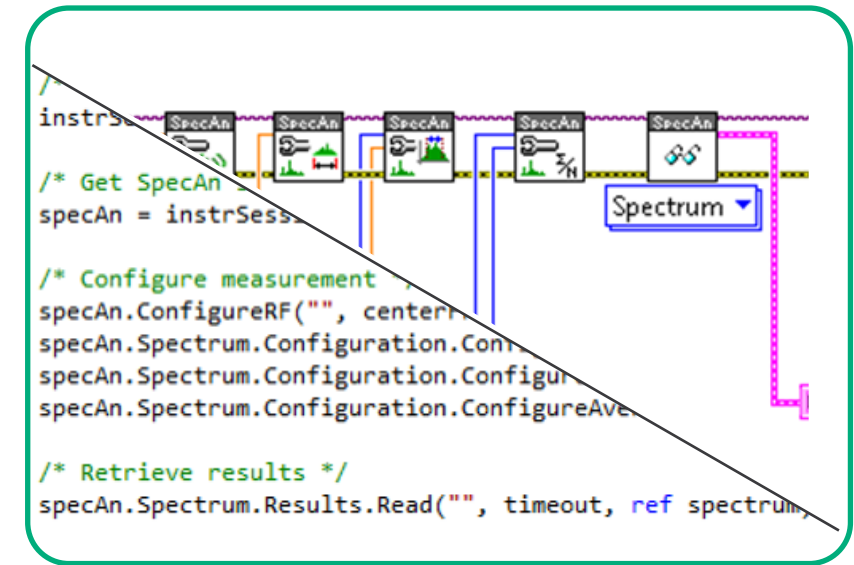
Quick Start—Begin measurement out-of-the-box with interactive soft front panels and with waveform creation software, generate and modify unlocked waveforms.

Accelerated Development—Start automation with provided programming examples for every measurement in LabVIEW and text-based languages.

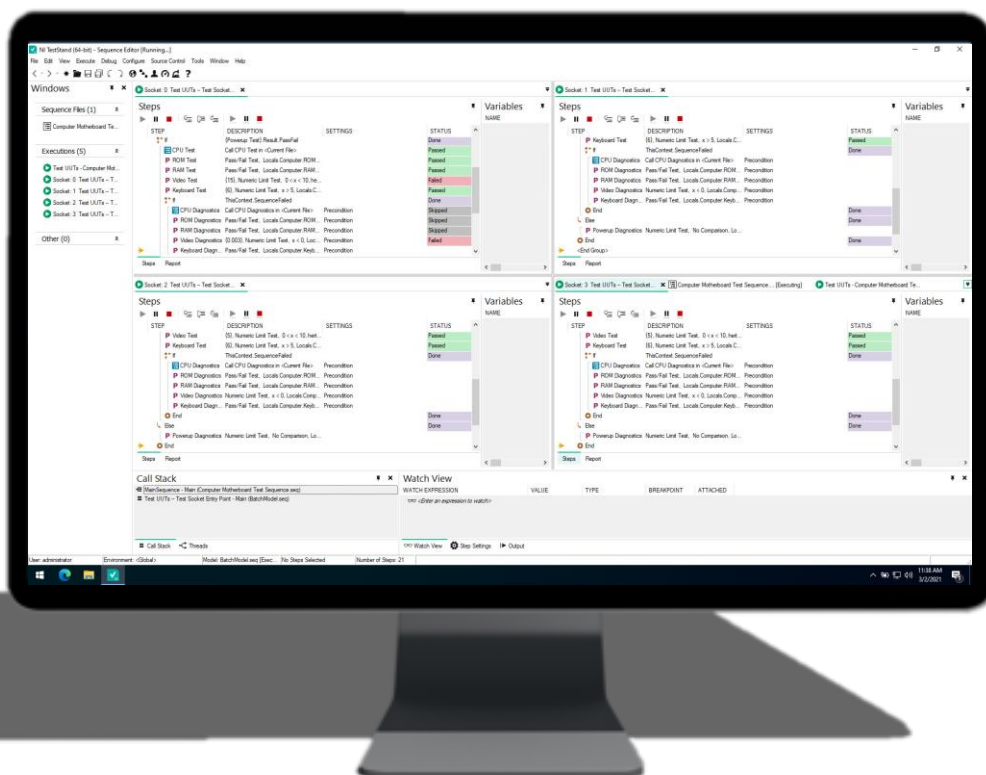
Faster Execution—Complete testing quicker by taking advantage of innate high-speed measurement algorithms and composite measurement functionality.

RFmx Automation API

- Program in LabVIEW, C/C++, and .NET and with included measurement examples
- Extensive help documentation for RFmx programming reference and understanding RF measurement concepts
- Single instrument session for multiple personalities use, meaning spectral, modulation measurements, and standard-specific measurements can be programmed efficiently
- Optimized for faster test times with composite measurement functionality and parallel measurement execution



Automate Your Testbed Using TestStand and the VST



Build a Framework for Standardization

Standardize the overall process and use lifecycle management to simplify maintenance overtime.



Automate Your System

Simplify complex task such as sweeping, looping, and synchronization for quicker testing.



Customize for Your Application

Develop in LabVIEW, Python, C/C++, or .NET. Create professional operator interfaces.



Decrease Cost and Speed Up Development Time

Increase throughput with parallel testing, report generation, and databases integration.

For More Information

What is RFmx?

- Visit ni.com/rfmx or scan the QR code below



Introduction to RFmx – Learning Path

- Visit ni.com/learn or scan the QR code below to learn more about generating and analyzing waveform in this 6 video lesson plan



Thank you for attending!

Q&A w/ R&D:

- Dylan Caswell – Principal Program Manager
- Andres Guillen – Principal Microwave Hardware Design Engineer
- Mark Hendricks – Principal Microwave Hardware Design Engineer