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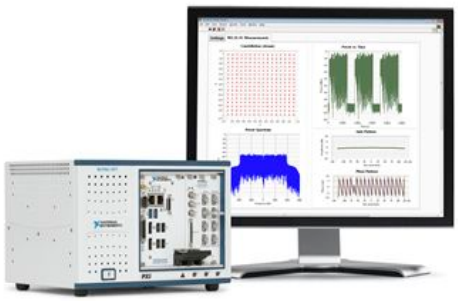
NI PXIe-5644R

6 GHz RF Vector Signal Transceiver



- Vector signal analyzer and generator in a single PXI module
- 65 MHz to 6 GHz frequency range
- 80 MHz instantaneous bandwidth
- 24 channels of high-speed digital I/O up to 250 Mbit/s
- Built on FPGA technology programmable with NI LabVIEW software
- Industry-leading performance and test times for testing the latest wireless standards such as 802.11ac
- Easily expands to support multiple input, multiple output (MIMO) configurations or parallel testing in a single PXI chassis

Overview

Composed of a vector signal generator, a vector signal analyzer, and digital I/O, the NI PXIe-5644R RF vector signal transceiver (VST) combines multiple instruments into a single 3-slot PXI Express module. Backed by software to support the latest RF standards, including 802.11ac, the NI PXIe-5644R features the performance and flexibility of an R&D-grade box instrument with the speed, low cost, and small form factor of a manufacturing test system. In addition, the NI PXIe-5644R has a user-programmable FPGA at its core, making it the world's first software-designed instrument. This allows users to customize the firmware of their instrument down to the pin.

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Application and Technology

A vector signal transceiver (VST) is a new class of instrumentation that combines a vector signal generator (VSG) and a vector signal analyzer (VSA) with FPGA-based real-time signal processing and control. The world's first VST from National Instruments also features a user-programmable FPGA, so you can implement custom algorithms directly into the hardware design of the instrument. This software-designed approach gives VST the flexibility of a software defined radio (SDR) architecture with RF instrument class performance. Figure 1 shows the difference between traditional approaches to RF instrumentation and a software-designed approach with a VST.

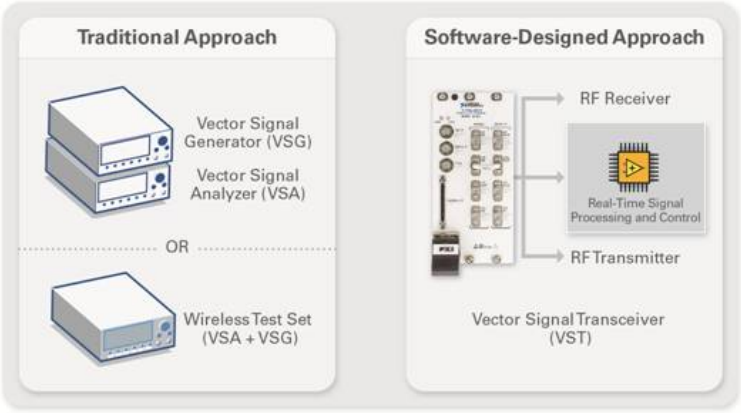

Figure 1. *Compare the software-designed approach of a VST with traditional approaches.*

RF Receiver

The NI PXIe-5644R features a zero-IF receiver to offer higher potential bandwidths, lower cost, less power consumption, and a smaller footprint when compared to heterodyne receivers. Other advantages include simpler designs with single local oscillators (LOs) as well as high selectivity, which allows the separation of adjacent channels whose signals overlap. Table 1 compares the RF receiver on the NI PXIe-5644R with existing NI vector signal analyzers.

	NI PXIe-5661	NI PXIe-5663E	NI PXIe-5644R	NI PXIe-5665	Phase Matrix
Frequency Range	9 kHz to 2.7 GHz	10 MHz to 6.6 GHz	65 MHz to 6 GHz	20 Hz to 3.6 GHz/ 14 GHz	Up to 26.5 GHz
Bandwidth	20 MHz	-50 MHz	80 MHz	25 MHz or 50 MHz	350 MHz
Phase Noise (10 kHz offset) at 1 GHz	-90 dBc/Hz	-105 dBc/Hz	-112 dBc/Hz	-129 dBc/Hz*	-118 dBc/Hz
Absolute Amplitude Accuracy	±0.6 dB	±0.65 dB	± 0.35 dB to ± 0.55 dB	± 0.1 dB	± 1.5 dB
Average Noise Floor	-122 dBm/Hz	-158 dBm/Hz	-161 dBm/Hz	-165 dBm/Hz	-162 dBm/Hz
Architecture	Multi Stage	Single Stage	Zero-IF	Multi Stage	Multi Stage
List Mode	No	Yes	Yes	Yes	No
Peer to Peer Streaming	No	Yes	Yes	Yes	Yes

[1]NI 5665 phase noise is measured at 800 MHz

Table 1. *Comparison of NI Vector Signal Analyzers*

RF Transmitter

The NI PXIe-5644R RF transmitter uses direct RF upconversion from differential baseband I/Q, which upconverts the baseband signal from DC to RF at the configured LO frequency. Table 2 compares the RF transmitter on the NI PXIe-5644R with existing NI vector signal generators.

	NI PXIe-5650/51/52	NI PXIe-5671/72	NI PXIe-5673E	NI PXIe-5644R
Frequency Range	500 kHz to 1.1/3.3/6.6 GHz	250 kHz to 2.7 GHz	85 MHz to 6.6 GHz	65 MHz to 6 GHz
Bandwidth	N/A	20 MHz	100 MHz	80 MHz
Phase Noise (10 kHz offset) at 1 GHz	-112 dBc/Hz	-95 dBc/Hz	-112 dBc/Hz	-112 dBc/Hz
Maximum Output Power (CW)	+10 dBm	+10 dBm	+10 dBm	+10 dBm
Minimum Output Power	-100 dBm	-147 dBm/Hz	-154 dBm/Hz	-168 dBm/Hz
Modulation Capabilities	CW, 2-FSK, OOK	Vector Modulation	Vector Modulation	Vector Modulation
RF List Mode	Yes	No	Yes	Yes
Tuning Time	200 µs	2 ms	200 µs	380 µs

Table 2*. Comparison of NI Vector Signal Generators*

For more information on the hardware design of the NI PXIe-5644R, read the NI PXIe-5644R VST Hardware Architecture white paper.

Industry-Leading Performance for the Latest RF Standards

The NI PXIe-5644R RF vector signal transceiver offers industry-leading performance and measurement speed for the latest cellular and wireless standards. Using IEEE 802.11ac as an example, the VST measures an error vector magnitude (EVM) instrument floor of better than -45 dB (0.5 percent) at 5.8 GHz for a 256-QAM signal. This measurement is typically done in less than 40 ms. Figure 2 shows a typical 802.11ac EVM measurement.

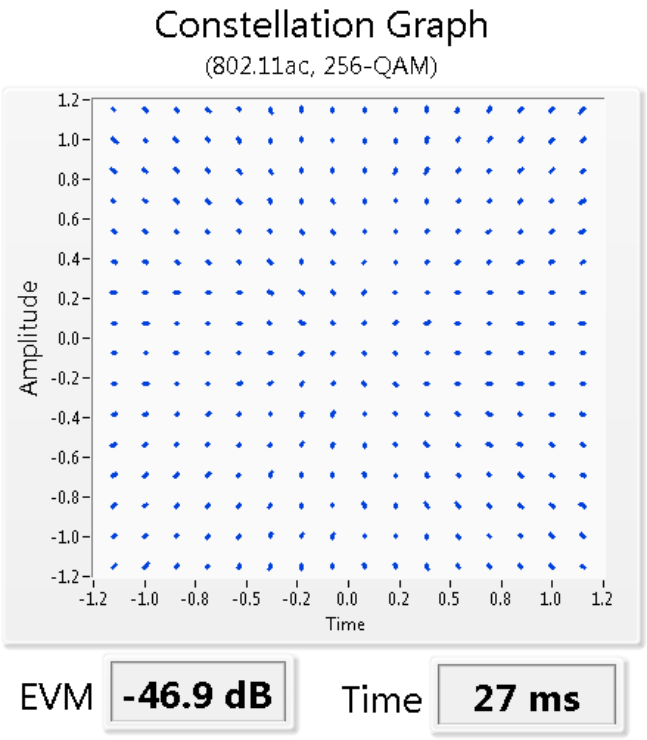

Figure 2. *Typical Constellation Graph, EVM Measurement, and Measurement Time of an 802.11ac MCS9 Signal at 5.8 GHz.*

For this measurement, the NI PXIe-5644R RF vector signal transceiver is used to generate an 80 MHz 802.11ac MCS9 (256-QAM) signal at a frequency of 5.8 GHz and power level of -10 dBm. The NI WLAN Generation Toolkit is used to create the waveforms that are then downloaded to the NI PXIe-5644R. The NI WLAN Analysis Toolkit is used to analyze the acquired signal on the same NI PXIe-5644R with the following settings:

- IQ Mismatch Compensation: On
- Channel Tracking: Off
- Amplitude Tracking: On
- Phase Tracking: On
- Time Tracking: On
- Number of Averages: 1

User-Programmable FPGA

The NI PXIe-5644R features a Xilinx Virtex-6 FPGA, which is used for system configuration, digital data movement, and digital signal processing. The FPGA has direct connections to the ADCs, DACs, PCI Express bus, DRAM, SRAM, PFI 0, digital I/O, and PXI triggers for custom programming to meet a variety of application needs. Figure 3 shows an overview of the FPGA basecard architecture.

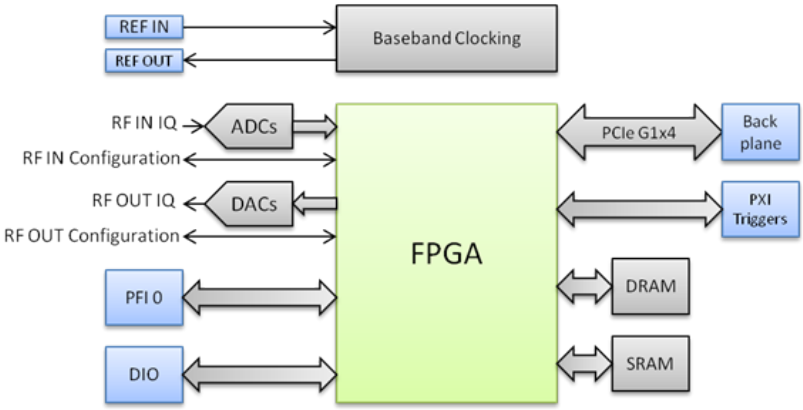

Figure 3. *Block Diagram of the NI PXIe-5644R FPGA Basecard*

The Xilinx FPGA on the NI PXIe-5644R is fully programmable using the LabVIEW FPGA Module. LabVIEW is well suited for FPGA programming because it clearly represents parallelism and data flow, so whether you are experienced or inexperienced in traditional FPGA design, you can productively apply the power of reconfigurable hardware.

You can make small modifications to the FPGA to optimize the performance of the VST to meet your needs, or you can completely redesign the FPGA code to enable embedded

applications, such as channel emulation. For more information on how to program the NI PXIe-5644R using LabVIEW FPGA, read the NI VST Software Architecture white paper.

Phase-Coherent MIMO and Parallel Testing

The flexibility of the NI vector signal transceiver enables multiple RF transmitters and receivers to share common start triggers, reference clocks, and LOs. As a result, you can synchronize multiple NI PXIe-5644R modules for phase-coherent acquisition or parallel device testing. The VST's small form factor allows up to five modules to fit into a single 18-slot PXI Express chassis (see Figure 4).

Figure 4. *Up to five NI PXIe-5644R modules can fit into a single PXI Express chassis for applications such as MIMO or parallel testing.*

Additional Features

Other NI PXIe-5644R features include RF record and playback, RF list mode, and device control over standard or proprietary digital buses. With flexible software that allows access all the way down to the pin, the NI vector signal transceiver helps you design your instrument specifically for your RF application needs.

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Support and Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

Calibration

NI measurement hardware is calibrated to ensure measurement accuracy and verify that the device meets its published specifications. To ensure the ongoing accuracy of your measurement hardware, NI offers basic or detailed recalibration service that provides ongoing ISO 9001 audit compliance and confidence in your measurements. To learn more about NI calibration services or to locate a qualified service center near you, contact your local sales office or visit ni.com/calibration.

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