2.7 GHz RF Vector Signal Generator

NI PXI-5671

- 250 kHz to 2.7 GHz
- 16-bit resolution, 100 MS/s arbitrary waveform generation (400 MS/s interpolated)
- 32, 256, or 512 MB memory
- 20 MHz real-time bandwidth
- High-stability time base (10 MHz OCXO)
  - ±20 ppb frequency stability
  - ±50 ppb frequency accuracy
- -145 dBm to +10 dBm output power

Operating Systems
- Windows 2000/XP

Recommended Software
- LabVIEW
- LabWindows/CVI

Application Software (included)
- Modulation Toolkit for LabVIEW

Driver Software (included)
- NI-RFSG

NEW

Overview

The National Instruments PXI-5671 is a 2.7 GHz RF vector signal generator module with quadrature digital upconversion. Digital upconversion provides a more efficient means of waveform generation resulting in a tremendous reduction in download and signal generation time. The NI PXI-5671 provides 16-bit resolution arbitrary waveform generation at 100 MS/s (400 MS/s interpolated), up to 512 MB of memory, and 20 MHz real-time bandwidth. The PXI-5671 can generate custom and standard modulation formats such as AM, FM, PM, ASK, FSK, MSK, GMSK, PSK, QPSK, PAM, and QAM.

The Modulation Toolkit for LabVIEW accompanies the PXI-5671, providing functions and tools for signal generation, analysis, visualization, and processing of custom and standard digital and analog modulation formats.

The combined functionality of the PXI-5671 and the Modulation Toolkit deliver a highly flexible and powerful solution for scientific research, consumer electronics, communications, aerospace/defense, and semiconductor test applications as well as for emerging areas including software-defined radio, radio-frequency identification (RFID), and wireless sensor networks.

Hardware

The PXI-5671 provides vector signal generation from 250 kHz to 2.7 GHz over a wide range of signal levels from -145 dBm to +10 dBm in a compact, 3 slot 3U module. It follows industry-standard plug and play specifications for the PXI bus and can be seamlessly integrated with compliant systems.

The PXI-5671 features an onboard ultrahigh-stability oven-controlled crystal oscillator (OCXO), which provides frequency stability of ±20 ppb and frequency accuracy of ±50 ppb. These specifications make it useful for a range of automation applications. A sophisticated calibration scheme is implemented in the PXI-5671 to ensure power level accuracy over varying temperatures from 0 to 55 °C. This feature is important to many applications, especially in manufacturing environments where the stable operation over varying temperature ranges is critical.

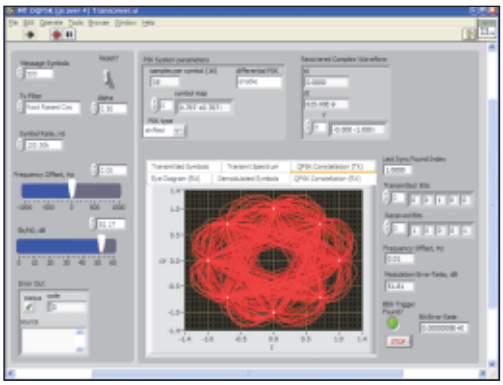

Figure 1. Modulation Toolkit for LabVIEW Displaying π/4 DQPSK

Software

The PXI-5671 is shipped with the NI-RFSG instrument driver and the Modulation Toolkit for LabVIEW. NI-RFSG is a fully functional instrument driver, compatible with a variety of application software environments such as NI LabVIEW, LabWindows/CVI, and C. NI-RFSG features easy-to-use functions for configuring the timing and synchronization, CW tone, and arbitrary waveform generation capabilities of the PXI-5671. Also included are a number of interactive, instructional examples and interactive online help that can help jump-start your application test development.

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2.7 GHz RF Vector Signal Generator

The Modulation Toolkit for LabVIEW provides functions for signal generation, analysis, and visualization of custom and standard analog and digital modulation. With the Modulation Toolkit, you can also develop and analyze custom modulation formats and generate these with the PXI-5671. Some of the standard measurement functions include EVM (error vector magnitude), MER (modulation error ratio), and ρ (rho). Functions are also available for injecting impairments including IQ Gain Imbalance, Quadrature Skew, and AWGN (additive white Gaussian noise). Visualization functions include trellis, constellation, and 2D and 3D eye diagrams. This hardware and software combination gives you access to customizable functionality not available in traditional instrumentation.

NI Modulation Toolkit Functions[1]

Modulation/Demodulation

- AM, FM, PM
- ASK, FSK, PSK
- MSK, GMSK
- PAM, QAM
- BPSK, QPSK, OQPSK, DQPSK, π/4DQPSK

Modulation Analysis Functions

- ρ (rho)
- DC offset
- Phase error
- Quadrature skew
- IQ gain imbalance
- Bit error rate (BER)
- Frequency deviation
- Burst timing measurements
- Modulation error ratio (MER)
- Error vector magnitude (EVM)

Visualization and Analysis

- Trellis diagrams
- Constellation plot
- 2D and 3D eye diagrams

Modulation Impairments

- Multitone
- DC offset
- Fading profile
- Frequency offset
- Quadrature skew
- IQ gain imbalance
- Additive white Gaussian noise (AWGN)
- Phase noise

[1]A Modulation Toolkit datasheet is available separately.

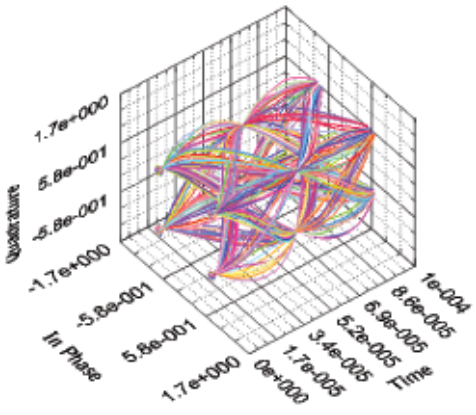

Figure 2. A 3D IQ plot created by the Modulation Toolkit visually separates the I and Q components for this PSK modulated signal.

Figure 3. RF test system – PXI-5671 and PXI-5660

Superior Flexibility

Providing customers with a flexible platform is necessary to meet the needs of today's complex, rapidly evolving systems. The PXI-5671 consists of two components – the NI PXI-5610 2.7 GHz RF upconverter and the NI PXI-5441 arbitrary waveform generator, a high-spectral-purity baseband signal generator with onboard signal processing. The PXI-5610 and the PXI-5441 work together to provide vector signal generation from 250 kHz to 2.7 GHz. Because of the flexible hardware and software, and with access to low-level driver functionality, the PXI-5610 and the PXI-5441 can also be used independently for RF upconversion and arbitrary waveform sequencing. For advanced applications, combine additional modular instruments in the same PXI chassis with the PXI-5671 and take advantage of the tight synchronization between PXI modules. For example, combine the PXI-5660 RF Vector Signal Analyzer with the PXI-5671 to build an RF communications test system with complete modulation and demodulation capabilities.

Calibration

The PXI-5610 and the PXI-5441 are calibrated separately by National Instruments with NIST-traceable and ISO-9002-certified calibration certificates. Temperature variations are calibrated and corrected during normal operation resulting in very high stability and repeatability.

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Specifications

Valid over specified Operating Environment (0 to 55 °C) unless otherwise stated.

General

Channels ..... 1 RF, 1 IF

Frequency Characteristics

Frequency range ..... 250 kHz to 2.7 GHz
Frequency minimum (performance below
250 kHz not guaranteed) ..... 9 kHz
Real-time bandwidth (Digital vector
modulation bandwidth) ..... 20 MHz
Locking range ..... 5 Hz minimum
Warm-up time (typical) ..... 30 minutes
Frequency resolution (dependent on NI PXI-5441 memory)
32 MB ..... 355 nHz
≥256 MB ..... 355 nHz

Tuning Speed

Sine wave, 50 Hz tolerance
Thermal correction disabled ..... 35 ms typical
Thermal correction enabled ..... 50 ms max
1 MS record, phase continuity off
Digital IF equalization off ..... 340 ms typical 370 ms max
Digital IF equalization on ..... 950 ms typical 1.6 s max

Note: The NI PXI-5671 tuning speed and tuning resolution depend on resampling done by the PC. This means that fine resolution tuning speed is dependent on the speed and memory of the computer. Specifications below are the result of using an NI PXI 8186 Pentium IV controller 2.2 GHz with 1 GB RAM with the Windows XP operating system and NI-RFSG phase continuity disabled.

Internal Frequency Reference

Frequency ..... 10 MHz
Temperature stability ..... ±20 ppb max (referenced to 25 °C)
Aging
Per year ..... ±100 ppb
Per day ..... ±1 ppb
Initial achievable accuracy ..... ±50 ppb
Lock time for the 5610
to ext frequency reference ..... 5 s max
Locking range ..... 5 Hz minimum
Reference Input ..... 50 Ω SMA female
Input amplitude ..... -5 to +16 dBm
Input frequency range ..... 10 MHz ± 0.5 ppm
Reference Output ..... 50 Ω SMA female
Signal ..... Square wave
Output Frequency ..... 10 MHz
Output Amplitude ..... 6.7 dBm into 50 Ω load, fundamental frequency (1± 0.1 Vpp sine wave)

Spectral purity

Phase Noise

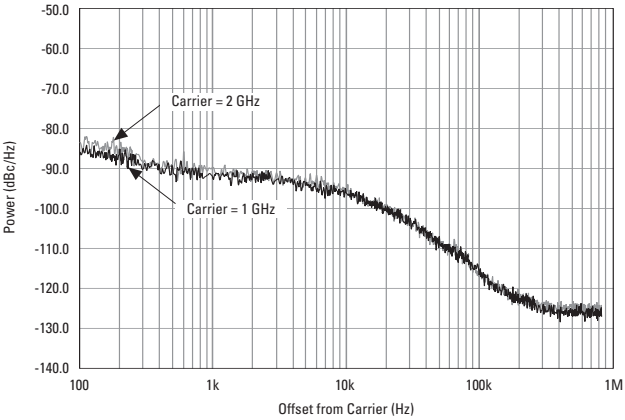

Figure 1. Typical Phase Noise at 1 GHz with Real-Time Bandwidth ≤10 MHz

	Real-time bandwidth ≤10 MHz	
Offset Frequency	**Carrier Frequency = 1 GHz**	**Carrier Frequency = 2 GHz**
100 Hz	–82 dBc/Hz maximum	–79 dBc/Hz maximum
1 kHz	–85 dBc/Hz maximum	–83 dBc/Hz maximum
10 kHz	–93 dBc/Hz maximum	–92 dBc/Hz maximum
100 kHz	–110 dBc/Hz maximum	–110 dBc/Hz maximum

	Real-time bandwidth >10 MHz	
Offset Frequency	**Carrier Frequency = 1 GHz**	**Carrier Frequency = 2 GHz**
100 Hz	–72 dBc/Hz maximum	–70 dBc/Hz maximum
1 kHz	–75 dBc/Hz maximum	–72 dBc/Hz maximum
10 kHz	–98 dBc/Hz maximum	–96 dBc/Hz maximum
100 kHz	–116 dBc/Hz maximum	–116 dBc/Hz maximum

Residual FM ..... 4.5 Hz rms maximum (continuous wave, 300 Hz to 3 kHz integration bandwidth)

Spurious Responses

Second harmonic (>10 MHz) 0 to 55 °C ..... -40 dBc maximum
Output third-order distortion (IMD)
(two -3 dBm tones, >200 kHz apart) ..... -75 dBc typical
Residual spurious response
(no input signal, 0 dB attenuation/maximum
power level, excluding LO feedthrough) ... <80 dBc typical
NI PXI-5441 system clock rate ..... 100 MHz
Harmonic and spurious response ..... -105 dBm typical
Output-related spurious
response (nonharmonic) ..... -80 dBc maximum
(IF – RF output frequency) ..... -64 dBc typical, -58 dBc maximum

Close-in Spurious Responses (Carrier-Modulated)

		Spurious Response
Real-Time Bandwidth	**Offset from Carrier**	**Maximum Power (dBc)**
≤10 MHz	<100 Hz	-50
	100 Hz to 10 kHz	-60
>10 MHz	<400 Hz	-40
	100 Hz to 2 kHz	-50

RF Output Characteristics

Output power range ..... -145 dBm to +10 dBm minimum
Amplitude resolution
PXI-5671 ..... 0.02 dB minimum
PXI-5610 ..... 1 dB typical
Amplitude settling time PXI-5610
NI 5610 ..... 0.1 dB within 5 ms, typical
NI 5441 ..... 0.1 dB within 30 ms, typical

Level Accuracy

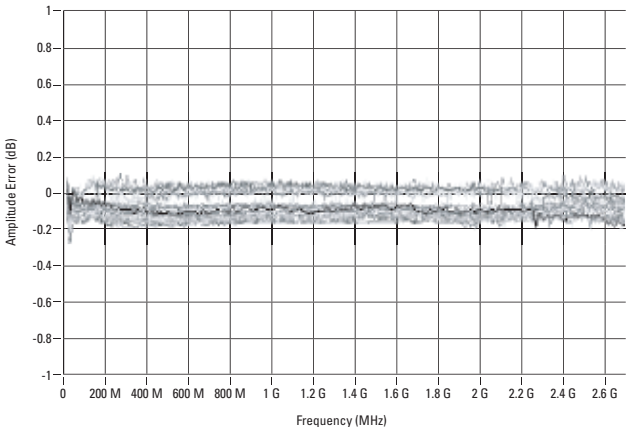

Figure 2. Typical Output Power Level Accuracy from -45 dBm to +10 dBm

	Output Power Range			
Output Frequency	**+7 to -30 dBm**	**-30 to -80 dBm**	**-80 to -127 dBm**	**<-127 dBm (typical)**
250 kHz to 10 MHz	±1.2 dB	±1.3 dB	±1.5 dB	±2 dB
10 MHz to 2.7 GHz	±0.7 dB	±0.8 dB	±1 dB	±1.5 dB

25 °C ±10 °C.
Accuracy degrades by < 0.03 dB per °C over full temperature range.
Accuracy degrades by 0.1 dB per dB above +7 dBm power levels, and by 0.15 dB per dB above +10 dBm power levels.
At nonsystem spur frequencies. Refer to the Spurious Responses section for more information.

Voltage Standing Wave Ratio (VSWR)
10 MHz to 2.3 GHz 1.6:1
2.3 to 2.7 GHz 1.7:1

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Output 1 dB Gain Compression Point (minimum)

Output Frequency (GHz)	15 to 35 °C (dBm)	0 to 55 °C (dBm)
Up to 2.0	16	14.5
2.0 to 2.5	14	12.5
2.5 to 2.7	13	11.5

Noise density (0 dBm output)

Output Power Level (dBm)	15 to 35 °C (dBm/Hz)	0 to 55 °C (dBmHz)
0	-120	-115
-20	-140	-135

Typical Noise Floor at 2 GHz

Output Power Level (dBm)	Typical Noise Floor (dBm/Hz)
-57	-158
-50	-157
-40	-154
-30	-147
-20	-140
-10	-130
0	-120
10	-110

Vector modulation bandwidth flatness ..... ±0.5 dB typical[1]
Group delay variation (within the vector modulation bandwidth) ..... ±20 ns typical
Group delay
- PXI-5441 ..... 750 ns typical
- PXI-5610 ..... 1200 ns typical

Overload protection on RF output
- Maximum reverse RF power ..... 4 W
- Maximum DC input ..... ±50 VDC

[1]Equilization enabled. ±1.8 dB maximum with equilization disabled.

Local Oscillator Output

Frequency range ..... 3.2 to 5.9 GHz
Output power ..... -22 dBm (typical)
VSWR ..... 1.5:1 maximum

Phase noise – Local Oscillator

	Carrier Frequency		
Offset Frequency (kHz)	3.2 GHz (dBc/Hz)	4.2 GHz (dBc/Hz)	5.2 GHz (dBc/Hz)
1	-89	-88	-85
10	-98	-98	-95
100	-120	-120	-120

FM Modulation

FM Distortion (modulation frequency 1 kHz, carrier frequency 1 GHz, FM deviation 100 kHz, filter bandwidth 2 MHz ..... <1% Typical

Digital Modulation

QPSK, 16-QAM, 64-QAM (root raised cosine Filter, alpha = 0.25, carrier frequency = 1 GHz, 2,000 symbol PRBS, equalization: ON)

Symbol Rate	EVM (%)	MER (dB)
200 kS/s	1.0	37.0
1 MS/s	1.0	37.0
2.56 MS/s	1.0	37.0
5.12 MS/s	1.0	37.0
10 MS/s	1.2	36.0

Power Requirements

Typical	+3.3 VDC	+5 VDC	+12 VDC	-12 VDC	Total Power
PXI-5610	150 mA	2.6 A	900 mA	60 mA	25.0 W
PXI-5441	150 mA	2.6 A	900 mA	60 mA	25.0 W

Calibration

Self-calibration
- PXI-5610 ..... Correction for YIG offset and gain
- PXI-5441 ..... Correction for DC gain offset and timing errors

External calibration interval
- PXI-5610 ..... 1 year
- PXI-5441 ..... 2 years

Physical

PXI-5610 (2 slots) ..... 10 by 16 cm (3.9 by 6.3 in.)
PXI-5441 (1 slot) ..... 10 by 16 cm (3.9 by 6.3 in.)

Environmental

Operating Environment
- Operating temperature ..... 0 to +55 °C (Tested in accordance with IEC-60068-2-1 and IEC-60068-2-2)[1]
- Relative humidity ..... 10 to 90%, noncondensing (Tested in accordance with IEC 60068-2-56)
- Altitude (indoor use only) ..... 0 to 2,000 m (at 25 °C ambient temperature)

Storage Environment
- Ambient temperature ..... -20 to 70 °C (Tested in accordance with IEC-60068-2-1 and IEC-60068-2-2.)
- Relative humidity ..... 5 to 95%, noncondensing (Tested in accordance with IEC-60068-2-56.)

Shock and Vibration
- Nonoperational shock ..... 30 g peak, half-sine, 11 ms pulse (Tested in accordance with IEC-60068-2-27. Test profile developed in accordance with MIL-PRF-28800F.)
- Random vibration Non-operating ..... 5 to 500 Hz, 2.4 g_{rms} (Tested in accordance with IEC-60068-2-64. Non-operating test profile exceeds the requirements of MIL-PRF-2880F, Class B)

[1]When installed in the NI PXI-101x or PXI-1000B chassis, the PXI-5441 operating temperature is 0 to +45 °C

Certifications and Compliances

CE Mark 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
- CAN/CSA C22.2 No. 61010-1

Electromagnetic Compatibility
- Emissions ..... EN 55011 Class A at 10 m FCC Part 15A above 1 GHz
- Immunity ..... EN 61326:1997 + A2:2001, Table 1
- EMC/EMI ..... CE, C-Tick and FCC Part 15 (Class A) Compliant

Ordering Information

NI PXI-5671
- 32 MB memory 779079-02
- 256 MB memory 779079-03
- 512 MB memory 779079-04

Includes PXI-5610, PXI-5441, NI-RFSG, Modulation Toolkit for LabVIEW, and cables.

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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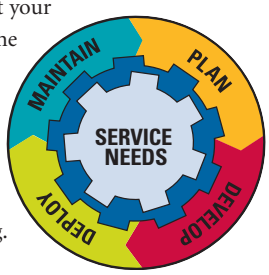

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NI Factory Installation Services (FIS) is the fastest and easiest way to use your PXI or PXI/SCXI combination systems right out of the box. Trained NI technicians install the software and hardware and configure the system to your specifications. NI 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.

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