100 MHz, 100 MS/s 8 to 21-Bit Digitizer

NI PCI-5911

- 1 channel with flexible resolution – 21 bits at 10 kS/s to 8 bits at 100 MS/s
- 100 MS/s real-time and 1 GS/s random interleaved sampling
- 100 MHz bandwidth
- ±100 mV to ±10 V input range
- Deep memory of 4 or 16 MB with multirecord capture mode
- Antialias protection for flexible resolution sampling mode

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

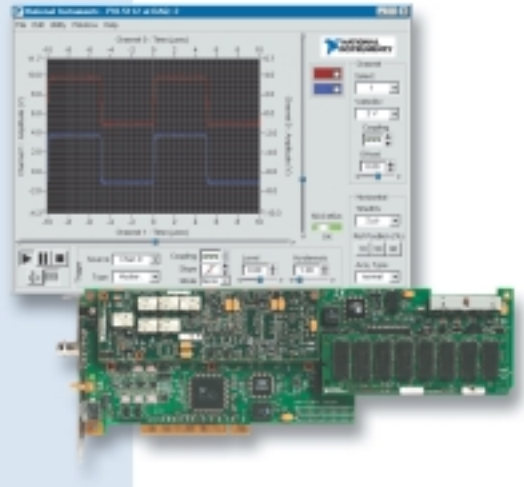
Recommended Software
- LabVIEW
- LabWindows/CVI
- Measurement Studio for Visual C++

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

Driver Software (included)
- NI-SCOPE

Calibration Certificate Included

See page 21



Product	Bus	Operating Systems	Channels	Sampling Rate	Bandwidth	Memory per Channel	Resolution
PCI-5911	PCI	Windows 2000/NT/XP/Me/9x	1	100 MS/s	100 MHz	4 or 16 MB	8-21 bits

Table 1. PCI-5911 Channel, Speed, and Resolution Specifications

INFO CODES
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pci5911

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Overview

The National Instruments PCI-5911 is more than a 100 MHz digitizer. It is a flexible, high-speed, high-resolution digitizer with variable speed and resolution. The resolution ranges from 8 bits at 100 MS/s to more than 21 bits at 10 kS/s. Whether you analyze spectra, capture transients, digitize IFs, or record waveforms, the NI PCI-5911 offers low distortion and low noise for a low cost. In addition, because it is PCI-based, data transfers are faster than with traditional instruments, which means faster measurements. With the PCI-5911, you can build lower cost test, measurement, and data acquisition systems spanning a wide variety of applications in semiconductor test, video test, component characterization, and electronic test.

Flexible Resolution Technology

The PCI-5911 uses a patented digital signal processing technique to significantly increase the sample precision. The flexible resolution technology consists of a specialized filter, a flash analog-to-digital converter (ADC), a digital-to-analog converter (DAC), and a DSP for decimation and linearization.

Hardware

Analog Input

The PCI-5911 flexible resolution digitizer has one analog input channel with 100 MHz input bandwidth and seven input ranges from ±0.1 to ±10 V. The analog input stage features a 1 MΩ input impedance, AC and DC coupling, onboard self-calibration, and overvoltage protection up to ±42 V.

Acquisition System

Signal acquisition is performed in one of two modes of operation – conventional mode or flexible-resolution mode. In conventional mode, the PCI-5911 functions as an 8-bit, 100 MHz digitizer with 100 MS/s real-time sample rates and 1 GS/s random interleaved sampling (RIS) for repetitive signals. Conventional mode must be used to digitize signals with bandwidths between 4 and 100 MHz.

When digitizing signals with bandwidths less than 4 MHz, you can use flexible-resolution mode, a patented signal processing technology, to extend the effective resolution beyond eight bits. The ADC circuitry functions as a multibit sigma-delta converter. The signal is sampled at 100 MS/s. A noise-shaping circuit moves quantization noise in the data from lower frequencies to higher frequencies. The data is then passed to a DSP where the signal is linearized to a precision of 21 bits, and the high-frequency noise is removed by a digital lowpass filter, which also serves as an antialiasing filter. Finally, the data is resampled at a lower rate (decimation) with a higher effective resolution. All the signal processing on the 100 MHz data stream is performed in real-time so that no

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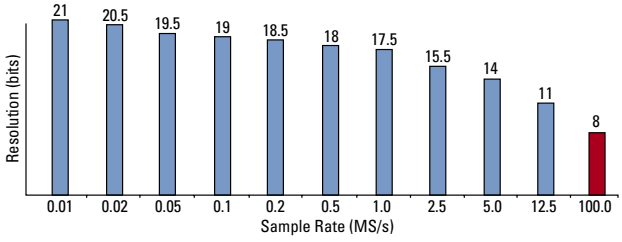

Figure 1. Typical Effective Resolution versus Sampling Rate with Voltage Range of ±10 V

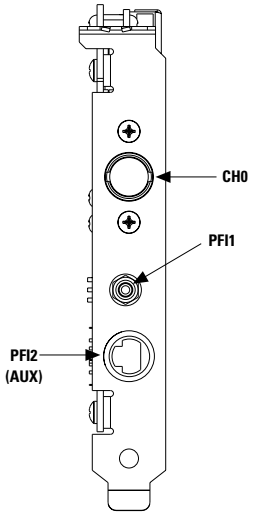

Figure 2. I/O Connector for the PCI 5911

data is lost during acquisition and analysis. Figure 1 shows the effective resolution as a function of acquisition rate.

Acquisition Memory

You can order your PCI-5911 with either 4 or 16 MB of waveform memory. Data is acquired into the onboard memory before being transferred to the host PC memory. Data is acquired in a single shot or in multiple records. When in multiple-record operation, the hardware acquires and rearms for the next record.

The PCI-5911 uses the scatter-gather bus master capability of the PCI-MITE to move data to computer memory at speeds faster than traditional instrument interfaces such as GPIB and RS-232. This transfer speed is one reason why PCI-based measurement systems decrease overall test time.

Clock Generation

When building multi-instrument measurement systems, routing a precise clock to each instrument can be challenging. The PCI-5911 uses an advanced 100 MHz clock generator, immune to jitter on a reference clock, to produce a low jitter, low phase-skew clock for easy synchronization and precise clocking of multiple devices.

Triggering

The PCI-5911 has three trigger sources – analog, digital, and software control. An analog trigger is derived by comparing the waveform to either one threshold or two thresholds forming a hysteresis condition. Digital triggers come from either the RTSI synchronization bus or from the external digital connectors. The PCI-5911 uses the NI-TIO timing ASIC as its timing engine.

Multiple-Instrument Synchronization

The RTSI bus routes timing and trigger signals between two or more PCI-5911 boards or other National Instruments PCI products. Multiple-instrument synchronization includes triggering several measurement devices with a signal from a single instrument and the synchronizing of all the instruments to the same clock. This results in more accurate measurements across multiple instruments.

Calibration

Every PCI-5911 is factory calibrated and is shipped with a calibration certificate verifying that it meets NIST-traceable standards. The PCI-5911 has an onboard calibration generator that corrects for any environmental effects on gain, offset, and linearity. You can also perform self-calibration (or internal calibration) to ensure that your board is within specifications. To externally calibrate your device, return your PCI-5911 to National Instruments or ship it to a qualified metrology lab for recalibration.

Please see page 21 or visit ni.com/calibration for more information about calibration services.

Software

Every National Instruments high-speed digitizer comes with the NI-SCOPE instrument driver, which is fully compatible with LabVIEW, LabWindows/CVI, Microsoft Visual C++, and Microsoft Visual Basic. With more than 50 built-in measurement and analysis functions, including time and frequency-domain measurements, digital filters, windows, histograms, and waveform math, you can build automated test solutions in minimal time. Further customize your waveform analysis using LabVIEW, LabWindows/CVI, DIAdem, and TestStand. NI high-speed digitizers also include the interactive SCOPE Soft Front Panel to help you get started quickly and troubleshoot throughout the development process.

Related Products

- Arbitrary Waveform and Function Generator (page 467)
- High-Speed Digital I/O (page 378)
- S Series Simultaneous-Sampling DAQ (page 196)

Ordering Information

NI PCI-5911

4 MB memory 777478-01

16 MB memory 777478-02

Includes the NI 5911 hardware, NI-SCOPE, and SCOPE Soft Front Panel.

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

See page 480 for accessory and cable information.

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Specifications

Typical for 25 °C unless otherwise noted.

Acquisition System

Bandwidth ..... 100 MHz at all input ranges
Number of channels 1
Number of flexible resolution ADC 1
Max sample rate ..... 1 GS/s repetitive, 100 MS/s single shot
Sample onboard memory per channel ..... 4 or 16 MB
Memory sample depth

Sampling Rate	Sampling Mode	Sample Depth (4 MB option)	Sample Depth (16 MB option)
100 MS/s	conventional	4 Msamples	16 Msamples
12.5 MS/s	flexible resolution	1 Msamples	4 Msamples
5 MS/s	flexible resolution	1 Msamples	4 Msamples
2.5 MS/s	flexible resolution	1 Msamples	4 Msamples
1 MS/s	flexible resolution	1 Msamples	4 Msamples
500 kS/s	flexible resolution	1 Msamples	4 Msamples
200 kS/s	flexible resolution	1 Msamples	4 Msamples
100 kS/s	flexible resolution	1 Msamples	4 Msamples
50 kS/s	flexible resolution	1 Msamples	4 Msamples
20 kS/s	flexible resolution	1 Msamples	4 Msamples
10 kS/s	flexible resolution	1 Msamples	4 Msamples

Memory record sizes ..... 2,000 samples, up to maximum sample depth determined by memory option and sampling mode

Acquisition Characteristics

Vertical sensitivity (input ranges for all sampling rates)

Input Range	Noise Referred to Input
±10 V	-174 dBfs/$\sqrt{Hz}$
±5 V	-168 dBfs/$\sqrt{Hz}$
±2 V	-160 dBfs/$\sqrt{Hz}$
±1 V	-154 dBfs/$\sqrt{Hz}$
±0.5 V	-148 dBfs/$\sqrt{Hz}$
±0.2 V	-140 dBfs/$\sqrt{Hz}$
±0.1 V	-128 dBfs/$\sqrt{Hz}$

Accuracy

DC gain accuracy ..... ±0.05% signal ±0.0001% fs for all input ranges at 1 MS/s in flexible resolution mode
DC offset accuracy ..... ±0.1 mV ±0.01% fs for all input ranges at 1 MS/s in flexible resolution mode
Input coupling ..... DC and AC, software selectable
AC coupling cut-off frequency (-3dB) ..... 2.5±0.5 Hz
Input impedance ..... 1 MΩ ±2%
Max measurable input Voltage ..... ±10 V (DC + peak AC)
Input protection ..... ±42 VDC (DC + peak AC)
Input bias current ..... ±1 nA typical at 25 °C

Common-Mode Characteristics

Impedance to chassis ground ..... 10 kΩ
Common-mode rejection ratio ..... CMRR > -70 dB, (F_{in} < 1 kHz)

Filtering (for all input ranges)

Sampling Rate	Filter Mode	Bandwidth	Ripple	Alias Attenuation
100 MS/s	conventional	100 MHz (typ.)	±3 dB	N/A
12.5 MS/s	flexible resolution	3.75 MHz	±0.2 dB	-60 dB
5 MS/s	flexible resolution	2 MHz	±0.1 dB	-70 dB
2.5 MS/s	flexible resolution	1 MHz	±0.05 dB	-80 dB
1 MS/s	flexible resolution	400 kHz	±0.005 dB	-80 dB
500 kS/s	flexible resolution	200 kHz	±0.005 dB	-80 dB
200 kS/s	flexible resolution	80 kHz	±0.005 dB	-80 dB
100 kS/s	flexible resolution	40 kHz	±0.005 dB	-80 dB
50 kS/s	flexible resolution	20 kHz	±0.005 dB	-80 dB
20 kS/s	flexible resolution	8 kHz	±0.005 dB	-80 dB
10 kS/s	flexible resolution	4 kHz	±0.005 dB	-80 dB

Dynamic Range

Noise (excluding input-referred noise)

Sampling Rate	Bandwidth	Noise Density	Total Noise
100 MS/s	100 MHz	-120 dBfs/$\sqrt{Hz}$	-43 dBfs
12.5 MS/s	3.75 MHz	-135 dBfs/$\sqrt{Hz}$	-64 dBfs
5 MS/s	2 MHz	-143 dBfs/$\sqrt{Hz}$	-83 dBfs
2.5 MS/s	1 MHz	-152 dBfs/$\sqrt{Hz}$	-91 dBfs
1 MS/s	400 kHz	-160 dBfs/$\sqrt{Hz}$	-104 dBfs
500 kS/s	200 kHz	-160 dBfs/$\sqrt{Hz}$	-107 dBfs
200 kS/s	80 kHz	-160 dBfs/$\sqrt{Hz}$	-111 dBfs
100 kS/s	40 kHz	-160 dBfs/$\sqrt{Hz}$	-114 dBfs
50 kS/s	20 kHz	-160 dBfs/$\sqrt{Hz}$	-117 dBfs
20 kS/s	8 kHz	-160 dBfs/$\sqrt{Hz}$	-121 dBfs
10 kS/s	4 kHz	-160 dBfs/$\sqrt{Hz}$	-124 dBfs

Calculation

To calculate total noise, use the equation below, where "V" is the "corresponding noise referred to input" from the Vertical Sensitivity Chart and "D" is the "noise density" from the Dynamic Range Chart.

$$20 \log \sqrt{10^{V/10} + 10^{D/10}}$$

Distortion

**1<n<2^20 in Oscilloscope mode*

Sampling Rate	SFDR for Input 0 dBfs	SFDR for Input -20 dBfs	SFDR for Input -60 dBfs (typical)
100/n* MS/s*	50 dBfs	50 dBfs	N/A
12.5 MS/s	65 dBfs	85 dBfs	125 dBfs
5 MS/s	70 dBfs	90 dBfs	130 dBfs
2.5 MS/s	75 dBfs	95 dBfs	135 dBfs
1 MS/s	85 dBfs	105 dBfs	145 dBfs
500 kS/s	90 dBfs	110 dBfs	150 dBfs
200 kS/s	100 dBfs	110 dBfs	160 dBfs
100 kS/s	100 dBfs	110 dBfs	160 dBfs
50 kS/s	100 dBfs	110 dBfs	160 dBfs
20 kS/s	100 dBfs	110 dBfs	160 dBfs
10 kS/s	100 dBfs	110 dBfs	160 dBfs

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Specifications (continued)

Timebase System

PCI	Internal 10 MHz ref clock	RTSI 10 MHz ref clock (can export or import via RTSI bus)	External 10 MHz ref clock (PFI 1 or PFI 2)

Number of timebases
Clock accuracy (as master) ..... 10 MHz ±50 ppm
Clock input tolerance (as slave) ..... 10 MHz ±100 ppm
Clock jitter ..... <75 pS rms, independent of reference clock source
Clock compatibility ..... TTL for both input and output
Interpolator resolution (repetitive only) ..... 1 ns

Sampling clock frequencies

Conventional mode ..... 100 n/MHz, where $1<n<2^{32}$
Flexible resolution mode ..... 100 n/MHz, where n = 8, 20, 50, 100, 200, 500, 1000, 2000, 5000, 10000
Synchronization ..... Via RTSI trigger lines
Phase difference between multiple instruments ..... <5 ns, at any input frequency <100 MHz from input connector to input connector

Triggering Systems

Modes ..... Above threshold, below threshold, outside thresholds
Source ..... CH0, RTSI<0..6>, PFI 1,2
Slope ..... Rising/falling
Hysteresis ..... Full-scale voltage/n, where n is between 1 and 256; full-scale voltage on TRIG is fixed to ±5 V (without external attenuation)
Coupling ..... AC/DC on CH0, TRIG
Pretrigger depth ..... 1 to 16 million samples*
Posttrigger depth ..... 1 to 16 million samples*
Holdoff by time ..... 100 µs to 171.85 s in increments of 40 ns
Resolution ..... 8 bits, 170 steps in full-scale voltage range
TRIG input range ..... ±5 V (without external attenuation)
TRIG input impedance ..... 1 MΩ ±1% in parallel with 30 pF ±15 pF
TRIG input protection ..... ±42 V [(DC + peak AC) < 10 kHs, without external attenuation]

Acquisition Modes

RIS ..... 1 GS/s down to 200 MS/s effective sample rate, repetitive signals only. Data is interleaved in software.
RIS accuracy ..... <0.5 nS
Single shot ..... 100 MS/s down to 10 kS/s sample rate for transient and repetitive signals

Power Requirements

+5 VDC ..... 4 A
+12 VDC ..... 100 mA
-12 VDC ..... 100 mA

Physical

Dimensions ..... 33.8 x 9.9 cm (13.3 x 3.9 in.)

I/O connectors
Analog input CH0 ..... BNC female
Digital triggers ..... SMB female, 9-pin mini DIN

Environment

Operating temperature ..... 5 to 40 °C
Storage temperature ..... -20 to 65 °C
Relative humidity ..... 10 to 90%, noncondensing

Calibration

Internal ..... Internal calibration is done upon software command. The calibration involves gain, offset and linearity correction for all input ranges and input modes.
Interval ..... 1 week, or anytime temperature changes beyond ±5 °C. Temperature variations beyond calibration limits are detected by hardware and may be queried by software.
External ..... Internal reference requires recalibration
Interval ..... 1 year
Warm-up time ..... 15 minutes

Certifications and Compliances

CE Mark Compliance CE

* Depending on memory option and sampling mode