

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

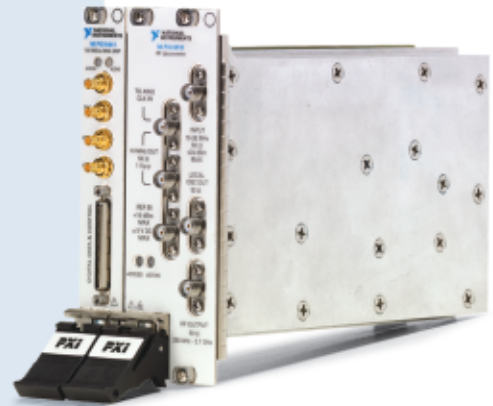
Application Software (included)

- 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

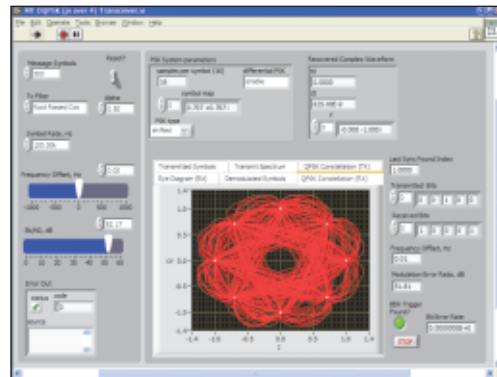


Figure 1. Modulation Toolkit for LabVIEW Displaying $\pi/4$ DQPSK

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.

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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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 Functions¹

Modulation/Demodulation

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

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

¹A Modulation Toolkit datasheet is available separately.

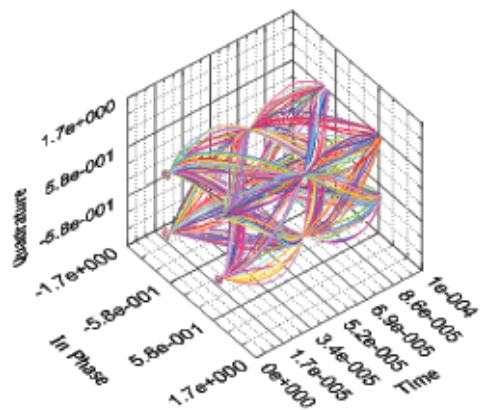


Figure 2. A 3D IQ plot created by the Modulation Toolkit visually separates the I and Q components for this PSK modulated signal.



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

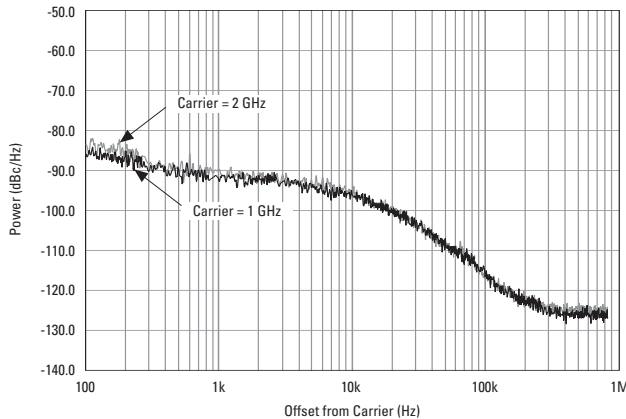


Figure 1. Typical Phase Noise at 1 GHz with Real-Time Bandwidth ≤10 MHz

Offset Frequency	Real-time bandwidth ≤10 MHz	
	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

Offset Frequency	Real-time bandwidth >10 MHz	
	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)

Real-Time Bandwidth	Spurious Response	
	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

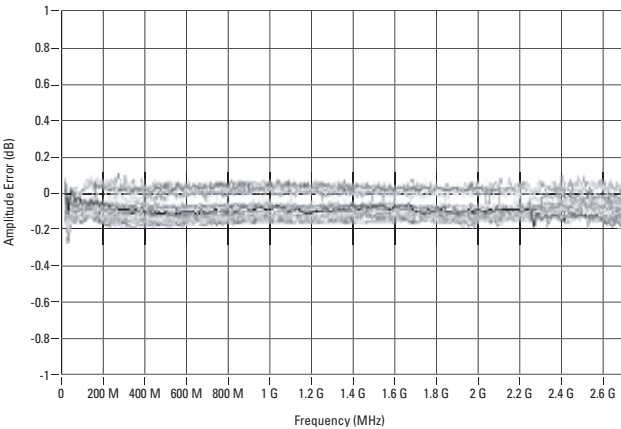


Figure 2. Typical Output Power Level Accuracy from -45 dBm to +10 dBm

Output Frequency	Output Power Range			
	+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 (dBm/Hz)
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

¹Equalization enabled. ±1.8 dB maximum with equalization 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

Offset Frequency (kHz)	Carrier Frequency		
	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
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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-28800F, Class B)

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

Certifications and Complies

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

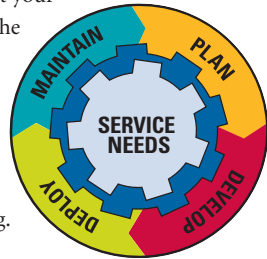
NI PXI-5671	
32 MB memory	779079-02
256 MB memory	779079-03
512 MB memory	779079-04
Includes PXI-5610, PXI-5441, NI-RFSG, Modulation Toolkit for LabVIEW, and cables.	

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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