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2.7 GHz RF Vector Signal Analyzer with Digital Downconversion

NI PXI-5661

- 9 kHz to 2.7 GHz
- 20 MHz real-time bandwidth with quadrature digital downconversion
- Burst power triggering
- High-stability timebase (10 MHz OCXO)
  - ±20 ppb frequency stability
  - ±50 ppb frequency accuracy
- Up to 80 dB spurious-free dynamic range
- +30 dBm full signal input range
- 14-bit resolution, 100 MS/s digitizer
- 64 or 256 MB memory

Operating Systems
- Windows 2000/XP

Recommended Software
- LabVIEW
- LabWindows/CVI
- Modulation Toolkit

Application Software (included)
- Spectral Measurements Toolkit

Driver Software (included)
- NI-RFSA



Overview

The National Instruments PXI-5661 is a modular 2.7 GHz RF vector signal analyzer with wide real-time bandwidth, optimized for automated test in a compact, 3U PXI package. It is ideal for high-throughput RF acquisition and measurements. The 20 MHz wide onboard quadrature digital downconverter (DDC) significantly reduces the required load size and the time Needed to transfer waveform data to the host controller or PC. This functionality is ideal for engineers who require data streaming with rapid response time for software-defined radio (SDR), real-time signal processing, or faster transfer times for spectral monitoring applications. The module is also compatible with Conduant StreamStor devices, enabling terabyte recording.

The NI PXI-5661 RF analyzer also includes a burst power trigger ideal for communications applications and signal intelligence. The PXI-5661 features a highly stable timebase and flexible software tools, including Express VIs for National Instruments LabVIEW.

The NI Spectral Measurements Toolkit for LabVIEW and LabWindows/CVI accompanies the PXI-5661, providing common measurements such as power spectrum, peak power and frequency, in-band power, adjacent-channel power, and occupied bandwidth. Additionally, it offers vector capabilities, such as 3D spectrograms, I/Q data for modulation analysis, and analog modulation analysis functions for LabVIEW. You can also use the PXI-5661 with the NI Modulation Toolkit to analyze custom and standard modulation formats.

Hardware

The PXI-5661 consists of a 2.7 GHz downconverter and a high-spectral-purity digitizer.

Analog Input

The PXI-5661 can acquire a wide range of signal levels, from +30 dBm to less than -130 dBm, and provides up to 50 dB of input attenuation, selectable in 10 dB steps.

Frequency Characteristics

The PXI-5661 provides outstanding frequency characteristics over its operating range of 9 kHz to 2.7 GHz. It offers a typical noise density of <-140 dBm/Hz, extendable to -165 dBm/Hz with a PXI-5690 preamplifier, and up to 80 dB of intermodulation spurious-free dynamic range. Typical phase noise is <-94 dBc/Hz at a 10 kHz offset.

Superior Measurement Throughput

The most significant advantage of the PXI-5661 over traditional RF instrumentation is measurement throughput. Figure 1 illustrates the difference in throughput between the PXI-5661 and a traditional analyzer. Two comparisons are shown. One graph is a spectral sweep that illustrates the advantages of the wide real-time bandwidth of the downconverter. The other graph is an in-band power measurement comparison that shows the throughput advantages of the PXI-5661 as a whole.

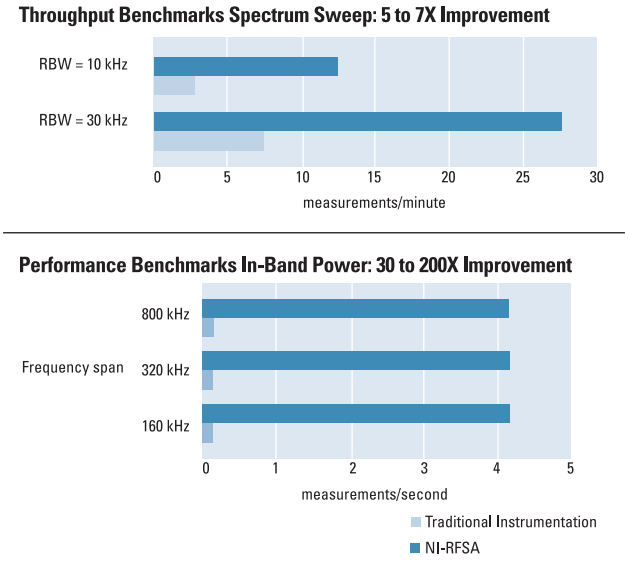


Figure 1. PXI-5661 Performance Benchmarks

Ultrahigh-Stability Timebase

The PXI-5661 offers an extremely stable timebase with frequency stability of ±20 ppb and frequency accuracy of ±50 ppb, making it useful for a range of automation applications.

Accuracy

The noise and distortion characteristics of the PXI-5661 are stable and repeatable over time and a wide range of temperature. For example, with a 1 MHz measurement bandwidth, a -10 dBm signal has a repeatability of less than 0.1 dB, where resolution bandwidth (RBW) = 1 kHz and number of averages = 10. The PXI-5661 employs amplitude equalization that reduces amplitude error to less than 0.2 dB over a 20 °C change.

Acquisition Memory

The PXI-5661 includes up to 256 MB of onboard memory. With this memory, you can acquire up to 128 million real 16-bit samples, or 64 million complex 16-bit samples. The PXI-5661 uses the bus master capability of the NI MITE ASIC to move data to computer memory at much higher speeds – up to 10 times faster – than traditional instrument interfaces. Because this ASIC performs memory management functions usually handled by the host CPU, all the computer power of the host CPU can be devoted to data analysis.

Clock Generation and Triggering

The 10 MHz reference clock on the PXI-5661 can synchronize to any one of three sources – the onboard high-precision OCXO reference clock, an external reference clock, or the PXI backplane. Using the PXI backplane, you can synchronize two or more PXI-5661 units with each other and other PXI modules without using cables. You can synchronize the PXI-5661 to an external source using front panel connectors. The PXI-5661 can import and export TTL triggers from the PXI trigger bus, the PXI star trigger line, or the front panel SMB connector. The PXI trigger bus greatly simplifies synchronizing RF measurements with other PXI modules such as digital multimeters, audio analyzers, and machine vision modules. The PXI-5661 also includes a burst power trigger with which you can trigger an acquisition based on the power within the configured modulation bandwidth.

Digital Downconversion and Decimation

With the digital downconversion (DDC) functionality of the PXI-5661, you can acquire signals at much less than the full digitization rate. By downconverting channels of up to the full 20 MHz bandwidth to baseband, the PXI-5661 dramatically reduces the sampling rate necessary to acquire these signals. This feature results in dramatic throughput improvements for many applications. For example, if you want to acquire a signal with a 200 kHz bandwidth centered at 900 MHz, the rate at which samples are stored can be as low as 250 kS/s. Digital downconversion and decimation in combination with the high-throughput PXI backplane provide RF and communication data streaming to a controller or PC for real-time signal processing and analysis or record and playback applications.

Calibration

National Instruments calibrates the amplitude accuracy of the analog input of the downconverter and digitizer modules. Temperature variations are calibrated and corrected during normal operation, resulting in very high stability and repeatability. The modules are shipped with NIST-traceable and ISO-9002-certified calibration certificates. Visit **ni.com/calibration** for more information about calibration services.

Software

The National Instruments Spectral Measurements Toolkit and NI-RFSA driver software are included with the PXI-5661. The Spectral Measurements Toolkit plugs directly into LabVIEW and LabWindows/CVI to offer high-level measurement functionality. For a list of measurement functions, refer to Table 1. The driver software provides a driver-level interface and integrates with LabVIEW and LabWindows/CVI.

Zoom FFT	Spectrum peak search
Zoom power spectrum	In-band power
Averaged power spectrum	Adjacent channel power
Averaged cross spectrum	Occupied bandwidth
Averaged frequency response	Demodulate AM
Amplitude calibration	Demodulate FM
Power spectral density	Demodulate PM
Peak frequency	Downconvert passband
Peak amplitude/power	

Table 1. Spectral Measurements Toolkit Functions

General-Purpose Test	Commercial Electronics Test
Spectral analysis	Cable modem
Semiconductor ATE	Mobile phones and pager
Ultrasound/radar/lidar	Wireless LAN and Bluetooth
RF component characterization	Commercial radio
Military/aerospace	Digital television
Signal Intelligence (Sig Int)	

Table 2. Applications for the PXI-5661

Ordering Information

NI PXI-5661 with:

64 MB 779782-01

256 MB 779782-02

256 MB with Modulation Toolkit 779782-03

Includes modules, cables, NI-RFSA driver, and Spectral Measurements Toolkit for LabVIEW and LabWindows/CVI.

BUY NOW!

For complete product specifications, pricing, and accessory information, call (800) 813 3693 (U.S. only) or go to **ni.com/rf**.

Specifications

Valid over specified operating environment (0 to 50 °C) unless otherwise stated. See detailed NI PXI-5661 specifications for more information.

General

Ports	1 RF 1 IF

Frequency

Frequency range	9 kHz to 2.7 GHz
Real-time bandwidth	20 MHz
Resolution bandwidth (RBW)	Fully adjustable (<1 Hz to 10 MHz)
Internal reference frequency	10 MHz
Temperature stability	±20 ppb max[1]
Initial achievable accuracy	±50 ppb max
Aging	±100 ppb/year
Locking range	>±0.5 ppm
Lock time to ext frequency reference	<10 s
Warm-up time (typical)	15 minutes
Selectivity (60 dB : 3 dB)	<2.5 (Flat Top) <4.1 (7-term Blackman-Harris)
Tuning resolution	
Frequency-domain digitizer (PXI-5142)	355 nHz
RF downconverter (PXI-5600)	1 MHz, minimum
Tuning speed downconverter	
(1% of step size)	10 ms max
(0.01% of step size)	20 ms max
(1 ppm of step size)	30 ms max
Spectral purity (noise sidebands) at 100 MHz, minimum	
1 kHz offset	<-80 dBc/Hz[2]
10 kHz offset	<-90 dBc/Hz
30 kHz offset	<-95 dBc/Hz
100 kHz offset	<-110 dBc/Hz
1 MHz offset	<-120 dBc/Hz
Sideband spurs	
>10 kHz offset	<-70 dBc
<10 kHz offset	<-55 dBc
Residual FM	<10 Hz_{pp} in 10 ms

[1]0 to 50 °C, referenced to 25 °C
[2]For spans 20 kHz; for spans >20 kHz the value is <-78 dBc/Hz at 1 Hz offset

Amplitude

Input signal range	<-130 to 30 dBm
Maximum safe input power (continuous)	+30 dBm (atten ≥10 dB) +20 dBm (no atten)
RF input attenuator	0 to 50 dB (10 dB steps)
Maximum DC input voltage	±25 VDC[3]
Relative accuracy (to 100 MHz, 15 to 35 °C)	
<2 GHz, calibrated	±0.75 dB, ±0.5 dB typical
>2 GHz, calibrated	±1.25 dB, ±0.9 dB typical
Absolute accuracy (15 to 35 °C)	
<2 GHz, calibrated	±1 dB, ±0.6 dB typical
>2 GHz, calibrated	±1.5 dB, ±1 dB typical
Group delay variation	30 ns_{pp}
All signal levels are mixer stage levels at RF input port	
1 dB gain compression	
10 MHz to 1 GHz	>0 dBm
1 to 2.7 GHz	>2 dBm

[3]DC levels up to ±25 VDC at input will not damage the instrument; however, high transient currents from low impedance DC step voltages at input can cause damage.

Spurious Response

2nd-order harmonic distortion (single -30 dBm tone)	
20 MHz to 2.7 GHz	<-80 dBc typical
3rd-order intermodulation distortion	
(two -30 dBm tones, >200 kHz separation)	
20 MHz to 2.7 GHz	<-85 dBc typical
Input-related spurs	
Signal level = -30 dBm, 0 dB attenuation	
>5 MHz	<-70 dBc
<5 MHz	<-60 dBc
Residual response related spurs	
Input terminated, 0 dB input attenuation	
≥20 MHz	<-100 dBm
<20 MHz	<-70 dBm
Noise density	
9 kHz to 1 GHz	<-135 dBm/Hz (-144 dBm/Hz typical)
1 to 2 GHz	<-134 dBm/Hz (-142 dBm/Hz typical)
2 to 2.5 GHz	<-130 dBm/Hz (-139 dBm/Hz typical)
2.5 to 2.7 GHz	<-129 dBm/Hz (-133 dBm/Hz typical)

NI PXI-5600 RF Downconverter Module

Input	
Connector	SMA female
Impedance	50 Ω
Coupling	AC
Output	
Connector	SMA female
Impedance	50 Ω
Frequency	5 to 25 MHz
Amplitude	0 dBm full scale
Frequency reference input	
Connector	SMA female
Impedance	50 Ω
Input amplitude	-5 to +15 dBm
Maximum safe input level	+16 dBm
Maximum DC input voltage	±5 V
Input frequency range	10 MHz ±0.5 ppm
10 MHz output (2 ports)	
Connector	SMA female
Impedance	50 Ω
Signal	Square wave
Amplitude	±0.5 V (+7 dBm) into 50 Ω (±1 V into open circuit)
Accuracy	Refer to *Internal Frequency Reference*

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PXI 10 MHz I/O
- Connector ..... SMA female
- Impedance ..... 50 Ω
- Frequency ..... -5 to +15 dBm
- Output amplitude ..... 0.5 V (=7 dBm) into 50 Ω

NI PXI-5142 IF Digitizer Module

CH0, CH1
- Connector ..... BNC female
- Impedance ..... 50 Ω

Maximum input overload ..... 7 V_{rms}; ≤10 V_p (30 dBm)

Clk in
- Connector ..... SMB female
- Impedance ..... 50 Ω
- Input amplitude ..... -10 dBm to +13 dBm (square wave)

Maximum input overload ..... 7 V_{rms}; ≤10 V_p (30 dBm)

Clk out
- Connector ..... SMB
- Output impedance ..... 50 Ω
- Logic type ..... 3.3 V CMOS
- Maximum driver current ..... ±48 mA

PFI 0, PFI 1
- Connector ..... 9-pin minicircular DIN
- Logic type ..... 3.3 V CMOS
- Maximum input voltage ..... 5.5 V

Power Requirements

Module	+3.3 VDC	+5 VDC	+12 VDC	-12 VDC
PXI-5600 RF downconverter	920 mA	2.3 A	700 mA	115 mA
PXI-5142 IF digitizer	1 A	1.7 A	800 mA	270 mA

Voltages ±5%

Calibration

Interval ..... 1 year for PXI-5600
2 years for PXI-5142

IF/Baseband

Resolution ..... 14 bits

System IF frequency rate ..... 5 to 25 MHz

Sample rate ..... 100 MS/s

Digital downconverter (OSP) bandwidth 20 MHz to 4.88 kHz using 100 MS sample clock timebase

Onboard memory ..... 64 MB
256 MB

Note: Refer to the PXI-5142 specifications document for additional IF/baseband and onboard signal processing (OSP) specifications.

Physical Dimensions

PXI-5600 (3 slots) ..... 3U, PXI/cPCI module
6.0 by 13.0 by 21.6 cm
(2.4 by 5.1 by 8.5 in.)

PXI-5142 (1 slot) ..... 3U, PXI/cPCI module
2.0 by 13.0 by 21.6 cm
(0.8 by 5.1 by 8.5 in.)

Weight (combined unit) ..... 1,165 g (41.1 oz)

Safety and Compliance

Safety

This product is designed to meet the requirements of the following standards of safety for electrical equipment for measurement, control, and laboratory use:

- IEC 61010-1, EN 61010-1
- UL 61010-1, CSA 61010-1

Note: For UL and other safety certifications, refer to the product label or visit **ni.com/certification**, search by model number or product line, and click the appropriate link in the Certification column.

Electromagnetic Compatibility

This product is designed to meet the requirements of the following standards of EMC for electrical equipment for measurement, control, and laboratory use:

- EN 61326 EMC requirements; Minimum Immunity
- EN 55011 Emissions; Group 1, Class A
- CE, C-Tick, ICES, and FCC Part 15 Emissions; Class A

Note: For EMC compliance, operate this device according to product documentation.

CE Compliance

This product meets the essential requirements of applicable European Directives, as amended for CE marking, as follows:

- 73/23/EEC; Low-Voltage Directive (safety)
- 89/336/EEC; Electromagnetic Compatibility Directive (EMC)

Note: Refer to the Declaration of Conformity (DoC) for this product for any additional regulatory compliance information. To obtain the DoC for this product, visit **ni.com/certification**, search by model number or product line, and click the appropriate link in the Certification column.

Waste Electrical and Electronic Equipment (WEEE)

EU Customers: At the end of their life cycle, all products must be sent to a WEEE recycling center. For more information about WEEE recycling centers and National Instruments WEEE initiatives, visit **ni.com/environment/weee.htm**.

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Hardware Services

NI Factory Installation Services

NI Factory Installation Services (FIS) is the fastest and easiest way to use your PXI or PXI/SCXI combination systems right out of the box. Trained NI technicians install the software and hardware and configure the system to your specifications. NI extends the standard warranty by one year on hardware components (controllers, chassis, modules) purchased with FIS. To use FIS, simply configure your system online with **ni.com/pxiadvisor**.

Calibration Services

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