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PRODUCT FLYER

PXI Vector Signal Transceivers

CONTENTS

PXI Vector Signal Transceivers

PXIe-5831, PXIe-5830, PXIe-5841, PXIe-5820, PXIe-5655, PXIe-5646, PXIe-5645, and PXIe-5644

- Generate and acquire wide instantaneous bandwidth from baseband through RF in one instrument for test and measurement
- Ensure test coverage for new and legacy wireless standards, including 5G NR and all Wi-Fi bands
- Stream high-speed data to and from the instrument through front panel Digital I/O
- Achieve better than -50dB EVM performance for higher order modulation schemes, such as Wi-Fi 6
- Synchronize multiple VSTs with phase-coherent generation and acquisition for true MIMO applications.
- Utilize I/Q baseband signals for wideband testing and envelope tracking applications
- Get maximum test speed and customization with access to onboard FPGA
- Take advantage of easy to use software with soft front panels for interactive control and extensive measurement API for rapid test automation

Built for RF Automated Test and Measurement

The PXI Vector Signal Transceiver (VST) combines a vector signal analyzer and vector signal generator with a user-programmable FPGA and high-speed serial and parallel digital interfaces for real-time signal processing and control. With up to 1 GHz of instantaneous RF or complex I/Q bandwidth, the NI VST is ideally suited for a wide range of applications including RFIC validation and production testing, radar prototyping, and other RF wideband test scenarios.

The VST product line provides the high performance necessary to support lab design and validation applications and incorporates the fast measurement speed and small form factor required to scale to production test applications. You can use VST instruments throughout the design cycle from design, to validation, to production test – minimizing measurement correlation errors and improving efficiency with

test software reuse. The VST can be used to test a variety of cellular and wireless standards including 5G NR, Wi-Fi 6, and Bluetooth. The modular PXI platform allows users to configure systems with multiple VSTs in order to support multiple input, multiple output (MIMO) applications, and simplifies synchronization between instruments thanks to shared timing and synchronization resources in the PXI chassis.

The software that supports the VST provides several layers of functionality:

- soft front panels for fast, interactive instrument configuration and measurement execution
- measurement-focused APIs that abstract complex RF measurement science into a few function calls
- a suite of ready-to-run automation examples that provide a foundation for building cohesive automated test and measurement applications.

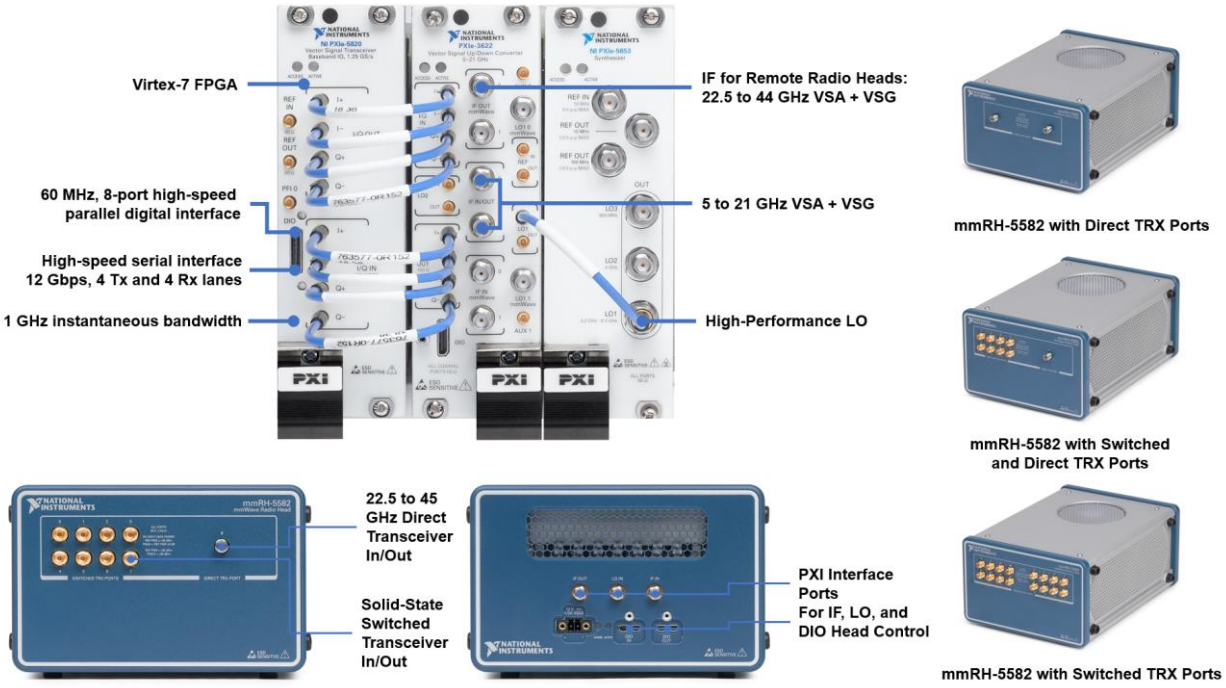
For advanced processing and control applications, users can access the built-in FPGA using LabVIEW FPGA software that includes application IP, reference designs, and examples.

Table 1. NI offers VSTs up to 1GHz instanteous bandwidth and 44 GHz center frequency

	2nd Generation VST			1st Generation VST	
	PXIe-5831	PXIe-5841 w/ PXIe-5655 LO	PXI-5820	PXIe-5646	PXIe-5644
Frequency Range	5 GHz to 21 GHz 22.5 GHz to 44 GHz	9 kHz to 6 GHz	DC to 500 MHz	65 MHz to 6 GHz	
Instantaneous Bandwidth	1 GHz	1 GHz	1 GHz complex I/Q	200 MHz	80 MHz
RF Channels	Up to 32 In/Out (switched)	1 In 1 Out	1 In, 1 Out Baseband IQ (100 Ω diff)	1 In 1 Out	
EVM (Wi-Fi 6 80 MHz, loopback)	≤ -50 dB	-50 dB	-54 dB	-48 dB	
EVM (5G NR 100MHz, loopback)	0.65 % @ 28 GHz	< 0.35 % @ 3.5 GHz	N/A		
VSG Maximum Output Power (CW @ 1 GHz)	+15 dBm @ 6-10 GHz +15 dBm @ 28 GHz	≥ +20 dBm	N/A	+13 dBm	
Tuning Time	see specifications	175 µs	N/A	950 µs	
Slots	4 to 6	2 to 3	2	3	
Supports mmWave Test Heads	Yes	No	No	No	
Digital I/O	8 channels at 60 MHz, 4 channels high-speed serial up to 12 Gbps			24 channels at 125 MHz	

Note: This table provides an overview of NI's VST Line; refer to the Product Specifications for more information.

Detailed View of PXIe-5831 Vector Signal Transceiver with Optional mmWave Radio Heads



Detailed View of PXIe-5841 Vector Signal Transceiver

Key Features

Instantaneous Bandwidth for Wideband Applications

From next-generation wireless technologies like Wi-Fi 6 and 5G NR, to advanced aerospace/defense applications like radar test and spectrum monitoring, there is a demand for wider signal bandwidth to achieve higher peak data rates. Leveraging fast sampling, high-linearity DACs and ADCs, and wide-band internal calibration mechanisms, the VST offers 80 MHz, 200 MHz or 1 GHz of instantaneous RF and complex I/Q bandwidth with excellent measurement accuracy.

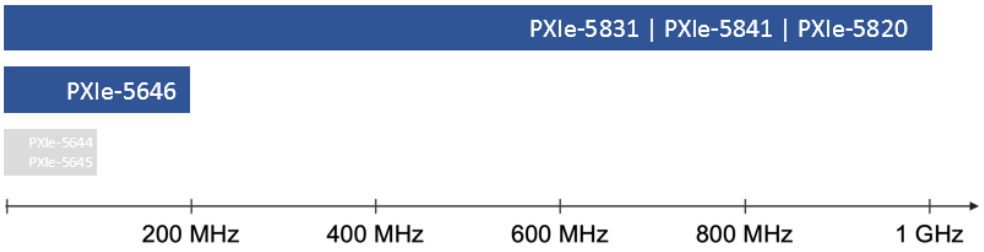


Figure 1. Instantaneous RF bandwidth of the NI VST Models

Wider bandwidth introduces the need for advanced signal processing at higher throughputs, and the VST addresses this requirement by offering FPGA-based signal processing for applications such as radar target simulation, multi-carrier aggregation, digital pre-distortion algorithm implementations, and real-time spectrum analysis. Additionally, the VST incorporates patented algorithms for amplitude and phase correction for high absolute amplitude accuracy and low deviation from linear phase across the span of their wide instantaneous bandwidth.

Baseband I/Q Functionality

For engineers that require high bandwidth analog baseband signals, the PXIe-5820 and PXIe-5645 VSTs combine a wideband I/Q digitizer and arbitrary waveform generator into a single two-slot PXI Express module. The PXIe-5820 offers up to 1 GHz real time baseband complex I/Q generation and analysis and supports programmable common mode ranging and voltage swing. The combination of high linearity, low phase noise, and patented IQ calibration techniques enables the PXIe-5820 to achieve better than -54 dB EVM performance with higher-order modulation schemes such as Wi-Fi 6 1024 QAM.

Additionally, engineers can synchronize the baseband VST with the RF VST to create a unified testbench for complex envelope tracking applications.

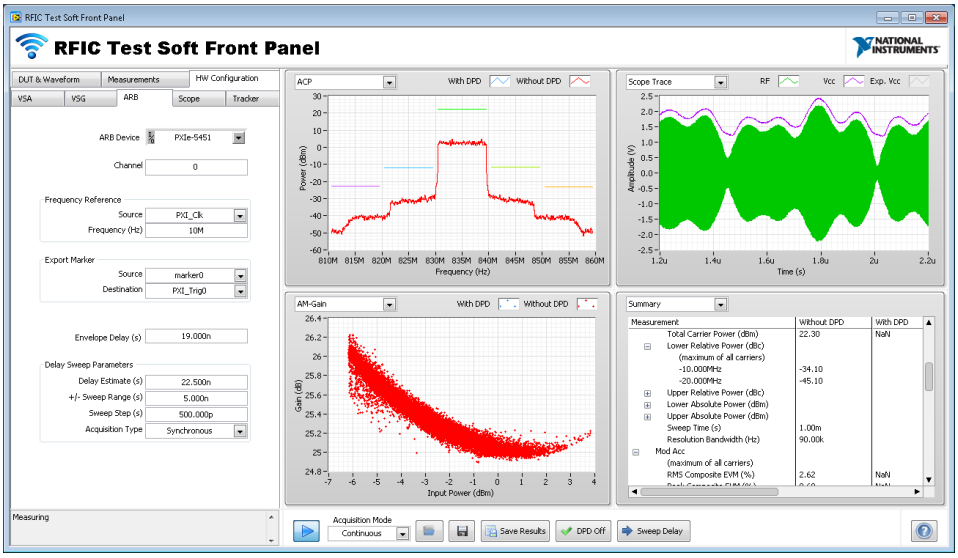


Figure 2. RFIC Test Software to perform envelope tracking and digital predistortion using the NI PXIe-5820, baseband VST in tight-synchronization with the NI PXIe-5841, RF VST

EVM Measurement Performance

The VST uses advanced, patented IQ calibration techniques to deliver best-in-class EVM performance for wideband signals. With higher order modulation schemes and wideband multicarrier signal configurations, the RF front ends of today's wireless devices require better linearity and lower phase noise. To measure complex and demanding modulation schemes, NI's RF test instrumentation provides even more accurate and reliable performance.

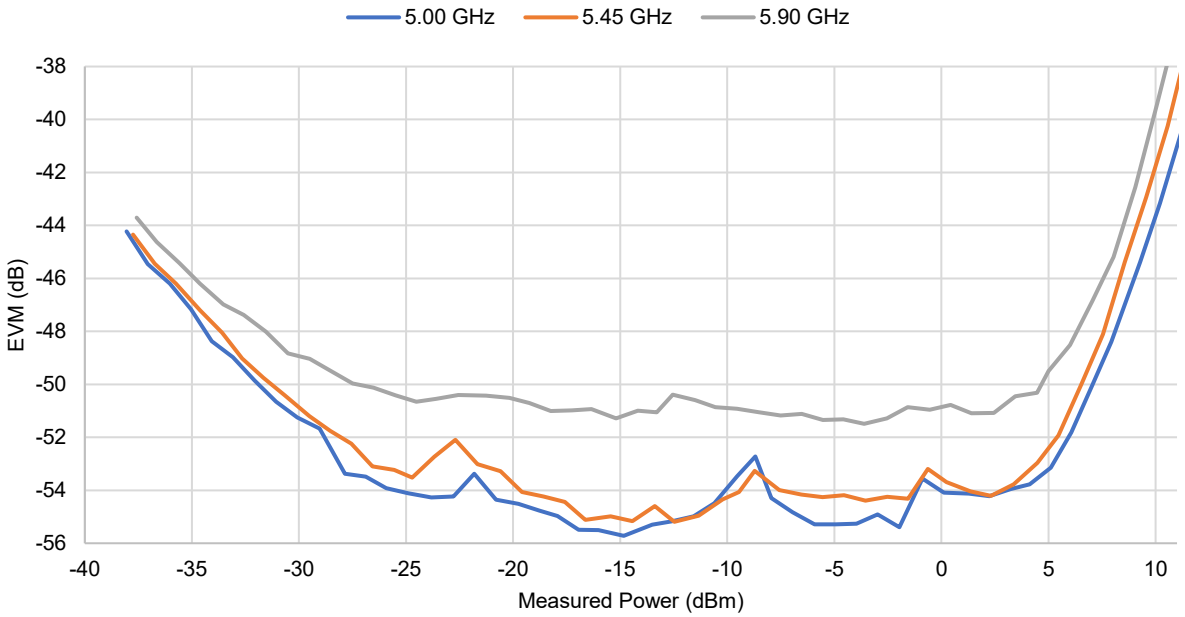


Figure 3. Wi-Fi 6 80 MHZ EVM performance 1024 QAM (w/ 5841 Loopback) External LO, Noise Correction Enabled

Engineers can push the EVM performance of the VST even lower by pairing it with a PXI Local Oscillator. Systems based on the second-generation VST (PXIe-5820, PXIe-5841, PXIe-5831) can achieve EVM performance better than -50 dB for high order modulation applications, such as Wi-Fi 6 and 5G New Radio as shown in Figure 3.

Modular and Easily Synchronized

Engineers are employing Multiple Input Multiple Output (MIMO) systems in a wide range of electronic warfare and radar applications ranging from phased array radars to beamforming and direction-finding systems. Modern communications standards like Wi-Fi 6 and 5G NR also use MIMO schemes with multiple RF chains on a single device to provide a combination of higher data rates through more spatial streams and more robust communications through beamforming.

NI enables engineers to achieve phase coherent generation and analysis for 2, 4, 8 or more VSTs to support other advanced test configurations.

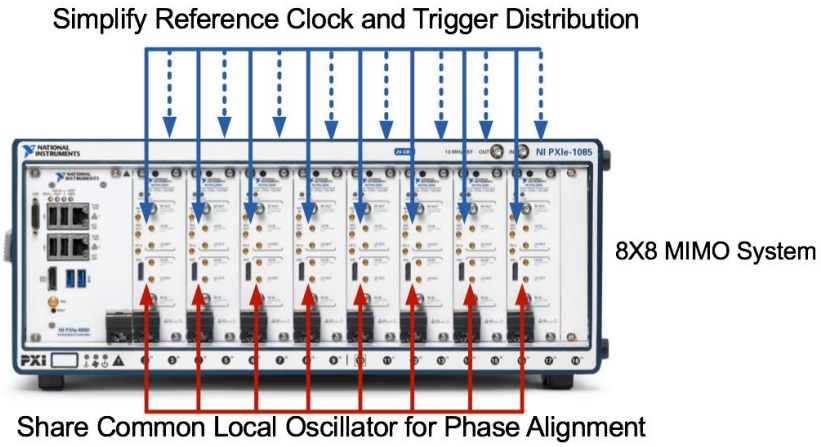


Figure 4. Typical 8x8 MIMO system with eight PXIe-5841 VSTs

Reduced Tuning Time

With a typical LO tuning time below 175µS, the PXIe-5841 with PXIe-5655 Local Oscillator can support applications that require very low latency frequency hopping common to Aerospace and Defense applications. These applications include radar target simulation, and spectrum monitoring in electronic warfare, key parametric measurements for TR module test of AESA radar. Additionally, this enhancement will reduce test time by reducing individual measurement times.

Flexible Digital Interface

The VST features a flexible digital interface capable of both high-speed parallel and serial communication. In PXIe-5644/45/46, the digital I/O buffers are connected directly to the FPGA, allowing the functionality of the individual digital I/O signals to be programmed for custom applications using LabVIEW FPGA. In PXIe-5840/41 the digital lines are directly connected to a user-programmable FPGA through level shifting buffers. The digital lines exposed on the front panel support various standard voltage levels.

The high-speed serial interface features four multi-gigabit transceivers (MGTs) that operate at data rates of up to 12 Gb/s per lane and support high-speed serial standards such as Xilinx Aurora and Serial RapidIO. Users can stream full bandwidth I/Q data out of the front panel to external signal processing

modules. Thus, engineers have two data streaming options: the front panel connector or the PCI Express backplane.

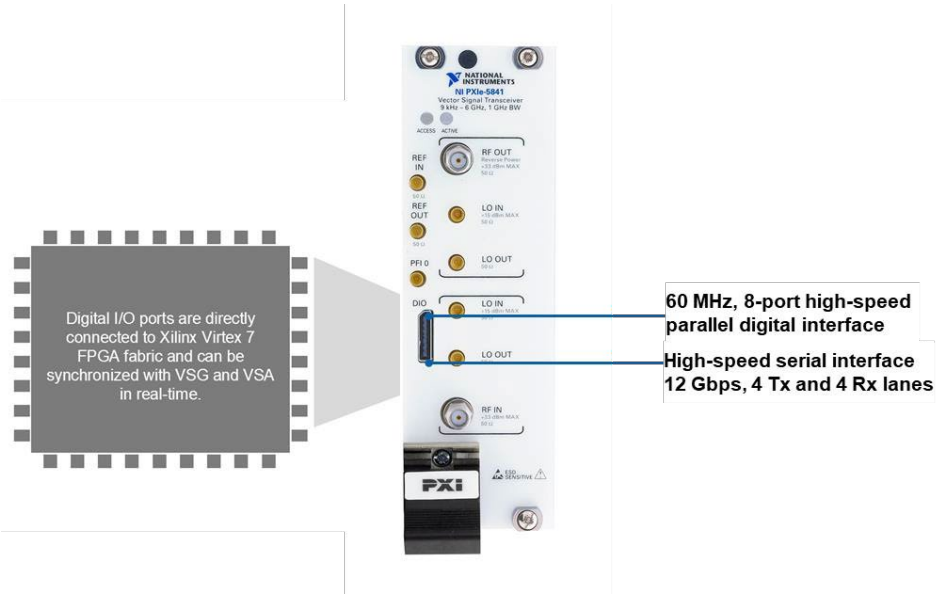


Figure 5. Digital interfacing ports on the PXIe-5841 front panel

Wide Frequency Range

VSTs offer a broad frequency coverage from 9 kHz to 44 GHz (center frequency). NI provides a full suite of software for spectral and wireless standards measurements to test a wide range of wireless technologies like Wi-Fi 6 and 5G New Radio, even as they expand to higher bands. mmWave signal chains demand coverage for test points at both intermediate frequencies and at mmWave. NI's PXIe-5831 VST covers these new frequency requirements in a single, integrated instrument, with support for interactive measurements and test automation fully defined by software.

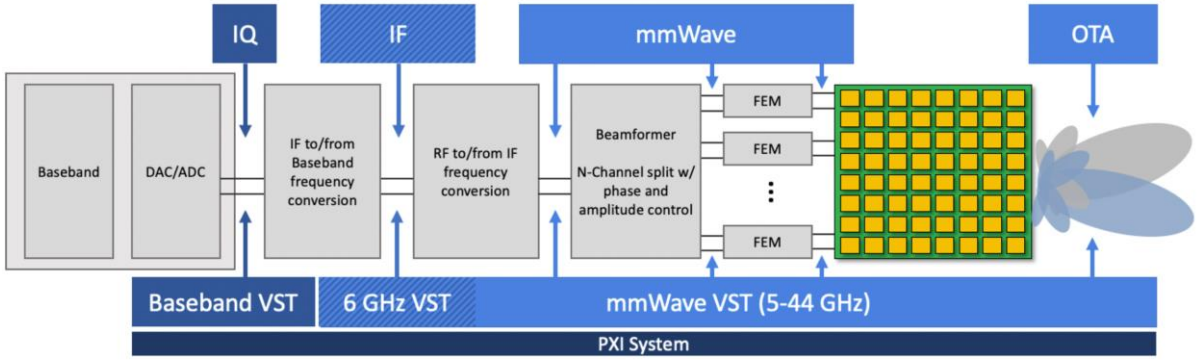


Figure 6. Modern RF Signal Chain with Test Points from Baseband to mmWave Over-the-Air

Connected Software

RFmx

RFmx is a set of interoperable measurement personalities together with waveform creation software that extends the capability of NI RF instrumentation for general-purpose, connectivity, cellular, and aerospace/defense test applications. Using RFmx, you can perform and debug measurements quickly and easily with interactive software front panels, create and playback open, unlocked waveforms with RFmx Waveform Creator, and speed up automated testing with the performance-optimized API.

Using RFmx with NI VST, you can achieve excellent RF performance with ultrafast measurement speeds, enabling you to create test systems that span your entire product life cycle from design validation to production test.

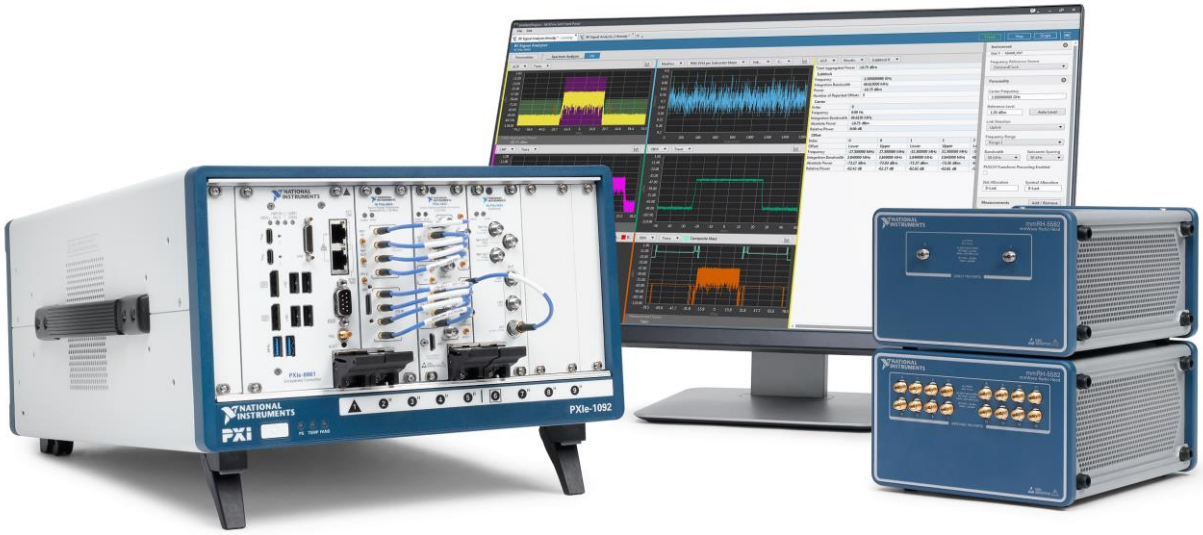


Figure 7. Use RFmx soft front panels for interactive measurement and debugging of complex RF signals.

Customizable with FPGA Extensions

For advanced users that need customization of fast measurements and algorithm execution with a calibrated RF front end, the open FPGA onboard the VSTs allows measurement acceleration, closed-loop testing, and real-time algorithm prototyping. Engineers will benefit from application-specific FPGA IP running on Xilinx Virtex-7 or Virtex-6 FPGAs. This IP includes real-time channelizers, wideband RF record and playback, real-time spectrum analysis, power servoing (leveling), real-time digital predistortion, channel emulation, and radar target simulation.

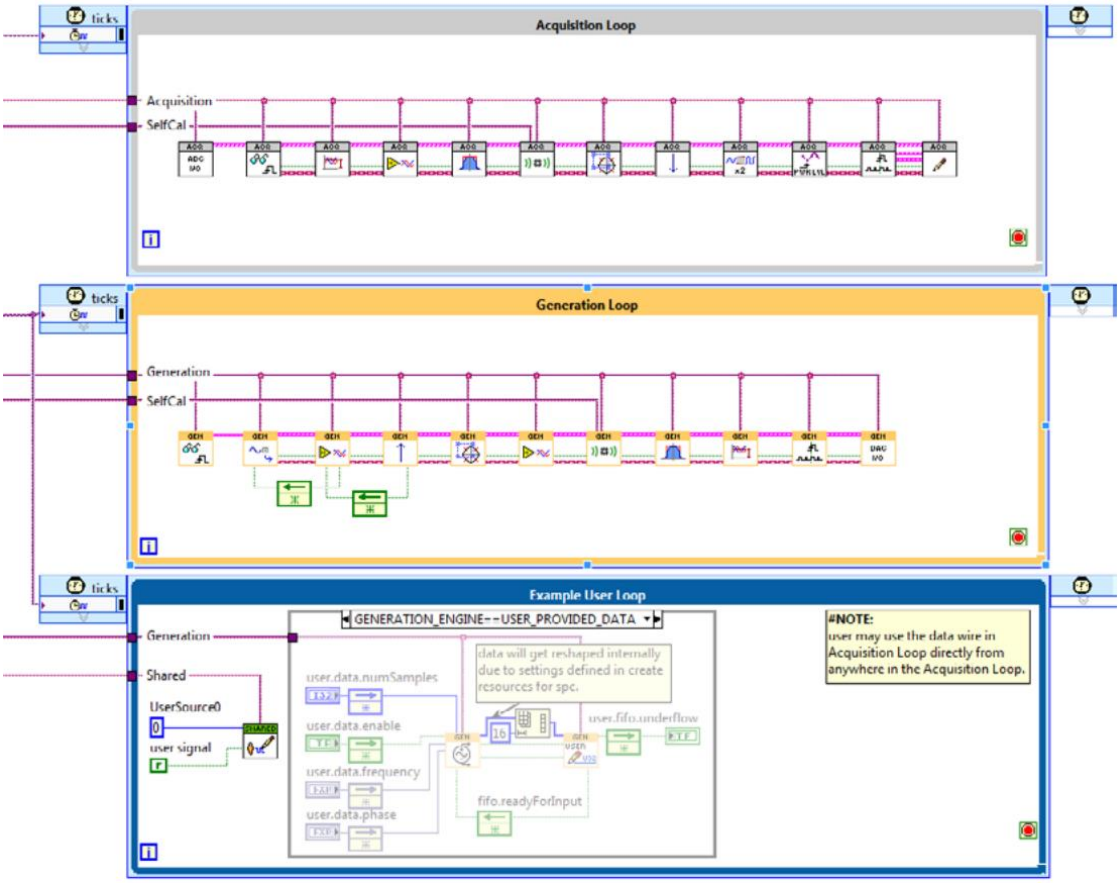


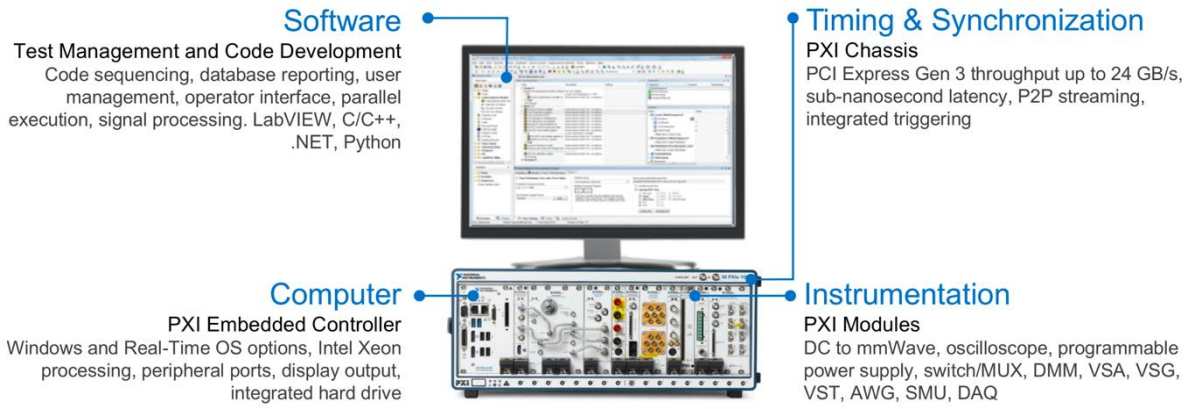
Figure 9. Channel power measurement in RFmx using LabVIEW FPGA

In Figure 9, the LabVIEW FPGA diagram is divided into three Timed Loops. The first loop controls acquisition loop and the second loop handles signal generation. The third loop, referred to as the Example User Loop, is explicitly designed for user customization. Typical IP for the user loop could be digital control, input-to-output signal processing, or closed-loop control.

Platform Approach to Test and Measurement

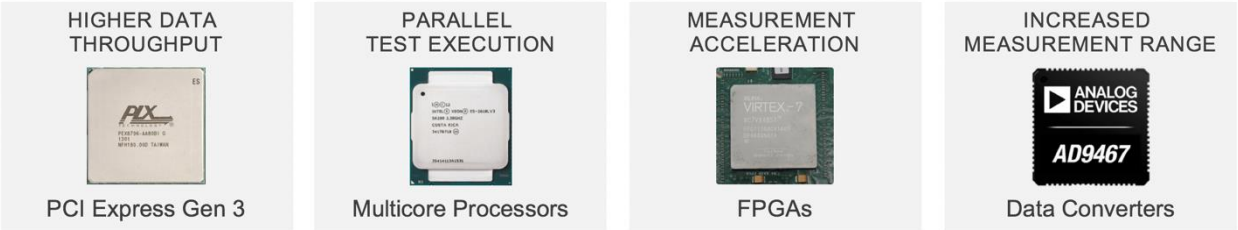
What Is PXI?

Powered by software, PXI is a rugged PC-based platform for measurement and automation systems. PXI combines PCI electrical-bus features with the modular, Eurocard packaging of CompactPCI and then adds specialized synchronization buses and key software features. PXI is both a high-performance and low-cost deployment platform for applications such as manufacturing test, military and aerospace, machine monitoring, automotive, and industrial test. Developed in 1997 and launched in 1998, PXI is an open industry standard governed by the PXI Systems Alliance (PXISA), a group of more than 70 companies chartered to promote the PXI standard, ensure interoperability, and maintain the PXI specification.



Integrating the Latest Commercial Technology

By leveraging the latest commercial technology for our products, we can continually deliver high-performance and high-quality products to our users at a competitive price. The latest PCI Express Gen 3 switches deliver higher data throughput, the latest Intel multicore processors facilitate faster and more efficient parallel (multisite) testing, the latest FPGAs from Xilinx help to push signal processing algorithms to the edge to accelerate measurements, and the latest data converters from TI and ADI continually increase the measurement range and performance of our instrumentation.



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PXI Instrumentation

NI offers more than 600 different PXI modules ranging from DC to mmWave. Because PXI is an open industry standard, nearly 1,500 products are available from more than 70 different instrument vendors. With standard processing and control functions designated to a controller, PXI instruments need to contain only the actual instrumentation circuitry, which provides effective performance in a small footprint. Combined with a chassis and controller, PXI systems feature high-throughput data movement using PCI Express bus interfaces and sub-nanosecond synchronization with integrated timing and triggering.

Oscilloscopes
Sample at speeds up to 12.5 GS/s with 5 GHz of analog bandwidth, featuring numerous triggering modes and deep onboard memory

Digital Multimeters
Perform voltage (up to 1000 V), current (up to 3A), resistance, inductance, capacitance, and frequency/period measurements, as well as diode tests

Digital Instruments
Perform characterization and production test of semiconductor devices with timing sets and per channel pin parametric measurement unit (PPMU)

Waveform Generators
Generate standard functions including sine, square, triangle, and ramp as well as user-defined, arbitrary waveforms

Frequency Counters
Perform counter timer tasks such as event counting and encoder position, period, pulse, and frequency measurements

Source Measure Units
Combine high-precision source and measure capability with high channel density, deterministic hardware sequencing, and SourceAdapt transient optimization

Power Supplies & Loads
Supply programmable DC power, with some modules including isolated channels, output disconnect functionality, and remote sense

FlexRIO Custom Instruments & Processing
Provide high-performance I/O and powerful FPGAs for applications that require more than standard instruments can offer

Switches (Matrix & MUX)
Feature a variety of relay types and row/column configurations to simplify wiring in automated test systems

Vector Signal Transceivers
Combine a vector signal generator and vector signal analyzer with FPGA-based, real-time signal processing and control

GPIB, Serial, & Ethernet
Integrate non-PXI instruments into a PXI system through various instrument control interfaces

Data Acquisition Modules
Provide a mix of analog I/O, digital I/O, counter/timer, and trigger functionality for measuring electrical or physical phenomena