100 MS/s, 16-Bit Arbitrary Waveform Generator

NI 5421

- 1 analog output channel
- 16-bit resolution, 100 MS/s sampling rate
- 400 MS/s maximum effective sampling rate with interpolation
- 43 MHz analog bandwidth
- 12 V_{p-p} into 50 Ω load
- 91 dBc close-in SFDR at 10 MHz
- -67 dBc THD at 10 MHz
- -148 dBm/Hz average noise density
- 8, 32, or 256 MB of onboard memory
- Optional 16-bit LVDS digital pattern output

Operating Systems
- Windows 2000/NT/XP

Recommended Software
- LabVIEW™
- LabWindows™/CVI™
- Measurement Studio™
- Analog Waveform Editor
- Digital Waveform Editor

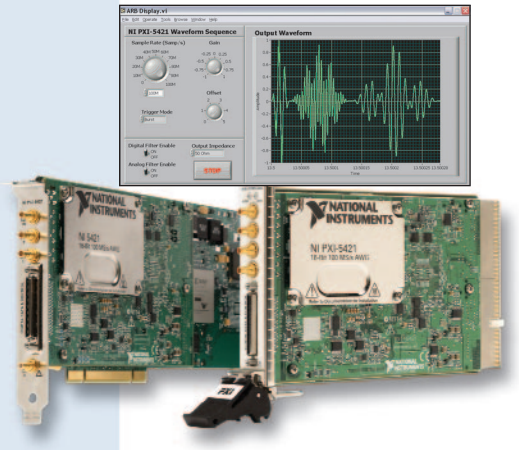
Other Compatible Software
- Visual Basic
- Visual C/C++

Application Software
- Analog Waveform Editor (32 and 256 MB models only)

Driver Software (included)
- NI-FGEN

Calibration Certificate Included

NEW



Overview

The NI 5421 is a 100 MS/s arbitrary waveform generator (AWG) featuring 16-bit resolution and up to 256 MB of onboard memory in a compact, 1 slot 3U PXI module or PCI board. With this combination of high resolution and deep memory, you can generate long, precise aperiodic waveforms, ideal for a range of applications in communications, consumer electronics, scientific research, automotive, and military/aerospace. Because the NI 5421 uses the PCI bus, waveforms can be downloaded up to 280 times faster than with GPIB-based AWGs. With the NI Synchronization and Memory Core (SMC) architecture of the NI 5421, you can create stimulus/response systems with digitizers and digital waveform generator/analyzers or synchronize multiple arbitrary waveform generators to form a phase-coherent multichannel system.

Analog Output Performance

Because of its 100 MS/s, 16-bit digital-to-analog converter (DAC) and clean back-end analog design, the NI 5421 has a close-in spurious-free dynamic range (SFDR) of 91 dBc and an average noise density of -148 dBm/Hz. These features make it ideal for even the most stringent frequency-domain applications common in communications. Depending on your signal and application needs, you can select from 2x, 4x, or 8x interpolation for an effective sampling rate up to 400 MS/s. For demanding time-domain applications, the NI 5421 has <5% pulse aberration and <1.0 ps_{rms} jitter at the analog output.

The analog output path features a 43 MHz 7-pole elliptical analog filter to suppress undesired high-frequency signal images. You can also choose from 50 or 75 Ω output impedance and vary the output attenuation with three digits of accuracy. In addition, you can bypass the output gain and attenuation by using the direct path. The direct path excels at intermediate frequency (IF) applications with passband flatness of ±0.25 dB from 0 to 40 MHz.

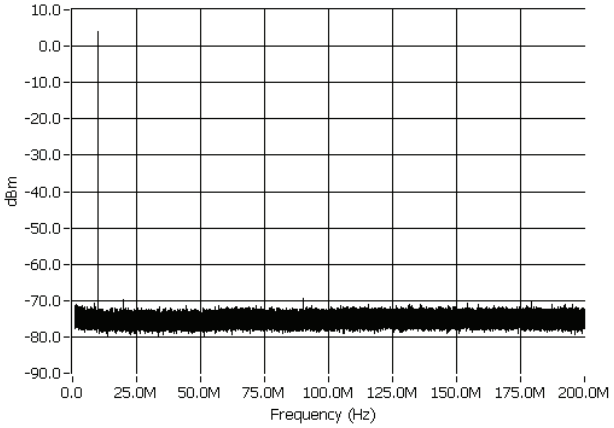


Figure 1. Power Spectrum of a 10 MHz Sine Wave Output from the PXI-5421

Shared Waveform and Instruction Memory

Because the NI 5421 is built on the SMC architecture, it uses the same physical memory for both waveform data and sequencing instructions. Traditionally, the instruction memory of AWGs is physically separate from the waveform data memory and is typically only a few kB. The limited instruction memory of traditional AWGs severely limits the maximum number of waveforms that can be sequenced as well as the overall flexibility of the AWG. The NI 5421 onboard memory of 8, 32, or 256 MB stores data and instructions together, giving you the flexibility to use as much space as you need for sequencing instructions. With shared memory, you can use the memory space for very long sequences with small waveforms, short sequences with very large waveforms, or a balance in between.

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Triggering and Sequencing

The NI 5421 has four triggering modes for controlling the starting and stopping of waveform generation – single, continuous, stepped, and burst. With these triggering modes combined with the linking and looping flexibility of the NI 5421, you can create sophisticated waveforms. With the 256 MB memory configuration, more than 1 million waveforms can be stored in memory and linked in any order. Each waveform segment can be looped up to 16,777,216 times or looped indefinitely. Triggers can be received from software as well as the front panel connectors, PXI trigger lines, PXI star trigger, or RTSI bus.

LVDS Digital Pattern Output

In addition to generating analog signals, the 32 and 256 MB configurations of the NI 5421 can generate low-voltage differential signal (LVDS) digital patterns. LVDS is increasingly used for digital signaling because of its reduced power consumption, lower electromagnetic interference, and immunity to noise. The digital patterns generated on the digital data and control (DDC) front panel connector correspond to the analog waveform being generated and make use of all of the linking, looping, triggering, and timing features. The sample clock is also available on the DDC I/O connector to latch the digital patterns. Alternatively, you can externally clock the NI 5421 via the DDC front panel connector. The NI Digital Waveform Editor is available as an add-on software package to provide you with further functionality in creating LVDS digital patterns.

Timing and Synchronization

The NI 5421 sample clock has three modes – Divide-by-N, High-Resolution, and External. Using the Divide-by-N sample clock, the jitter of the analog output is <1.0 ps rms and the phase noise is -137 dBc/Hz (10 MHz carrier, 10 kHz offset). The direct digital synthesis (DDS) based high-resolution sample clock has a sample rate resolution of 1.06 µHz, which offers you exceptional stability and sampling rate flexibility. The NI 5421 can also import its sample clock from the CLK IN and DDC connectors, PXI star trigger, and PXI trigger bus or RTSI bus. In addition, you can phase lock the NI 5421 oscillator to an external reference or the PXI 10 MHz reference clock.

With synchronization, you can create mixed-signal test systems by combining the NI 5421 with other modular instruments such as the NI 5122 digitizer and/or the NI 655x digital waveform generator/analyzer. You can also synchronize two or more NI 5421 modules to build a multichannel phase coherent AWG, important for applications such as I and Q signal generation or antilock brake system simulation.

To trigger other instruments such as oscilloscopes, the NI 5421 can generate marker event outputs. A marker event can be placed in a different location in each waveform segment.

Calibration

Every NI 5421 is factory calibrated using NIST-traceable standards. The NI 5421 has an onboard calibration reference that corrects for environmental effects on DC gain, offset, and timing errors. If you want to calibrate your device externally, return your NI 5421 to National Instruments or ship it to a qualified metrology lab for recalibration.

Software

Every National Instruments signal generator comes with the IVI-compliant NI-FGEN driver, which is fully compatible with NI LabVIEW, LabWindows/CVI, and Measurement Studio, as well as Microsoft Visual C++ and Visual Basic. NI-FGEN also includes the interactive FGEN Soft Front Panel, with which you can quickly generate standard signals such as sine, square, and ramp, as well as user-defined waveforms. Simulation mode is available in both the FGEN Soft Front Panel and the NI-FGEN instrument driver, so you can develop your application without having the hardware in your system. In this mode, several developers can write applications for the same hardware and share resources.

With the Analog Waveform Editor you can rapidly create or edit analog test signals for use with the NI 5421. To view or edit existing waveforms, you can open files saved in binary, ASCII, or the LabVIEW Express .lvm file format. Alternatively, you can create your waveform from scratch by selecting from a list of over 20 waveform primitives, such as sine and Gaussian noise, or enter a mathematical expression. The Analog Waveform Editor is included with the 32 and 256 MB models of the NI 5421, and is a separate add-on for use with the 8 MB model.

Ordering Information

NI PXI-5421
- 8 MB 778697-01
- 32 MB, LVDS output 778697-02
- 256 MB, LVDS output 778697-03

NI PCI-5421
- 8 MB 778692-01
- 32 MB, LVDS output 778692-02
- 256 MB, LVDS output 778692-03

Includes NI 5421 module, SMB112 cable, NI-FGEN, and FGEN Soft Front Panel. The 32 and 256 MB models also include the Analog Waveform Editor.

Software

NI Analog Waveform Editor 778848-01

LVDS Cable

SHC68-68-D3.....188143-01

Accessories

Recommended PXI switch
- NI PXI-2593 778793-01

Related Products

NI 5122 High-Speed Digitizer
NI 655x Digital Waveform Generator/Analyzers
NI SCXI-1193 Multiplexer Switch

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*Visit **ni.com/products** and enter pxi5421 or pci5421.*

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Specifications

Specifications are valid for 0 to 55 °C, unless otherwise noted.

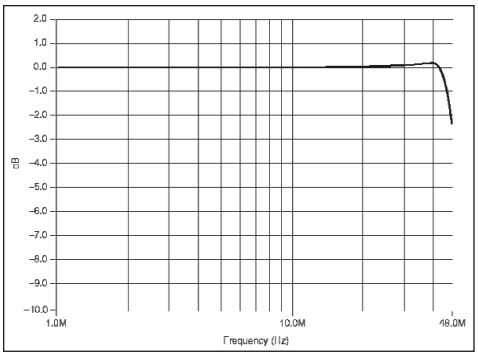
General

Number of channels 1
DAC resolution ..... 16 bits
Maximum sampling rate ..... 100 MS/s
Maximum effective sampling rate with Interpolation ..... 400 MS/s
Bandwidth ..... 43 MHz
Output paths ..... 1. Main Output Path setting with driver selected Low Gain Amplifier or the High Gain Amplifier
2. Direct Path optimized for IF applications

Analog Output

Amplitude range (full scale)
Main output path ..... 12 V_{pp} to 5.64 mV_{pp} (50 Ω load)
Direct path ..... 1 V_{pp} to 0.707 V_{pp} (50 Ω load)
Offset range ..... ±25% of Amplitude Range
Output impedance ..... 50 or 75 Ω, software selectable
DC Accuracy
0 to 55 °C ..... ±0.4% of amplitude, ±0.05% of offset ±1 mV
Within ±10 °C of self-calibration temperature ..... ±0.2% of amplitude, ±0.05% of offset ±500 ΩV
AC amplitude accuracy ..... ± 1.0% of Amplitude ± 1 mV at 50 kHz
Output filters ..... 2. Software selectable seven-pole elliptical analog filter and finite impulse response (FIR) digital interpolating filter
Passband flatness ..... ± 0.25 dB (100 Hz to 40 MHz) for Direct Path

Normalized Passband Flatness, Direct Path



Rise/fall time ..... < 8 ns for Main Output Low Gain Path

Spectral Characteristics	Frequency	Direct Path	Low Gain Path	Comments
Signal to Noise and Distortion (SINAD)	1 MHz	64 dB	66 dB	Amplitude -1 dBFS Measured from DC to 50 MHz
	10 MHz	61 dB	60 dB	
Spurious Free Dynamic Range w/ Harmonics	1 MHz	76 dBc	71 dBc	
	10 MHz	68 dBc	64 dBc	
Spurious Free Dynamic Range w/o Harmonics	1 MHz	88 dBFS	91 dBFS	
	10 MHz	87 dBFS	-89 dBFS	
Total Harmonic Distortion (THD)	20 kHz	-77 dBc (0.014%)	-77 dBc (0.014%)	Amplitude -1 dBFS 2nd through 6th harmonics
	1 MHz	-75 dBc	-70 dBc	

Average Noise Density

	Amplitude Range		Average Noise Density		
Path	V_{p-p}	dBm	nV/√Hz	dBm/Hz	dBfs/Hz
Low gain	0.1	-16.0	9	-148	-132.0
High gain	12	25.6	213	-120	-145.6

Sample Clock

Sources ..... Internal Divide-by-N, Internal High-Resolution, External CLK IN, External DDC Clk In, PXI star Trigger, PXI_TRIG <0:7>, RTSI <0:7>
Frequency resolution
Divide-by-N ..... (100 MS/s) / N where 1 ≤ N ≤ 4,194,304
High Resolution ..... 1.06 µHz

	System Phase Noise Density	System Output Jitter	Comment
Divide-by-N (PXI)	-137 dBc/Hz (10 kHz offset)	< 1.0 ps rms	10 MHz carrier
Divide-by-N (PCI)	-137 dBc/Hz (10 kHz offset)	< 2.0 ps rms	
High Resolution	-126 dBc/Hz (10 kHz offset)	< 4.0 ps rms	

Onboard Clock (Internal VCXO)

Sample clock source ..... Phase locked to reference clock or derived from onboard VCXO frequency reference.
Frequency accuracy ..... ±25 ppm
PLL reference clock sources ..... PXI_CLK10, CLK IN, RTSI_7

Digital Data and Control, DDC (optional front panel connector)

Data output signals ..... 16 LVDS data lines (ANSI/TIA/EIA-644 compliant)

Start Trigger

Sources ..... PFI <0:3>, PXI_TRIG<0:7>, RTSI <0:7>
PXI Star Trigger, Software, Immediate
Modes ..... Single, Continuous, Stepped, Burst

Markers

Destinations ..... PFI <0:1>, PFI <4:5>, PXI_TRIG <0:7>, RTSI <0:7>
Quantity ..... 1 Marker per Segment

Waveform and Instruction Memory Utilization

	8 MB Standard	32 MB Option	256 MB Option
Onboard Memory Size	8,388,608 bytes	33,554,432 bytes	268,435,456 bytes

Output modes ..... Arbitrary waveform; Arbitrary sequence
Loop count ..... 1 to 16,777,215. Burst trigger: unlimited

Memory Limits	8 MB	32 MB	256 MB	Comment
Arbitrary waveform Mode maximum Waveform memory	4,194,176 Samples	16,777,088 Samples	134,217,600 Samples	Refer to detailed specifications for all trigger modes.
Arbitrary sequence Mode maximum Waveform memory	4,194,120 Samples	16,777,008 Samples	134,217,520 Samples	Condition: One or two segments in a sequence
Arbitrary sequence Mode maximum Waveforms	65,000	262,000	2,097,000	Condition: One or two segments in a sequence
Arbitrary sequence Mode maximum Segments in a sequence	104,000	418,000	3,354,000	Condition: Waveform memory is <4,000 samples.

Power

+3.3 VDC	+5 VDC	+12 VDC	-12 VDC	Total Power
1.9 A	2.0 A	0.46 A	0.01 A	21.9 W

Physical

Front panel connectors
CH0 ..... SMB (Jack)
CLK IN ..... SMB (Jack)
PFI 0 ..... SMB (Jack)
PFI 1 ..... SMB (Jack)
Digital data and control ..... 68-pin VHDCI Female Receptacle

Environment

Operating temperature (PXI) ..... 0 to +55 °C (Meets IEC-60068-2-1 and IEC-60068-2-2)
Operating temperature (PCI) ..... 0 to +45 °C
Storage temperature ..... -25 to +85 °C (Meets IEC-60068-2-1 and IEC-60068-2-2)
Relative humidity ..... 10 to 90%, noncondensing (Meets IEC 60068-2-56)

Calibration

Self-calibration ..... Correction for DC gain offset, and timing errors
External calibration interval ..... 2 years

Certifications and Compliances

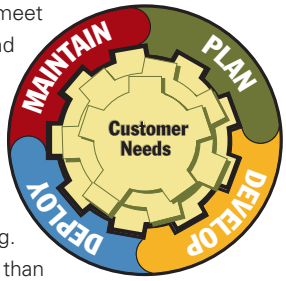
CE Mark compliance CE

Note

Unless otherwise noted, the following conditions were used for each specification:
A. Analog filter enabled
B. Interpolation set to maximum allowed factor for a given sample rate
C. Signals terminated with 50Ω
D. Direct path set to 1 Vpk-pk, Low Gain Amplifier Path set to 2 Vpk-pk, and High Gain Amplifier Path set to 12 Vpk-pk
E. Sample clock set to 100 MS/s

For detailed specifications on power, environmental, safety, and physical dimensions, please visit ***ni.com/products*** and enter express code: ***pxi5421*** or ***pci5421***

Global Services and Support



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