

# 16 MHz Function Generator

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Modular Instrumentation

## NI 5401

- 1 channel
- 16 MHz sine wave
- 1 MHz square, triangle, ramp waveforms
- 9.31 mHz frequency resolution
- 12-bit resolution
- 50 or 75  $\Omega$  output impedance, software selectable
- Linear and logarithmic sweeps
- Frequency hopping
- 4 triggering modes
- SYNC (TTL) output
- 16 KB memory for arbitrary waveform generation

## Models

- NI PCI-5401
- NI PXI-5401

## Operating Systems

- Windows 2000/NT/XP/Me/9x

## Recommended Software

- LabVIEW
- LabWindows/CVI
- Measurement Studio for Visual C++

## Other Compatible Software

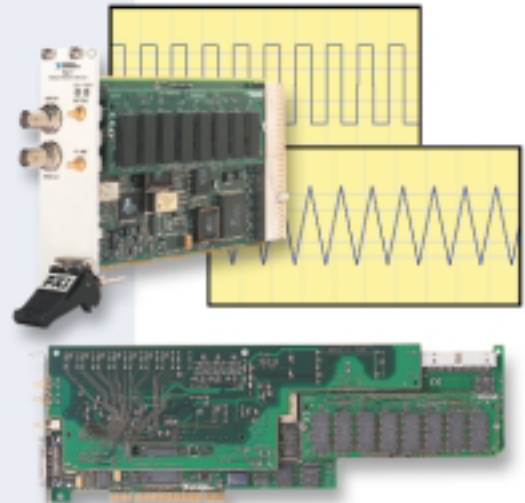
- Visual Basic
- C/C++

## Driver Software (included)

- NI-FGEN

## Calibration Certificate Included

See page 21.



## Overview

NI 5401 devices are full-featured 40 MS/s function generators for use with PCI and PXI. Using an NI 5401, you combine the power and capability of a stand-alone function generator with the flexibility and benefits of your computer to create highly capable virtual instrument solutions.

Direct digital synthesis (DDS) is used to precisely generate standard waveforms that are repetitive in nature, including sine, TTL, square, and triangular waveforms. The number of waveform samples stored is 16,384, and the number of frequency steps that can be stored in the instruction FIFO memory is 512. The minimum frequency resolution is 9.31 mHz.

Analog voltages generated by the 12-bit DAC pass through a lowpass filter and amplification/attenuation scheme to maximize dynamic range.

## SYNC Output

The SYNC output is a TTL version of the sine wave generated by the DAC and has a maximum frequency of 16 MHz. SYNC is useful as a high-frequency resolution and software-programmable clock source.

## Triggering

Triggering controls the starting and stopping of waveform generation. Trigger sources are either external or software controlled. Like the NI 5411 AWGs, NI 5401 generators, include four triggering modes – single, continuous, stepped, and burst. See page 470 for a description of each mode.

## Frequency Hopping and Frequency Sweeps

Frequency hopping and frequency sweeps are possible using the linking capabilities in DDS mode. All frequency changes are phase continuous, and a burst of several tones can be generated.

## Phase-Locked Loops

The phase-locked loops (PLLs) of the instruments synchronize waveform generation to an external clock to within a tuning range of  $\pm 100$  ppm. The reference clock source may come from the external connector, RTSI bus (for PCI), or PXI trigger bus (for PXI). The NI 5401 phase-locks to an external reference clock source of 1 MHz or 5 to 20 MHz in 1 MHz steps. The PLL can lock to a signal level from 1.0 V<sub>p-p</sub> to 5.0 V<sub>p-p</sub>.

## INFO CODES

For more information, or to order products online visit [ni.com/info](http://ni.com/info) and enter:

pxi5401  
pci5401

**BUY ONLINE!**

Product	Bus	Operating Systems	Channels	Update Rate	Frequency Range (sine)	Resolution	Memory
NI 5401	PCI, PXI	Windows 2000/NT/XP/Me/9x	1	40 MS/s	16 MHz	12 bits	16 KB

Table 1. NI 5401 Channel, Speed, and Resolution Specifications

# 16 MHz Function Generator

## Calibration

Every NI 5401 is factory calibrated and is shipped with a calibration certificate verifying that it meets NIST-traceable standards. You can perform self-calibration (internal calibration) to ensure that your device is within specifications. If you want to externally calibrate your device return your NI 5401 to National Instruments or ship it to a qualified metrology lab for recalibration. External calibration is usually performed on an annual basis.

**Please see page 21 or visit [ni.com/calibration](http://ni.com/calibration) for more information about calibration services.**

## I/O Connector

The PCI-5401 has three SMB connectors for access to the analog output on ARB, to the sync pulse on SYNC, and to the PLL reference input on PLL Ref. The Dig Out connector is a 50-pin, very-high-density (VHD) SCSI connector for access to the external trigger input. The PXI-5401 has two BNC connectors for the analog output and SYNC pulse signals, and two SMB connectors for the PLL reference signal and external trigger input. The PXI-5401 does not have a VHD SCSI connector.

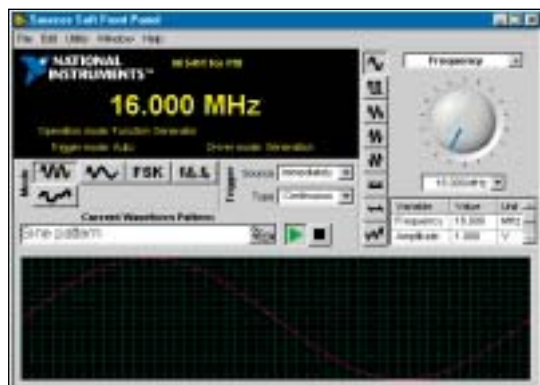


Figure 1. The Source Soft Front Panel provides interactive control of the NI 5401.

## Software

To build an automated test application or integrate an NI 5401 in your test software, use the IVI-compliant NI-FGEN instrument driver with:

- LabVIEW
- LabWindows/CVI
- Measurement Studio for Visual C++
- Microsoft Visual Basic
- Microsoft C++

## Interactive Control

NI 5401 generators come with the versatile Sources Soft Front Panel (SFP) with which you can interactively control the device. You can generate standard and arbitrary periodic waveforms with control of frequency, amplitude, and DC offset amplitude with the Sources SFP. You can generate linear and logarithmic frequency sweeps and phase-continuous frequency hopping of standard waveforms. Additionally, you can use the Sources SFP to set the sequential output with several triggering modes.

## Ordering Information

NI PCI-5401 .....777949-01  
 NI PXI-5401 .....777950-01  
 Includes the NI 5401 hardware, cable, NI-FGEN, Sources Soft Front Panel, and calibration certificate.

For information on extended warranty and value added services, see page 20.

See page 480 for accessory and cable options.

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## Specifications

These specifications are typical at 25 °C unless otherwise stated.

### Analog Output

Number of channels .....	1
Resolution .....	12 bits
Update rate .....	40 MS/s maximum; 610 S/s minimum
Type of DAC .....	Multiplying
DDS accumulator .....	32 bits
Frequency range	
Sine .....	16 MHz maximum
SYNC (TTL) .....	16 MHz maximum
Square .....	1 MHz
Ramp .....	1 MHz
Triangle .....	1 MHz
Frequency resolution (DDS mode) .....	9.31 mHz

### Voltage Output

Ranges .....	±5 V into 50 Ω load
	±10 V into high impedance load
Accuracy .....	±0.1 dB
Output attenuation .....	0 to 73 dB
Resolution .....	0.001 dB steps
Preattenuation offset	
Range .....	±2.5 V into 50 Ω (but with less than 10 dB of attenuation, single maximum and offset [before attenuation] must not exceed ±5 V [into 50 Ω])
Accuracy .....	±5 mV
DC .....	DC
Output coupling .....	50 or 75 Ω, software selectable
Output impedance .....	50 Ω or greater
Load impedance .....	50 Ω or greater
Output enable .....	Software switchable
Protection .....	Short circuit protected
Sine Spectral Purity	
Harmonic and spurious	
Up to 1 MHz .....	-60 dBc
Up to 16 MHz .....	-35 dBc
Phase noise .....	-105 dBc/Hz at 10 kHz from carrier

### Filter Characteristics

Digital	
Type .....	Half-band interpolating
Selection .....	Software switchable
Taps .....	67
Filter coefficients .....	Fixed 20-bit
Data interpolating frequency .....	80 MS/s
Pipeline signal delay .....	26 sampling periods
Analog	
Type .....	7th-order, L-C lowpass filter
Passband ripple .....	±2 dB

### Waveform Definition

Memory .....	16,384 samples exact, 16-bit
Frequency list length .....	512 steps

### Timing I/O

Internal	
Update clock .....	40 MHz maximum
Interval count .....	2 to 65,535
Internal clock	
Frequency .....	40 MHz
Initial accuracy .....	±5 ppm
Temperature stability (0 to 55° C) ...	±25 ppm
Aging (1 year) .....	±5 ppm
Phase Locking	
External reference sources .....	Input connector, RTSI clock line or internal
Reference clock frequencies .....	1 MHz, 5 to 20 MHz in 1 MHz steps
Frequency locking range .....	±100 ppm

### Digital Trigger

Compatibility .....	TTL
Response .....	Rising edge
Pulse width .....	20 ns minimum
Trigger to waveform output	
DDS mode .....	28 sample clocks + 150 ns, maximum

### RTSI Bus, PXI Trigger Lines

Trigger lines .....	7
Clock lines .....	1
Bus Interface .....	Slave
SYNC out	
Level .....	TTL
Duty cycle .....	20 to 80%, software controllable
External Clock Reference Input	
Frequency .....	1 MHz or 5 to 20 MHz, in 1 MHz steps
Amplitude .....	1.0 to 5 Vpp

### Power Requirements

+5 VDC .....	3.5 A maximum
+12 VDC .....	125 mA

### Physical

Dimensions	
PCI .....	33.8 by 9.9 cm (13.3 by 3.9 in.)
PXI .....	10 by 16 cm (3.9 by 6.3 in.)
I/O Connectors	
Arb out, SYNC out (PCI) .....	SMB
Arb out, SYNC out (PXI) .....	BNC
PLL reference in (PCI, PXI) .....	SMB
External trigger (PCI) .....	50-pin, (VHD), SCSI connector
External trigger (PXI) .....	SMB

### Environment

Operating temperature .....	0 to 55 °C
Storage temperature .....	-20 to 70 °C
Relative humidity .....	5 to 90%, noncondensing

### Certifications and Compliances

CE Mark Compliance 