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Scientific Solutions ® Inc.

LabMaster ® PRO PCI

Product Description

Our Solution Includes

Key Features

Applications

Functional Description

Analog-to-Digital Conversion

Digital-to-Analog Conversion

Timer/Counter

Digital I/O

Interrupts & Bus Mastering

System Resources

Technical Specifications

Frequently Asked Questions

LabMaster PRO provides true 16 bit 333Khz A/D with up to 256 channels using high-performance Bus Mastering PCI!

Multiple cards can be synchronized for 1000 analog input channels!



- True 16 bit ADC and DAC
- High-speed 333Khz operation!
- Advanced 32-bit PCI Bus Mastering
- On-board Sample Memory for data integrity in long-latency operating systems!
- Plug-and Play easy to install and use!

The LabMaster PRO combines the features of several high-performance products onto an advanced PCI card. With a full range of features such as Analog Input, Analog Output, Digital I/O and Precision Timer/Counters - the LabMaster PRO provides the functionality required for a wide range of test and measurement applications. Great care is taken in the design and manufacturing of the LabMaster PRO to insure a quality product that provides accuracy and stability for demanding applications. Its unique features, rugged design and reliability make it ideal for acquiring and analyzing data in industrial, scientific, and educational fields.

Whether your applications are laboratory research, product development or

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production testing, the LabMaster PRO is up to the task and should provide you with years of reliable and trusted service.

Scientific Solutions has been providing data acquisition products since 1974. The LabMaster products from Scientific Solutions are the longest selling and supported PC based data acquisition products in the world. First introduced in 1981, they created the PC data acquisition market and were the world's first add in products of any type for the IBM PC. The LabMaster PRO continues with this fine tradition.

Product Description

The Lab Master PRO PCI brings the power, performance, and flexibility needed to handle the toughest assignments in engineering and scientific research. Designed for today's faster PCI systems, the Lab Master PRO delivers the advanced features you expect in a data acquisition interface, with the precision of current technology and ease of use of an all software configurable interface.

Lab Master PRO is an advanced data acquisition product. It features high speed analog-to-digital conversion, sample FIFO buffering, coordinated simultaneous ADC and DAC capabilities, programmable gain amplifiers, high speed counters/timers and digital I/O on a single card. Complete solutions include the Lab Master card, cabling, and desktop connector termination unit.

The 16-bit analog to digital converter (ADC) handles 16 to 256 input lines at rates up to 333,000 samples/second. Precision software programmable gain amplifiers handle voltage ranges between ±l00mV and ±10V. Two independent 16-bit digital to analog converters (DAC) supply a ±10V output range. Five 16-bit precision counters can time intervals with 250nsec. resolution or count events up to 6MHz. Digital I/O lines (8 input/16 output) connect to switches, LEDs, relays, etc. Connections are made using a single high density connector with included RF-shielded cable.

Our Solution Includes

- Lab Master PRO PCI Interface - Data Acquisition & Control interface for inside the PC
- 1.5 meter double shielded cable
- Desktop Unit (several versions available)
- Software Drivers

Key Features

- True 16-bit Analog-to-Digital and Digital-to-Analog Conversion.
- True simultaneous sample-and-hold
- 16 Analog input channels expandable to 256.
- High data rates (333,000 samples/second) to provide maximum speed and versatility.
- Dual High-Speed (500KHz) Analog Outputs.
- Five 16-bit High Resolution Cascadable Timer/Counters.
- Digital I/O lines - 8 in, 8 out, 8 FIFO controlled for digital pattern generation or digital In/Out expansion.
- Digital output coordinated with DACs (can be used with PCI Bus Mastering)

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- Provisions for digital I/O & Analog input channel expansion
- Precision Software programmable gain amplifiers.
- High-performance ADC Channel / Gain Array with auto-increment allows automatic sampling of the analog inputs in any order with different gains at full speed.
- Dedicated on-board FIFO memory for high-performance acquisition and waveform generation with reduced CPU overhead
- On-board timers provide timed, simultaneous ADC and DAC updates.
- Continuous DAC output with on-board memory buffering and PCI Bus Mastering - excellent for clean waveform generation!
- Timed, simultaneous DAC updates ("no-jitter" analog outputs)
- Coordinated ADC and DAC using simultaneous and concurrent 32-bit PCI Bus Mastering (allows for simultaneous "record & playback")
- Multiple active hardware interrupt sources
- Advanced Surface mount technology for high reliability
- Physical small size (9" length) with narrow height for newer slim line computers.
- Advanced ESD protection against damage by human static discharge or lightning strikes.

Applications

- Energy Management
- Chromatography
- BioMedical (neuron stimulation, muscular stress)
- Psychology (infant stimulation, stimulus/response, interval timing, Galvanic skin response)
- Process Automation (relay control, stepper motor control, timing/counting, die cutting monitor)
- Test and Measurement (PC board tester, particle counter, component solderability determination)

Functional Description

The LabMaster PRO installs into a PCI expansion slot of a computer. A single high-density connector is provided for easy access to all input and output lines. The LabMaster PRO is capable of multiple concurrent Bus Master operations for optimal PCI data performance. Designed for maximum flexibility, all features on the LabMaster PRO are software programmable.

Analog-to-Digital Conversion (ADC)

The Analog-to-Digital converter (ADC) is a 16-bit successive approximation converter with a 3µSec. conversion time for a maximum throughput of 333Khz. The analog inputs (single-ended or true-differential) pass thru a programmable, precision gain amplifier prior to the analog-to-digital conversion. Examples of analog inputs are: Temperature, Flow, Displacement, Voltage, Current, Acceleration, Velocity, Level, Pressure, Moisture, and Humidity.

A conversion can be started by a software command, a trigger signal from one of the on-board precision timer/counters, a rising edge from an external source, self-triggered by the end of the last conversion, or by using the on-board analog compare. An on-board channel/gain memory allows any combination of channels and gains with complete auto-sequencing and burst mode performance. Channels can be selected for conversion one at a time or as a set. The software enabled auto-scan feature automatically increments the

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channel number with each conversion. Both the starting and ending channel in the sequence are software selectable.

Converted data is transferred to dedicated on-board sample memory buffers. The buffers permit full-speed operation under non-real time operating systems. High speed transfer of the data to memory is possible using the Advanced PCI Bus Mastering of the LabMaster PRO. When Bus Mastering is used, the end of the conversion strobe will initiate the transfer from the on-board memory to system memory. When not using Bus Mastering, the end of a conversion can be detected by using an interrupt or polling the status register. Data is transferred by reading the converted data byte from the buffer memory or via automatic Bus Master transfer.

A/D conversions can be coordinated to occur simultaneously with D/A updates. The LabMaster PRO supports up to 256 analog input channels.

Analog-to-Digital Conversion Features

Resolution	True 16-bit performance over industrial temperature range
Input Range	-10volts to +10volts
Conversion Time	3µSec, allows for 333Khz sampling rate
Input Channel Count	16 to 256, single-ended or differential configuration.
Input Current	100pAmps
Input Source Impedance	<10Kohms
S/(N+D)	93dB Typical
THD	-100dB typical
performance	No missing codes over temperature
Voltage Reference	2ppm/ deg C high-precision low tempco dedicated ADC reference
Integral linearity	± 1 LSB
Offset Error	Auto-calibrated to zero
Full Scale Error	Auto-calibrated within 1/3 LSB (100uVolts)
Programmable Gain	1, 2, 4, 5, 10, 20, 25, 50, 100
On-Board Sample Memory	8 KBytes
Input Protection	± 35 volts
Gain Switching Time	500nsec
Gain Nonlinearity vs. Temperature	0.0003%
Configuration	All ADC features are set by software
ADC Trigger (software selectable)	• On-board precision timer • External TTL trigger • Software Initiated strobe
On-Board Channel Gain	Permits converting channels in any sequence at any gain at full speed

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Array Table Sampling Modes (at maximum rate)	• Single Channel • Non-consecutive channels • Auto-scan blocks of channels
Data Format	32-bit Two's Complement
Data Transfer	Advanced PCI Bus Mastering with direct transfer from on-board memory to system memory without using the CPU
Interrupt Sources (software enabled)	• End-of-Conversion • ADC Data Memory Overrun • Bus Mastering Terminal Count

Digital-to-Analog Conversion (DAC)

Two independent 16-bit Digital-to-Analog converters (DAC) can be accurately and simultaneously updated at a 500KHz rate. The DACs have output ranges of ±10V. Each output value is latched and remains constant until the next digital value is presented to the DAC. The DACs are precisely updated from an on-board sample memory buffer with replay control for waveform generation with zero CPU overhead. The on-board memory buffer can be loaded using memory access instructions or from system memory using PCI Bus Mastering. The latching of the DAC data is controlled by an on-board precision timer which can be programmed to provide the desired "sample" (update) rate. Alternatively, an external supplied signal can be used to update the DAC from the on-board memory.As an example of using the DAC, an application could fill the DAC on-board memory buffer with samples to generate a waveform. The LabMaster PRO could then be configured to play out the samples to the DAC at a very precise rate. After the samples have been sent to the DAC, the waveform generation could then stop, or the waveform could be continuously played from the on-board memory if configured for "repetitive" mode. The on-board timers are very precise and have very little jitter. The use of the on-board precision timer source for controlling the DAC update results in waveform generation with very low harmonic distortion.

Digital-to-Analog Conversion Features

Resolution	True 16-bit performance over industrial temperature range
Output Range	-10volts to +10volts
Update Rate	500KHz
Channel Count	2 (Expansion option for additional 8 inputs!!)
DNL and INL	1 LSB max
Power-on / reset	DAC outputs initialize to 0.00 volts
Glitch Impulse	< 2nV - Sec
Output current	5ma
On-board Memory	8K Bytes with auto-buffer replay for continuous waveform generation and glitch-free performance.
DAC update (software	• On-board precision timer

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selectable)	• External "update" signal
Data Format	32-bit Two's Complement
Data Transfer	Advanced PCI Bus Mastering with direct transfer from system memory to on-board memory without using the CPU
Interrupt Sources (software enabled)	• DAC Data Under-run • Data Transfer Terminal Count

System Timer/Counter (STC)

Five independent 16-bit counters count TTL compatible pulses (rising or falling edge) generated from a wide range of equipment and sensors. Six separate source and gate input lines are provided on the external connector for signals that can be used by any counter. A TTL compatible pulse/level output signal is available from three counters for the user application.Each gateable counter counts up or down (binary or BCD). The accumulated count may be read at any time without disturbing the counting process. Each of the counters can be connected to others to form a counter with resolution up to 80 bits. The counters provide a resolution of 250nSec. to 2.5mSec. External events can be counted at speeds to 6.25MHz.

System Timer/Counter Features

Resolution	Each counter is 16-bits and can be cascaded to 80-bits
Number of counters	Five independent counters
Logic Thresholds	TTL
Interval Counting Resolution	250nSec
Event Counting	6.25Mhz (160 nSec. intervals)
On-board frequency sources	5 precision sources for interval timing to 250nSec resolution.
Input/Output Protection	Advanced ESD and Over-voltage protection with fast 6nSec switching
Counter signals 15 total signals	Each counter has individual • Input (TTL compatible pulses) • Output (TTL load, pulse/level) • Gate (TTL edge or level)
Uses for Counter Outputs	• Trigger A/D conversions • Update D/A conversions • Trigger hardware interrupts • Square & complex waveforms • Gate counters on/off • Drive TTL devices

Digital Input/Output (DIO)

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Digital Input/Output is supported by dedicated 8 lines of digital input and 8 lines of digital output. An additional 8 digital output lines are provided and can be used for general outputs, or coordinated with the DAC outputs (including DMA control). These lines can also be used with a strobe line as a bank select register to expand the Digital I/O up to 256 Bytes.

Digital Input/Output Features

Digital Inputs	Dedicated 8-bit
Digital Outputs	Dedicated 8-bit
Expansion Outputs	8-bit can be used for: • Additional 8 digital outputs • Expansion of DIO to 2048 bits in & out • Digital waveform from FIFO
Digital Sample Memory	4KBytes for expansion outputs
Logic Thresholds	TTL
Current sink/source	10 ma
Input/Output Protection	Advanced ESD and Over-voltage protection with fast 6nSec switching

Interrupts & Bus Mastering Features

Hardware interrupts (IRQs) allow the computer to react to special events when they occur. The Lab Master PRO provides software enabled sources to the PCI bus. Internal interrupt sources are counter output, A/D or D/A data overrun, and A/D or D/A Bus Master transfer complete. High speed 32-bit Advanced PCI Bus Mastering permit the transfer of data to/from the LabMaster card without CPU intervention. The Bus Mastering supports full simultaneous and concurrent ADC and DAC operations. Interrupts fully conform to the PCI specification.

Interrupts & Bus Mastering Features

Interrupt Channels (PCI BIOS auto-selected)	Fully implements PCI edge or level triggered interrupts.
Interrupt Sources (software enabled)	• Counter Output • A/D over-run • D/A under-run • A/D DMA transfer complete • D/A DMA transfer complete
PCI Bus Mastering	Fully implements high-speed 32-bit PCI Bus Mastering
Bus Mastering Data	Individual or concurrent operation: • A/D data from card memory • D/A data to card memory

System Resources

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The LabMaster PRO occupies a single PCI slot and is a short board for today's smaller computer cases. The connection from the computer to the outside world is thru a small single High-Density connector. The LabMaster PRO comes with a double-shielded 1.5 meter cable. The connectors on the cable and on the LabMaster PRO are designed for only one correct alignment. The cable connectors have retaining clips that lock the cable to the mating connector on the computer board. These clips prevent the cable from being accidentally disconnected and provide a very fast and easy method of connection.The LabMaster PRO is mapped directly into the computers memory space and thus does not have any I/O conflict restrictions! Configuration of the card is completely by software. Resource allocation is automatic using PCI BIOS and plug-and-play operation.

LabMaster PRO System Resources

Interrupt Channels (PCI BIOS auto-selected)	Plug-and-Play
32-bit PCI Bus Mastering (PCI BIOS auto-selected)	Plug-and-Play
Memory Mapped (PCI BIOS auto-selected)	Plug-and-Play
Computer Interface	Single PCI (32-bit or 64-bit) 5volt slot
Board Size	Short card, 9" length with narrow height to clear system board.
External Connection	60pin or 68pin High-Density
Standard Cable	Double Shielded, 1.5 meters

Note:

The LabMaster PRO is available with either a 60pin connector or a 68pin connector. The LabMaster PRO with a 60pin connector provides the same pinout as the LabMaster AD/ADEX (which also has the same 60pin connector). Current external hardware connecting to the LabMaster AD or the newer LabMaster ADEX, can also connect to the Lab Master PRO PCI using the 60pin connector. For applications that do not require the 60pin compatibility with the LabMaster AD/ADEX, a 68pin connector is normally used.

Technical Specifications

A/D Characteristics

Resolution	16-bit
Input Range	±10V
±10V (per interval)	305µV/Int.
Conversion Time	3µSec.
Maximum Sampling rate	333,000 samples/second
Channel Count	16 to 256
Input Bias Current	100pAmps
Input Source Current	< 10Kohms
S/(N+D)	93dB typical
THD	-100dB typical
Low Drift Voltage Reference	2 ppm/°C

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Integral Linearity	±1 LSB
Full Scale Error	1/3 LSB, auto-calibrated
Offset Error	0 volts, auto-calibrated
Performance	No missing codes
Programmable Gain	1, 2, 4, 5, 10, 20, 25, 50, 100
Gain switching time	500 nSec.
Gain Non-linearity vs. Temp	0.0003%
On-board Sample Memory	8 KBytes
Input Protection	±35 volts
Data Format	32 bit Two's Complement
Data Transfer	Advanced 32-bit PCI Bus Master

D/A Characteristics

Resolution	16-bit
Output Range	±10V
±10V (per interval)	305µV/Int.
Maximum Update rate	500,000 samples/second
Channel Count	2 (expandable to 10)
Differential Non-Linearity	1 LSB max
Integral Non-Linearity	1 LSB max
Power-on / reset condition	0 volts
Glitch Impulse	< 2nV - Sec.
Output Current	5ma
On-board Sample Memory	8 KBytes
Data Format	32 bit Two's Complement
Data Transfer	Advanced 32-bit PCI Bus Master

System Timer/Counter Characteristics

Resolution	16-bit / counter
Number of Counters	5 Independent
Maximum Counter Resolution	80bit by cascading
Logic Thresholds	TTL
Interval Counting Resolution	250nSec.
Event Counting	6.25Mhz (160nSec. intervals)
Input/Output Protection	ESD Overvoltage, 6nSec. switching

Digital Input/Output Characteristics

Dedicated inputs	8-bit
Dedicated Outputs	8-bit

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Expansion Outputs	8-bit
Input Expansion Capabilities	2048-bit
Output Expansion Capabilities	2048-bit
Digital Sample Memory	4 KBytes
Logic Thresholds	TTL
Current Sink/Source	10 ma
Input/Output Protection	ESD Overvoltage, 6nSec. switching

System Resources

Bus Interface	Single 32-bit or 64-bit PCI slot
IRQ Channels (PCI BIOS auto-select)	Plug-and-Play
DMA Channels (PCI BIOS auto-select)	Plug-and-Play
Memory mapped(PCI BIOS auto-select)	Plug-and-Play
Bus Load	1 TTL load/bus line

Environmental Specifications

Operating Temperature	0º to 70º Celsius
Storage Temperature	-25º to +85º Celsius
Relative Humidity	To 95% non-condensing
Agency Approvals	FCC Class A, CE-Mark

Frequently Asked Questions

Q1. What is the difference between the LabMaster ADEX and the LabMaster PRO

A1. There are a number of differences between these cards. The LabMaster ADEX was made to replace the LabMaster AD and as such is completely 100% register level compatible so as to run "AD" software without modification. However, the LabMaster PRO uses a completely different register set. This means that software written for the LabMaster AD/ADEX that communicates directly with the hardware will not run on the LabMaster PRO. However, if the software was written to use the Scientific Solutions device drivers and LabPac32 library, then the software should run on either board (depends on how the software was written). The LabMaster ADEX uses the ISA bus, whereas the LabMaster PRO uses the PCI bus with advanced Bus Mastering capabilities. Here is a short comparison list:

Comparison: LabMaster PRO vs. LabMaster ADEX

LabMaster PRO	LabMaster ADEX
PCI Interface	ISA Interface
16-bit ADC/DAC	16-bit ADC/DAC
ADC/DAC data treated as 32-bit values	ADC/DAC data treated as 16-bit values
32-bit Bus Mastering	16-bit DMA
Up to 256 Analog Input channels	Up to 64 Analog Input channels

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LabMaster PRO hardware register set, memory mapped	LabMaster AD/ADEX hardware register set, I/O mapped
Easy to support multiple boards in a system for higher channel count	Multiple boards in a system contingent upon available free computer resources.

Q2. Does the LabMaster PRO have support under all the various versions of Windows?

A2. Scientific Solutions offers true 32-bit kernel mode drivers for the LabMaster PRO. These drivers support the various flavors of 32-bit Windows (98, 2k, XP). The driver interfaces to Scientific Solutions LabPac DLL. This DLL contains many high-level library functions and serves as the interface (API) between the user's application code and the actual device driver.

Q3. How do I convert the raw A/D data from the LabMaster PRO into volts?

A3. The conversion of the "raw" data to the actual units you are measuring (volts in this example), depends upon four factors - the data format of the ADC(32-bit), the range (-10volts to +10volts) of the ADC, the Gain used when the analog signal was converted, and the format of the raw data (Two's complement). Here is a quick equation that you can use, however make sure the arithmetic you are using is "signed" to account for two's complement formats:

volts = (count) * (range) / (gain) / (2 *raised to the power of "data format*")

Example: count of 3FFF0000h, range of -10v to +10v, gain = 1, data format of 32-bit:

note: 3FFF0000h = 1073676288 decimal

volts = (3FFF0000) * (20) / (1) / (2 *raised to the power of 32*)

volts = (1073676288) * (20) / (1) / (4294967296)

volts = 4.999



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