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.

**Throughput Benchmarks Spectrum Sweep: 5 to 7X Improvement**

**Performance Benchmarks In-Band Power: 30 to 200X Improvement**

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.

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.

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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 max¹
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 MHz
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/Hz²
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 Hzsp in 10 ms
¹0 to 50 °C, referenced to 25 °C
²For 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 VDC³
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 nspp
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
³DC 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
(1% of step size) ............. 10 ms max
(0.01% of step size) ........... 20 ms max
(1 ppm of step size) ........ 30 ms max

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 Vrms; ≤10 Vp (30 dBm)
- Clk in
  - Connector: SMB female
  - Impedance: 50 Ω
  - Input amplitude: -10 dBm to +13 dBm (square wave)
  - Maximum input overload: 7 Vrms; ≤10 Vp (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

<table>
<thead>
<tr>
<th>Module</th>
<th>+3.3 VDC</th>
<th>+5 VDC</th>
<th>+12 VDC</th>
<th>-12 VDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>PXI-5600 RF downconverter</td>
<td>920 mA</td>
<td>2.3 A</td>
<td>700 mA</td>
<td>115 mA</td>
</tr>
<tr>
<td>PXI-5142 IF digitizer</td>
<td>1 A</td>
<td>1.7 A</td>
<td>800 mA</td>
<td>270 mA</td>
</tr>
</tbody>
</table>

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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We also offer service programs that provide automatic upgrades to your application development environment and higher levels of technical support. Visit ni.com/ssp.

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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Repair and Extended Warranty

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