

100 MS/s, 16-Bit Arbitrary Waveform Generator

NEW

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++

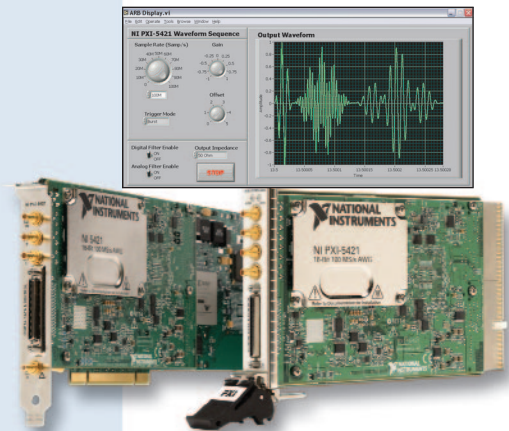
Application Software

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

Driver Software (included)

- NI-FGEN

Calibration Certificate Included



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.

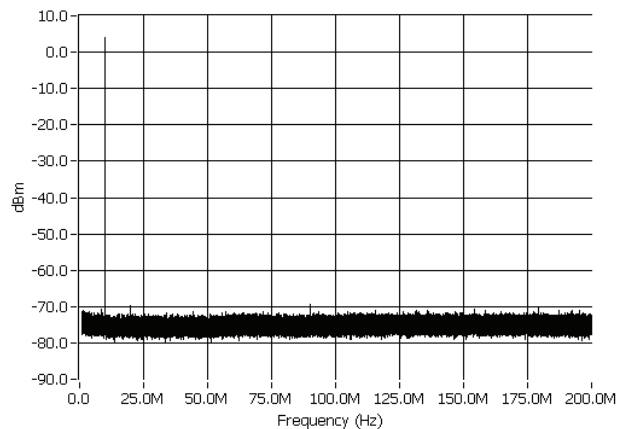


Figure 1. Power Spectrum of a 10 MHz Sine Wave Output from the PXI-5421

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.

100 MS/s, 16-Bit Arbitrary Waveform Generator

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 μ Hz, 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 Editor778848-01

LVDS Cable

SHC68-68-D3188143-01

Accessories

Recommended PXI switch
NI PXI-2593778793-01

Related Products

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

BUY ONLINE!

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.

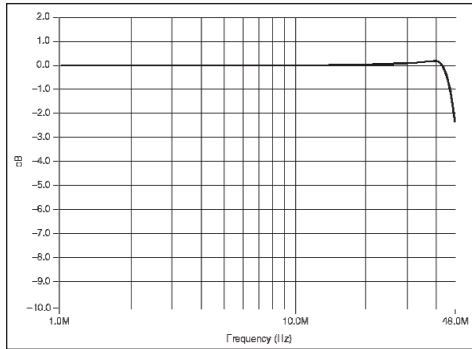
General

| | |
|---------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| 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 | |
| Spurious Free Dynamic Range w/o Harmonics | 10 MHz | 68 dBc | 64 dBc | |
| Total Harmonic Distortion (THD) | 20 kHz | -77 dBc (0.014%) | -77 dBc (0.014%) | Amplitude -1 dBFS |
| | 1 MHz | -75 dBc | -70 dBc | 2nd through 6th harmonics |

Average Noise Density

| Path | Amplitude Range | Average Noise Density | | |
|-----------|------------------|-----------------------|--------|--------|
| | V _{p-p} | dBm | nV/√Hz | dBm/Hz |
| Low gain | 0.1 | -16.0 | 9 | -148 |
| High gain | 12 | 25.6 | 213 | -120 |

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

| Onboard Memory Size | 8 MB Standard | 32 MB Option | 256 MB Option |
|---------------------|-----------------|------------------|-------------------|
| | 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:

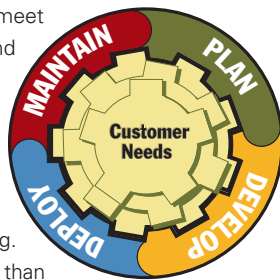
- Analog filter enabled
- Interpolation set to maximum allowed factor for a given sample rate
- Signals terminated with 50Ω
- Direct path set to 1 V_{pk-pk}, Low Gain Amplifier Path set to 2 V_{pk-pk}, and High Gain Amplifier Path set to 12 V_{pk-pk}
- Sample clock set to 100 MS/s

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

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