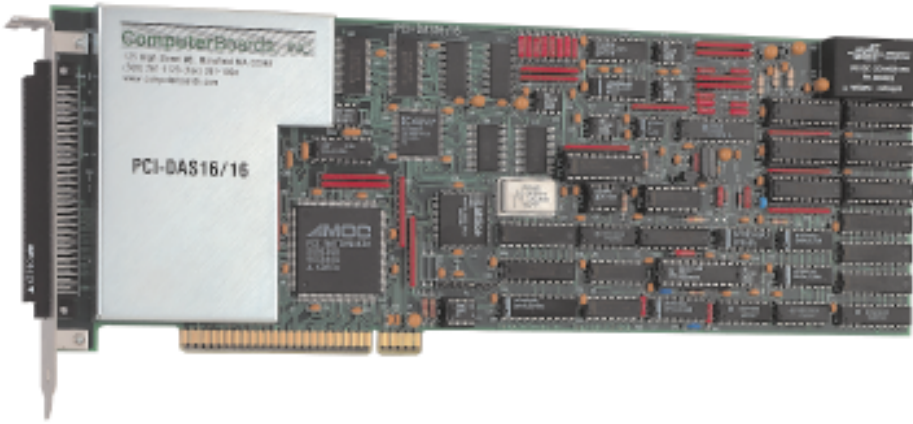# PCI-DAS1602/16 & PCI-DAS1602/16/JR

High-Speed PCI-bus Compatible, 16-bit, 16-Channel Analog Input Board with Dual Analog Output Channels & 24 Digital I/O bits

Features

- 16 channel SE / 8 channel diff.
- 16-bit A/D resolution
- 200 KHz sample rate
- Analog trigger input (not avail on /JR)
- Burst-Mode SS&H emulation
- 512 sample FIFO
- Dual 16-bit D/As (not avail on /JR)
- 100 KHz D/A update rate
- One 16-bit counter
- 24-bits, high current digital I/O
- Fully Plug-and-Play
- Fully Autocalibrating

Block Diagram

PCI-DAS1602/16 Block Diagram
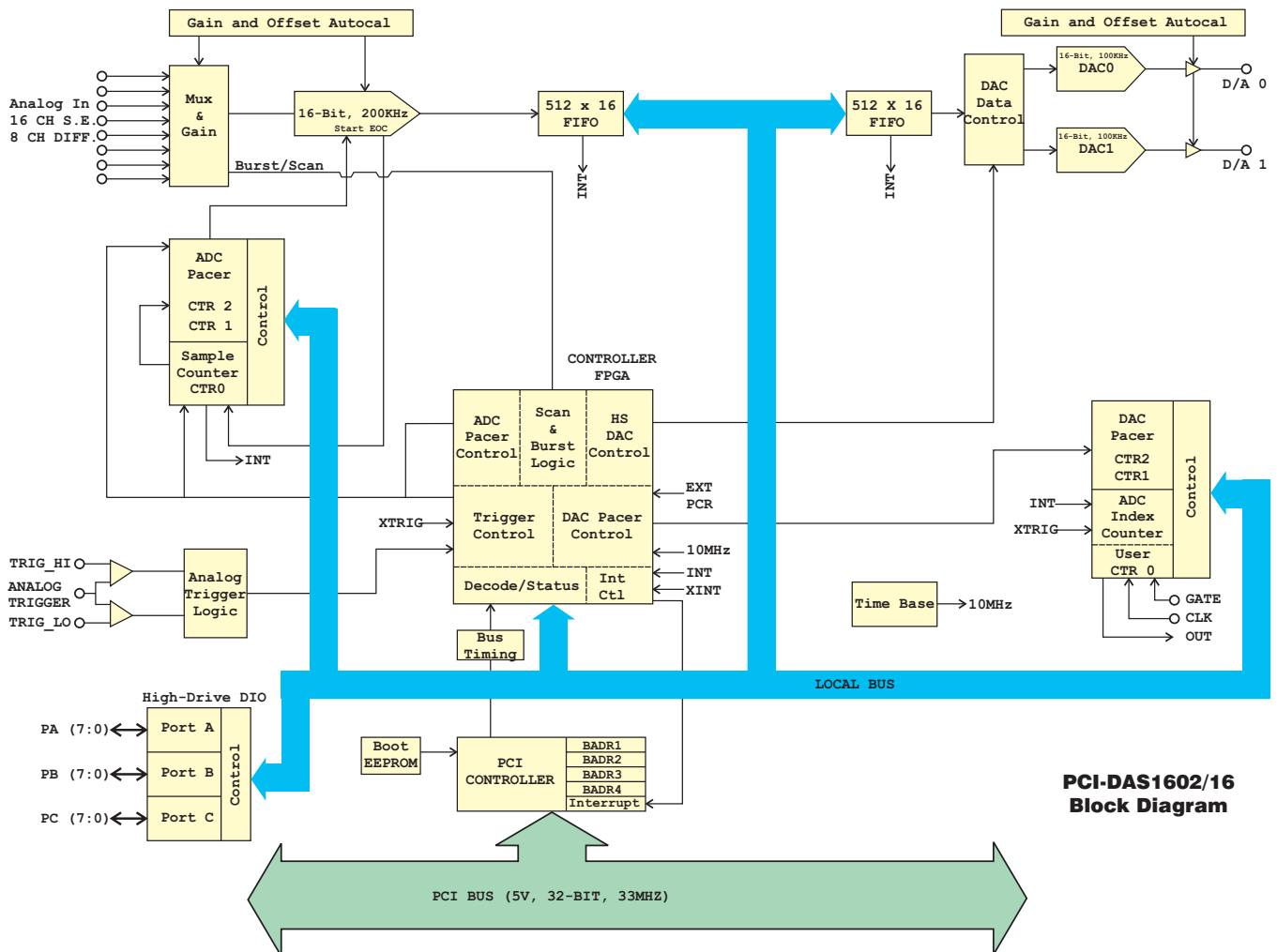
Functional Description

The PCI-DAS1602/16 multifunction analog and digital I/O board sets a new standard for high speed, high resolution data acquisition on the PCI-bus. Offering 16 single-ended or 8 differential 16-bit analog inputs with sample rates up to 200 KHz, 24 bits of high current digital I/O, three 16-bit down counters. The PCI-DAS1602/16 has an analog trigger input with trigger levels and direction selectable by software and offers two FIFO buffered 16-bit analog outputs with 250 KHz maximum update rates. The lower cost PCI-DAS1602/16/JR does not provide the analog output or analog input trigger functions.

The PCI-DAS1602/16 is completely plug-and-play. There are no switches, jumpers or potentiometers on the board. All board addresses, interrupt channels etc. are set by your computer's plug-and-play software. Even calibration is performed via software by using on-board digital potentiometers and trim D/A converters. (For more details on our digital calibration techniques, please see our calibration tutorial on page 74).

Analog Inputs

The PCI-DAS1602/16 provides 8 fully differential or 16 single-ended analog inputs. The input mode is software selectable, with no switches or jumpers to set. The board offers a 200 KHz maximum sample rate in single and multichannel scans at any gain setting. A 512 sample FIFO assures data taken from the board is transferred into computer memory without the possibility of missed samples.
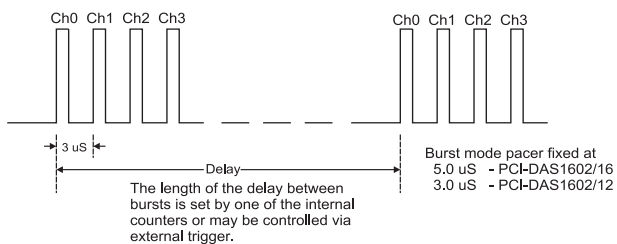
Software also selects the bipolar/unipolar input configuration as well as selecting among the input ranges. The table below details the input ranges and resolutions for the available input configurations and gains.

Bipolar Range	Resolution	Unipolar Range	Resolution
±10V	305 uV	0 - 10V	153 uV
±5V	153 uV	0 - 5V	76.3 uV
±2.5V	76.3 uV	0-2.5V	38.1 uV
±1.25V	38.1 uV	0-1.25V	19.1 uV

Burst Mode

Channel-to-channel skew is the result of multiplexing the A/D inputs and is defined as the time between consecutive samples. For example, if four channels are sampled at a rate of 1 KHz per channel, the channel skew is 250 µs (1 ms/4).

Burst mode minimizes channel-to-channel skew by clocking the A/D at the maximum rate between successive channels. For example, at the 1-ms pulse channel 0 is sampled, channel 1 is sampled 5 µs later, channel 2, 5 µs after that, and channel 3, 5 µs after that. Then no samples are taken until the next 1-ms pulse, when channel 0 is sampled again. In this mode the rate for all channels is 1 KHz, but the channel-to-channel skew (delay) is now 5 µs, or 20 µs total. The minimum burst mode skew/delay on the PCI-DAS1602/16 is 5 us.

Ch0 Ch1 Ch2 Ch3   Ch0 Ch1 Ch2 Ch3

3 uS

Delay

The length of the delay between bursts is set by one of the internal counters or may be controlled via external trigger.

Burst mode pacer fixed at
5.0 uS - PCI-DAS1602/16
3.0 uS - PCI-DAS1602/12

Burst Mode Timing Diagram

Analog Outputs

The PCI-DAS1602/12 provides two channels of high speed 16-bit analog output. The analog outputs are updated via on-board FIFO and REP OUTSW commands and provide a 100 KHz max. update rate. Software selectable output ranges of 0-10V, 0-5V, ±10V and ±5V are provided, and channels may be set at different ranges. The D/A outputs provide rated accuracy to ±5 mA, are short circuit protected (25 mA limit) and are cleared to 0 volts on power up or reset.

Parallel Digital I/O

The PCI-DAS1602/16 provide 24 bits of high current (64mA sink, 15 mA source) parallel, digital I/O in the form of two 8-bit ports, and two 4-bit ports. This digital capability is an 82C55 mode 0 chip emulation, allowing each port to be set independently as input or output. On power up or reset, the ports default to the input state (high impedance).

Counter/Timer I/O

The PCI-DAS1602/16 provides one 16-bit down counter (one third of an 82C54 chip). The counter provides clock, gate and output connections. The Counter clock may also be connected to the on-board 10 MHz xtal oscillator or may be left uncommitted for user input.

Installed in any PCI-bus compatible personal computer the PCI-DAS1602/16 turns your personal computer into a high speed data acquisition and control station suitable for laboratory data collection, instrumentation, production test, or industrial monitoring.

Software

All PCI-DAS1602/16 boards come complete with ComputerBoards's powerful *InstaCal*™ software package. *InstaCal* is a complete installation, calibration and test program for ComputerBoards data acquisition and control boards. Complete with extensive error checking, *InstaCal* guides you through installation and setup of your data acquisition board and creates the board configuration file for use by your program or application software package. *InstaCAL* is described in detail within the software section of this handbook.

Universal Library provides powerful, easy to use functions with extensive sample programs and greatly reduces your programming effort.

The PCI-DAS1602/16 boards are fully supported by ComputerBoards' powerful UniversalLibrary. Universal Library is a complete set of I/O libraries and drivers for all of our boards, for all Windows based languages. When using the Universal Library you can switch boards or even programming languages and the syntax remains constant. For details on Universal Library, please refer to the software section of this handbook.

The PCI-DAS-1602/16 boards are fully supported by a wide variety of applications software packages including DAS-Wizard™, (and DAS-Wizard Pro™), HP VEE®, Labtech Notebook® and LabVIEW® . For further details of these, as well as a number of other software packages, please refer to the software section provided earlier in this handbook. Thirty-day time locked versions and demos of many of these and other software packages are available for download on our web site.

PCI-DAS1602/16 Specifications

Analog input section

Resolution	16- bits
Programmable ranges	±10V, ±5V, ±2.5V, ±1.25V, 0 - 10V, 0 - 5V, 0 - 2.5V, 0 - 1.25V
A/D pacing	Programmable: internal counter or external source or software polled
Burstmode	Software selectable option, skew = 5μs

A/D Trigger sources   External analog or digital
A/D Triggering Modes

Digital: SW configurable for Edge (triggered) or level-activated (gated). Programmable polarity (rising/falling edge, high/low gate).

Analog: SW configurable for above/below reference, in/out window and hysteresis. Programmable polarity (rising/falling edge trigger, high/low gate). Trigger levels set by DAC0 and/or DAC1.

Pre-trigger: Unlimited pre- and post-trigger samples. Total # of samples must be > 512. Compatible with Digital and Analog trigger

Data transfer	via 512 sample FIFO via REPINSW, interrupt, or software polled
Polarity	Unipolar/Bipolar, software selectable
Number of channels	8 diff/16 SE, Software selectable
A/D conversion time	5μs
Throughput	200KHz min

Diff. Linearity error	±1.25V range	±3 LSB
	all other ranges	±1 LSB
Integral Linearity error	±1.25V	±3 LSB
	all other ranges	±1.5 LSB
Gain Error	±1.25V, 0-1.25V	22.5 ppm typ, 45 max
	all other ranges	22.5ppm max
No missing codes	16 bits guaranteed	
Gain drift / Zero drift	±20ppm/°C / ±10ppm/°C	
Input leakage current	200nA (25 Deg C)	
Input impedance	10 Meg Ohms, Min	
Maximum input voltage	±15V	

Analog Output:

Resolution	16-bits
Number of channels	2
Voltage Ranges	±10V, ±5V, 0-5V, 0-10V. Each channel independently programmable
D/A pacing	Internal or external clock or software paced
D/A trigger modes	Software or external gate.
Data transfer	via 512 sample FIFO via REPOUTSW or programmed I/O.
Offset error	±100uV max, all ranges (calibrated)
Gain error	±30.5ppm max (calibrated)
Differential nonlinearity	±1LSB max
Integral nonlinearity	±1LSB max
Monotonicity	16 bits at 25 DegC
D/A Gain drift	±15 ppm/°C max
D/A Bipolar offset drift	±5 ppm/°C max
D/A Unipolar offset drift	±3 ppm/°C max
Throughput	100KHz, 2 channels simultaneous.
Settling time (20V step to .0008%)	13 μs max
Settling time (10V step to .0008%)	6μs typ

Slew Rate	10V Ranges	6V/uS
	5V Ranges	3V/uS

Current Drive	±5 mA min
Short-circuit current	25 mA indefinite
Output Coupling / impedance	DC / 0.1 Ohms max
Miscellaneous	Power up/reset, all DAC's set to 0 volts

Digital Input / Output

Digital Type	8255 mode 0 emulation
Output:	74LS244
Input:	74LS373
Configuration	2 banks of 8, 2 banks of 4, programmable by bank as input or output
Default/Reset State	Input, High Impedance
Output High	2.4 volts @ -15mA min
Output Low	0.5 volts @ 64 mA min
Input High	2.0 volts min, 7 volts absolute max
Input Low	0.8 volts max, -0.5 volts absolute min
Interrupts	INTA# - mapped to IRQn via PCI BIOS at boot-time
Interrupt enable	Software programmable
Interrupt sources	External (rising TTL edge event) or a variety of internal FIFO status sources

Counter section

Configuration Two 82C54s with three 16-BIT down counters per 82C54

82C54A:

Counter 0 - ADC residual sample counter
Source: ADC Clock.
Gate: Internal programmable source
Output: End-of-Acquisition interrupt

Counter 1 - ADC Pacer Lower Divider
Source: 10 MHz oscillator
Gate: Tied to Counter 2 gate, programmable source
Output: Chained to Counter 2 Clock

Counter 2 - ADC Pacer Upper Divider
Source: Counter 1 Output.
Gate: Tied to Counter 1 gate, programmable source
Output: ADC Pacer clock (if software selected), available at user connector.

82C54B:

Counter 0 - Pretrigger Mode
Source: ADC Clock.
Gate: External trigger
Output: End-of-Acquisition interrupt.

Counter 0 - Non-Pretrigger Mode - User Counter 4
Source: User input at 100pin connector (CLK4) or internal 10MHz (software selectable)
Gate: User input at 100pin connector (GATE4)
Output: Available at 100pin connector (OUT4)

Counter 1 - DAC Pacer, Lower Divider
Source: 10 MHz on-board oscillator
Gate: Tied to counter 2 Gate
Output: Chained to Counter 2 Clock

Counter 2 - DAC Pacer, Upper Divider
Source: Counter 1 Output
Gate: Tied to Counter 1 Gate
Output: DAC Pacer Clock (available at I/O connector)

Clock input frequency	10Mhz max
High pulse width (clk input)	30ns min
Low pulse width (clk input)	50ns min
Gate width high or low	50ns min
Input low voltage	0.8V max
Input high voltage	2.0V min
Output low voltage	0.4V max
Output high voltage	3.0V min

Power consumption

+5V Operating	2.0A typical, 2.1A max

Environmental

Operating temperature range	0 to 70°C
Storage temperature range	-40 to 100°C
Humidity	0 to 90% non-condensing

I/O Connector & Cables

All I/O signals are brought through a 100-pin high-density connector. The (optional) C100FF-XX series cable splits the 100 pins into two seperate 50-pin cables. The first 50-pin cable contains the signals from pins 1-50, while the second carries pins 51-100 and keeps the analog signals in one cable and the digital in another. This configuration minimizes noise in the analog signal lines and greatly simplifies field wiring as well as connections to external signal conditioning products.

Pin	Signal		Pin	Signal
1	Analog Ground		51	Digital A0
2	Analog Input Ch 0 High		52	Digital A1
3	Analog Input Ch 0 Low / 8 High		53	Digital A2
4	Analog Input Ch 1 High		54	Digital A3
5	Analog Input Ch 1 Low / 9 High		55	Digital A4
6	Analog Input Ch 2 High		56	Digital A5
7	Analog Input Ch 2 Low / 10 High		57	Digital A6
8	Analog Input Ch 3 High		58	Digital A7
9	Analog Input Ch 3 Low / 11 High		59	Digital B0
10	Analog Input Ch 4 High		60	Digital B1
11	Analog Input Ch 4 Low / 12 High		61	Digital B2
12	Analog Input Ch 5 High		62	Digital B3
13	Analog Input Ch 5 Low / 13 High		63	Digital B4
14	Analog Input Ch 6High		64	Digital B5
15	Analog Input Ch 6 Low / 14 High		65	Digital B6
16	Analog Input Ch 7 High		66	Digital B7
17	Analog Input Ch 7 Low / 15 High		67	Digital C0
18	Analog Ground		68	Digital C1
19	NC		69	Digital C2
20	NC		70	Digital C3
21	NC		71	Digital C4
22	NC		72	Digital C5
23	NC		73	Digital C6
24	NC		74	Digital C7
25	NC		75	NC
26	NC		76	NC
27	NC		77	NC
28	NC		78	NC
29	NC		79	NC
30	NC		80	NC
31	NC		81	NC
32	NC		82	NC
33	NC		83	NC
34	NC		84	NC
35	D/A GND 0		85	NC
36	D/A OUT 0		86	NC
37	D/A GND 1		87	NC
38	D/A OUT 1		88	NC
39	CLK 4		89	PC Ground
40	GATE 4		90	PC +12V
41	OUT 4		91	PC Ground
42	A/D External Pacer		92	PC -12V
43	Analog Trigger In		93	NC
44	D/A External Pacer		94	NC
45	A/D External Trigger		95	A/D Internal Pacer Output
46	NC		96	D/A Internal Pacer Output
47	NC		97	External D/A Pacer Gate
48	PC +5V		98	NC
49	SSH OUT		99	External Interrupt
50	PC Ground		100	PC Ground

Auto-Calibration / Self-Calibration

In keeping with general plug-and-play standards, the PCI-DAS1602/16 board has no switches, jumpers or potentiometers. *Auto-calibration* is performed with digital potentiometers and/or trim D/A converters. Unlike some boards that use software lookup tables for post-acquisition error correction, the PCI-DAS1602/16 board's data is accurate when written into your computer's memory.

The calibration factors that control the digital trim components are stored in EEPROM on the board. You can remove the board from one computer, install it in another, and it will still provide calibrated data.

In addition to being auto-calibrating, the PCI-DAS1602/16 board is self calibrating. Standard calibration techniques require a channel to be calibrated with zero volts input (offset calibration) and with a known input voltage (gain calibration). The PCI-DAS1602/16 provides on-board circuitry that will short the inputs allowing offset calibration, and then connect the inputs to an ultra-stable, on-board voltage reference for the gain calibration. A complete PCI-DAS1602/16 calibration is as simple as issuing a single software command.

For a complete discussion of ComputerBoards unique and powerful auto-calibration and self-calibration techniques, please refer to our Auto- and Self-Calibration tutorial beginning on page 74.

Signal Conditioning & Accessories

Analog Signal Conditioning
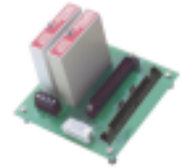
ISO-RACK16/P*   16-channel ISO-5B module rack connects an ISO-5B module to each analog input channel.
ISO-DA02/P*   2-channel ISO-5B module rack connects a ISO-5B module to each analog output channel.

Digital Signal Conditioning (requires DADP-5037 adaptor)

CIO-ERB24*   24 channel relay rack with 6 Amp, Form C relays
CIO-SERB24*   24 channel relay rack with 10 Amp, socketed and field replaceable Form C relays.
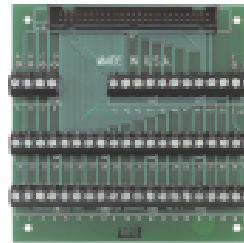SSR-RACK24*   24 channel solid state I/O module rack.

BNC Connector Interface Boxes

BNC-16SE   BNC interface box for 16 channel single-ended mode. Brings each channel out to a BNC connector.
BNC-8DI   BNC interface box for 8 channel differential mode. Each channel has a separate + and - BNC connector.

Screw Terminal Accessory Boards

CIO-MINI50*   50-pin, screw terminal board. If not using any of the above signal conditioning or BNC interconnect boxes, the standard configuration requires two CIO-MINI50s (one for analog connections and one for digital connections). Requires C100FF-2 cable.

* Items denoted with an asterisk are available with detachable screw terminals. These terminals simplify field wiring and board replacements. To specify detachable screw terminals simply add a /DST suffix to the part number (e.g. CIO-MINI50/DST or CIO-ERB24/DST).

Ordering Guide

PCI-DAS1602/16   16-channel, 200KHz, 16-bit A/D, D/A & digital I/O board for PCI-bus computers.

PCI-DAS1602/16/JR   16-channel, 200KHz, 16-bit A/D & digital I/O board for PCI-bus computers.

CPCI-DAS1602/16/JR   16-channel, 200KHz, 16-bit A/D & digital I/O board for PCI-bus computers.