

## Precision Sensor Input and Multi-Function I/O Boards for PCI bus Computers

### FEATURES

- High precision 16-bit A/D resolution
- Sample rates up to 200 KHz
- Up to 32 single-ended or 16 differential A/D channels
- Software programmable gain amplifier (PGA)
- Signal conditioning pads on each analog input
- On-board FIFO stores up to 512 A/D samples
- Pulse rate, pulse period, and event counting
- Programmable timebase and square wave generation
- Supplies precision, adjustable transducer excitation
- Two 16-bit D/A voltage and 4-20 mA current outputs
- 16 digital inputs and 16 digital outputs, high drive
- PCI bus interface supports DMA and plug and play (PnP)
- Pentium® and Windows® 95/98/NT compatible



### GENERAL DESCRIPTION

Harness and exploit the power of the PCI bus with this low cost solution to all your test, measurement, and control applications. The PCI-441 combines analog input, analog output, digital input/output (I/O), and counter/timer I/O on a desktop PCI plug-in board that is designed for intelligent, high precision data acquisition and process control. It is particularly suited to a host of sensor and transducer inputs, such as strain gauges, RTD's, bridge circuits, and displacement sensing elements, as well as strip chart recording, and multi-channel data logging in factory automation, research labs, and industrial control.

Using the latest data conversion technology, the PCI-441 combines many of the features usually provided in expensive stand alone data acquisition systems with significant savings. Numerous external signal conditioning modules are available to accommodate various sensor input requirements such as cold junction compensation (CJC) for thermocouples, linearization, channel isolation, current inputs, and relay switching. The PCI bus plug and play (PnP) interface enables PC auto-detection and initialization, and eliminates all user hardware configuration. Simply plug the board into your PC, install DATEL's PCI-441WIN software, and within minutes you will be analyzing and displaying data in real time, or archiving that data onto hard disk for later processing.

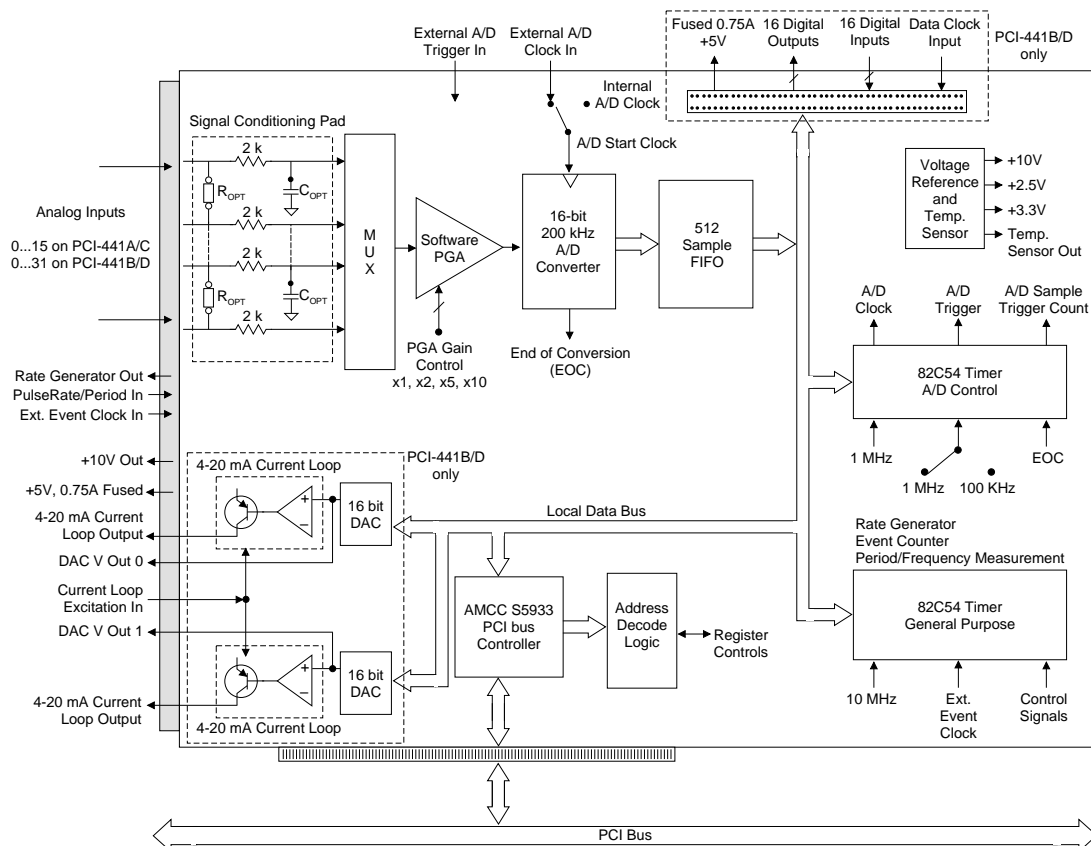


Figure 1. PCI-441 Functional Block Diagram

The PCI-441A or C offers 16 single-ended analog inputs that are software configurable as 8 true differential inputs. PCI-441B or D models include an additional 16 single-ended or 8 differential A/D channels, bringing the total count to 32 single-ended or 16 differential analog inputs. The full scale input voltage range is  $\pm 5V$  for models PCI-441A and B or  $\pm 10V$  for the PCI-441C or D. Each input channel includes blank component pads that are user-configurable to accept different input voltage ranges, current inputs, simple filters, or other signal conditioning. A software programmable gain amplifier (PGA) offers high input signal gains that allow the board to detect low level sensor inputs. The A/D resolution is 16 bits, and it can sample at up to 200 thousand times per second. Channels can be individually sampled, or a software selectable group of adjacent channels can be scanned continuously.

A/D data passes directly to an on-board first-in-first-out (FIFO) memory. This architecture allows non-stop, continuous data streaming to the PC without losing any samples. PC streaming mode uses high speed PCI bus mastering (also known as Direct Memory Access - DMA) to place the data directly into host memory without CPU intervention. This frees up host CPU processing time, allowing it to perform other concurrent tasks such as data analysis, data display, and process control. Slower speed applications can use the FIFO to store up to 512 samples. Synchronization provided by software detectable FIFO flags (full, half full, and empty), and an end of trigger frame indicator, enable the host to periodically read one or all stored samples, and then return to other simultaneous tasks until more data is ready.

The A/D sampling rate is software selectable using an on-board 82C54 timer. The timer allows software programmable sampling rates from the maximum A/D speed of 200 KHz all

the way down to 15.25 Hz. A/D sampling can also be directly controlled by a user-supplied external clock input. An internal programmable trigger timer allows acquisition of blocks of samples separated by programmable delays. In addition, external digital triggers can be used. For application synchronization and event detection, a programmable sample counter specifies the number of samples per trigger frame, which is independent of FIFO size and PCI bus transfer counts. This flexible timing architecture makes the PCI-441 an ideal solution for most medium speed electronic test, measurement, instrumentation, and control applications.

A second programmable counter/timer accommodates pulse rate (frequency) and period measurements, event counting, clock and timebase generation, square wave generation, and other general timing applications. An on-board, precision 10 MHz oscillator is used as the timebase for timing and wave generation. Digital pulse trains can be generated at pre-programmed rates and software selectable pulse widths for logic testing and simulation. Externally supplied inputs allow period and frequency measurements, as well as event counting.

The PCI-441 provides voltage and current excitation outputs for RTD's and strain gauges. The strain gauge voltage output is a regulated +10V (100 mA max.) source, while the RTD current source output is fixed at 500 $\mu A$  ( $\pm 2\%$  nominal). To verify strain gauge voltages and RTD currents these excitation outputs can be steered by software to the analog inputs. Other on-board software selectable A/D input sources include 2.5V and 3.33V fixed references and both D/A channels (on PCI-441B/D only). An on-board temperature transducer uses a precision bandgap voltage reference to provide an output voltage that varies linearly with temperature. This temperature sensor can be selected as an A/D input for reference temperature compensation for thermocouples and RTD's.

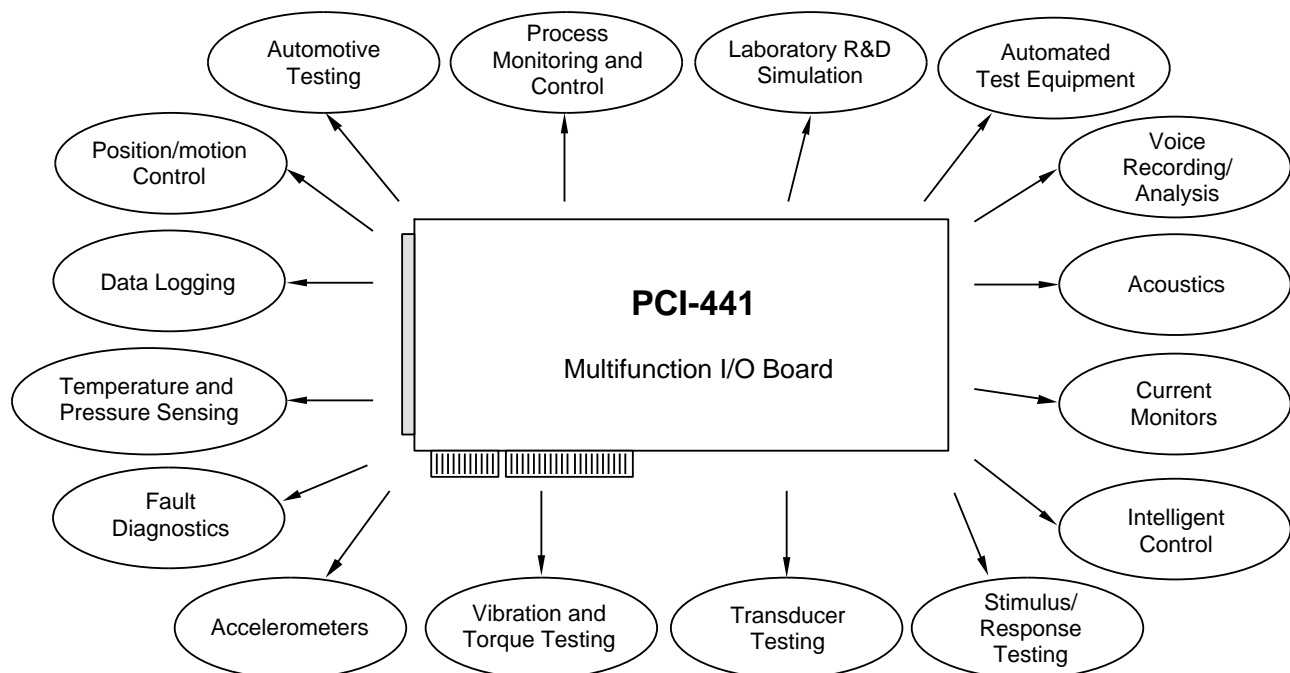


Figure 2. PCI-441 Typical Applications

PCI-441B/D models include two 16-bit digital to analog converters (DAC's) that add precision adjustable voltage and current outputs for transducer excitation, process control, and programmable voltage sources. The full scale output voltage range is  $\pm 10V$ , at 5 mA maximum per channel. Each DAC channel drives an on-board 4-20 mA current loop. The excitation power for the current loop is user-selectable from an internal 12V reference or from an external 12V to 30V supply. User supplied excitation allows higher impedance loads to be connected while still maintaining current loop voltage compliance. Gain and offset adjustment potentiometers are provided on each DAC channel for precision calibration. Under software control, the DAC outputs can drive the analog inputs for A/D and PGA calibration.

PCI-441B/D models also provide 16 digital inputs and 16 digital outputs for discrete monitoring and control systems, inter-machine communication, digital pattern recognition, digital signature generation, and relay switching applications. All the lines are TTL and CMOS compatible. The output port latches the data when commanded by host software. A user-supplied strobe latches data at the input port for reading by host software. The digital lines are accessed via an internal flat cable header, that also supplies +5V and ground for external circuits. Various transition panels allow direct connection to industry standard interfaces such as Opto 22 modules.

The PCI-441 is built on a three quarter length desktop PCI board that occupies one PCI slot. The product is manufactured in DATEL's ISO9001 facility. The PCI bus interface is implemented using an AMCC S5933 PCI bus controller that supports full PCI bus mastering.

#### PCI-441WIN(S) Software

Windows<sup>®</sup> 95/98/NT/2K have become the platforms of choice for many data acquisition, test, measurement, and control applications. These feature-rich, 32-bit operating systems exploit huge gigabyte memory, secure multi-threading, and hardware plug-and-play (PnP) to provide high performing, user friendly working environments. PCI-441WIN is an interactive data acquisition, analysis, display, signal generation, and digital I/O software system for the PCI-441 that runs under Windows<sup>®</sup> 95/98/NT/2K. It consists of a point-and-click graphic user interface (GUI), a dynamic link library (DLL), and a device driver.

#### PCI-441WIN main features include:

- Plug and Play (PnP) hardware detection and initialization.
- Easy-to-use, point and click graphic user interface (GUI).
- Transparent A/D data transfer to PC memory using DMA.
- Control multiple PCI-441's in the same PC simultaneously.
- A/D configuration – PGA gain, sample rate, etc.
- Set the DAC voltage and 4-20 mA current outputs.
- Read and write the digital I/O ports.
- Event counting, period, and frequency measurements.
- Generate digital signals, program pulse rates and widths.

PCI-441WIN automatically detects the PCI-441, configures the hardware, and continuously streams A/D sensor data to host memory using PCI bus DMA. A/D selections such as single-ended/differential, PGA gain, sample rate, trigger rate, and channel scan groups can be selected with the mouse.

Generate dynamic voltage waveforms or DC levels from both DAC voltage and 4-20 mA outputs. Read and write the digital I/O ports on command, or transfer blocks of data to and from the ports for pattern recognition, digital signature generation, and control. Timer control and manipulation selections perform event counting, pulse rate measurement, and pulse generation. Skillful graphic manipulation allows display panning and zooming, and the raw data can be displayed in decimal or hex, with real time scrolling.

PCI-441WIN turns your PC into an intelligent data logger, archiving all A/D sensor data to disk for later analysis using third party applications such as Excel<sup>®</sup>, DaDisp<sup>®</sup>, LabVIEW<sup>®</sup>, and HyperSignal<sup>®</sup>. Analog and digital channel expansion can be achieved by running multiple PCI-441's in the same PC simultaneously. Multiple, concurrent real time displays can be viewed, and the data from each board can be logged to separate disk files for later analysis.

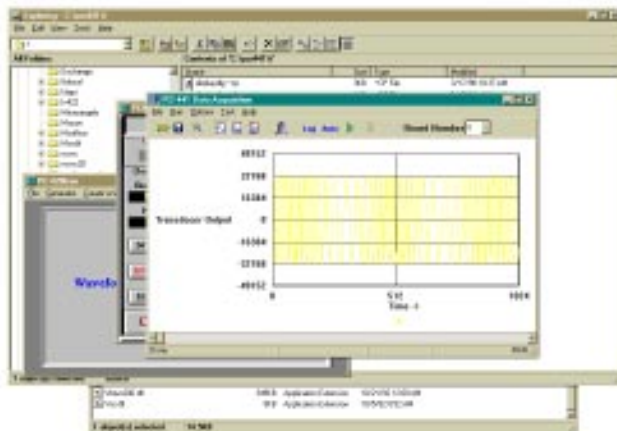


Figure 3. PCI-441WIN

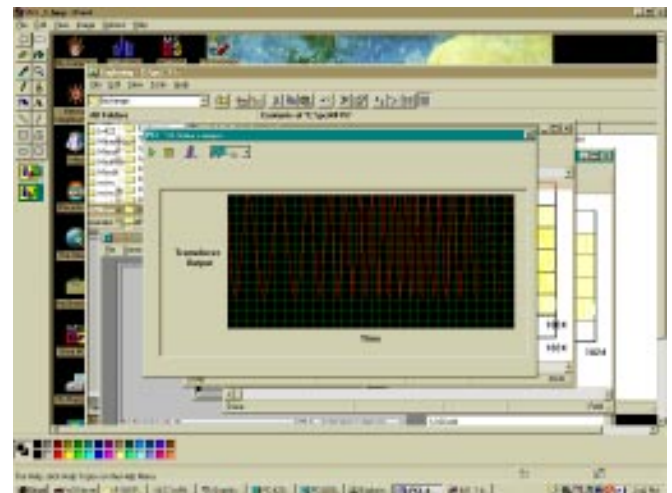


Figure 4. Strip Chart Recorder/Data Logger

Software engineers and programmers will be interested in PCI-441WINS — the source code for PCI-441WIN. It includes complete source code for the GUI (Borland C++ Builder) and the DLL (Visual C++ 5.0), and allows you to communicate with the PCI-441 from the familiar environment of your favorite high level language – C, Pascal, Visual® BASIC, Delphi®, etc. It's standard Windows programming hierarchy facilitates custom software development and PCI-441 integration into other applications. The source code contains a simple example console program, written in C, that exercises the PCI-441 through DLL function calls. This illustrates software writing if you do not normally use Borland's C++ Builder for GUI development.

PCI-441WINS hardware register access includes:

#### Command Register

Control fields for A/D trigger/clock selections, channel sequencing, single-ended or differential input configuration, PGA gain selections, and A/D calibration.

#### Status Register

FIFO flags (empty, half full, and full), counter/timer status, and channel block scan complete.

#### Start Channel Register

Select the first A/D channel in a contiguous, sequential group to scan.

#### Final Channel Register

Select the last A/D channel in a contiguous, sequential group to scan.

#### Reset FIFO

Flush all FIFO data. All previous data not saved will be lost.

#### A/D Data Register

Read blocks of A/D data.

#### Interrupt Source / 82C54 Timer Control Register

Select counter/time mode (rate generator, event counter, period, or frequency measurement), and non-DMA host interrupt mode (FIFO full, half full, empty, end of trigger block).

#### Digital Output Register

Write to the 16-bit digital port.

#### Digital Input Register

Read from the 16-bit digital input port.

#### Write DAC 0 Register

Update the 16-bit analog output (channel 0).

#### Write DAC 1 Register

Update the 16-bit analog output (channel 1).

#### Timer Control Registers

Configure both 82C54 timers.

#### Timer Data Registers

Load 82C54 timer data.

#### PCI Control Registers

Read/write access to all the registers on the AMCC S5933 PCI bus controller.

The hardware user manual contains detailed information on each bit in all the PCI-441 registers. In addition, it includes the complete product data book for the AMCC S5933 PCI controller.

\*For example, the sample rate per channel sampling 16 channels is 50 KHz/16 = 3.1 KHz/channel.

## SPECIFICATIONS

(Typical @ +25°C, dynamic conditions, gain = 1, unless noted)

ANALOG INPUTS	
<b>Number of Input Channels</b>	16 single-ended or 8 differential (PCI-441A or C). 32 single-ended or 16 differential (PCI-441B or D). Non-isolated.
<b>Input Configuration</b>	±5 V, ±2.5V, ±1V, and ±0.5V using the software PGA (models PCI-441A or B)
<b>Standard Input Voltage Range</b>	±10V, ±5V, ±2V, ±1V models PCI-441C or D. Per-channel higher ranges are possible by installing attenuation resistors in the blank component pads. 16 bits.
<b>A/D Resolution</b>	200 KHz (single channel).
<b>Single Channel Sample Rate</b>	50 KHz aggregate (per channel sample rate = 50 KHz/no. of chans.).*
<b>Multi-channel Sample Rate</b>	Two's complement, sign extended to indicate polarity. Software programmable — x1, x2, x5 or x10.
<b>A/D Output Data Coding</b>	10MΩ, minimum.
<b>Programmable Gain</b>	The board includes unpopulated component pads on each channel for user-installation of current shunts, attenuators, simple filters, etc.
<b>Input Impedance</b>	±10 Volts
<b>Signal Conditioning</b>	92 dB typical, DC to 60 Hz, 1 KΩ unbalance, gain=1.
<b>Common Mode Voltage Range</b>	±12 Volts max., sustained no damage, power on or off.
<b>Common Mode Rejection</b>	Diode clamp protection only. Gain and offset.
<b>Input Over-voltage</b>	1. Single channel by random addressing in software.
<b>A/D Adjustments</b>	2. Short cycle addressing – continuously sample a block of adjacent channels
<b>Addressing Modes</b>	±4 LSB of full scale range.
<b>Integral Linearity (gain=1)</b>	±3 LSB of full scale range.
<b>Differential Linearity (gain=1)</b>	±1 LSB per degree C.
<b>Full Scale Temp. Coefficient</b>	±1 LSB per degree C.
<b>Offset/Zero Temp. Coefficient</b>	-80 dB (optimized 16K FFT, 2 <sup>nd</sup> to 5 <sup>th</sup> harmonics)
<b>Total Harmonic Distortion</b>	Industry standard 37 pin DB-37 female for single-ended channels 0 through 15 (differential channels 0 through 7). 40 pin internal flat cable header for single-ended channels 16 through 31 (differential channels 8 through 15, available on PCI-441B or D models only.) External adapter cable available.
<b>Analog Input Connector</b>	



ANALOG OUTPUTS (PCI-441B or D only)	
<b>Number of D/A Channels</b>	Two, non-isolated
<b>D/A Resolution</b>	16 bits
<b>Settling Time</b>	
Full Scale Step	10 $\mu$ s (100 KHz) max.
Single Step	6 $\mu$ s
<b>Slew Rate</b>	10V/ $\mu$ s.
<b>Output Voltage Range</b>	$\pm$ 10V per channel.
<b>Output Current</b>	
(Voltage outputs)	$\pm$ 5 mA minimum per channel.
<b>Output Impedance</b>	0.1 Ohms.
<b>Short Circuit Protection</b>	Short circuit to ground.
<b>Integral Linearity Error</b>	$\pm$ 4 LSB's maximum.
<b>Differential Linearity Error</b>	$\pm$ 4 LSB's maximum.
<b>D/A Calibration</b>	Gain and offset adjust potentiometers per channel.
<b>Data Coding</b>	2's complement binary
<b>A/D Excitation</b>	The D/A channels may be software selected for voltage excitation of the A/D channels
<b>Current Loop Outputs</b>	Each D/A channel drives a 4-20 mA active current loop.
<b>Current Loop Excitation</b>	Internal fixed +12V supply or external user-supplied excitation (12V to 30V).
<b>Current Loop Compliance</b>	12V to 30V, non-isolated.
SENSOR EXCITATION OUTPUTS (all models)	
<b>RTD Current Excitation</b>	RTD excitation is fixed at 500 $\mu$ A, $\pm$ 2% typical. Under software control the PCI-441 can verify that the RTD current is present by directing this excitation output to the A/D.
<b>Strain Gauge Excitation</b>	10V regulated, $\pm$ 2%, 100 mA max. current output. Under software control the PCI-441 can verify that strain gauge voltage is present by directing this reference output to the A/D.
<b>Temperature Transducer</b>	On-board bandgap voltage source that varies linearly with temperature. It has an output voltage of 590 mV at 25°C, and a temperature coefficient of 2mV per °C.
A/D TIMING AND FIFO MEMORY	
<b>A/D Sample Clock (82C54)</b>	Internal software programmable or external TTL input.
<b>A/D Frame Trigger</b>	Internal software programmable or external TTL input.
<b>A/D Sample Counter</b>	Software programmable to 65535 samples. Can disable in software for continuous, non-stop sampling for long periods.
<b>A/D FIFO Memory</b>	512 A/D samples
GENERAL PURPOSE COUNTER/TIMER	
<b>Input Functions</b>	Pulse rate and period measurement, and event counting.
<b>Output Functions</b>	Clock, timebase, or square wave generator.
<b>Clock source</b>	Internal 10 MHz crystal or external input (10 MHz max.).
<b>Gate source</b>	Internal (software) or external.
<b>Input/output levels</b>	1 TTL load min. (output), 1 TTL-LS load max. (input).
<b>Controller</b>	Standard 82C54 timer.
DIGITAL INPUT/OUTPUT PORT (PCI-441B or D only)	
<b>Number of channels</b>	16 inputs and 16 outputs.
<b>Logic Levels</b>	TTL-CMOS compatible.
<b>Input Voltage</b>	Input LOW Voltage 0.8V max. Input HIGH Voltage 2.2V min.
<b>Input Leakage Current</b>	10 milliamps.
<b>Output Voltage</b>	Output HIGH 3.8 V min. Output LOW 0.5 V max.
<b>Output Drive Current</b>	Output High or Low 24 mA.
<b>Connector</b>	50 pin internal flat cable header, external adapter cable available
<b>Throughput</b>	2 MHz
ENVIRONMENTAL	
<b>Operating Temp. Range</b>	0 to +60°C
<b>Storage Temperature Range</b>	-25 to +85°C no thermal shock.
<b>Relative Humidity</b>	10% to 90%, non-condensing.
<b>Altitude</b>	0 to 10,000 feet. Forced cooling is required.
<b>Warm-Up Period</b>	5 minutes to rated accuracy.
MISCELLANEOUS	
<b>Bus Interface</b>	32-bit desktop PCI bus using the AMCC S5933 controller.
<b>PCI Bus Mastering</b>	PCI bus mastering (DMA) is automatically included with the AMCC S5933.
<b>PCI Interrupt Sources</b>	Non-DMA mode: A/D FIFO full, FIFO half full, FIFO empty, and end of trigger frame/block. DMA Mode: DMA T/C
<b>Local RAM</b>	The board includes non-volatile Random Access Memory (NVRAM) to initialize the PCI controller, store calibration tables, and other model specific information.
<b>Mechanical Outline Dimensions</b>	$\frac{3}{4}$ length desktop PCI bus board – 24cm x 9.9cm x 1.0cm. Occupies one PCI slot.
<b>Regulated DC Power Required</b>	Supplied by the host PCI bus: +5Vdc @ 750mA max., 500 mA typical +12Vdc @ 250mA max., 150 mA typical -12Vdc @ 150mA max., 100 mA typical
<b>Manufacturing Environment</b>	ISO 9001 certified facility.

### PCI-441LV for LabVIEW® (Windows® 95/98/NT/2K only)

Virtual instrumentation has revolutionized data acquisition and process control. LabVIEW® from National Instruments pioneers virtual instrumentation. Save yourself weeks and months of software development by graphically assembling your programs as a block diagrams rather than writing code. Together with Dattel's PCI-441LV driver library, LabVIEW® transforms the PCI-441 into easy-to-use virtual instruments that acquire, analyze, display, and archive digitized waveforms in real time, use the timer I/O for event counting and rate generation and measurement, and use the digital I/O and D/A channels for process control. Low level software development is replaced by visual, drag-and-drop programming that harnesses all the power of Windows® 95/98/NT/2K – graphic user interface (GUI), huge gigabyte memory, multi-tasking, plug-and-play, and inter-process communication via OLE/DDE. How does PCI-441 programming under LabVIEW® work? It's very simple! Using the mouse, you select a set of VI's from a function palette and "wire" them together...like creating a flowchart. There is absolutely no coding involved. All the low-level hardware interaction and control is transparently included in the drag-and-drop VI's supplied in PCI-441LV. You can concentrate on the real specifics of your application (such as data processing, display, and storage), rather than wasting time getting the hardware up and running. In addition to the hardware control provided by PCI-441LV, LabVIEW® provides hundreds of data analysis and display functions that can be used in real time or for post-processing.

PCI-441LV is a comprehensive library of simple, fast, modular VI's that allow complete hardware control. VI's can be visually strung together to acquire non-stop, seamless data into huge host buffers using PCI DMA or CPU status polling. Multiple PCI-441's can be configured to operate simultaneously in the same PC. You can install and run as many boards as there are vacant PCI bus slots in your computer. All boards will perform concurrent PCI bus DMA data transfer to host memory without conflicts.

Dattel's VI library includes complete functional VI programs that exercise all PCI-441 features – A/D, D/A, digital I/O, event counting, rate generation, and period/frequency measurements. They include:

- Plug-and-play hardware detection and initialization.
- Run multiple PCI-441's in the same PC.
- Allocate DMA buffers – single and dual (circular buffering).
- Configure data acquisition – sample and trigger rate, clock/trigger source, sample count, channel scan blocks, etc.

- Update analog outputs – voltage and 4-20mA current.
- Read and write the digital I/O ports.
- Configure the event counter and rate generator.
- Measure pulse frequency and period.
- Monitor the FIFO flags during data acquisition.
- Transfer data from the FIFO using status or PCI bus DMA.
- Pause DMA – allow access to local registers during DMA.
- Reload the DMA registers without interrupting the A/D.
- Low level register I/O – read/write all PCI-441 registers.
- Fully functional VI example programs to illustrate usage.

The LabVIEW® libraries, supplied by National Instruments, include hundreds of user-interaction, data analysis, and data display functions, including:

Controls/indicators	Meters/gauges	Knobs/dials
Toggle/slide switches	Slider controls	Numeric math
Boolean evaluation	Looping	Histograms
Standard deviation	Matrix math	Vector Math
Linear evaluation	Polynomials	Statistics
Curve fitting	File I/O	2-D plotting
3-D plotting	Charts/graphs	Frames/borders
Internet communication	OLE automation	DDE

In addition, National Instrument's offers various add-on and helper packages for LabVIEW®. An Advanced Analysis package provides still more data analysis and display functions. The DSP Analysis library includes signal generation functions (impulse, pattern, white noise, etc.), various digital filters, data windowing, and time and frequency domain processing. Application Builder® can be used to generate a standalone application from your VI program. This can then be executed under Windows® 95/98/NT/2K, independent of LabVIEW®. Make your applications Internet-aware with the Internet Developers Toolkit®. Transfer data via E-mail or FTP and use a Web browser to monitor and control experiments remotely on the World Wide Web. Please contact National Instruments directly for more information on these and other "plug-ins".

PCI-441LV is accompanied by a detailed user manual that describes each VI. LabVIEW® allows DLL function calls directly from a VI graphic. If you wish to develop your own VI's or modify existing VI's, PCI-441LV is the source code for PCI-441LV. It includes all functions contained in the dynamic link library(DLL). The DLL, which was developed using Microsoft Visual C++ 5.0, implements all hardware control and monitor functions and does not need to be modified. To help with your development, the DLL functions are thoroughly documented in the PCI-441 users manual.

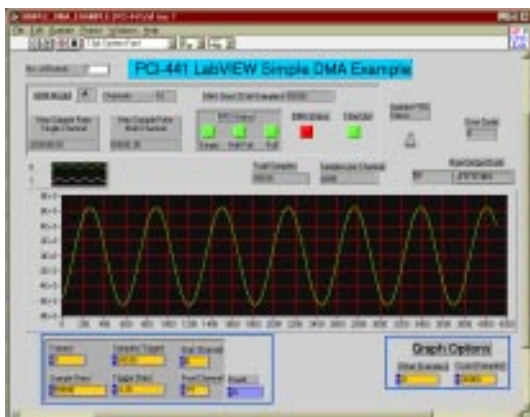


Figure 5. PCI-441LV Virtual Instrument

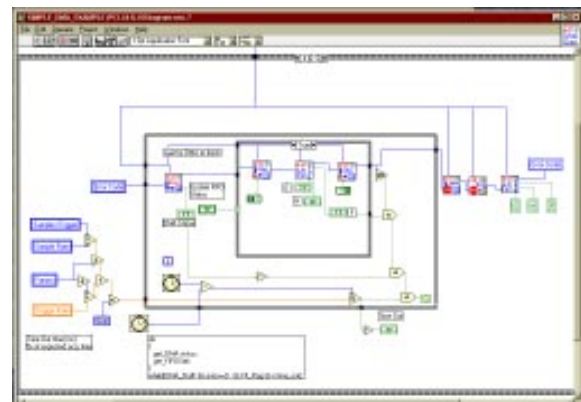
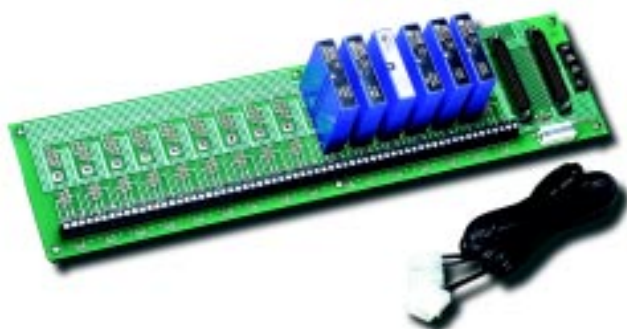


Figure 6. PCI-441LV Visual Program



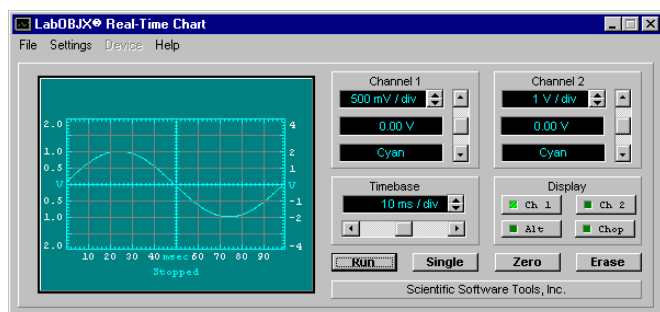
### PC-5B Series Modules

The 5B Series provides excellent signal conditioning performance. Modules can be mixed and matched on one backplane, permitting users to address their exact needs, and may be changed without disturbing field wiring. The isolated input modules provide 0 to +5 V, or -5 V to +5 V outputs (depending on model type) and accept J, K, T, E, R, S, N, and B thermocouples; 100  $\Omega$  platinum RTD's; strain gauges; mV, V, 4-20 mA, frequency (0 to 250 KHz), and wide bandwidth (10 KHz) mV and V signals. These modules feature complete signal conditioning functions including CJC (Cold Junction Compensation) for Thermocouple inputs.



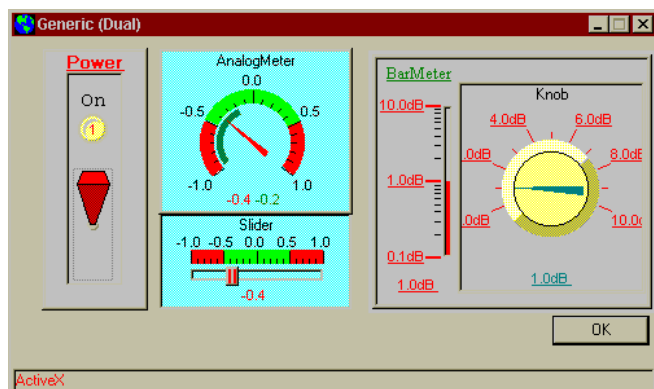
### Solid State Relays

DATEL offers the industry standard G4 series of base boards, solid state and mechanical relay modules, as well as some custom designed mechanical relay boards and screw terminal panels. Direct connect cabling is also available.



### RT Chart

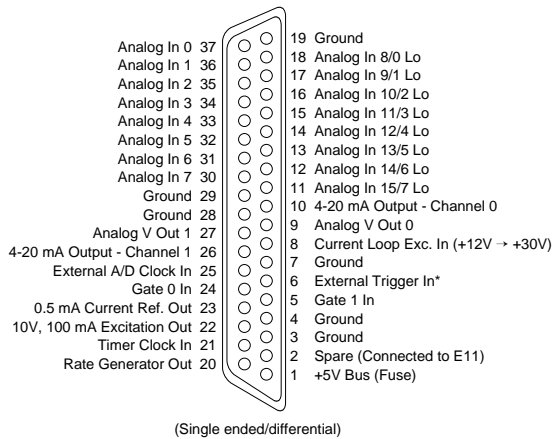
LabOBJX Real-Time Chart is a versatile 32-bit Active-X control for quickly and easily adding high-speed graphing and charting to your data acquisition applications. LabOBJX Real-Time Chart uses advanced graphical techniques to maximize visual display rates for creating realistic and fast oscilloscope and strip chart displays.



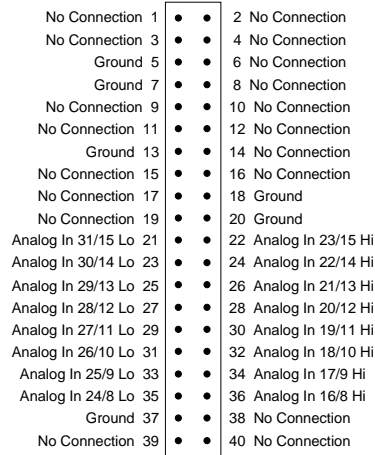
### VIX COMPONENTS

VIX COMPONENTS is a collection of Active X controls and functions for data analysis, manipulation, and control. You can create professional looking data acquisition and control applications by dropping one or more Active X controls like analog meter, strip chart, switches, knobs, and more onto your form.

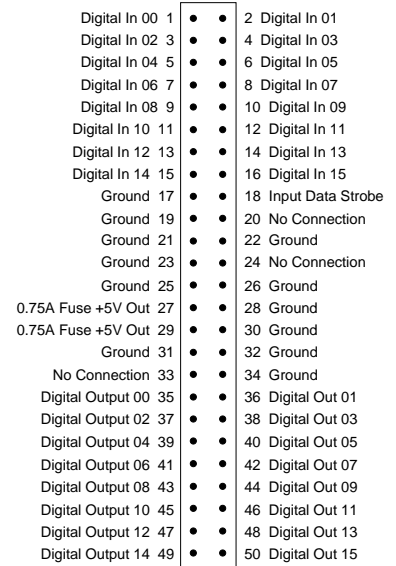
## Input/Output Connectors



**Figure 7. Rear Panel DB-37 Connector (J1)**



**Figure 8. Auxilliary Analog Input Connector - P2 (PCI-441B or D only)**



**Figure 9. Digital I/O Connector - P5 (PCI-441B or D only)**

## ORDERING INFORMATION

<b>PCI-441A</b>	Multifunction PCI board with 16S/8D A/D inputs, $\pm 5V$ full scale range. Includes timer I/O and PCI-441WIN (binary executables only) for Windows® 95/98/NT/2K. No D/A's or digital I/O.
<b>PCI-441B</b>	Same as PCI-441A with the addition of 16S/8D analog outputs (total 32S/16D), two D/A's with 4 - 20 mA current loops and digital I/O.
<b>PCI-441C</b>	Multifunction PCI board with 16S/8D A/D inputs, $\pm 10V$ full scale range. Includes timer I/O and PCI-441WIN (binary executables only) for Windows® 95/98/NT/2K. No D/A's or digital I/O.
<b>PCI-441D</b>	Same as PCI-441C with the addition of 16S/8D analog inputs (total 32S/16D), two D/A's with 4 - 20 mA current loops and digital I/O.
<b>PCI-441WIN</b>	Windows® 95/98/NT/2K software application included with PCI-441. Interactive data acquisition that includes data analysis, display, signal generation, and digital I/O control features. It includes a Windows device driver, DLL, and graphic user interface (GUI).
<b>PCI-441WINS</b>	Source code for PCI-441WIN. Includes the source code for the GUI, (written using Borland's C++ Builder®), and the DLL source code (written using Microsoft Visual C++ 5.0®). Includes a simple console program, (written in Microsoft C), that illustrates DLL function calling without the GUI.
<b>PCI-441LV</b>	Library of drivers for National Instruments' LabVIEW® for Windows® 95/98/NT/2K. Purchase LabVIEW separately from National Instruments.
<b>PCI-441LVS</b>	Library of LabVIEW® drivers for Windows® 95/98/NT/2K. Includes DLL source code.
<b>Accessories</b>	Request the DATEL Data Acquisition Accessories data sheet for more information.

All boards are fully burned in, tested, and calibrated at the factory. All boards are shipped with a comprehensive hardware users manual, which includes register details, timing diagrams, and application information. The manual also contains software documentation, including API reference manuals for the source code (PCI-441WINS)

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