PCIe-DAS1602/16

PCI Express Analog and Digital I/O Board

Features

- 16-bit resolution
- 16 single-ended or 8 differential analog input channels (switch-selectable)
- Up to 100 kS/s overall throughput (100 kS/s max for any channel)
- Two 12-bit analog outputs
- 32 digital I/O
- Three 16-bit counters
- 1 kS FIFO
- Connector- and software-compatible with the PCIM-DAS1602/16

Software

- TracerDAQ® software included for acquiring and displaying data and generating signals
- Universal Library includes support for Visual Studio® and Visual Studio® .NET, with examples for Visual C++®, Visual C#®, Visual Basic®, and Visual Basic® .NET
- InstaCal software utility for installation, calibration, and test
- ULx for NI LabVIEW™
- Comprehensive drivers for DASYLab®
- Supported by MATLAB® Data Acquisition Toolbox™
- Supported Operating Systems: Windows 7/Vista/XP SP2, 32-bit or 64-bit

Overview

The PCIe-DAS1602/16 is a multifunction measurement and control board designed for the PCI Express (PCIe) bus. The board provides 16 single-ended (SE) or eight differential (DIFF) input channels with 16-bit resolution, two 12-bit analog outputs, 32 DIO, and three 16-bit counters.

The PCIe-DAS1602/16 is a fully connector-compatible and software-compatible replacement for the Measurement Computing PCIM-DAS1602/16.

Signal Connections

One 37-pin connector provides access to the 16 SE/8 DIFF analog inputs, two analog outputs, four digital inputs, four digital outputs, and three counter/timer channels.

The PCIe-DAS1602/16 provides 16 single-ended or eight differential analog inputs, sampling rates up to 100 kS/s, two 12-bit analog outputs, 32 digital I/O, and three 16-bit counters

A 40-pin connector provides access to 24 DIO connections.

Analog Input

The PCIe-DAS1602/16 provides 16 SE or eight DIFF analog inputs. The input mode is switch-selectable to configure all channels as either SE or DIFF.

The board offers bipolar analog input ranges of ±10 V, ±5 V, ±2.5 V, and ±1.25 V, and unipolar ranges of 0 V to 10 V, 0 V to 5 V, 0 to 2.5 V, and 0 V to 1.25 V.

Input ranges are software-selectable, and polarity is switch-selectable.

Sample Rate

The PCIe-DAS1602/16 offers a single-channel sample rate of 100 kS/s divided by the number of channels being sampled.

Analog Output

Two 12-bit multiplying digital-to-analog converters (DACs) provide analog output on the PCIe-DAS1602/16. DAC0 and DAC1 each accept a precision 5 V or 10 V reference, which provides onboard D/A unipolar ranges of 0 V to 5 V and 0 V to 10 V, and bipolar ranges of ±5 V and ±10 V.

Other ranges between 0 V and 10 V are available when an external precision voltage reference is supplied to the DAC0 REF IN pin or DAC1 REF IN pin of the main connector.

Onboard reference voltage, user-supplied reference voltage, and polarity are all jumper-selectable.

Digital I/O

The 24 digital I/O connections available on the 40-pin DIO connector of the PCIe-DAS1602/16 are available as two eight-bit ports (ports A and B) and two four-bit ports (ports CH and CL). Each port can be configured independently as either input or output. These ports default to the input state (high impedance) on power up or reset.

The eight digital I/O connections available on the main 37-pin connector consist of two 4-bit ports. One port is permanently configured as input, and the other port is permanently configured as output.

Pull-Up/Pull-Down Configuration

The PCIe-DAS1602/16 includes jumpers to set the digital bits for pull-up (+5 V) or pull down (0 V) when the board is powered on and reset. Ports A, B, CH, and CL are factory-configured for pull-up (+5 V).

Counter/Timer I/O

Each PCIe-DAS1602/16 offers three 16-bit down counters. Each counter accepts frequency inputs up to 10 MHz, and provides clock, gate, and output connections.

The frequency of the square wave used as a clock by the A/D pacer circuitry is jumper-selectable for 1 MHz (default), or 10 MHz. The internal pacer output driving the A/D converter is also available at pin 20 (CTR 3 Output) on the main 37-pin I/O connector.

Connect the counter clock to the onboard 10 MHz crystal oscillator, or leave unconnected for user input.

The A/D pacer clock trigger edge (rising or falling) that initiates the A/D conversions is jumper-selectable on the PCIe-DAS1602/16. The jumper is configured for rising edge by default.

Calibration

The PCIe-DAS1602/16 can be fully calibrated either at the factory or in the field using InstaCal.

MCC DAQ Software

Each PCIe-DAS1602/16 ships with the MCC DAQ software CD, which includes InstaCal, a software utility for installing, calibrating, and testing Measurement Computing hardware, along with the following software packages:

TracerDAQ

TracerDAQ is an out-of-the-box application that can generate, acquire, analyze, display, and export data within seconds of installing Measurement Computing data acquisition hardware. TracerDAQ includes a strip chart, an oscilloscope, a function generator, and a rate generator, all of which are accessed through a common, easy-to-use interface.

TracerDAQ provides four virtual instrument applications used to graphically display and store input data

Universal Library

The Universal Library (UL) is a set of programming libraries for developing applications with Visual Studio programming languages (and others) for use with Measurement Computing hardware. UL includes a complete function library that simplifies the configuration and operation of your measurement device. UL supports Visual Studio and Visual Studio .NET, and includes 64-bit driver support for Windows 7 and Vista.

ULx for NI LabVIEW

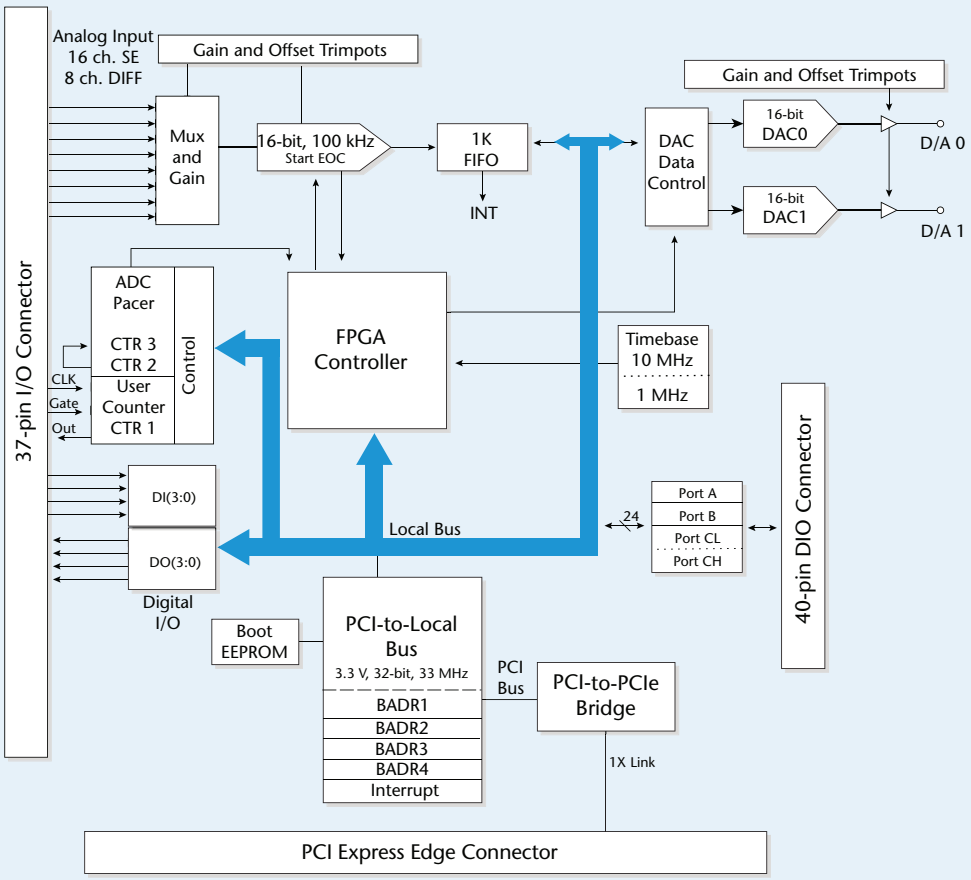
ULx for NI LabVIEW is a comprehensive library of graphical functions and example programs comprising all the power of the Universal Library and InstaCal. ULx for NI LabVIEW is compatible with NI LabVIEW 8.5 and later, and allows quick development of NI LabVIEW instrumentation, acquisition, and control applications with Measurement Computing hardware.

Software Available Separately

TrecerDAQ Pro is available as a purchased upgrade to TracerDAQ. TracerDAQ Pro supports more active channels, more samples per channel, and a selection of options and enhancements designed to address many test and measurement applications.

The PCIe-DAS1602/16 is also supported by DASYLab and the MATLAB Data Acquisition Toolbox.

PCIe-DAS1602/16 Block Diagram



Specifications

All specifications are subject to change without notice.
Typical for 25 °C unless otherwise specified.

Power Consumption

3.3 V Quiescent: 500 mA typ, 750 mA max
12 V Quiescent: 100 mA typ, 150 mA max
User 5 V Outputs: 10 mA

Analog Input

A/D Converter Type: LTC1605CSW
Resolution: 16 bits
Number of Channels (Switch-Selectable): 16 SE/8 DIFF
Input Ranges
Gain (Software-Selectable)
Unipolar/Bipolar Polarity (Switch-Selectable)
±10 V, ±5 V, ±2.5 V, ±1.25 V, 0 V to 10 V, 0 V to 5 V, 0 to 2.5 V, 0 V to 1.25 V
A/D Pacing (Software-Selectable)
Internal Counter: 82C54, positive or negative edge (jumper-selectable)
External Source: Pin 25, positive or negative edge (software-selectable)
Software Polled
A/D Trigger (Only Available When Internal Pacing Selected, Software-Selectable)
External Edge Trigger: Pin 25, positive or negative edge (software-selectable)
A/D Gate (Only Available When Internal Pacing Selected, Software-Selectable)
External Gate: Pin 25, high or low level (software-selectable)
Simultaneous Sample and Hold Trigger
TTL Output: Pin 26 (jumper-selectable); Logic 0 = Hold, Logic 1 = Sample
Burst Mode (Software-Selectable): Burst interval = 10 us
Data Transfer: From 1024 sample FIFO through interrupt with REPINSW, Interrupt, Software polled
Interrupt: INTA# mapped to IRQ*n* through PCI BIOS at boot-time
Interrupt Enable: Programmable through PCI9030
Interrupt Polarity: Active high level or active low level, programmable through PLX9030
Interrupt Sources (Software-Selectable): End of conversion; FIFO not empty; End of Burst; End of Acquisition; FIFO half full
A/D Conversion Time: 10 µs max
Throughput
Single Channel: 100 kS/s
Multi-Channel: (100 kS/s)/(# of channels)
Common Mode Range: ±10 V min
CMRR @ 60 Hz: –100 dB typ, –80 dB min
Input Leakage Current: ±3 nA max
Input Impedance: 10 MΩ min
Absolute Maximum Input Voltage: 55 V/–40 V fault-protected through input mux

Analog Input Accuracy	
Typical Accuracy	±2.3 LSB
Absolute Accuracy	±5.0 LSB

Analog Input Accuracy Components	
Gain error	Trimmable by potentiometer to 0
Offset error	Trimmable by potentiometer to 0
PGA linearity error	±1.3 LSB typ , ±10.0 LSB max
Integral linearity error	±0.5 LSB typ , ±3.0 LSB max
Differential linearity error	±0.5 LSB typ, ±2.0 LSB max

Each PCIe-DAS1602/16 is tested at the factory to assure the overall error of the board does not exceed ±5 LSB.
Total board error is a combination of gain, offset, differential linearity, and integral linearity error. The theoretical absolute accuracy of the board may be calculated by summing these component errors. Worst case error is realized only in the unlikely event that each of the component errors is at their maximum level, and causes error in the same direction.

Analog Input Drift			
Range	Analog Input FS Gain Drift	Analog Input Zero drift	Overall Analog Input Drift
±10.00 V	2.2 LSB/°C max	1.8 LSB/°C max	4.0 LSB/°C max
±5.000 V	2.2 LSB/°C max	1.9 LSB/°C max	4.1 LSB/°C max
±2.500 V	2.2 LSB/°C max	2.0 LSB/°C max	4.2 LSB/°C max
±1.250 V	2.2 LSB/°C max	2.3 LSB/°C max	4.5 LSB/°C max
0 V to 10.00 V	4.1 LSB/°C max	1.9 LSB/°C max	6.0 LSB/°C max
0 V to 5.000 V	4.1 LSB/°C max	2.1 LSB/°C max	6.2 LSB/°C max
0 V to 2.500 V	4.1 LSB/°C max	2.4 LSB/°C max	6.5 LSB/°C max
0 V to 1.250 V	4.1 LSB/°C max	3.0 LSB/°C max	7.1 LSB/°C max

Absolute error change per °C temperature change is a combination of the gain and offset drift of many components. The theoretical worst case error of the board may be calculated by summing these component errors. Worst case error is realized only in the unlikely event that each of the component errors is at their maximum level, and causes error in the same direction.

The following table summarizes the worst case noise performance for the PCIe-DAS1602/16. Noise distribution is determined by gathering 50,000 samples with inputs tied to ground at the PCIe-DAS1602/16 main connector. Data is for both SE and DIFF modes of operation.

Noise Performance				
Range	±2 counts	±1 count	Max Counts	LSBrms
±10.00 V	97%	80%	11	1.7
±5.000 V	97%	80%	11	1.7
±2.500 V	96%	79%	11	1.7
±1.250 V	96%	79%	11	1.7
0 V to 10.000 V	88%	65%	15	2.3
0 V to 5.000 V	88%	65%	15	2.3
0 V to 2.500 V	83%	61%	15	2.3
0 V to 1.250 V	83%	61%	16	2.4

Input noise is assumed to be Gaussian. An RMS noise value from a Gaussian distribution is calculated by dividing the peak-to-peak bin spread by 6.6. Noise performance may be affected by input cabling and/or excessive noise from adjacent PCBs within the PC enclosure.

Crosstalk is defined here as the influence of one channel upon another when scanning two channels at the specified per channel rate for a total of 50,000 samples. A full-scale (FS) 100 Hz triangle wave is input on channel 1, with channel 0 tied to analog ground at the 37 pin user connector. The table below summarizes the influence of channel 1 on channel 0 and does not include the effects of noise.

Crosstalk			
Range	1 kHz Crosstalk (LSB pk-pk)	10 kHz Crosstalk (LSB pk-pk)	50 kHz Crosstalk (LSB pk-pk)
±10.000 V	4	13	24
±5.000 V	3	7	18
±2.5000 V	2	5	16
±1.250 V	3	4	14
0 V to 10.000 V	4	8	23
0 V to 5.000 V	3	5	16
0 V to 2.500 V	2	4	16

Analog Output

D/A Converter Type: MX7548
Resolution: 12 bits
Number of Channels: 2
Channel Type: SE voltage output
Output Range (Jumper-Selectable Per Output): ±10 V, ±5 V, 0 to 10 V, or 0 V to 5 V using onboard references, or user-defined using external reference
Reference Voltage (Jumper-Selectable)
Onboard: –10 V and –5 V
External: Independent (DAC0 REF IN pin 10 and DAC1 REF IN/SSH OUT pin 26)
External Reference Voltage Range: ±10 V max
External Reference Input Impedance: 10 kΩ min
Data Transfer (System-Dependent): Programmed I/O
Monotonicity: Guaranteed monotonic over temperature
Slew Rate: 2.0 V/µs min
Settling Time: 30 µS max to ±½ LSB for a 20 V step
Current Drive: ±5 mA min
Output Short-Circuit Duration: Indefinite at 25 mA
Output Coupling: DC
Output Impedance: 0.1 Ω max
Output Stability: Any passive load
Coding: Offset binary
Bipolar Mode
0 code = Vref
4095 code = –Vref – 1 LSB, Vref < 0 V
–Vref + 1 LSB, Vref >0 V
Unipolar Mode
0 code =0 V
4095 code = –Vref – 1 LSB, Vref < 0 V
–Vref + 1 LSB, Vref > 0 V
Output Voltage On Power Up and Reset: 0 V ± 10 mV

Analog Output Accuracy	
Typical Accuracy	±1 LSB
Absolute Accuracy	±2 LSB

Analog Output Accuracy Components	
Gain Error	Trimmable by potentiometer to 0
Offset Error	Trimmable by potentiometer to 0
Integral Linearity Error	±0.5 LSB typ , ±1 LSB max
Differential Linearity Error	±0.5 LSB typ, ±1 LSB max

Total board error is a combination of gain, offset, differential linearity and integral linearity error. The theoretical absolute accuracy of the board may be calculated by summing these component errors. Worst case error is realized only in the unlikely event that each of the component errors is at their maximum level, and causes error in the same direction.

Analog Output Drift	
Analog Output FS Gain Drift	±0.22 LSB/°C max
Analog Output Zero Drift	±0.22 LSB/°C max
Overall Analog Output Drift	±0.44 LSB/°C max

Absolute error change per °C temperature change is a combination of the gain and offset drift of many components. The theoretical worst case error of the board may be calculated by summing these component errors. Worst case error is realized only in the unlikely event that each of the component errors is at their maximum level, and causing error in the same direction.

Digital Input/Output

40-Pin Digital I/O Connector

Digital Type: 82C55
Number of I/O: 24
Configuration Per 82C55: 2 banks of 8 and 2 banks of 4, or 3 banks of 8, or 2 banks of 8 with handshake
Input High: 2.0 V min, 5.5 V absolute max
Input Low: 0.8 V max, –0.5 V absolute min
Output High: 3.0 V min @ –2.5 mA
Output Low: 0.4 V max @ 2.5 mA
Power-Up/Reset State: Input mode (high impedance)
Pull-Up/Pull-Down Resistors (Jumper-Selectable): All pins pulled up to +5 V by default through individual 47 kΩ resistors

37-Pin Main Connector

Digital Output Type: 74ACT244, power up/reset to LOW logic level
Digital Input Type: 74AHCT373, pulled to logic high through 47 kΩ resistors
Number of I/O: 8
Configuration: 4 fixed input, 4 fixed output
Output High: 2.7 V @ –0.4 mA min
Output Low: 0.5 V @ 8 mA max
Input High: 2.0 V min, 7 V absolute max
Input Low: 0.8 V max, –0.5 V absolute min

Counter

Counter Type: 82C54
Configuration: 3 down counters, 16 bits each
Counter 1 Source (Software-Selectable)
External Source: Main connector pin 21*
Internal Source: 100 kHz
Counter 1 Gate: External gate from main connector pin 24*
Counter 1 Output: Available from main connector pin 2
Counter 2 Source (Jumper-Selectable): Internal 1 MHz; internal 10 MHz
Counter 2 Gate (Software-Selectable): External source from main connector pin 25*
Counter 2 Output: Internal only, chained to counter 3 source
Counter 3 Source: Counter 2 output
Counter 3 Gate (Software-Selectable): External source from main connector pin 25*

* Pins 21, 24, and 25 are pulled to logic high through 47 kΩ resistors

Counter 3 Output: Available from main connector pin 20; programmable as A/D converter pacer clock.
Clock Input Frequency: 10 MHz max
High Pulse Width (Clock Input): 30 ns min
Low Pulse Width (Clock Input): 50 ns min
Gate Width High: 50 ns min
Gate Width Low: 50 ns min
Input High: 2.0 V min, 5.5 V absolute max
Input Low: 0.8 V max, –0.5 V absolute min
Output High: 3.0 V min @ –2.5 mA
Output Low: 0.4 V max @ 2.5 mA
Crystal Oscillator Frequency: 10 MHz
Frequency accuracy: 50 ppm

Environmental

Operating Temperature Range: 0 °C to 70 °C
Storage Temperature Range: –40 °C to 100°C
Humidity: 0% to 95% non-condensing

Mechanical

Board Dimensions (L × W × H): 168 × 111 × 19 mm (6.6 × 4.4 × 0.7 in.)

Main Connector

Connector Type: 37-pin male D connector
Connector Compatibility: Identical to PCIM-DAS1602/16 connector

Digital I/O Connector

Connector Type: 40-pin header
Connector Compatibility: Identical to PCIM-DAS1602/16 connector

Ordering Information

Description	Part No.
16-Channel, 16-Bit Digital I/O PCI Express Board with Dual Burst Mode D/As	PCIe-DAS1602/16

Accessories & Cables

Description	Part No.
Backplate and cable assembly with 40-pin IDC female to 37-pin D male for CIO boards	BP40-37
Cable, 37-conductor ribbon, female to female, 2 ft.	C37FF-2
Cable, 37-conductor ribbon, female to female, 3 ft.	C37FF-3
Cable, 37-conductor ribbon, female to female, 4 ft.	C37FF-4
Cable, 37-conductor ribbon, female to female, 5 ft.	C37FF-5
Cable, 37-conductor ribbon, female to female, 10 ft.	C37FF-10
Cable, 37-conductor ribbon, female to female, 15 ft.	C37FF-15
Cable, 37-conductor ribbon, female to female, 20 ft.	C37FF-20
Cable, 37-conductor ribbon, female to female, 25 ft.	C37FF-25
Cable, 37-conductor ribbon, female to female, 50 ft.	C37FF-50
Cable, 37-conductor shielded, female to female molded connectors, 5 ft.	C37FFS-5
Cable, 37-conductor shielded, female to female molded connectors, 10 ft.	C37FFS-10
Universal screw-terminal board, 37-pin	CIO-MINI37
Universal screw-terminal board, 37-pin D male connector, vertical	CIO-MINI37-VERT
Universal screw-terminal board, prototyping area 37 terminals	CIO-TERMINAL
Signal connection box, 37-conductor, shielded	SCB-37

Signal Conditioning Options

The PCIe-DAS1602/16 is compatible with many Measurement Computing signal conditioning accessories. Refer to the PCIe-DAS1602/16 product page at www.mccdaq.com/pci-data-acquisition/PCIe-DAS1602-16.aspx for a list of compatible accessories.

Software

Icon-based data acquisition, graphics, control, and analysis software	DASYLab
Out-of-the-box virtual instrument suite with strip chart, oscilloscope, function generator, and rate generator – professional version	TracerDAQ Pro