ADAC/5500 Series User's Manual

12-Bit and 16-Bit PCI Data Acquisition Series Boards

the smart approach to instrumentation ™

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ADAC/5500 Series

Data Acquisition Boards

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Warranty Information

Your IOtech warranty is as stated on the *product warranty card*. You may contact IOtech by phone, fax machine, or e-mail in regard to warranty-related issues. Phone: (440) 439-4091, fax: (440) 439-4093, e-mail: sales@iotech.com

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IOtech devices emit radio frequency energy in levels compliant with Federal Communications Commission rules (Part 15) for Class A devices. If necessary, refer to the FCC booklet *How To Identify and Resolve Radio-TV Interference Problems* (stock # 004-000-00345-4) which is available from the U.S. Government Printing Office, Washington, D.C. 20402.

CE Notice

Many IOtech products carry the CE marker indicating they comply with the safety and emissions standards of the European Community. As applicable, we ship these products with a Declaration of Conformity stating which specifications and operating conditions apply.

Warnings, Cautions, Notes, and Tips

Refer all service to qualified personnel. This caution symbol warns of possible personal injury or equipment damage under noted conditions. Follow all safety standards of professional practice and the recommendations in this manual. Using this equipment in ways other than described in this manual can present serious safety hazards or cause equipment damage.

This warning symbol is used in this manual or on the equipment to warn of possible injury or death from electrical shock under noted conditions.

This ESD caution symbol urges proper handling of equipment or components sensitive to damage from electrostatic discharge. Proper handling guidelines include the use of grounded anti-static mats and wrist straps, ESD-protective bags and cartons, and related procedures.

This symbol indicates the message is important, but is not of a Warning or Caution category. These notes can be of great benefit to the user, and should be read.

In this manual, the book symbol always precedes the words "Reference Note." This type of note identifies the location of additional information that may prove helpful. References may be made to other chapters or other documentation.

Tips provide advice that may save time during a procedure, or help to clarify an issue. Tips may include additional reference.

Specifications and Calibration

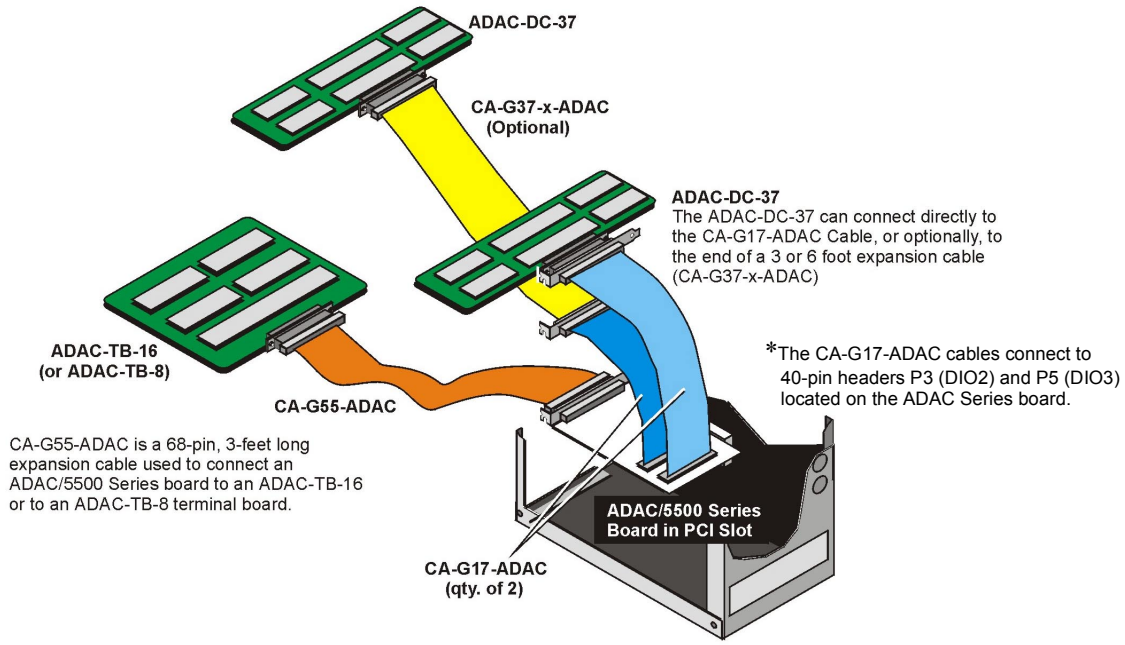
Specifications are subject to change without notice. Significant changes will be addressed in an addendum or revision to the manual. As applicable, IOtech calibrates its hardware to published specifications. Periodic hardware calibration is not covered under the warranty and must be performed by qualified personnel as specified in this manual. Improper calibration procedures may void the warranty.

Quality Notice

IOtech has maintained ISO 9001 certification since 1996. Prior to shipment, we thoroughly test our products and review our documentation to assure the highest quality in all aspects. In a spirit of continuous improvement, IOtech welcomes your suggestions.

ADAC/5500 Series Boards

Feature	/5500MF	/5501MF /5501MF-V	/5502MF /5502MF-V	/5503HR /5503HR-V	/5504HR /5504HR-V
Analog Inputs	8 Single-Ended	16 Single-Ended, or 16 Pseudo-Diff., or 8 Differential	16 Single-Ended, or 16 Pseudo-Diff., or 8 Differential	16 Single-Ended, or 16 Pseudo-Diff., or 8 Differential	16 Single-Ended, or 16 Pseudo-Diff., or 8 Differential
Ranges- Unipolar	0 to 10V	0 to10V 0 to 5V 0 to 2.5V 0 to 1.25V	0 to10V 0 to 1V 0 to 95mV 0 to 9.5mV	0 to10V 0 to 5V 0 to 2.5V 0 to 1.25V	0 to10V 0 to 1V 0 to 99.84 mV
Bipolar	± 10V	± 10V ± 5V ± 2.5V ± 1.25V	± 10V ± 1V ± 95mV ± 9.5mV	± 10V ± 5V ± 2.5V ± 1.25V	± 10V ± 1V ± 99.86mV
Resolution	12-bit	12-bit	12-bit	16-bit	16-bit
A/D Sample Rate	100 kHz	100 kHz	100 kHz	200 kHz	200 kHz
Gains (Programmable)	N/A	1, 2, 4, 8	1, 10, 100, 1000	1, 2, 4, 8	1, 10, 100
D/A Outputs (16-Bit)	0	2 Clocked DACs (/5501MF-V only)	2 Clocked DACs (/5502MF-V only)	2 Clocked DACs (/5503HR-V only)	2 Clocked DACs (/5504HR-V only)
Digital I/O	16 (Two 8-bit registers)	16 – from main I/O (Two 8-bit registers) 16 – from aux. P3* 16 – from aux. P5*	16 – from main I/O (Two 8-bit registers) 16 – from aux. P3* 16 – from aux. P5*	16 – from main I/O (Two 8-bit registers) 16 – from aux. P3* 16 – from aux. P5*	16 – from main I/O (Two 8-bit registers) 16 – from aux. P3* 16 – from aux. P5*
Counters (16-Bit)	2	2	2	2	2
Timers	2	2	2	2	2
Associated Terminal Boards	ADAC-TB-8	ADAC-TB-16 ADAC-DC-37 (qty. 2)	ADAC-TB-16 ADAC-DC-37 (qty. 2)	ADAC-TB-16 ADAC-DC-37 (qty. 2)	ADAC-TB-16 ADAC-DC-37 (qty. 2)
Associated Cables (see figure)	CA-G55-ADAC	CA-G55-ADAC CA-G17-ADAC CA-G37-x-ADAC	CA-G55-ADAC CA-G17-ADAC CA-G37-x-ADAC	CA-G55-ADAC CA-G17-ADAC CA-G37-x-ADAC	CA-G55-ADAC CA-G17-ADAC CA-G37-x-ADAC



ADAC/5500 Series, Possible Connections to Terminal Boards

1. INTRODUCTION

1.1 CHOICE OF MODELS

ADAC/5500 PCI Series cards are part of an extensive line of data acquisition boards for use in PCs. ADAC series boards are low cost and are optimized for use with Windows. We offer "sensor specific" DIRECT CONNECT™ boards, isolated digital I/O boards, boards for DSP applications, and much more. Visit our web site to learn about our complete line of products.

1.2 PRODUCT DESCRIPTION ADAC/5500 SERIES

The ADAC/5500 Series includes several models of data acquisition boards. These are discussed briefly below, and in the preceding table. Pages 2 and 3 consist of block diagrams to provide a better understanding of board function.

The **ADAC/5500MF** has 8 single-ended analog inputs multiplexed to a 12-bit A/D converter with maximum throughput of 100 kHz, two counter input channels, two timer output channels and 16 lines of digital I/O.

The **ADAC/5501MF** has 16 single-ended/pseudo-differential or 8 differential analog inputs multiplexed to a 12-bit A/D converter with maximum throughput of 100 kHz, programmable gains of 1, 2, 4 or 8, two optional clocked 16-bit D/A voltage outputs, two counter input channels, two timer output channels and 48 lines of digital I/O.

The **ADAC/5502MF** is the same as the ADAC/5501MF, but with programmable gains of 1, 10, 100 or 1000.

The **ADAC/5503HR** has 16 single-ended/pseudo-differential or 8 differential analog inputs multiplexed to a 16-bit A/D converter with maximum throughput of 200 kHz, programmable gains of 1, 2, 4 or 8, two optional clocked 16-bit D/A voltage outputs, two counter input channels, two timer output channels and 48 lines of digital I/O.

The **ADAC/5504HR** is the same as the ADAC/5503HR, but with programmable gains of 1, 10, 100.

V-versions of the boards include two clocked DACs, with exception of ADAC/5500MF, which has no "V"- version counterpart.

All boards feature *on-board digital calibration* for both A/D and D/A, and a DMA engine for optimum performance in a Windows environment. Board connections are terminated in a 68-pin "high density" SCSC III connector at the rear of the PC.

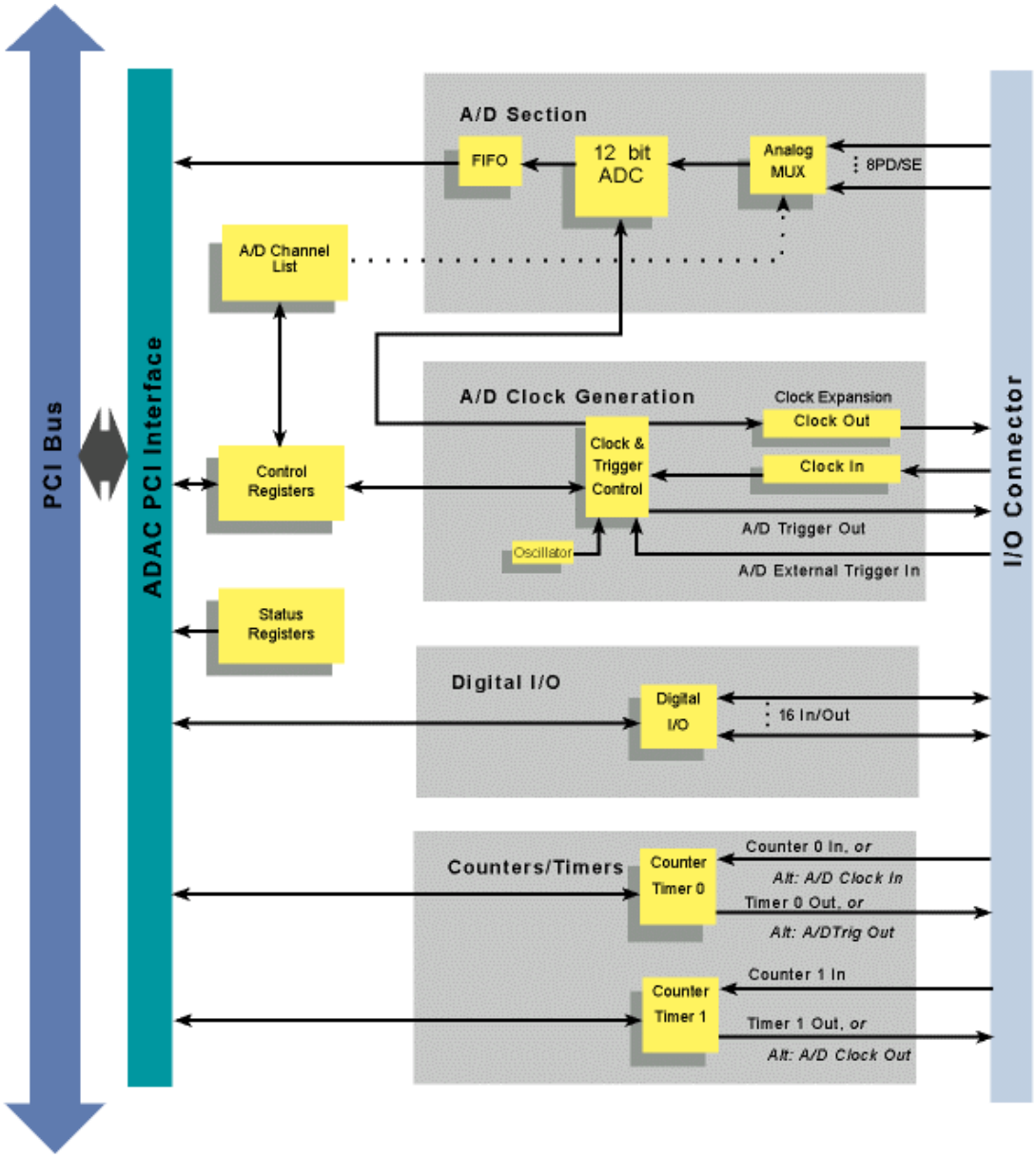


Figure 1.1

Block Diagram for ADAC/5500MF

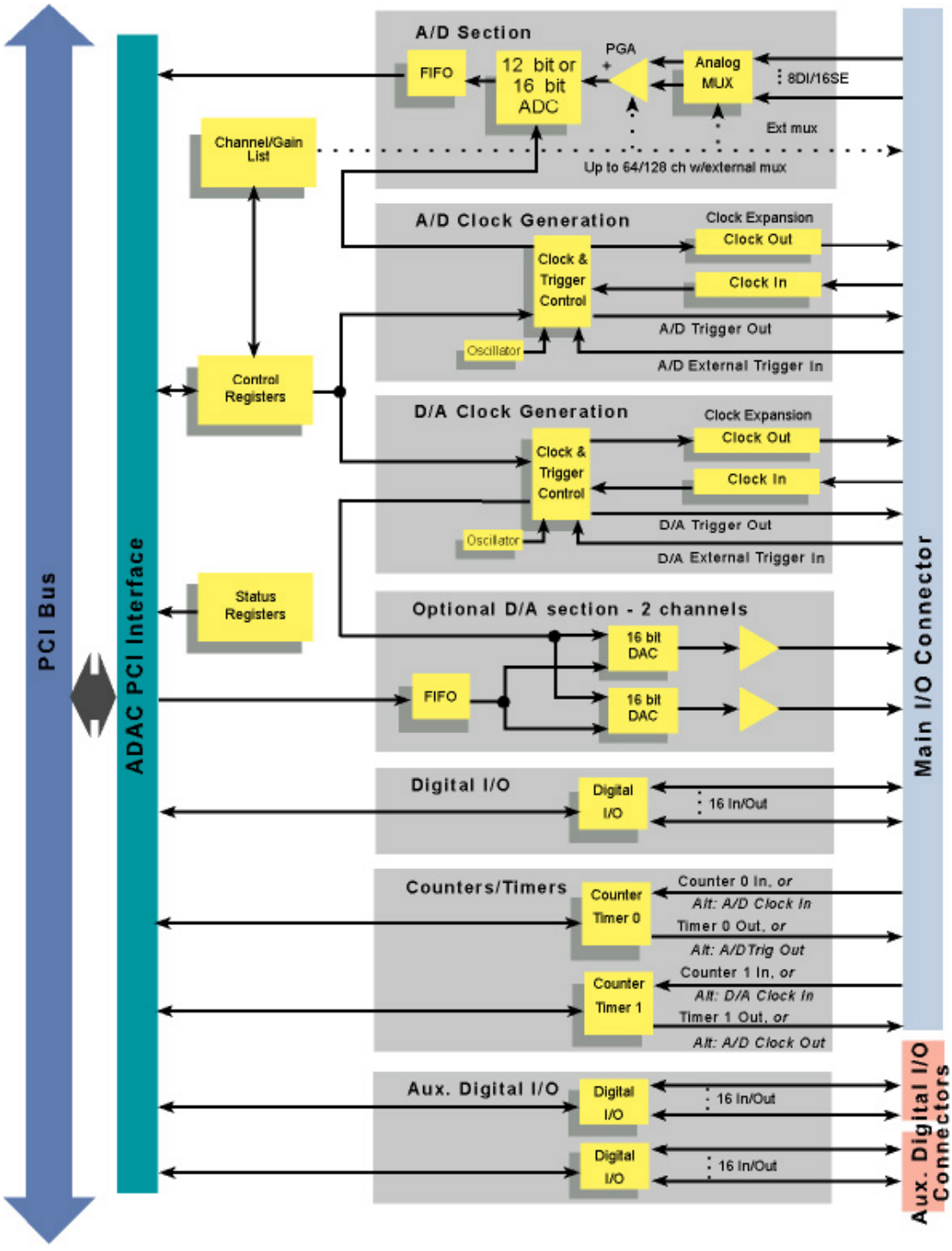


Figure 1.2

Block Diagram for ADAC/5501MF, ADAC/5502MF, ADAC/5503HR and ADAC/5504HR

1.2.1 Analog Inputs

The ADAC/5500MF has 8 single-ended analog inputs multiplexed to a 12-bit A/D converter. The input multiplexer is supported by 176 elements of channel list RAM, which allows the board to access channels in any order. The 12-bit A/D has a maximum throughput of 100 kHz and a programmable input range of ±10 V or 0-10 V. An A/D Pacer Clock is provided to allow sampling rates from 0.0009 Hz to 100 kHz. An on-board Counter/Timer circuit provides two counters and two timers dedicated to user connections.

The ADAC/5501MF, ADAC/5502MF, ADAC/5503HR and ADAC/5504HR models support 16 single-ended / pseudo-differential analog inputs, or 8 differential analog inputs (expandable to 64) multiplexed to a 12 or 16-bit A/D converter. The input multiplexer is supported by a 176 element channel gain RAM which allows the board to select gain on a per channel basis and to access channels in any order. The 12-bit A/D has maximum throughput of 100 kHz and the 16-bit A/D has a maximum throughput of 200 kHz. An A/D Pacer clock is provided to allow sampling rates from 0.0009Hz to 200 kHz.

1.2.1.1 4-20mA Current Loop Inputs – n/a

1.2.2 Analog Outputs

The ADAC/5501MF, ADAC/5502MF, ADAC/5503HR and ADAC/5504HR models may be equipped with two optional clocked DACs (D/A). Both DAC channels are DC accurate with 16-bit resolution and 200 kHz throughput. The output ranges of the DACs are programmable to ±10 V or 0 to +10 V. A Pacer clock is provided to allow sampling rates from 0.0009Hz to 200 kHz.

1.2.3 Digital I/O

All boards have 16 lines of TTL level digital I/O programmable in 8-bit ports as either inputs or outputs. All 16 lines are brought out via the main 68-pin SCSI III connector, user accessible at the back of the PC.

Two additional 40 pin headers on the ADAC/5501MF, ADAC/5502MF, ADAC/5503HR and ADAC/5504HR models (internal to the PC) provide access to an additional thirty two 5 V CMOS/LSTTL compatible digital lines, programmable in 16-bit ports as either inputs or outputs. Both sets of digital I/O lines may be brought to the back of the computer with optional adapter connectors that are compatible with the ADAC line of isolated digital I/O panels.

1.2.4 Counters 0 and 1

Counter 0 and 1 can provide either cumulative or incremental counting capabilities. The counters are capable of counting 5 V LSTTL rising edges to a maximum count of 131071 decimal.

1.2.5 Timers 0 and 1

Timer0 and Timer1 provide a 50% duty cycle square wave 5 V LSTTL output with an output frequency range of 7.7 Hz to 500 kHz. The Timer's output frequency is based on a 1 MHz oscillation with a divisor of 1 to 65536 decimal.

1.2.6 PCI Interface

The ADAC/5500 Series boards communicate to the PCI bus through an ADAC PCI interface controller. The boards are fully Plug&Play compatible with no switches, potentiometers, or jumpers. The boards feature digitally calibrated A/D and D/A's, and Plug&Play compatibility to provide automatic integration into the PC's configuration when first installed. The interface also provides access to all on-board registers for software configuration of all on-board functions. For maximum performance, the ADAC/5500 boards feature a 32-bit bus-mastering DMA engine on the ADC and DAC hardware to provide high-speed transfers between the board and system memory.

1.3 SOFTWARE COMPATIBILITY

The ADAC/5500 Series boards are shipped with ADAC ADLIB WDM (a full-feature Windows 98/ME/NT/2000/XP driver library based on Microsoft's Windows Driver Model). This library provides functions to set all of the software programmable modes of operation, and includes examples to acquire and output data.

In addition, drivers are available for PC data acquisition packages such as LabVIEW™, and TestPoint. See Section 5.1 DEVICE DRIVERS for details.

1.4 CE COMPLIANCE

The ADAC/5500 Series meets the essential health and safety requirements, and is in conformity with the EC Directives as listed in the relevant sections of the following EC standards and other normative documents:

EN 55022 Class B: Limits and methods of measurements of radio interference characteristics of information technology equipment.

EN 50082-1: EC generic immunity requirements.

IEC 801-2: Electrostatic discharge requirements for industrial process measurement and control equipment.

IEC 801-3: Radiated electromagnetic field requirements for industrial process measurement and control equipment.

IEC 801-4: Electrically fast transients for industrial process measurement and control equipment.

1.5 FUSE AND CONNECTOR PLACEMENT

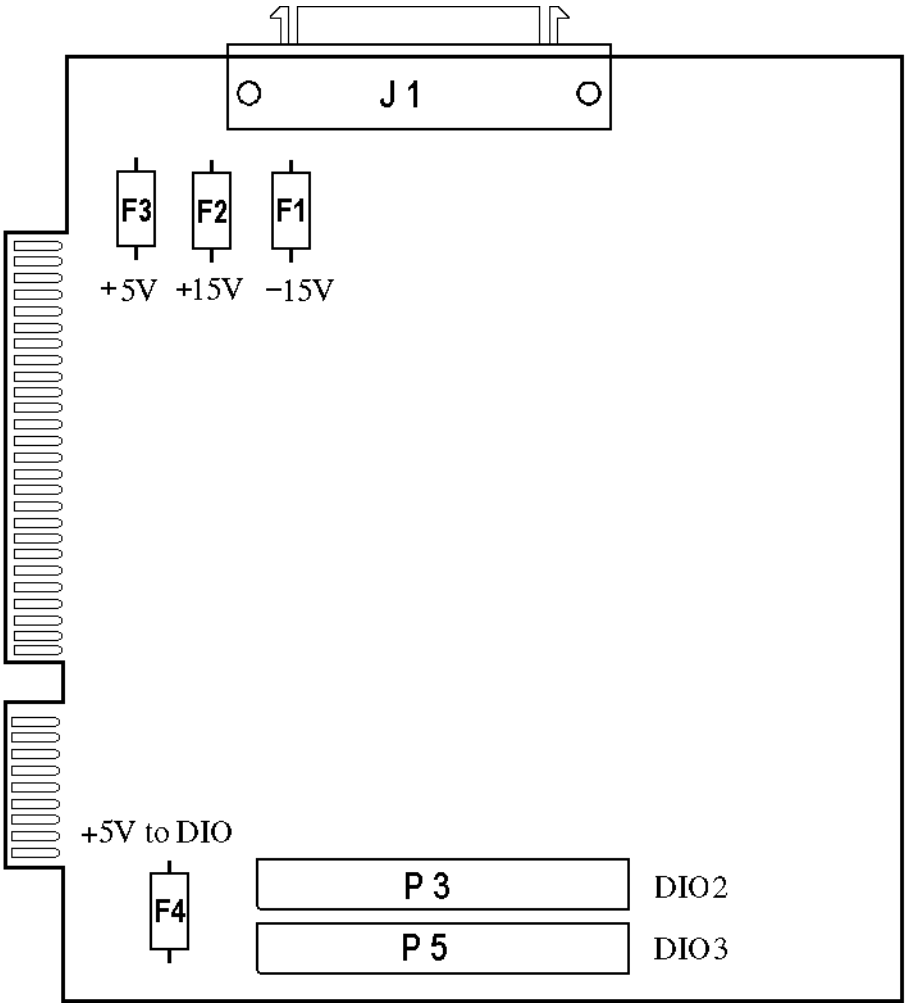


Figure 1.3
Fuse and Connector Placement for ADAC/5500 Series Boards.

Note that the ADAC/5500MF does NOT contain the J2 & J3 Aux. Digital I/O connectors

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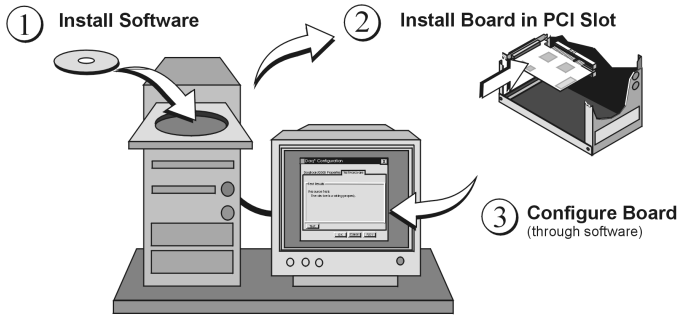
2. GETTING STARTED

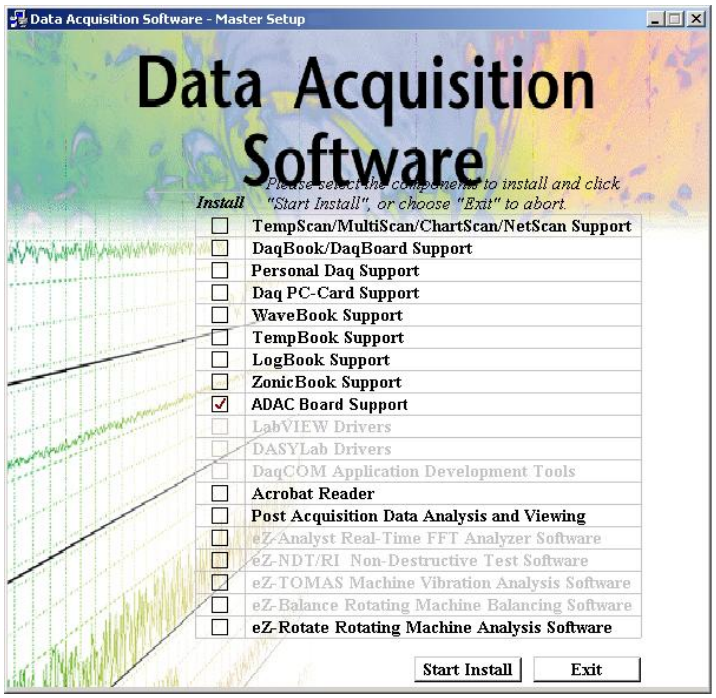


This section contains information from the *ADAC/5500 Series Installation Guide*, p/n 1107-0940. If you have already installed your software and ADAC board, you should move on to chapter 3, *Hardware Configuration*.

STEP 1 – INSTALL SOFTWARE

IMPORTANT: Software must be installed before installing hardware.

1. Place the Data Acquisition Software CD in the host PC's CD-ROM drive and wait for the PC to auto-access the CD. *If auto-access is disabled*, run **Setup.exe** using Windows Run application from the desktop.



Selecting ADAC/5500 Series Support

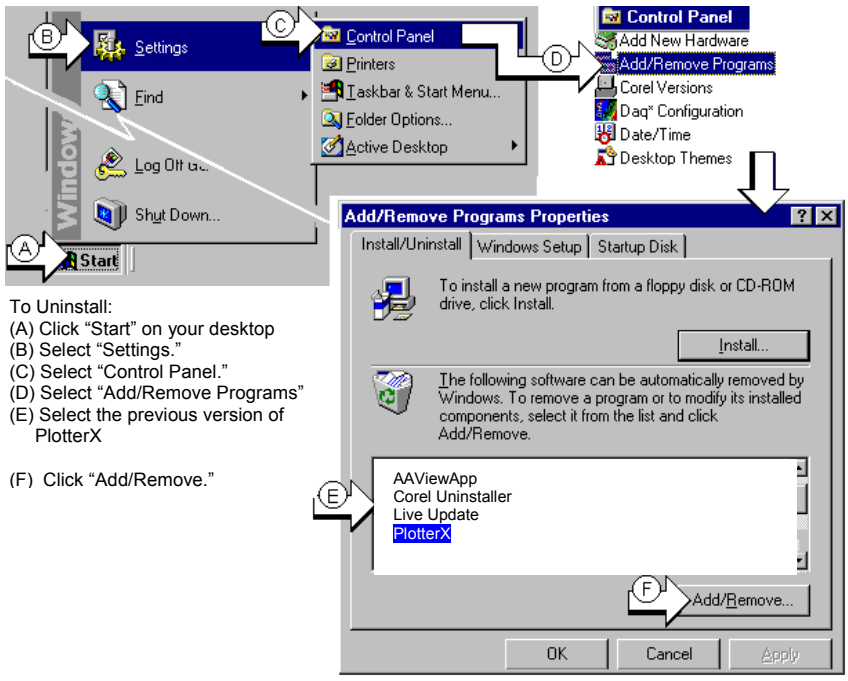
2. After the Data Acquisition Software *Master Setup* screen appears, select **ADAC Board Support**.

3. *If you do not have Acrobat Reader version 4.0 or greater* installed on your PC, select **Acrobat Reader**. This will enable you to read and print documentation that is included on the install CD-ROM.
4. Click "**Start Install**."
5. If you get the following message:

   "Setup detected previously installed components. Would you like to exit setup now and uninstall the previous installation manually?"

   Select "**Yes**" and use Microsoft's ***Add/Remove Programs*** feature to remove *any previous* version of **PlotterX** software. This procedure is detailed in steps A through F of the following figure.

   Actual screen images may vary from those depicted, depending on your operating system.



Removing Previously Installed IOtech ADAC Software

Note: If you receive a message regarding *shared files*, read the message before selecting a provided option button. *If you are not sure what to do* after reading the message, select the "**No to All**" option.

6. After removing previous versions of **PlotterX**, click **OK** and exit the Control Panel.

   Note: The install should take place automatically. If it does not, run **Setup.exe** using the Windows Run application from the desktop.
7. If you have the option to "**Exit viewing Readme file**" after the install is complete, you should select it. Readme files often contain important information that may not be available elsewhere. After reviewing the **Readme** file exit the program.
8. Remove the install CD.
9. Shutdown the PC.

You are now ready to install your ADAC/5500 Series PCI board(s) as discussed in the following section.

STEP 2 – INSTALL BOARDS IN AVAILABLE PCI BUS-SLOTS

IMPORTANT: Software must be installed before installing hardware.

WARNING

Turn OFF power to, and UNPLUG the host PC and externally connected equipment prior to removing the PC's cover and installing an ADAC/5500 Series Board. Failure to do so could result in electric shock, or damage to equipment.

CAUTION

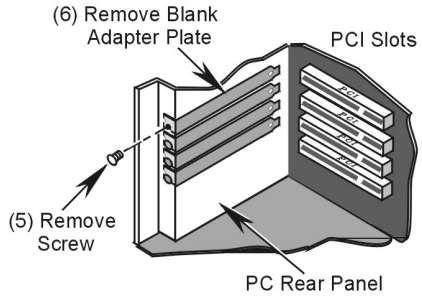
Take ESD precautions (packaging, proper handling, grounded wrist strap, etc.)
Use care to avoid touching board surfaces and onboard components. Only handle boards by their edges (or ORBs, if applicable). Ensure boards do not come into contact with foreign elements such as oils, water, and industrial particulate.

IMPORTANT: Bus Mastering DMA *must be* Enabled.

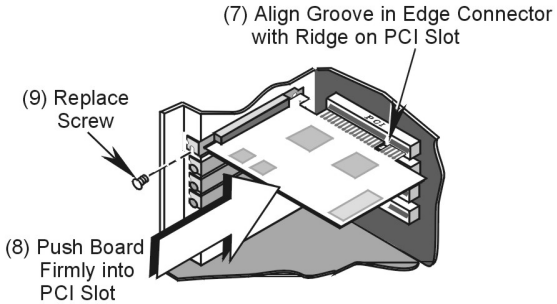
For an ADAC/5500 Series board to operate properly, Bus Mastering DMA *must be enabled* on the PCI slot [for which the board is to be installed]. Prior to installation, verify that your computer is capable of performing Bus Mastering DMA for the applicable PCI slot. Note that some computers have BIOS settings that enable [or disable] Bus Mastering DMA. If your computer has this BIOS option, ensure that Bus Mastering DMA is *Enabled* on the appropriate PCI slot.

Refer to your PC Owner's Manual for additional information regarding your PC and enabling Bus Mastering DMA for PCI slots.

1. Turn **OFF** power to, and **UNPLUG the host PC** and externally connected equipment.
2. Remove the PC's cover. *Refer to your PC Owner's Manual as needed.*
3. Choose an available PCI bus-slot.
4. Carefully remove ADAC/5500 Series Board from its anti-static protective bag. If you have not already done so, write down the serial number and type of ADAC board in the space provided on page 3 of this document.
5. On the PC's rear panel, loosen and remove the screw for the blank adapter plate that corresponds with the chosen PCI bus. *See left-hand figure, below.*



Removing a Blank Adapter Plate



Installing an ADAC/5500 Series Board

6. Remove the blank adapter plate. Refer to your PC Owner's Manual if needed.
7. Align the groove in the ADAC/5500 Series board's PCI edge-connector with the ridge of the desired PCI slot. *See preceding right-hand figure.*
8. Push the board firmly into the PCI slot. The board should "snap" into position.
9. Secure the board by inserting the rear-panel adapter-plate screw.
10. Using the previous steps, install additional boards into available PCI bus-slots, if applicable to your application.
11. Replace the computer's cover.
12. Plug in all cords and cables that were removed in step 1.
13. Apply power to, and start up the PC.

Note: At this point some PCs may prompt you to insert an installation disk. While this is rare, if you do receive such a prompt simply place the install CD-ROM into the disk drive and follow additional screen prompts.

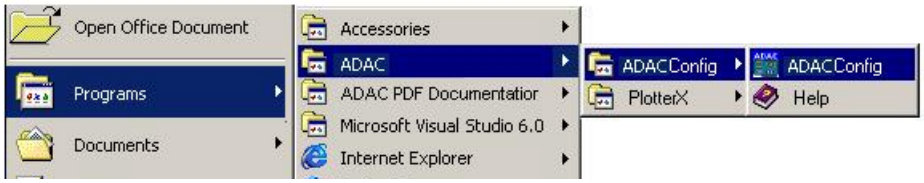
STEP 3 – CONFIGURE BOARDS

WARNING

Always turn the computer power OFF and unplug it before connecting or disconnecting a screw terminal panel or a cable to the PCI card. Failure to do so could result in electric shock, or equipment damage.

Before you can use your ADAC/5500 Series Board, you will need to configure it according to information contained in chapters 3 and 4 of this document. However, prior to doing so you may find it helpful to review the following points:

- All configuration, including data-acquisition settings such as analog input, data collection rates, input voltage range, and operating modes are made through ADAC configuration software. The ADAC configuration software (**ADAC Config**) file can be accessed from the Windows desktop Start Menu by navigating as follows:
  Start ⇒ Programs ⇒ ADAC ⇒ ADACConfig ⇒ ADAC Config



Desktop Path to ADAC Config

- **ADAC ADLIB WDM** software drivers provide an application level software interface to Windows 98/ME/NT/2000/XP. Software packages such as **LabVIEW™** communicate through our ADLIB driver software. These packages configure and collect, or output, acquisition data in a GUI based interface.

- The **ADAC/5501MF, ADAC/5502MF, ADAC/5503HR** and **ADAC/5504HR** analog inputs are impedance buffered and drive a differential gain amplifier that can be referenced in a number of ways, allowing the following programmable input configurations: ***Single-Ended***, ***Pseudo-Differential,*** **and** ***Fully-Differential.***

- The **ADAC/5500MF** analog inputs are impedance buffered. They can only be referenced in ***Single-Ended*** input configuration. 1 to 176 element channel-configuration RAM is provided to allow each ADC channel to be programmed with a different combination of Gain, Range, and Input Configuration. Note that these modes also apply to expansion channels located on the ADAC line of accessory screw terminal panels.

- The **analog inputs** on the ADAC/5500, ADAC/5501MF, ADAC/5502MF, ADAC/5503HR and ADAC/5504HR may be configured for either ±10 V bipolar or 0-10 V unipolar operation. The input range is programmable on a channel-by-channel basis in a 176-element channel configuration RAM. Note that the range selection also applies to expansion channels.

- The **programmable gain circuitry** on the ADAC/5501MF, ADAC/5502MF, ADAC/5503HR and ADAC/5504HR must be taken into account in defining the usable error free input range. The boards provide a wide range of programmable ranges and resolutions.

- The ADAC/5500 Series Boards each bring out ±15 V and +5 V to the main I/O connector (J1). In addition, the ADAC/5501MF, ADAC/5502MF, ADAC/5503HR and ADAC/5504HR bring +5 V to the auxiliary digital I/O connectors (P3 and P5), located on the backside of those boards. These power lines are individually fused to protect the ADAC/5500 Series Board. Note that connecting or disconnecting cables or screw terminal panels (as well as any user connections to these power lines) may blow a fuse, or cause damage to the board.

- Incorrect connection of user wiring is one of the most common problems experienced by users of data acquisition boards. To ensure proper results, you must first determine what type of signal source you are measuring (*Ground Referenced Source* or *Floating Source*), and then choose the appropriate input configuration on your data acquisition card (*Differential, Pseudo-Differential,* or *Single-Ended*). Chapter 4 of this manual includes detailed information.

3. HARDWARE CONFIGURATION

3.1 CONFIGURING THE ADAC/5500 SERIES

The ADAC/5500 Series contains no hardware jumpers; all board configuration elements are software selectable. Data-acquisition settings such as analog input, data collection rates, input voltage range, and operating modes are configured through application software. ADAC ADLIB WDM software drivers provide an application level software interface to Windows 98/ME/NT/2000/XP. Software packages such as LabVIEW™ communicate through our ADLIB driver software. These packages configure and collect, or output, acquisition data in a GUI based interface.

3.1.1 DMA and Interrupt Utilization

The PCI specification uses a shared interrupt scheme to increase the availability of interrupts in an attempt to alleviate limitations imposed by ISA interrupt constraints. This shared interrupt scheme, known as *interrupt chaining,* comes at a price. When a PCI card that uses interrupts is installed into a PC, the system software adds the device to a list of interrupt service routines for all PCI devices that share a common interrupt signal. When a PCI device generates an interrupt, the system software detects the interrupt and executes the first Interrupt Service Routine (ISR) in the list. The first routine in the list may not be your data acquisition device. If not, the first device determines if its device asserted the interrupt, if so the software services the interrupt and returns. The processor immediately interrupts again because the second device is still generating an interrupt request. The processor again jumps to the first device in the list, the device determines it has not requested an interrupt and jumps to the entry point of the second ISR to be serviced. If the first device in the list were to generate interrupts at a high frequency, the second device might over-run or under-run, generating an error condition while awaiting service. Well-behaved PCI devices generate interrupts infrequently. ADAC driver software only determines if the ADAC board has requested an interrupt, if so it defers the ISR to a callback procedure and quickly returns control to the interrupted process. Now that the facts are on the table, interrupt latency on the PCI bus can be extremely inefficient for high-speed data acquisition. To overcome this inefficiency we incorporate an on-board DMA engine analogous to the older ISA type of DMA controller. The on-board DMA engine supports *scatter/gather*, also known as *buffer chaining*, with a pair of chain address registers that point to system memory to be used in the buffered transfer. The DMA controller is loaded with the previously allocated physical addresses of these buffers and only generates interrupt requests when the current transfer buffer has been completed, thus reducing the burden of CPU interrupt intervention.

3.1.2 DMA Engine

Both analog input and analog output channels have on-board DMA engine support for high-speed data transfers. The two analog output channels have individual DMA engines and clocking methods available. DAC1's clocking source may be set to the DAC0 clocking source to allow simultaneously DAC transfers. All PCI bus transfers are 32-bit operations. Analog input and analog output transfers are each independently software selectable to allow either 16-bit or 32-bit data transfers. An immediate improvement of twice the memory bandwidth can be achieved by transferring two analog input data points or two analog output data points into memory as a single 32-bit PCI transfer.

3.1.3 Analog Input Configuration

For selecting the best configuration for your application see Section 4.1 Connecting User Wiring.

The ADAC/5501MF, ADAC/5502MF, ADAC/5503HR and ADAC/5504HR analog inputs are impedance buffered and drive a differential gain amplifier that can be referenced in a number of ways allowing the following programmable input configurations: Single-Ended, Pseudo-Differential and Fully-Differential.

The ADAC/5500MF analog inputs are impedance buffered, and can only be referenced in Single-Ended input configuration.

For selecting the best configuration for your application see Section 4.1 Connecting User Wiring.

A 1 to 176 element channel configuration RAM is provided to allow each ADC channel to be programmed with a different Gain, Range, Thermocouple type and Input Configuration selection combinations. Note that these modes also apply to expansion channels located on the ADAC line of accessory screw terminal panels.

3.1.4 ADC Range

The analog inputs on the ADAC/5500, ADAC/5501MF, ADAC/5502MF, ADAC/5503HR and ADAC/5504HR may be configured for either ±10 V bipolar or 0-10 V unipolar operation. The input range is programmable on a channel by channel basis in a 176-element channel configuration RAM. Note that the range selection also applies to expansion channels.

The programmable gain circuitry on the ADAC/5501MF, ADAC/5502MF, ADAC/5503HR and ADAC/5504HR must also be taken into account in defining the usable error free input range. The boards provide a wide range of programmable ranges and resolutions. The following tables indicate the maximum resolution under different conditions. Note that resolution is not accuracy. Resolution defines the minimum definable voltage increment. Absolute DC accuracy and relative accuracy defines exactly how close the reading will be to the actual voltage input. Refer to Section 6, SPECIFICATIONS for accuracy specifications.

Fixed Gain	Full Scale Range	Microvolt Resolution
	Bipolar	
x1	± 10.00 V	5.00 mV/bit
	Unipolar	
x1	0 to 10.00 V	2.50 mV/bit

Table 3.1 ADAC/5500MF Input Range/Resolution

Programmable Gain	Full Scale Range	Microvolt Resolution
	Bipolar	
x1	± 10.00 V	5.00 mV/bit
x2	± 5.00 V	2.50 mV/bit
x4	± 2.50 V	1.25 mV/bit
x8	± 1.25 V	0.625 mV/bit
	Unipolar	
x1	0 to 10.00 V	2.50 mV/bit
x2	0 to 5.00 V	1.25 mV/bit
x4	0 to 2.50 V	0.625 mV/bit
x8	0 to 1.25 V	0.3125 mV/bit

Table 3.2 ADAC/5501MF Input Range/Resolution

Programmable Gain	Full Scale Range	Microvolt Resolution
	Bipolar	
x1	± 10.00 V	5.00 mV/bit
x10	± 1 V	500 µV/bit
x100	±95 mV	50.0 µV/bit
X1000	±9.5 mV	5.00 µV/bit
	Unipolar	
x1	0 to 10.00 V	2.50 mV/bit
x10	0 to 1.00 V	250 µV/bit
x100	0 to 97.5 mV	25.0 µV/bit
X1000	0 to 9.75 mV	2.50 µV/bit

Table 3.3 ADAC/5502MF Input Range/Resolution

Programmable Gain	Full Scale Range	Microvolt Resolution
	Bipolar	
x1	± 10.00 V	310.140 µV/bit
x2	± 5.00 V	155.070 µV/bit
x4	± 2.50 V	77.535 µV/bit
x8	± 1.25 V	38.768 µV/bit
	Unipolar	
x1	0 to 10.00 V	155.070 µV/bit
x2	0 to 5.00 V	77.535 µV/bit
x4	0 to 2.50 V	38.768 µV/bit
x8	0 to 1.25 V	19.384 µV/bit

Table 3.4 ADAC/5503HR Input Range/Resolution

Programmable Gain	Full Scale Range	Microvolt Resolution
	Bipolar	
x1	± 10.00 V	310.140 µV/bit
x10	± 1 V	31.0140 µV/bit
x100	± 99.68 mV	3.10140 µV/bit
	Unipolar	
x1	0 to 10.00 V	155.070 µV/bit
x10	0 to .1 V	15.5070 µV/bit
x100	0 to 99.84 mV	1.55070 µV/bit

Table 3.5 ADAC/5504HR Input Range/Resolution

3.1.5 DAC Range

The output range of both DACs are independently programmable to either ±10 V or 0 to 10 V.

The following table indicates the maximum resolution for each available range. Note that resolution is not accuracy. Resolution defines the minimum definable voltage increment. Absolute DC accuracy and relative accuracy define exactly how close the actual voltage output will be to the expected output. Refer to Section 6, SPECIFICATIONS, for accuracy specifications.

Range Configuration	Full Scale Range	Microvolt Resolution
BIPOLAR	± 10.00 V	305.600 µV/bit
UNIPOLAR	0 to 10.00 V	152.800 µV/bit

Table 3.6 ADAC/5500 Series Analog Output Range/Resolution

4. EXTERNAL CONNECTIONS

WARNING

Always turn the computer power OFF and unplug it before connecting or disconnecting a screw terminal panel or a cable to the PCI card. Failure to do so could result in electric shock, or equipment damage.

The ADAC/5500 cards bring out ±15 V and +5 V to the main I/O connector J1, and +5 V to the auxiliary digital I/O connectors P3 and P5. These power lines are individually fused to protect the ADAC/5500 card. Connecting or disconnecting cables or screw terminal panels (as well as any user connections to these power lines) may blow a fuse, or worse, cause damage to the board. If you are getting incorrect data readings on your ADAC/5500 card, check all fuses to make sure they have not blown. Replacement fuses can be obtained from the factory, or from most electronics stores (such as Radio Shack in the USA). Fuse values on the ADAC/5500 card are as follows:

Fuse #	Power Line	Fuse Value
F1	-15 V to J1	Pico Fuse 125mA 125 V
F2	+15 V to J1	Pico Fuse 125mA 125 V
F3	+5 V to J1	Pico Fuse 3.0A 125 V
F4	+5 V to P3, P5	Pico Fuse 3.0A 125 V

4.1 CONNECTING USER WIRING

Incorrect connection of user wiring is one of the most common problems experienced by users of data acquisition boards. To ensure proper results, you must first determine what type of signal source you are measuring (Ground Referenced Source or Floating Source), and then choose the appropriate input configuration on your data acquisition card (Differential, Pseudo-Differential, or Single-Ended).

4.1.1 Signal Types

Floating Sources

A Floating Source is a signal that has no connection to the building's power ground. Examples of Floating Sources are thermocouples, batteries and battery powered devices, and signals from optically isolated devices. When connecting Floating Sources to a data acquisition card, the ground reference of the signal must be tied to the analog ground (AGND) in order to establish a common reference point.

Ground Referenced Sources

A Ground Referenced Source is one that is connected to the same common ground as the host PC, and therefore has the same ground as the data acquisition cards. An example is equipment that plugs into the same building power source as the host PC.

Due to differences in a building's power system, the Ground Referenced Source and the data acquisition board's ground may be at different voltage levels. This difference is referred to as a Common Mode Voltage. Common Mode Voltage can be eliminated by using either Pseudo-Differential (PD) or Fully-Differential (DI) input configurations on the data acquisition board.

Signal Level

In addition to the grounding of source signals, the maximum voltage level of the signal should be taken into account when choosing the optimum input configuration on the data acquisition board. When working with signals with a maximum level below 1 V (Low Level), care must be taken to minimize possible affects caused by noise in the environment. The addition of noise will have less effect on signals in the 1-10 V range (High Level), and therefore High Level signals can use more types of input configurations.

4.1.2 Choosing A/D Input Configuration

Once you have determined what type of input signal source you have, and the voltage level, you then need to select the proper/optimum input configuration on your data acquisition card:

4.1.2.1 Single-Ended

Applications with a Floating Source are typically wired to a data acquisition board configured for Single-Ended (SE) configuration. Since only one wire from each input signal is connected to a multiplexed input of the A/D, the Single-Ended configuration provides a larger number of inputs per board than Differential (see below) configuration. Grounded Signal Sources can be wired in Single-Ended configuration only when signal leads are less than 12 feet **AND** when all signals share a common ground (the signals must be local to one another).

With the Single-Ended configuration, the input signals are tied to the Channel Hi side of an analog input, and all signal low sides are tied to the SGND ground on the data acquisition card.

Single-Ended configuration should only be used when:

- There is no Common Mode Voltage
- Ground isolation is not required
- Signal leads are less than 12 feet.

Note that of all the three possible input configurations, Single-Ended offers the least amount of noise rejection. Because of this, Low Level signals should only be wired in Single-Ended configuration when you are certain that there is little or no noise being introduced to the signal from the system, or the environment. We DO NOT recommend using Single-Ended configuration with Low Level signals.

Figure 4.1 shows proper wiring for Single-Ended configuration.

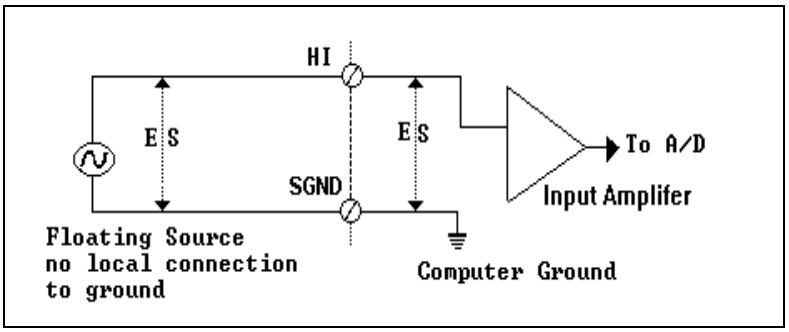


Figure 4.1
Single-Ended Configuration

4.1.2.2 Pseudo-Differential (PD)

For multiple signal sources that share a common ground (signals must be local to one another), the Pseudo-Differential mode may be the most desirable. The Pseudo-Differential configuration is similar to Single-Ended, but the analog low side of each signal is isolated from analog ground (AGND) by a 10 megohm resistor and a capacitor. All input returns are tied together to PDIN. Pseudo-Differential configuration allows the system to reject any common-mode voltage difference that may exist.

Pseudo Differential configuration should be used when:

- Common Mode Voltage exists
- Common Mode Noise does not exist
- Each Source has a local ground
- Input signals are greater than 1 V (High Level)
- Signal leads are longer than 12 feet

Figure 4.2 shows proper wiring for Pseudo-Differential configuration.

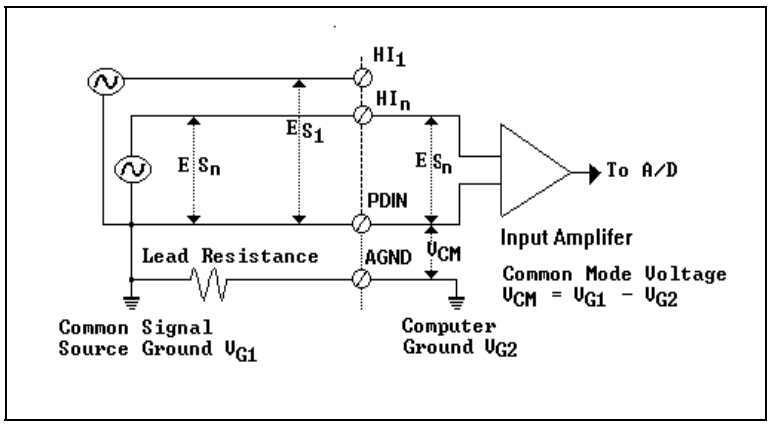


Figure 4.2
Pseudo-Differential Configuration

4.1.2.3 Fully-Differential (DIFF)

In installations where each Ground Referenced Source signal has a local ground (signal located remote from one another), the Fully-Differential configuration must be used. Since the Fully-Differential configuration only responds to the difference in a signal between its high and low voltages, any Common Mode Voltage will be cancelled out. In addition, Fully-Differential configuration provides the best performance of the three configurations in an electrically noisy environment.

The Fully-Differential configuration should be used when any of the following exists:

- Each source has a local ground
- Signal sources are remote from one another
- Common Mode Voltage exists
- Common Mode Noise exists
- Signal sources are low-level (less than 1 V)
- Signal source leads are longer that 12 feet

Fully-Differential for Grounded Signal Sources

See Figure 4.3 for an example of connecting Grounded Signal Sources in Fully Differential configuration.

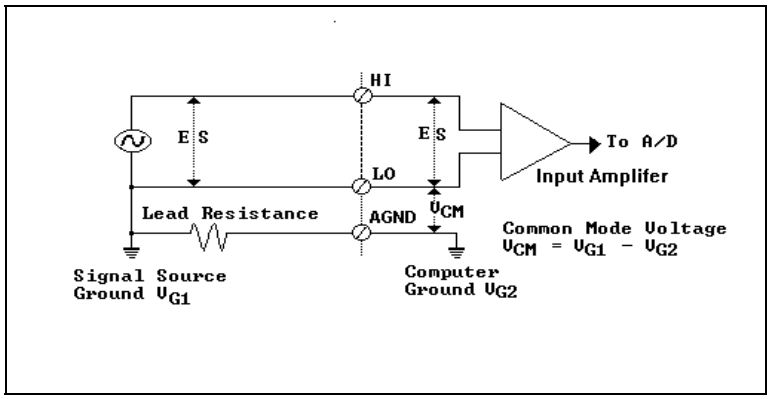


Figure 4.3
Fully-Differential Configuration for Grounded Sources

Fully-Differential for Floating Signal Sources

Floating Signal Sources are typically wired to a data acquisition board in Single-Ended configuration, however, when the Floating Source signal leads pass through an electrically noisy environment, Fully-Differential configuration will give the best performance. When wiring Floating Signal sources in Fully-Differential configuration, a resistor must be connected from the low side of the sources to analog ground (AGND). These resistors create a return path to AGND for the bias currents of the instrumentation amplifier. If a return path is not provided, the bias current will build up on stray capacitance, resulting in drift and possible saturation of the amplifier.

If the input signal is DC coupled a 10 K ohm to 100 K ohm resistor must be connected from the input signal's return to the data acquisition board's AGND.

For AC coupled input signals a 10 K ohm to 100 K ohm resistor must be connected from both input signal high and input signal low to AGND.

Figure 4.4 shows how to properly wire a Floating Source Signal in Fully-Differential configuration. In the case where there is a combination of Ground Referenced Sources and Floating Sources, the Fully-Differential mode should be used.

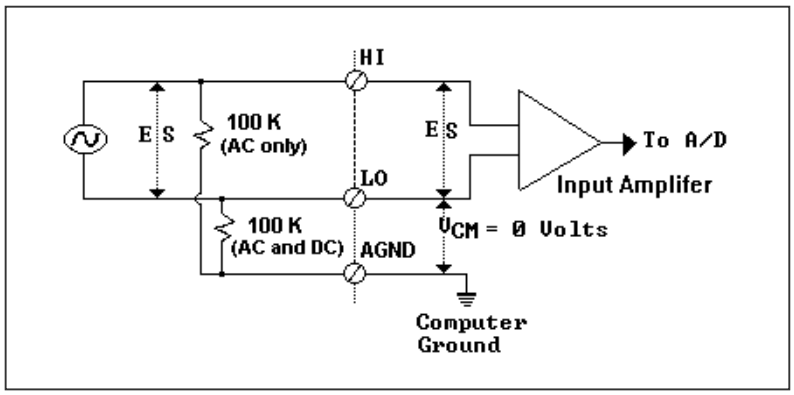


Figure 4.4
Fully-Differential Configuration for Floating Sources

4.2 MAIN I/O CONNECTOR (J1)

The main board connector is a 68 pin "SCSI III" style connector. This connector carries all the Analog I/O connections as well as the 16 Digital I/O connections.

The ADAC/5500 input channels may be connected directly to any High Level voltage source. If long leads are run from transducers to the system, it is very important that the leads be shielded to protect against pickup of power frequency and other noise.

The factory has a line of screw terminal panels which can be used to ease field wiring to the PCI cards. Any of these panels may be connected to the PCI card with an SCSC-III type cable (which can be ordered from the factory as a G55 cable).

The ADAC line of screw terminal panels includes:

ADAC-TB-8 - For use with the ADAC/5500MF boards only, this panel provides access to the 8 on-board analog input channels, as well as the DIO ports 0 and 1 and various clocking and triggering signals.

ADAC-TB-16 - For use with the ADAC/5501MF, ADAC/5501MF-V, ADAC/5502MF, ADAC/5503HR, ADAC/5503HR-V, and ADAC/5504HR boards only, this panel provides access to the 16 on-board analog input channels, as well as the DIO ports 0 and 1, various clocking and triggering signals, and two optional DACs.

4.2.1 Signal Definitions

The following is a description of each of the signals available at the J1-pin connector at the front edge of the board.

4.2.1.1 Analog / Thermocouple Input Channels

These channel signals are over-voltage protected to 20 V above or below the ±15 V power supply. The channel inputs can withstand input voltages of up to ±20 volts when the power to the system is off.

ADAC-TB-8

CH 0..CH 7 - These signals are the positive half of the associated single-ended input channels.

ADAC-TB-16

CH 0..CH 14 EVEN - These signals are either the positive half of the associated differential input channel pairs 0 through 7, or single-ended/pseudo-differential input channels 0 through 14 even.

CH 1..CH 15 ODD - These signals are either the negative half of the associated differential input channel pairs 0 through 7, or single-ended/pseudo-differential input channels 1 through 15 odd.

4.2.1.2 Analog Outputs

DAC 1, DAC 0 - These signals are the voltage output signals from the optional DACs.

RTN 1, RTN 0 - These signals are the return lines for the voltage outputs. These inputs are essentially tied to AGND (Analog Ground) on the board.

4.2.1.3 Digital I/O Lines

DIO 0..DIO 15 - These signals are the 16 TTL level digital controls lines configurable as 8 bit input or output lines. These lines are not clocked.

4.2.1.4 Terminal Panel Control

These signals are used to control the various optional terminal panels. The function of some signals may vary slightly depending on the panel used.

MUX 0..MUX 7 - These signals are used to control the external multiplexers on active panels. These lines directly reflect the current state of the Channel RAM bits of the same name.

ADCLKIN - This is the ADC External Pacer clock input. This input recognizes TTL level signals and is edge sensitive. The active edge is selectable as either rising or falling.

The ADCLKIN signal line is shared *with the on-board COUNTER 0 Clock Input signal (CNTR0) pin #39 on the 68-pin J1 connector. Therefore only one input signal may be connected to the ADCLKIN / CNTR0 terminal at any given time. Attempting to use COUNTER 0 when the ADC Pacer Clock Source is set for an External Clock Input would not be possible, unless COUNTER 0 was being used to count the ADC's External Clock Input signal.*

ADCLKOUT - This signal is the ADC's External Clock Output. Each time the ADC is clocked from any of the available clocking sources the ADCLKOUT signal pulses high for a period of 1 microsecond. This output can be used to synchronize multiple A/D converters on different PCI cards

allowing simultaneous A/D conversions by connecting the ADCLKOUT to the ADCLKIN input of each PCI card.

The ADCLKOUT signal line is shared *with the on-board TIMER 1 Clock Output* signal *(TMR1) pin #5 on the 68-pin J1 connector. Therefore only one output signal may be generated to the ADCLKOUT / TMR1 terminal at any given time. The TIMER 1 is automatically disabled in hardware when the ADCLKOUT is enabled.*

ADTGIN - This is the External ADC Trigger/Gate input. This input recognizes TTL level signals and is used to start or stop the ADC acquisition process. The input is selectable as either rising/falling edge or active high/low level sensitivity.

ADTGOUT - This signal is the internal ADC's Trigger output. Each time the ADC is triggered from any of the available triggering sources the ADTGOUT signal pulses high for a period of 1 microsecond. This output can be used to synchronize multiple A/D converters on different ADAC/5500 cards allowing simultaneous A/D triggering by connecting the ADTGOUT to the ADTGIN input of each PCI card.

The ADTGOUT signal line is shared *with the on-board TIMER 0 Clock Output* signal *(TMR0) pin #4 on the 68-pin J1 connector. Therefore only one output signal may be generated to the ADTGOUT / TMR0 terminal at any given time. The TIMER 0 is automatically disabled in hardware when the ADTGOUT is enabled.*

DACLKIN - This is the External DAC0 Pacer clock input. This input recognizes TTL level signals and is edge sensitive. The active edge is selectable as either rising or falling.

The DACLKIN signal line is shared *with the on-board COUNTER 1 Clock Input signal (CNTR1) pin #40 on the 68-pin J1 connector. Therefore only one input signal may be connected to the DACLKIN / CNTR1 terminal at any given time. Attempting to use COUNTER 1 when the DAC Pacer Clock Source is set for an External Clock Input would not be possible unless COUNTER 1 was being used to count the DAC's External Clock Input signal.*

DATGIN - This is the External DAC0 Trigger/Gate input. This input recognizes TTL level signals and is used to start or stop the DAC acquisition process. The input is selectable as either rising/falling active edge or active high/low level sensitivity.

4.2.1.5 Counters And Timers

CNTR0 - This is the general purpose Counter 0 clock input. This input recognizes TTL level signals and is rising edge sensitive. The input clock rate cannot exceed 500 kHz. The clock source must provide a minimum pulse width of 100 ns.

The COUNTER 0's External Clock Input line (CNTR0) is shared *with the ADC's External Clock Input signal (ADCLKIN) pin #39 on the 68-pin J1 connector. Therefore only one input signal may be connected to the ADCLKIN / CNTR0 terminal at any given time. Attempting to use COUNTER 0 when the ADC Pacer Clock Source is set for an External Clock Input would not be possible, unless COUNTER 0 was being used to count the ADC's External Clock Input signal.*

CNTR1 - This is the general purpose Counter 1 clock input. This input recognizes TTL level signals and is rising edge sensitive. The input clock rate cannot exceed 500 kHz. The clock source must provide a minimum pulse width of 100 ns.

The COUNTER 1's External Clock Input line (CNTR1) is shared *with the DAC's External Clock Input signal (DACLKIN) pin #40 on the 68-pin J1 connector. Therefore only one input signal may be connected to the DACLKIN / CNTR1 terminal at any given time. Attempting to use COUNTER 1 when the ADC Pacer Clock Source is set for an External Clock Input would not be possible, unless COUNTER 1 was being used to count the DAC's External Clock Input signal.*

TIMER0 - This LSTTL output signal provides a 50% duty cycle square wave derived from an independent TMR0 internal software pacer clock. The pacer clock period can be set from 1 us to 65535 us, producing an output clock rate from 500 KHz down to approximately 7.6295 Hz.

The TIMER 0's External Clock Output line (TMR0) is shared *with the ADC's External Trigger Output signal (ADTGOUT) pin #4 on the 68-pin J1 connector. Therefore only one output signal may be generated to the ADTGOUT / TMR0 terminal at any given time. TIMER 0 is automatically disabled in hardware when the ADC's External Trigger Output is enabled.*

TIMER1 - This LSTTL output signal provides a 2nd clock source, with characteristics identical to TIMER0, using a separate, independent, TMR1 internal software pacer clock.

The TIMER 1's External Clock Output line (TMR1) is shared *with the ADC's External Clock Output signal (ADCLKOUT) pin #5 on the 68-pin J1 connector. Therefore only one output signal may be generated to the ADCLKOUT / TMR1 terminal at any given time. TIMER 1 is automatically disabled in hardware when the ADC's External Clock Output is enabled.*

4.2.1.6 Ground Lines

SGND - This signal is the reference ground used for A/D conversions. If you are measuring from a fully floating source in differential mode, it would be beneficial to tie one of the channel inputs to this point. This signal should not be used for sinking large amounts of current. This signal also acts as the common reference line when the board is configured for single-ended inputs.

PDIN - This signal is the common return line used when the board is configured for pseudo differential input mode.

AGND - This signal is the power return for the ±15 V power supply lines. It is distinguished from the DGND line because it generally helps separate the potentially high frequency digital ground noise from the analog circuits that are powered by ±15 V.

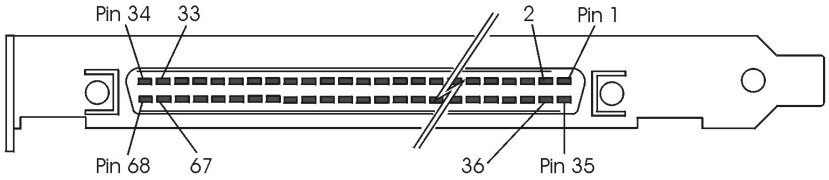
DGND - This signal is the +5 V power return line. It is generally noisier than AGND and is a good logic low reference point.

4.2.1.7 Power Lines

+15 V, -15 V - This power is only intended to power the optional terminal panels with active circuitry on them. These voltages are supplied by one of the on-board DC/DC converters. Approximately ±30 mA are available on these lines. Both lines are fused @ 125 mA.

+5 V - This signal is sourced directly from the PCI Bus. Take great care when using this power. These lines are fused @ 3 Amps.

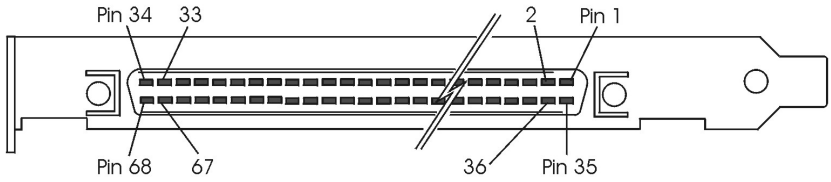
4.2.2 J1 Pin Assignments For ADAC/5500MF Only



Standard 68-Pin SCSCI Type III, Socket (Female) Connector with Orb

Pin	Signal	Description / Comments	Pin	Signal	Description / Comments
1	DGND	Digital Ground	35	+5 V (fused)	Power
2	+15 V (fused)	Power	36	+5 V (fused)	Power
3	-15 V (fused)	Power	37	+5 V (fused)	Power
4	ADTGOUT / TMR0	Internal ADC Trigger Output / Timer 0 Clock Output	38	ADTGIN	External Gate (level controlled), or External Trigger (edge active)
5	ADCLKOUT / TMR1	Internal ADC Trigger Output / Timer 1 Clock Output	39	ADCLKIN / CNTR0	External ADC Clock In, or Counter 0. Rising or Falling Edge Sensitive.
6	N/C	Not Connected	40	CNTR1	Counter 1 Clock Input
7	DIO_15	TTL Level Digital I/O Ch. 15	41	DIO_14	TTL Level Digital I/O Ch. 14
8	DIO_13	TTL Level Digital I/O Ch. 13	42	DIO_12	TTL Level Digital I/O Ch. 12
9	DIO_11	TTL Level Digital I/O Ch. 11	43	DIO_10	TTL Level Digital I/O Ch. 10
10	DIO_9	TTL Level Digital I/O Ch. 9	44	DIO_8	TTL Level Digital I/O Ch. 8
11	DIO_7	TTL Level Digital I/O Ch. 7	45	DIO_6	TTL Level Digital I/O Ch. 6
12	DIO_5	TTL Level Digital I/O Ch. 5	46	DIO_4	TTL Level Digital I/O Ch. 4
13	DIO_3	TTL Level Digital I/O Ch. 3	47	DIO_2	TTL Level Digital I/O Ch. 2
14	DIO_1	TTL Level Digital I/O Ch. 1	48	DIO_0	TTL Level Digital I/O Ch. 0
15	DGND	Digital Ground	49	N/C	Not Connected
16	N/C	Not Connected	50	N/C	Not Connected
17	N/C	Not Connected	51	N/C	Not Connected
18	N/C	Not Connected	52	N/C	Not Connected
19	N/C	Not Connected	53	N/C	Not Connected
20	N/C	Not Connected	54	N/C	Not Connected
21	AGND	Analog Ground	55	AGND	Analog Ground
22	N/C	Not Connected	56	N/C	Not Connected
23	SGND	Signal Ground	57	N/C	Not Connected
24	N/C	Not Connected	58	N/C	Not Connected
25	AIN_7	Analog Input, Ch. 7	59	AIN_3	Analog Input, Ch. 3
26	N/C	Not Connected	60	N/C	Not Connected
27	AIN_6	Analog Input, Ch. 6	61	AIN_2	Analog Input, Ch. 2
28	N/C	Not Connected	62	N/C	Not Connected
29	AIN_5	Analog Input, Ch. 5	63	AIN_1	Analog Input, Ch. 1
30	N/C	Not Connected	64	N/C	Not Connected
31	AIN_4	Analog Input, Ch. 4	65	AIN_0	Analog Input, Ch. 0
32	N/C	Not Connected	66	N/C	Not Connected
33	N/C	Not Connected	67	N/C	Not Connected
34	AGND	Analog Ground	68	DGND	Digital Ground

4.2.3 J1 Pin Assignments for ADAC/5501MF, ADAC/5502MF, ADAC/5503HR, & ADAC/5504HR



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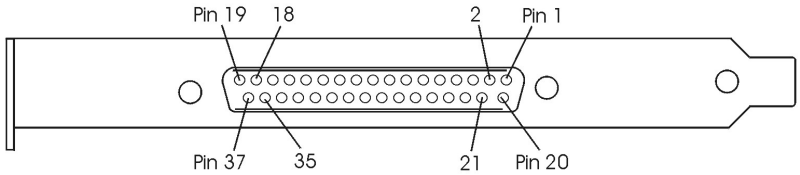
2	+15 V (fused)	Power	36	+5 V (fused)	Power
3	-15 V (fused)	Power	37	+5 V (fused)	Power
4	ADTGOUT / TMR0	Internal ADC Trigger Output / Timer 0 Clock Output	38	ADTGIN	External Gate (level controlled), or External Trigger (edge active)
5	ADCLKOUT / TMR1	Internal ADC Trigger Output / Timer 1 Clock Output	39	ADCLKIN / CNTR0	External ADC Clock In, or Counter 0. Rising or Falling Edge Sensitive.
6	DATRIGIN	DAC0 External Gate (Level Controlled), or External Trigger (Edge Active).	40	DACLKIN / CNTR1	External ADC Clock In, or Counter 0. Rising or Falling Edge Sensitive.
7	DIO_15	TTL Level Digital I/O Ch. 15	41	DIO_14	TTL Level Digital I/O Ch. 14
8	DIO_13	TTL Level Digital I/O Ch. 13	42	DIO_12	TTL Level Digital I/O Ch. 12
9	DIO_11	TTL Level Digital I/O Ch. 11	43	DIO_10	TTL Level Digital I/O Ch. 10
10	DIO_9	TTL Level Digital I/O Ch. 9	44	DIO_8	TTL Level Digital I/O Ch. 8
11	DIO_7	TTL Level Digital I/O Ch. 7	45	DIO_6	TTL Level Digital I/O Ch. 6
12	DIO_5	TTL Level Digital I/O Ch. 5	46	DIO_4	TTL Level Digital I/O Ch. 4
13	DIO_3	TTL Level Digital I/O Ch. 3	47	DIO_2	TTL Level Digital I/O Ch. 2
14	DIO_1	TTL Level Digital I/O Ch. 1	48	DIO_0	TTL Level Digital I/O Ch. 0
15	DGND	Digital Ground	49	CJ2	Reserved
16	CJ1	Reserved	50	CJ0	Reserved
17	MUX7	Reserved	51	MUX6	Reserved
18	MUX5	Reserved	52	MUX4	Reserved
19	MUX3	Reserved	53	MUX2	Reserved
20	MUX1	Reserved	54	MUX0	Reserved
21	AGND	Analog Ground	55	AGND	Analog Ground
22	ADEX_LO	Reserved, AD Expansion LO	56	ADEX_HI	Reserved, AD Expansion HI
23	SGND	Signal Ground	57	PDIN	Pseudo-Differential Input return
24	AIN_15	Analog Input, Ch. 15	58	AIN_7	Analog Input, Ch. 7
25	AIN_14	Analog Input, Ch. 14	59	AIN_6	Analog Input, Ch. 6
26	AIN_13	Analog Input, Ch. 13	60	AIN_5	Analog Input, Ch. 5
27	AIN_12	Analog Input, Ch. 12	61	AIN_4	Analog Input, Ch. 4
28	AIN_11	Analog Input, Ch. 11	62	AIN_3	Analog Input, Ch. 3
29	AIN_10	Analog Input, Ch. 10	63	AIN_2	Analog Input, Ch. 2
30	AIN_9	Analog Input, Ch. 9	64	AIN_1	Analog Input, Ch. 1
31	AIN_8	Analog Input, Ch. 8	65	AIN_0	Analog Input, Ch. 0
32	RTN1	Voltage output return, line 1.	66	DAC1 (Note 2)	Digital-to-Analog Converter 1
33	RTN0	Voltage output return, line 0.	67	DAC0 (Note 1)	Digital-to-Analog Converter 0
34	AGND	Analog Ground	68	DGND	Digital Ground

Note 1: The clock source of the primary DAC0 channel may be software command, DAC0 Pacer clock, or an external event (DACLKIN).

Note 2: The clock source of the secondary DAC1 channel may be software command, DAC1 Pacer clock, or Channel 0 clock source.

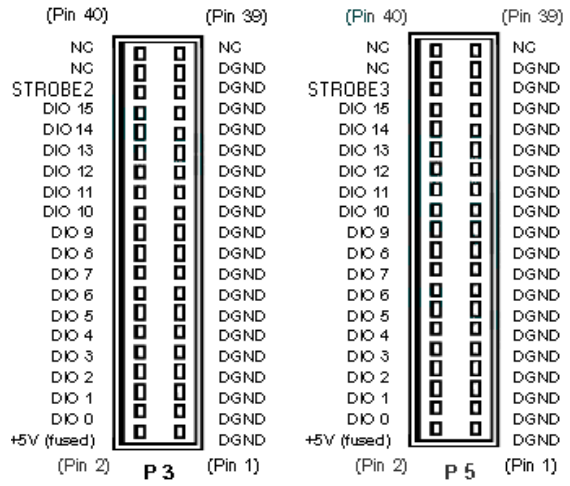
4.2.4 *P3 and P5 Pin Assignments*

The ADAC/5501MF, ADAC/5502MF, ADAC/5503HR and ADAC/5504HR include two auxiliary 40-pin headers. These are located on the back of the boards, and provide access to the two 16-bit DIO ports (DIO2 and DIO3). Two CA-G17-ADAC cables can be used to bring the DIO2 and DIO3 headers to separate37-pin D-type connectors [one GA-17 cable per DIO header]. GA17's orb (following figure) mounts at the back of the host PC.

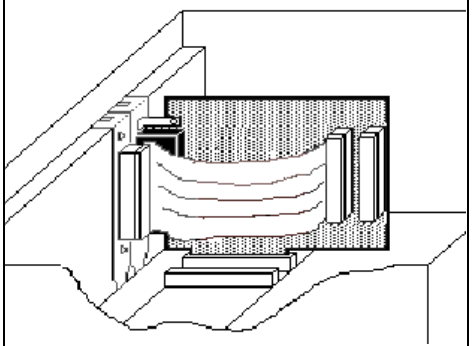


The DB37-end of a CA-G17-ADAC Cable, which includes an Orb for PC Mounting

SIGNAL NAME	P3 PIN or P5 PIN	G17 PIN (37-pin D)	SIGNAL NAME	P3 PIN or P5 PIN	G17 PIN (37-pin D)
DGND	1	1	DGND	21	11
+ 5 V (fused)	2	20	D9	22	30
DGND	3	2	DGND	23	12
D0	4	21	D10	24	31
DGND	5	3	DGND	25	13
D1	6	22	D11	26	32
DGND	7	4	DGND	27	14
D2	8	23	D12	28	33
DGND	9	5	DGND	29	15
D3	10	24	D13	30	34
DGND	11	6	DGND	31	16
D4	12	25	D14	32	35
DGND	13	7	DGND	33	17
D5	14	26	D15	34	36
DGND	15	8	DGND	35	18
D6	16	27	STROBE2 / 3	36	37
DGND	17	9	DGND	37	19
D7	18	28	DGND	38	n/c
DGND	19	10	DGND	39	n/c
D8	20	29	DGND	40	n/c



P3 & P5 Auxiliary Digital I/O Connectors
Standard 40-Pin Male Headers



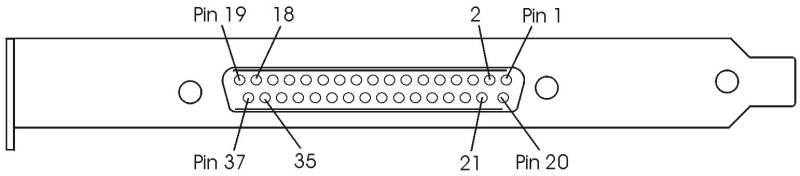
A CA-G17-ADAC Cable, Installed

Signal definitions for the P3 and P5 Auxiliary 40-Pin DIO headers and the DB37 connector follow.

4.2.5 *Signal Definitions for P3, P5, and GB17's DB37 Connector*

The following descriptions apply to each of the signals that are available at the 40-pin auxiliary DIO headers, designated as P3 and P5. The headers are located on the back of boards: ADAC/5501MF, ADAC/5502MF, ADAC/5503HR, and ADAC/5504HR. In addition, the signals apply to the corresponding pins on GA17's DB37 connector as indicated in the table on the preceding page.

GA17's orb (following figure) mounts at the back of the host PC.



The DB37-end of a CA-G17-ADAC Cable, which includes an Orb for PC Mounting

D0... D15 These signals are the sixteen 5 V CMOS/LSTTL level digital input/output lines of DIO2 on connector P3, and the D103 connector on P5.
On G17's DB37 connector, D0 through D15 correspond to pins 21 through 36, with DB0 assigned to pin 21, DB1 assigned to pin 22, DB2 assigned to pin 23, etc.

DGND This signal is the +5 V power return line. It may also be used as a reference ground for TTL signals. **On G17's DB37 connector**, the DGND lines connect to pins 1 through 19, inclusive.

+5 V This signal is +5 V power voltage signal that is sourced directly from the PC bus. The +5 V lines are fused at 3 amps. See **WARNING**. On G17's DB37 connector, the +5 V power signal corresponds to pin 20.

WARNING

Possible electric shock. Take great care when using the +5 V power as the voltage signal is sourced directly from the PC Bus. The +5 V lines are fused at 3 Amps.

STROBE The Strobe2 signal is provided on the DIO2 37-pin interface and the Strobe3 signal is provided on the DIO3 interface. When either port is configured as an input port, the associated Strobe signal is disabled and placed in a High Impedance state (Z off). When DIO port is configured as an output port, the associated strobe signal will be pulsed low for 1 microsecond following each data output event that occurs.

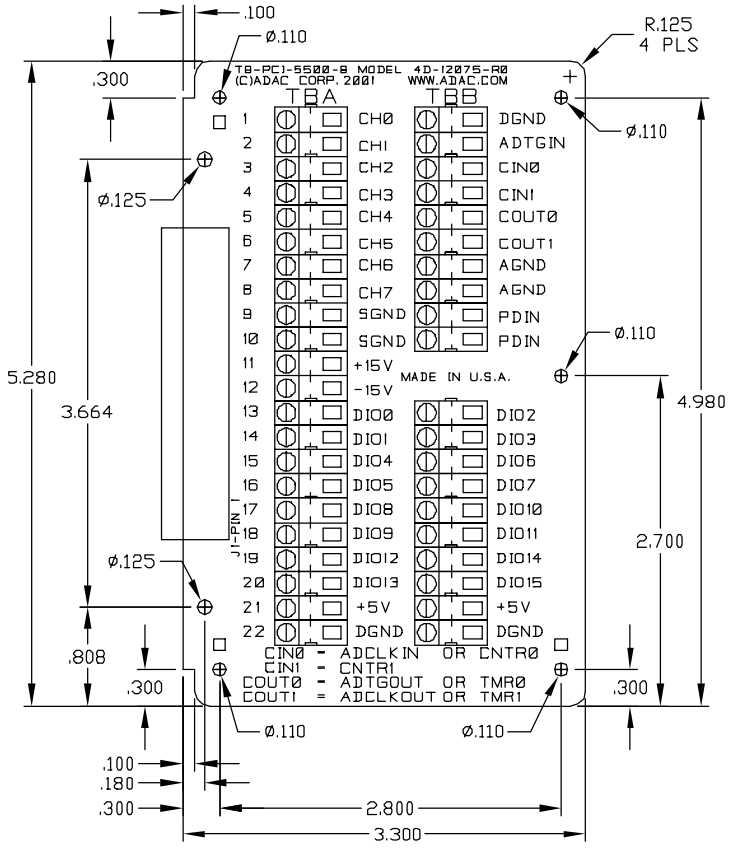
On system power-up the DIO Strobe signals are disabled and placed in a High Impedance state (Z off). 3.3 V CMOS signal.

In regard to the **G17 DB37 connector,** pin-37 is used for the strobe signal.

4.3 SCREW-TERMINAL BOARDS

4.3.1 ADAC-TB-8 Screw-Terminal Board Connections

The ADAC-TB-8 provides screw-terminal access to all of a ADAC/5500MF board's analog and digital I/O signals. The terminal board connects to the ADAC/5500MF via a 3-foot long 68-pin conductor expansion cable, p/n CA-G55-ADAC. The terminal board accepts wire up to 14 AWG.



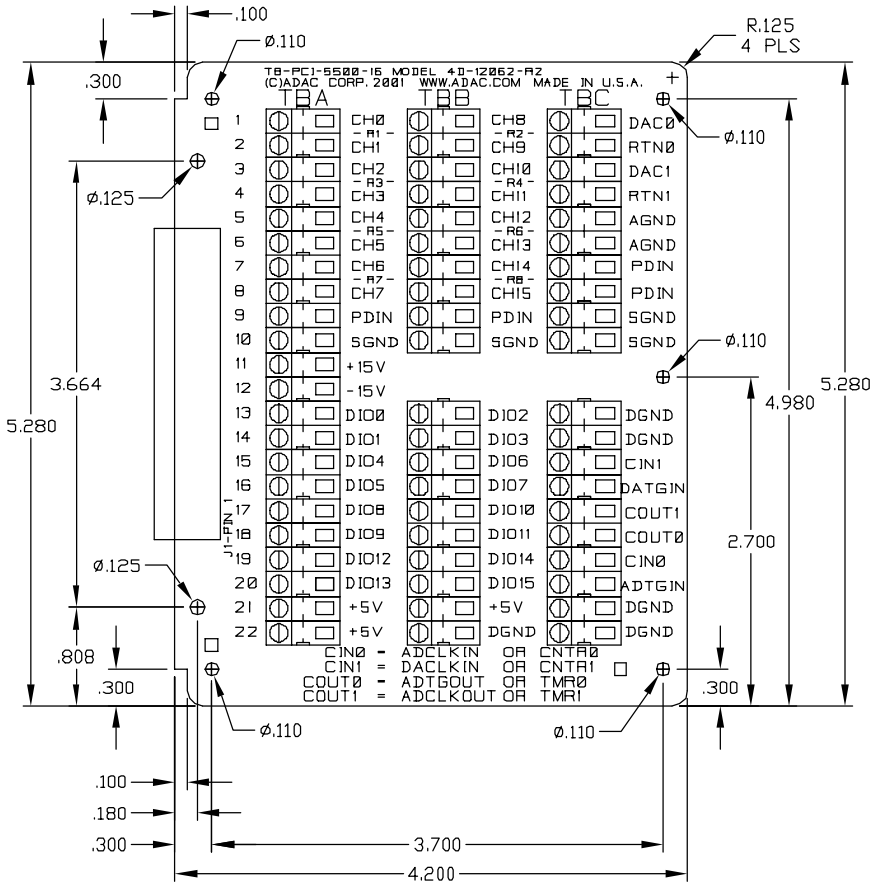
ADAC-TB-8

WARNING

Always turn the computer power OFF and unplug it before connecting or disconnecting a screw terminal panel or a cable to the PCI card. Failure to do so could result in electric shock, or equipment damage.

4.3.2 *ADAC-TB-16 Screw-Terminal Board*

One ADAC-TB-16 provides screw-terminal access to all analog and digital I/O signals from any one of the following boards: ADAC/5501MF, ADAC/5501MF-V, ADAC/5503HR, and ADAC/5503HR-V. The terminal board connects to the board via a 3-foot long 68-pin conductor expansion cable, p/n CA-G55-ADAC. The terminal board accepts wire up to 14 AWG.



ADAC-TB-16

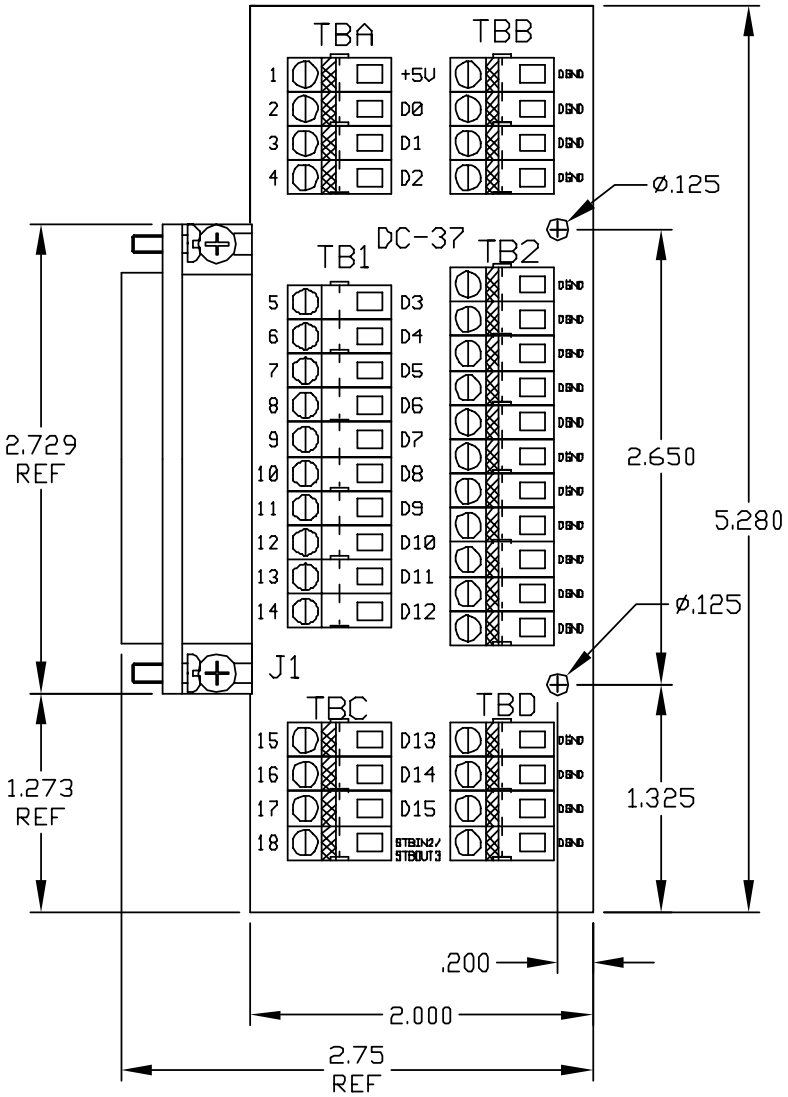
WARNING

Always turn the computer power OFF and unplug it before connecting or disconnecting a screw terminal panel or a cable to the PCI card. Failure to do so could result in electric shock, or equipment damage.

4.3.3 *ADAC-DC-37 Screw-Terminal Board for Auxiliary Digital I/O*

The ADAC-DC-37 provides access to 16 of the 32 available auxiliary digital I/O channels from ADAC/5501MF, ADAC/5501MF-V, ADAC/5503HR, and ADAC/5503HR-V boards. Two ADAC-DC-37 terminal boards are required to access all 32 digital I/O channels.

As depicted on page 4, each DC-37 terminal board can connect to an ADAC/5500 Series Board via a CA-G17-ADAC cable, or to an optional CA-G37-x-ADAC extension cable, which interfaces between a CA-G17 cable's orb and the ADAC-DC-37 board.



ADAC-DC-37

WARNING

Always turn the computer power OFF and unplug it before connecting or disconnecting a screw terminal panel or a cable to the PCI card. Failure to do so could result in electric shock, or equipment damage.

5. ADAC/5500 SERIES PCI CARD OPERATION

5.1 DEVICE DRIVERS

The simplest method of operating the card is by using a program package such as LabVIEW™. This package can be incorporated to do a wide range of display, data logging and control functions. For those who prefer to write their own programs, the ADAC/5500 cards include the ADAC ADLIB WDM Series of driver packages. These packages provide easy to use software function calls that can be used to perform most available board functions

5.1.1 LabVIEW™

The ADAC/5500 cards are fully supported by the ADAC-LVi data acquisition VIs for LabVIEW™. Please refer to the ADAC-LVi manual (p/n 1107-0901) for details on using ADAC cards with LabVIEW™. The ADAC-LVi software and user manuals are included on the ADAC CD that ships with the ADAC/5500 boards. Follow the instructions on the CD for proper installation.

5.1.2 TestPoint™

The ADAC/5500 cards are fully supported by the TestPoint software. Please refer to the TP Help manual for details on using ADAC cards with TestPoint. The TestPoint driver software and user help manual are included on the ADAC CD that ships with the ADAC/5500 boards. Follow the instructions on the CD for proper installation. Note that the ADAC driver software is also included with new releases of the TestPoint software. The *TP ADAC-32 User's Manual* is p/n 1107-0903.

5.1.3 Windows Drivers (ADLIB WDM)

ADLIB WDM is a set of sophisticated, high level, dynamically linked library (DLL) data acquisition subroutines for programmers involved in the developing of process and/or data acquisition applications. ADLIB WDM is both a Microsoft C interface library (C, Visual C++) and a Visual Basic interface library for Windows 98/ME/NT/2000/XP. The functions supplied with ADLIB WDM provide an easy to use interface to the line of PC data acquisition products, shielding the programmer from the complexity of low level DAQ board programming and complicated DMA and interrupt handling mechanisms of the PC and the Windows environment. Based on Microsoft's Windows Driver Model, ADLIB WDM supports DMA, Interrupt and Software Polled data transfer methods for acquiring data. ADLIB WWDM has full support for analog high level (10 V) and analog low level (mV) inputs. Routines for thermocouple inputs are included.

The ADLIB WDM software and user manuals are included on the ADAC CD that ships with the ADAC/5500 boards. Follow the instructions on the CD for proper installation.

5.2 THEORY OF OPERATION

5.2.1 Process Definitions

In order to best understand how to operate the various board functions, it is important to first understand the language that will be used to describe the board processes. The following is a list of pertinent terms and definitions used in this document.

ADC

Analog to Digital Converter, also referred to as A/D. This is the circuitry that samples the voltage present at one of the inputs and translates that reading to a number that is representative of the input voltage. The number supplied by the ADC is referred to as the ADC DATA or RAW DATA and its units are bits or binary digits.

DAC

Digital to Analog Converter, also referred to as D/A. This is the circuitry that translates a binary data word to a specific voltage level. The optional DACs on the ADAC/5500 Series boards are specified for DC accuracy. The DACs on these boards can be clocked and triggered; the outputs are updated as soon as they receive new data.

ADC Channel

This term is used to refer to any of the 256 addressable connections to the multiplexed ADC. The ADAC/5500MF has 8 on-board ADC channels available and supports the ADAC-TB-8 panel. The ADAC/5501MF, ADAC/5502MF, ADAC/5503HR and ADAC/5504HR have 16 on-board channels available and support the ADAC-TB-16 and ADAC-TB-8 panels for a maximum number of 256 input channels.

ADC Data- also Raw Data

This is the unscaled number returned by the ADC. For two's complement data coding (which is standard for bipolar inputs), this number will be either in the range of -2000...+1999 (for 12-bit A/D boards) or -32242…+32241 (for 16-bit boards). For straight binary data coding (which is standard for unipolar inputs), this number will be in the range of 0..+3999 on 12-bit A/D boards and 0...+64483 on 16-bit boards. This number is typically multiplied by some scale factor to convert the number to more useful engineering units. For example: the bipolar ±10 V input uses a scale factor of .005 V/bit. An ADC reading of +1000 when multiplied by .005 V results in +5.000 V. Similarly, the 16 bit scale factor for the ±10 V scale is .000130140 V/bit.

DAC Data- also Raw Data

This is the unscaled number sent to each DAC channel. For two's complement data coding (which is standard for bipolar inputs), this number will be either in the range of -32722...+32722. For straight binary data coding (which is standard for unipolar inputs), this number will be in the range of 0..+65445. This number is typically multiplied by some scale factor to convert the number to more useful engineering units. For example: 0-10 V input uses a scale factor of .000152800V/bit. A DAC DATA value of 32723 when multiplied by .00015280 results in 5.000044 V at the DAC output line.

ADC Conversion

This is the process of sampling a single input or transducer's voltage and generating a representative data value.

DAC Conversion

This is the process of outputting a single voltage generated from representative data value.

ADC Acquisition

This term is used to refer to a series of A/D conversions. This series may consist of sampling a single channel several times or sampling several channels sequentially one or more times. An acquisition has a clearly defined Starting point and Ending point. Thus an acquisition may be STARTED and STOPPED.

DAC Acquisition

This term is used to refer to a series of D/A conversions. This series may consist of outputting a single DAC channel several times or outputting both channels simultaneously one or more times. An acquisition has a clearly defined Starting point and Ending point. Thus an acquisition may be STARTED and STOPPED.

ADC and DAC Clock

This is the signal or impetus that initiates an A/D or D/A conversion. To CLOCK the ADC or DAC is to start an A/D conversion. The term clock is used for this process because typically a clock signal consists of a series of pulses that are periodic or evenly timed. If the conversions are evenly spaced it is then possible to digitally reconstruct the input waveform without distorting its component frequencies.

ADC and DAC PACER Clock

This is a timed periodic signal that may either directly clock the ADC/DAC or initiate a burst of ADC conversions. Thus the PACER clock is exclusive to both the ADC and DAC channels.

ADC BURST Clock

This is also a timed periodic signal that may be used to directly clock the ADC. When the Burst clock is used, this signal defines the time between individual conversions. This signal is not, however, continuous. It lasts for a predefined number of pulses and then stops. The duration of this signal is called the burst clock; and the period of individual pulses is the burst rate. The ADC Pacer Clock initiates Bursts.

ADC and DAC Trigger

This is the signal or impetus that initiates or terminates an Acquisition. Essentially the Trigger Starts or Stops the ADC or DAC PACER Clock.

ADC Channel Configuration RAM

This is the term used for the ADC's Channel, Gain, Range, Thermocouple type and Input Configuration lookup table. The length of this table can be anywhere from 1 element to 176 elements. When an ACQUISITION is in process, the board will sequentially go through this list to determine the channel and gain setting for the next conversion. Thus, channels may be sampled in any order and at any gain. Note, however, that for maximum performance, it is recommended that channels with like gains be grouped together in the sample sequence.

ADC Polled

This is an acquisition mode in which all aspects of the data collection is handled directly. Specifically, once an A/D conversion is initiated, the software must POLL the ADC's status register testing for a DATA available flag to set and data is then read from the board. This mode requires the most software overhead.

DAC Polled

This is an acquisition mode in which all aspects of the data collection is handled directly. Specifically, once a D/A conversion is initiated, the software must POLL the DAC's status register testing for a DATA ready flag to set before the next DAC conversion can be initiated. This mode requires the most software overhead.

ADC and DAC DMA

Short for Direct Memory Access, DMA is the most self-sufficient of the Acquisition Modes available over the PCI bus. In this mode, data from each conversion is automatically transferred directly from the ADAC/5500 board to or from some pre-specified block of system memory. Essentially, DMA allows the acquisition process to run in the background with virtually no software overhead.

5.2.2 Clocking the ADC

The source of the ADC clock may be any of the following:

1) Software Command
2) Pacer Clock
3) External Event (ADCLKIN)
4) Burst Clock

Once an ADC clock is received, the Analog input is immediately sampled. Converted data will become available within 10 microseconds of the clock (max) for 12-bit boards, and 5 microseconds (max) for 16-bit boards. Any attempt to clock the ADC while an A/D conversion is currently running will result in a Clock Error.

5.2.2.1 ADC Software Generated Single Clock

A single A/D conversion may be initiated by a software generated clock. The ADC will sample the voltage present on the channel selected by the Channel configuration RAM. After issuing the software convert command, the FNE[1] flag in the AD_STATUS register is monitored to determine when the conversion has completed, and data is available to be read out of the AD_FIFO register.

5.2.2.2 ADC Pacer Clocking

A series of A/D conversions may be controlled by the on-board pacer clock. This timer can be programmed to generate a periodic clock rate up to the ADC's maximum rate or as slow as 4 samples per hour.

5.2.2.3 ADC External Event Clocking

Conversions may also be caused by an external event. ADCLKIN is an edge sensitive input that can be programmed to cause conversions. The ADCLKIN is selectable as either rising or falling edge sensitive.

5.2.2.4 ADC Burst Clocking

This mode uses the Burst Rate clock to initiate conversions. The Burst Rate is defined as the time between ADC conversions and the duration of the burst is defined Burst Length. When burst mode is enabled, each burst will be started by any of the three previously mentioned clock sources.

[1] FIFO and DMA control bits and ADC status flags are grouped together in the AD_STATUS register.

5.2.2.5 ADC Maximum Clock Rate

The maximum rate which the ADC should be clocked and retain optimal accuracy will vary depending on several factors. These include ADC resolution (12 or 16-bits), gain setting, and sampling mode.

The first limiting factor is the ADC chip itself. Boards with 12-bit ADC chips are capable of performing analog to digital conversions at up to 100 kilo-samples per second. Models with 16-bit ADC chips will sample at rates up to 200 kilo-samples per second. These limits may not be exceeded. If the sample clock is run faster, some of the clock pulses will be ignored by the circuitry, and a clock error will be generated.

The second factor involves the front-end circuitry. The bandwidth of the front-end will vary depending on the gain setting (and the required resolution). The bandwidth will limit the maximum signal frequency the board can pass. Essentially, when sampling a single channel repeatedly, the ADC may be operated up to its maximum speed, but the front-end will filter out any frequency components of the input signal that exceeds the bandwidth of the system.

When changing channels, even if the input signal is static, the front-end is required to respond to a changing input each time the channel is changed. The net effect is that the maximum sampling speed of the ADC is limited to the bandwidth of the front-end when changing channels.

Each time a conversion is initiated, the ADC goes into hold mode and the front-end begins to settle on the next channel. At this point a timer is started. The duration of the timer is determined by the gain setting. If a new conversion is begun before the timer completes its cycle, the clock error flag, CERR, will set indicating the front-end has not settled sufficiently and the accuracy of the data may be compromised. The timer cannot, however, determine whether the channel has actually changed or not. For example, if the front-end bandwidth is 33 kHz but only a single channel is sampled at 100 kHz, the CERR flag will set even though the data is accurate.

The following table indicates the bandwidth and sampling rates for each of the models at different gains, and at what sample rate the error flag will set. Use this table as a guide in determining sampling rates and correct error flag interpretation.

Product	Gain	Front End Bandwidth (minimum)	Max Sample Rate*	Error Flag sets if rate above
12-bit ADC	×1, ×2, ×4, ×8	166 kHz	100 kHz	100 kHz
	×1, ×10	166 kHz	100 kHz	100 kHz
	×100, ×1000	16 kHz	33 kHz	33 kHz
16-bit ADC	×1, ×2	50 kHz	200 kHz	200 kHz
	×4, ×8	25 kHz	50 kHz	50 kHz
	×1	50 kHz	100 kHz	100 kHz
	×10	25 kHz	50 kHz	100 kHz
	×100	5 kHz	10 kHz	1 kHz

** **NOTE**: Max Sample Rate applies only if input channel is changing. For single channel acquisition, max sample rate = the max rate of the ADC itself (100 kHz or 200 kHz) regardless of gain*

5.2.3 Starting (Triggering) an ADC Acquisition

There are several methods that can be used to initiate an acquisition, all of these are achieved by triggering or gating the ADC clock as mentioned previously. Note that a trigger is an edge active event and a gate is a level controlled enable.

An acquisition can be initiated via the following:

1) Software Gate
2) External Gate (ADTGIN)
3) External Trigger (ADTGIN)

5.2.3.1 ADC Software Gate

The software Control Gate Enable bit (CGEN[2]) may be used to allow the starting and stopping of the on-board ADC pacer clock. CGEN may not be used to control the external clock input (ADCLKIN).

5.2.3.2 ADC External Gate

An ADC clock may be "switched On" (and Off) with the external ADTGIN input. The input is level sensitive and selectable as either active high or active low control. If the on-board pacer clock drives the ADC, the external gate input is used to enable and disable the ADC's pacer clock after being polarity conditioned. The ADC clock will be enabled as long as the gate input is in the active state.

[2] Control bits are grouped together in the AD_CTRL register.

5.2.3.3 ADC External Trigger

The external gate/trig input (ADTGIN) may also be configured as a rising or falling edge sensitive input to trigger the start of the ADC clock. External triggers are ignored until the ADC is enabled. Once the ADC is enabled, the next active edge signal on ADTGIN will enable the ADC Clock source. To disable the clock, refer to *Section 5.2.4* Stopping an ADC Acquisition (CLOCK).

5.2.4 Stopping an ADC Acquisition (CLOCK)

The current acquisition will halt under several circumstances. The most basic method is to simply disable the ADC by setting the Conversion Enable control bit, CVEN, to 0. This will effectively shut-off the ADC and re-prime the trigger inputs.

An acquisition can be halted via the following:

1. Software Gate
2. External Gate (ADTGIN)
3. External Trigger (ADTGIN)

5.2.4.1 ADC Software Gate

To stop the ADC clock when operating in software gated mode, simply disable the Control Gate Enable (CGEN). Refer to *Section 5.2.3.1* ADC Software Gate for additional information on this mode.

5.2.4.2 ADC External Gate

An ADC clock may also be "switched off" with the external trig/gate input (ADTGIN). Refer to *Section 5.2.3.2* ADC External Gate for additional information about this mode.

5.2.4.3 ADC External Trigger

The external gate/trig input (ADTGIN) may also be used to stop an acquisition. In this mode, referred to as ABOUT Trigger Mode, the ADC is disabled after a certain number of conversions are performed following a trigger. The number of conversions may be anywhere from 1 to 65,536, which represents the number of post trigger conversions. Once triggered, the ADC Conversion Counter immediately increments following each conversion until it reaches 0, whereupon ADC conversions are automatically disabled. If the timer is loaded with a value of -1, the ADC will be stopped after one valid clock. If this register is loaded with the value 0, the full count (65,536 conversions) will occur.

Note that the Software and External Gate modes described in Section 5.2.3 Starting (Triggering) an ADC Acquisition are ignored, i.e., the trigger source is always external when in the ABOUT Trigger Mode.

If the External Trigger input is disabled, conversions are enabled as soon as the ADC is enabled and the next valid trigger will enable the internal counter to count conversions. If the External Trigger input is enabled, the first external trigger will start the conversions and the next valid trigger will enable the internal counter to count conversions.

5.2.5 ADC Clock and FIFO Errors

If the ADC is running in DMA operating modes, the board will automatically interrupt if the Clock Error Flag (CERR) or FIFO Overflow Flag (FOVR) become active (i.e. set). These interrupt sources are automatically enabled when using DMA.

5.2.6 ADC Data Transfer Modes

ADC data can be read directly from the on-board ADC FIFO register or directly to system memory via the on-board DMA engine. The on-board FIFO data register requires 32-bit read access from the PCI bus. The FIFO register is used in both POLLING and DMA transfer modes. The on-board DMA engine provides for the fastest means of collecting ADC data by directly writing each conversion result to system memory. Two 32-bit DMA memory pointer registers and two 16-bit memory sample count registers provide for continuous DMA transfers. Each 32-bit FIFO location may contain two ADC samples or the upper 16-bits can contain the actual channel configuration settings for the current sample. Since all ADAC PCI bus transfers are 32-bit operations, it is possible to transfer two analog data points into memory during a single 32-bit transfer. This provides an immediate improvement in system bandwidth of a factor of two when compared to 16-bit PCI implementations.

5.2.6.1 Software Polled ADC Acquisition Mode

This mode is the most CPU intensive acquisition mode. Basically, the ADC Channel Configuration RAM list, clock and trigger modes are set up and initiated. The FIFO Not Empty signal is polled until data becomes available. Once data becomes available, it is read from the ADC FIFO register.

5.2.6.2 ADC DMA Transfer Mode

To overcome PCI interrupt inefficiencies, the cards include an on-board DMA engine analogous to the older ISA type of DMA controller. This on-board DMA engine supports *scatter/gather*, also known as *buffer chaining*, with a pair of chain address registers that point to the physical system memory to be used in the buffered transfer. The DMA controller is loaded with the physical addresses of these buffers, and only generates interrupts once the current buffer transfer has been completed, thus reducing the burden of CPU interrupt intervention. This PCI transfer mode requires the least software overhead, thus permitting the highest potential conversion speeds. In this mode, ADC data is automatically transferred to some predetermined physical memory location by the on-board DMA controller as soon as it becomes available. The number of samples transferred in this manner is limited only by the amount of system memory available. This mode can use any of the clocking methods, however, the overhead required for software clocking may defeat the purpose of using DMA.

DMA transfers will begin as soon as three conditions are met:

1. The DMA controller is programmed
2. The on-board DMA controller is enabled
3. The ADC data becomes available.

There are a number of interrupts that are useful in DMA transfer mode. The Interrupt on DMATC event is enabled automatically when DMA is enabled. Essentially, an interrupt is sent when the DMA transfer is complete. Another useful interrupt is the Interrupt on Conversion Counter terminal count. This is used with ABOUT Trigger Mode (see *section 5.2.4.3* ADC External Trigger). Here the CPU is interrupted and the clock is stopped when the on-board conversion counter reaches zero. Interrupt on conversion counter terminal count is automatically enabled when using DMA.

If a clock or FIFO error is generated during a DMA transfer it is an indication that the PCI bus is overloaded. Essentially this means that another board in the system is using up too much of the available bus transfer bandwidth. If this is the case, concurrent bus accesses must be stopped, or the conversion frequency must be slowed down.

5.2.7 Clocking the DAC

Two DAC channels are provided. The clock source of the primary DAC0 channel may be any of the following:

1) Software Command
2) DAC0 Pacer Clock
3) External Event (DACLKIN).

The clock source for the secondary DAC1 channel is limited to the following sources:

1) Software Command
2) DAC1 Pacer Clock
3) Channel 0 Clock Source.

The DAC processes, once started, immediately copy the next data sample to a holding register. Upon receipt of a DAC clock, the analog output immediately changes to the current value in the holding register, and the next data sample is immediately copied from system memory into the holding register. If the DACs are clocked before their previous outputs have fully settled, their outputs will simply begin slewing to the new level.

5.2.7.1 DAC Software Generated Single Clock

A single D/A conversion may be initiated by a software generated clock. The DAC will output the next FIFO data sample for the selected DAC channel. After issuing the software convert command, the DAC READY flag is monitored to determine when the conversion has completed, and DAC is ready for the next conversion.

5.2.7.2 DAC Pacer Clocking

A series of DAC conversions may be controlled by the on-board pacer clock. This timer may be programmed to generate a periodic clock rate as high as 200 kHz or as slow as 4 samples per hour. Refer to *section 5.2.8* Starting (Triggering) a DAC Acquisition for information on triggering (starting) a clocked acquisition.

5.2.7.3 DAC External Event Clocking

Conversions may also be caused by an external event. DACLKIN is an edge sensitive input that can be programmed to cause conversions. The DACLKIN is selectable as either rising or falling edge sensitive.

5.2.7.4 DAC Maximum Clock Rate

The maximum rate which the DAC should be clocked and retain optimal accuracy is limited by the DAC chip itself. These limits may not be exceeded. If the pacer clock is run faster, some of the clock pulses will be ignored by the circuitry, and the clock error flag will set.

5.2.8 Starting (Triggering) a DAC Acquisition

There are several methods that can be used to initiate an acquisition. All of these are achieved by triggering or gating the DAC clocks mentioned previously in *section 5.2.7* Clocking the DAC. Note that a trigger is an edge active event and gate is a level controlled enable. Note also that all trigger and clocking functionality is available for the primary DAC channel 0. The secondary DAC channel 1 is limited to software control methods (no external trigger or clock) except that it can be synchronized to output samples simultaneously with channel 0. In this latter mode, it performs identically to channel 0 as far as triggering and clocking methods are concerned.

1) Software Gate
2) External Gate (DATGIN)
3) External Trigger (DATGIN)

5.2.8.1 DAC Software Gate

The software Control Gate Enable (CGEN) may be used to allow the starting and stopping of the on-board DAC pacer clock. CGEN may *not* be used to control the external clock input (DACLKIN).

5.2.8.2 DAC External Gate

The DAC0 clock may be “switched On” (and Off) with the external DATGIN input. The input is level sensitive and selectable as either active high or active low control. If the on-board pacer clock drives the DAC0 the external gate input is used to enable and disable the DAC0’s pacer clock after being polarity conditioned. The DAC0 clock will be enabled as long as the external gate input is in the active state.

5.2.8.3 DAC External Trigger

The external gate/trig input (DATGIN) may also be configured as a rising or falling edge sensitive input to trigger the start of the DAC0 clock. External triggers are ignored until the DAC0 is enabled. Once the DAC0 is enabled, the next active edge signal on DATGIN will enable the DAC0 Clock source. To disable the clock, refer to *section 5.2.9,* Stopping a DAC Acquisition (CLOCK).

5.2.9 Stopping a DAC Acquisition (CLOCK)

The current acquisition will halt under several circumstances. The most basic method is to simply disable the DAC by setting the Conversion Enable bit, CVEN, to 0. This will effectively shut off the DAC and re-prime the trigger inputs. Other methods to stop the acquisition are:

1) Software Gate
2) External Gate (DATGIN)

5.2.9.1 DAC Software Gate

To stop the DAC clock when operating in software gated mode, simply disable the Control Gate Enable (CGEN). Refer to *section 5.2.3.1* ADC Software Gate for additional information on this mode.

5.2.9.2 DAC External Gate

The DAC0 clock may also be "switched off" with the external trig/gate input (DATGIN). Refer to *section 5.2.3.2* ADC External Gate for additional information about this mode.

5.2.9.3 DAC Clock and FIFO Errors

When the DACs are running using DMA operating modes, the board will automatically interrupt if the Clock Error Flag (CERR), FIFO Empty Flag (FE) or FIFO Error Flag (FERR) becomes active (i.e. set). These interrupt sources are automatically enabled when using DMA.

5.2.10 DAC Data Transfer Mode

DAC data can be written directly to the on-board DA_FIFO[3] register or read directly from system memory to the DA_FIFO via the on-board DMA engine. Each DA_FIFO data register implements a 32-bit read access from the PCI bus. Two data samples are transferred during each DMA access. The first data sample always occupies the upper bits (31-16) while the second sample always occupies the lower bits (15-0). Either DAC channel may be enabled or disabled from their DA_CTRL registers. If either of the DAC channels is disabled, data is only sent to the enabled channel(s). Both DAC channels can be independently configured in either POLLING or DMA modes. For POLLING mode, each write to the DA_FIFO will immediately be output to, and update, the selected DAC channel(s). For DMA mode, the on-board DMA engine directly reads data points from system memory to the DA FIFO register, thus providing the fastest means of outputting DAC Data. Two 32-bit DMA memory pointer registers and two 16-bit memory sample count registers provide for continuous DMA transfers. All PCI bus transfers are 32-bit operations. By transferring two analog data points from system memory simultaneously to the destination DAC FIFO in one PCI bus operation, the ADAC PCI cards are twice as efficient as 16-bit PCI implementations. Furthermore, skew between the DAC0 and DAC1 channel can be entirely eliminated by using the linked clocking mode.

5.2.10.1 Software Polled DAC Acquisition Mode

This mode is the most CPU intensive acquisition mode. Basically the READY flag is monitored until the DAC indicates it is ready to accept new data and then the DAC output is updated by writing the next data sample to the DAC FIFO.

5.2.10.2 DAC DMA Transfer Mode

To overcome PCI interrupt inefficiencies, we have incorporated an on-board DMA engine analogous to the older ISA type of DMA controller. The on-board DMA engine supports *scatter/gather*, also known as *buffer chaining*, with a pair of address registers that point to the physical system memory to be used in the buffered transfer. The DMA controller is loaded with the physical addresses of these buffers and only generates an interrupt when the current transfer buffer process has been completed, thus further reducing the burden of

[3] In this discussion, DA_FIFO refers to either DA0_FIFO or DA1_FIFO.

CPU interrupt intervention. This mode requires the least software overhead of the various PCI transfer methods, and thus permits the highest potential conversion speeds. In this mode, DAC data is automatically transferred from some predetermined physical memory location by the on-board DMA controller directly to the DA FIFO. The DA FIFO data is then sent to the DAC holding register, where it is held and then output on each DAC clock event. The pipeline continues to be maintained by automatic DMA actions until all samples have been clocked out. The number of samples transferred in this manner is limited only by the amount of system memory available. This mode can use any of the clocking methods, however, the overhead required for software clocking may defeat the purpose of using DMA.

DMA Transfers will begin as soon as three conditions are met:

1. The DMA controller is programmed
2. The on-board DMA controller is enabled
3. Room exists in the DA FIFO.

Each DAC channel has its own FIFO register. The READY flag indicates when the DAC outputs have settled. If the DACs are written to before their outputs have fully settled, the CERR flag will be immediately set causing an interrupt if DMA is enabled.

The data written to the DACs may either be written as a two's complement 16-bit word for bipolar applications, or a 16-bit unsigned word when configured for unipolar operation.

There are a number of interrupts that are useful in DMA transfer mode. The Interrupt on DMATC is enabled automatically when DMA is enabled. Essentially, an interrupt is sent when the DMA transfer is complete. Another useful interrupt source is the DAC FIFO Underflow condition. If a DAC clock occurs and the D/A FIFO is empty, the FERR flag sets, indicating a DAC underflow condition. Interrupt on DAC FIFO errors are automatically enabled when using DMA.

If a clock or FIFO underflow error is generated during a DMA transfer, it is an indication that the PCI bus is overloaded. Essentially this means that another board in the system is using up too much of the available bus transfer bandwidth. If this is the case, concurrent bus accesses must be stopped, or the conversion frequency must be slowed down.

Note: *At power-up, both of the DACs are preloaded to output 0 volts.*

5.2.11 Digital Acquisition

The ADAC/5500MF supports 16-bits of digital I/O and the ADAC/5501MF, ADAC/5502MF, ADAC/5503HR and ADAC/5504HR Series boards support 48 bits of digital I/O. The first 16 bits on all boards are LSTTL compatible. The 32 additional bits on the ADAC/5501MF, ADAC/5502MF, ADAC/5503HR and ADAC/5504HR are both 3.3 V CMOS and LSTTL compatible. All input ports are terminated to +5 V with 4.7 KΩ resistors, and all output ports power up driving low. The DIO ports operate with positive logic: A "0" represents a TTL low, and a "1" represents a TTL high.

5.2.11.1 DIO0 and DIO1 - 8-bit Input/Output Ports

These signals are available at the main 68-pin I/O connector. They are accessed via the DIO0, DIO1, and DIO_16 ports. Each 8-bit DIO0 and DIO1 port can be individually programmed as either an input or output port. The DIO_16 port provides access to both DIO0 and DIO1 in a single 16-bit port for read and write operations.

5.2.11.2 DIO2 and DIO3 - 16-bit Digital Input and Digital Output Ports

The two 16-bit ports on the ADAC/5501MF, ADAC/5502MF, ADAC/5503HR and ADAC/5504HR boards are accessible through two 40-pin headers on the board. The signals on these connectors can be brought out to the back of the PC (at the cost of a slot for each port) using an optional G17 cable. This cable is terminated with a 37-pin D-type connector which is compatible with the ADAC line DC-37 screw terminal panel, as well as our other ADAC line of 4000 VRMS isolated digital I/O panels.

The DIO2 and DIO3 ports can be programmed to be either an input or output port. A strobe signal is provided in the 37 pin interface. When DIO2 or DIO3 is configured as an input port, the strobe is disabled. When DIO2 or DIO3 is configured as an output port, the strobe signal will be pulsed following each data output event.


Notes

6. SPECIFICATIONS

6.1 ADAC/5500MF

Function:	High speed, 8 channel multiplexed 12 Bit analog to digital converter with 16 digital I/O lines for PC compatibles.
Bus Interface:	The ADAC/5500MF plugs into the PCI bus, complies with the industry standard "PCI Local Bus Specification Revision 2.0 and higher".
Board Configuration:	The ADAC/5500MF is completely software configurable: The host PC sets all Bus-related selections. All data acquisition-related configuration is done by the user via the ADAC PCI Software Utility.
Calibration:	The ADAC/5500MF is digitally calibrated.

6.1.1 A/D Inputs - ADAC/5500MF

Number of Inputs:	8 Single-Ended
Resolution:	12 bit (2.5mV/bit on 0 to 10 V range)
Acquisition Rate:	100 kHz max
A/D Full Scale Ranges:	±10 V 0 to 10 V
Differential Linearity:	±0.9 LSB, no missing codes
Gain Error:	Adjustable to Zero
Gain Drift:	±5 ppm/ °C
Zero Error:	Adjustable to Zero
Zero Drift:	±2 ppm/ °C
Signal to Noise and Distortion:	S/(N+D) 73 dB min. @ gain = 1
Total Harmonic Distortion:	-90dB (typical) @ gain = 1, measured to 5th harmonic
Full Power Bandwidth:	250 kHz
Input Impedance	
Shunt Res. to Ground:	10 M ohm
Shunt Capacitance:	28 pf
On Resistance:	400 ohm
Overvoltage Protection:	±25 V (powered) ±40 V (unpowered)

Acceptable Operating Limit
Signal Plus Common Mode: ±12 V

Output Coding
Unipolar: Straight binary
Bipolar: Offset binary 2's complement

Data Format: 16-bit right justified

6.1.2 A/D Trigger - ADAC/5500MF

Clock Sources:
- software
- on board programmable pacer
- user defined external TTL

External Clock Input Delay: - 100ns uncertainty

Trigger Sources:
- software
- on board pacer (burst mode)
- external (TTL)

Triggering Modes:
- software gate
- external gate
- periodic burst
- pre-trigger (sample until trigger)
- post-trigger (sample after trigger)
- about-trigger (sample before and after trigger)

External Trigger Input Delay: - 100ns uncertainty

6.1.3 Digital Inputs / Outputs – ADAC/5500MF

Number: 16

I/O Direction Select: Software selectable in groups of eight

Register: Two 8 bit registers configurable as either inputs or outputs. Inputs are unlatched read-only.

Data Coding: Positive logic

Input Level: 5 V CMOS/TTL with 4.7 Kohm pull-up resistor

High Level Input Voltage: 2 V min.

Low Level Input Voltage: 0.8 V max.

High Level Output Voltage: 2.4 V

Low Level Output Voltage: 0.5 V

Maximum Output Current: Low: 24 mA (sinking)
High: 24 mA (sourcing)

6.1.4 Counters/Timers– ADAC/5500MF

Number:	2 Counters / 2 Timers
Counter 0	Shared with ADCLKIN terminal
Counter 1	Shared with DACLKIN terminal
Counter 0/1Input Delay:	- 100ns uncertainty
Counter 0/1 Maximum Count	65536
Counter 0/1 Maximum Input Freq.	900Khz
Timer 0	Shared with ADTGOUT terminal
Timer 1	Shared with ADCLKOUT terminal
Timer 0/1 Output Rate	7.6Htz to 500Khz 50 % Duty Cycle Square Wave
Counter Input Levels:	5 V CMOS/TTL with 4.7 Kohm pull-up resistor
High Level Input Voltage:	2 V min.
Low Level Input Voltage:	0.8 V max.
Timer Output Levels:	5 V CMOS/TTL with 4.7 Kohm pull-up resistor
High Level Output Voltage:	2.4 V
Low Level Output Voltage:	0.5 V
Maximum Output Current:	Low: 24 mA (sinking) High: 24 mA (sourcing)

6.1.5 Physical & Environmental - ADAC/5500MF

Size:	4.2" (10.6cm) H x 5.57" (14.1cm) L
Connector:	68 Pin standard SCSI Type III Female Connector brought to outside of PC.
Temp. Range of Operation:	0 °C – 55 °C
CE Conformity:	EN 55022 Class B EN50082-1 IEC801-2 IEC801-3 IEC801-4

6.2 ADAC/5501MF AND ADAC/5502MF

Function:	High speed, 16 channel multiplexed 12 Bit analog to digital converter with programmable gain, two optional digital to analog converters, and 16 + 32 digital I/O lines for PC compatibles.
Bus Interface:	The ADAC/5501 and ADAC/5502MF plug into the PCI bus, complies with the industry standard "PCI Local Bus Specification Revision 2.0" and higher.
Board Configuration:	ADAC/5501 and ADAC/5502MF are completely software configurable: The host PC sets all Bus-related selections. All data acquisition-related configuration is done via the ADAC PCI Software Utility.
Calibration:	The ADAC/5501 and ADAC/5502MF are digitally calibrated.

6.2.1 A/D Inputs ADAC/5501MF and ADAC/5502MF

Number of Inputs:	16 Single-ended 16 pseudo-differential 8 differential
A/D Expansion:	Up to 256 channels external
Resolution:	12 bit (2.500 mV/bit on 0 to 10 V range)
Acquisition Rate:	100 kHz max
A/D Full Scale Ranges:	±10 V, 0 to 10 V
Programmable Gain	
High level (ADAC/5501MF):	x1, x2, x4, x8
Low level (ADAC/5502MF):	x1, x10, x100, x1000
Full Scale Input Ranges	
A/D Full Scale Range Plus Input Gain	
ADAC/5501MF:	±10 V, ±5 V, ±2.5 V, ±1.25 V, 0-10 V, 0-5 V, 0-2.5 V, 0-1.25 V
ADAC/5502MF:	±10 V, ±.1 V, ±0.095 V, ±9.50 mV 0-10 V, 0-1 V, 0-0.0975 V, 0-9.75 mV
ADAC/5501MF:	0-20mA
Differential Linearity:	±0.9 LSB, no missing codes
Gain Error:	Adjustable to Zero
Gain Drift:	±5 ppm/ °C
Zero Error:	Adjustable to Zero

Zero Drift:	±2 ppm/ °C
Signal to Noise and Distortion:	S/(N+D) 73 dB min. @ gain = 1
Total Harmonic Distortion:	-90dB (typical) @ gain = 1, measured to 5th harmonic
Full Power Bandwidth:	250 kHz
Input Impedance	
Shunt Res. to Ground:	10 M ohm
Shunt Capacitance:	28 pf
On Resistance:	400 ohm
Over-voltage Protection:	±25 V (powered) ±40 V (unpowered)
Acceptable Operating Limit	
Signal Plus Common Mode:	±12 V
Output Coding	
Unipolar:	Straight binary
Bipolar:	Offset binary 2's complement
Gain/Channel/Sequence Selection:	256 element RAM
Data Format:	16-bit right justified

6.2.2 A/D Trigger – ADAC/5501MF and ADAC/5502MF

Clock Sources:	- software - on board programmable pacer - user defined external TTL
External Clock Input Delay:	- 100ns uncertainty
Trigger Sources:	- software - on board (burst mode) - external (TTL)
Triggering Modes:	- software gate - external gate - periodic burst - pre-trigger (sample until trigger) - post-trigger (sample after trigger) - about-trigger (sample before and after trigger)
External Trigger Input Delay:	- 100ns uncertainty

6.2.3 D/A Outputs (-V Option only) - ADAC/5501MF and ADAC/5502MF

Number of Outputs:	2 (optional) Clocked DACs
Resolution:	16 bit (152.870 µV/bit on 0 to 10 V range)
D/A Full Scale Range:	±10 V, 0 to 10 V
Settling time to 0.006% of FSR:	10 µsec for 20 V step
Differential Linearity:	± 0.25 LSB @ 25° guaranteed monotonic
Relative Accuracy	
Bipolar:	± 2 LSB typ.
Unipolar:	± 4 LSB typ.
Gain Error:	Adjustable to zero
Zero Error:	Adjustable to zero
Data Coding:	
Unipolar:	Straight binary
Bipolar:	Offset binary 2's complement
Data Format:	16 bit right justified
Data Storage:	FIFO
DAC Clock Update Source:	- Software Pacer - Internal Pacer - External TTL
DAC Triggering:	- Software Trigger - External Trigger TTL - Software Gate - External Gate
Output Current:	±5mA
Total Harmonic Distortion:	Not specified, DACs for DC level only

6.2.4 Digital Inputs / Outputs – ADAC/5501MF and ADAC/5502MF

Number:	16 accessible from main I/O connector, 32 accessible from two auxiliary I/O connectors

6.2.4.1 Main I/O Connector – ADAC/5501MF and ADAC/5502MF

Number:	16 accessible from main I/O connector
I/O Direction Select:	Software selectable in groups of eight
Register:	Two 8 bit registers configurable as either inputs or outputs. Inputs are unlatched read-only.
Data Coding:	Positive logic
Input Level:	5.0V/3.3 V CMOS/LSTTL compatible with 4.7 K ohm pull-up resistor
High Level Input Voltage: Low Level Input Voltage:	2 V min. 0.8 V max.
High Level Output Voltage: Low Level Output Voltage:	2.4 V 0.4 V
Maximum Output Current:	Low: 24 mA (sinking) High: 24 mA (sourcing)

6.2.4.2 Auxiliary Digital I/O Connectors – ADAC/5501MF and ADAC/5502MF

Number:	32 accessible from 2 Auxiliary Digital I/O connectors
I/O Direction Select:	Software selectable in groups of sixteen.
Register:	Two 16 bit registers configurable as either inputs or outputs. Inputs are unlatched read-only.
Data Coding:	Positive logic
Input Level:	5.0V/3.3V CMOS/LSTTL compatible with 4.7 K ohm pull-up resistor
High Level Input Voltage:	2 V min.
Low Level Input Voltage:	0.8 V max.
High Level Output Voltage:	2.4 V
Low Level Output Voltage:	0.4 V
Maximum Output Current:	Low: 24 mA (sinking) High:24 mA (sourcing)

6.2.5 Counters/Timers– ADAC/5501MF and ADAC/5502MF

Number:	2 Counters / 2 Timers
Counter 0	Shared with ADCLKIN terminal
Counter 1	Shared with DACLKIN terminal
Counter 0/1Input Delay:	- 100ns uncertainty
Counter 0/1 Maximum Count	65536
Counter 0/1 Maximum Input Freq.	900Khz
Timer 0	Shared with ADTGOUT terminal
Timer 1	Shared with ADCLKOUT terminal
Timer 0/1 Output Rate	7.6Htz to 500Khz 50 % Duty Cycle Square Wave
Counter Input Levels:	5 V CMOS/TTL with 4.7 K ohm pull-up resistor
High Level Input Voltage:	2 V min.
Low Level Input Voltage:	0.8 V max.
Timer Output Levels:	5 V CMOS/TTL with 4.7 K ohm pull-up resistor
High Level Output Voltage:	2.4 V
Low Level Output Voltage:	0.5 V
Maximum Output Current:	Low: 24 mA (sinking) High: 24 mA (sourcing)

6.2.6 Physical & Environmental – ADAC/5501MF and ADAC/5502MF

Size:	4.2" (10.6cm) H x 5.57" (14.1cm) L
Connector:	68 pin standard "SCSI Type III" female connector brought to outside of PC.
Temp. Range of Operation:	0 °C – 55 °C
CE Conformity:	EN 55022 Class B EN50082-1 IEC801-2 IEC801-3 IEC801-4

6.3 ADAC/5503HR AND ADAC/5504HR

Function:	High speed, 16 channel multiplexed 16 Bit analog to digital converter with programmable gain, two optional digital to analog converters, and 16 + 32 digital I/O lines for PC compatibles.
Bus Interface:	The ADAC/5503 and ADAC/5504HR plug into the PCI bus, and comply with the industry standard "PCI Local Bus Specification Revision 2.0" and higher.
Board Configuration:	The ADAC/5503 and ADAC/5504HR are completely software configurable: The host PC sets all Bus-related selections, all data acquisition-related configuration is done by the user via the ADAC PCI Software Utility.
Calibration:	The ADAC/5503 and ADAC/5504HR are digitally calibrated.

6.3.1 A/D Inputs – ADAC/5503HR and ADAC/5504HR

Number of Inputs:	16 Single-ended 16 pseudo-differential 8 differential
A/D Expansion:	Up to 256 channels external
Resolution:	16 bit (155.070 µV/bit on 0 to 10 V range)
Acquisition Rate:	200 kHz max
A/D Full Scale Ranges:	±10 V 0 to 10 V
Programmable Gain	
High level (ADAC/5503HR):	x1, x2, x4, x8
Low level (ADAC/5504HR):	x1, x10, x100
Full Scale Input Ranges	
A/D Full Scale Range Plus Input Gain	
ADAC/5503HR:	±10 V, ±5 V, ±2.5 V, ±1.25 V, 0-10 V, 0-5 V, 0-2.5 V, 0-1.25 V
ADAC/5504HR:	±10 V, ±1 V, ±0.09968 V, 0-10 V, 0-1 V, 0-0.0998 V
ADAC/5503HR:	0-20mA
Differential Linearity:	± 3 LSB, no missing codes
Gain Error:	Adjustable to Zero
Gain Drift:	± 7 ppm/ °C
Zero Error:	Adjustable to Zero
Zero Drift:	± 2 ppm/ °C
Signal to Noise and Distortion:	S/(N+D) 83 dB min. @ gain = 1
Total Harmonic Distortion:	90 dB (typical) @ gain = 1, measured to 5th harmonic
Full Power Bandwidth:	1 MHz
Input Impedance	
Shunt Res. to Ground:	10 M ohm
Shunt Capacitance:	28 pf
On Resistance:	400 ohm
Overvoltage Protection:	±25 V (powered) ±40 V (unpowered)
Acceptable Operating Limit	
Signal Plus Common Mode:	±12 V
Output Coding	
Unipolar:	Straight binary
Bipolar:	Offset binary 2's complement

Gain/Channel Selection:	256 element RAM
Data Format:	16-bit right justified

6.3.2 A/D Trigger – ADAC/5503HR and ADAC/5504HR

Clock Sources:	- software - on-board programmable pacer - user defined external TTL
External Clock Input Delay:	- 100ns uncertainty
Trigger Sources:	- software - on-board pacer (burst mode) - external (TTL)
Triggering Modes:	- software gate - external gate - periodic burst - pre-trigger (sample until trigger) - post-trigger (sample after trigger) - about-trigger (sample before and after trigger)
External Trigger Input Delay:	- 100ns uncertainty

6.3.3 D/A Outputs (-V Option only) – ADAC/5503HR and ADAC/5504HR

Number of Outputs:	2 (optional) Clocked DACs
Resolution:	16 bit (152.800 µV/bit on 0 to 10 V range)
D/A Full Scale Range:	±10 V, 0 to 10 V
Settling time to 0.006% of FSR:	10 µsec for 20 V step
Differential Linearity:	± 0.25 LSB @ 25° guaranteed monotonic
Relative Accuracy	
Bipolar:	± 2 LSB typ.
Unipolar:	± 4 LSB typ.
Gain Error:	Adjustable to zero
Zero Error:	Adjustable to zero
Data Coding	
Unipolar:	Straight binary
Bipolar:	Offset binary 2's complement
Data Format:	16 bit right justified
Data Storage:	FIFO
DAC Clock Update Source:	- Software Pacer - Internal Pacer - External TTL

DAC Triggering:	- Software Trigger - External Trigger TTL - Software Gate - External Gate
Output Current:	±5 mA
Total Harmonic Distortion:	Not specified, DACs for DC level only

6.3.4 Digital Inputs / Outputs – ADAC/5503HR and ADAC/5504HR

Number:	16 accessible from main I/O connector, 32 accessible from two auxiliary I/O connectors

6.3.4.1 Main I/O Connector – ADAC/5503HR and ADAC/5504HR

Number:	16 accessible from main I/O connector
I/O Direction Select:	Software selectable in groups of eight
Register:	Two 8 bit registers configurable as either inputs or outputs. Inputs are unlatched read-only.
Data Coding:	Positive logic
Input Level:	5.0V/3.3V CMOS/LSTTL compatible with 4.7 Kohm pull-up resistor
High Level Input Voltage:	2 V min.
Low Level Input Voltage:	0.8 V max.
High Level Output Voltage:	2.4 V
Low Level Output Voltage:	0.4 V
Maximum Output Current:	Low: 24 mA (sinking) High: 24 mA (sourcing)

6.3.4.2 Auxiliary Digital I/O Connectors – ADAC/5503HR and ADAC/5504HR

Number:	32 accessible from 2 Auxiliary Digital I/O connectors
I/O Direction Select:	Software selectable in groups of sixteen.
Register:	Two 16 bit registers configurable as either inputs or outputs. Inputs are unlatched read-only.
Data Coding:	Positive logic
Input Level:	5.0V/3.3V CMOS/LSTTL compatible with 4.7 K ohm pull-up resistor
High Level Input Voltage:	2 V min.
Low Level Input Voltage:	0.8 V max.

High Level Output Voltage:	2.4 V
Low Level Output Voltage:	0.4 V
Maximum Output Current:	Low: 24 mA (sinking) High: 24 mA (sourcing)

6.3.5 Counters/Timers– ADAC/5503HR and ADAC/5504HR

Number:	2 Counters / 2 Timers
Counter 0	Shared with ADCLKIN terminal
Counter 1	Shared with DACLKIN terminal
Counter 0/1Input Delay:	- 100ns uncertainty
Counter 0/1 Maximum Count	65536
Counter 0/1 Maximum Input Freq.	900Khz
Timer 0	Shared with ADTGOUT terminal
Timer 1	Shared with ADCLKOUT terminal
Timer 0/1 Output Rate	7.6Htz to 500Khz 50 % Duty Cycle Square Wave
Counter Input Levels:	5 V CMOS/TTL with 4.7 K ohm pull-up resistor
High Level Input Voltage:	2 V min.
Low Level Input Voltage:	0.8 V max.
Timer Output Levels:	5 V CMOS/TTL with 4.7 K ohm pull-up resistor
High Level Output Voltage:	2.4 V
Low Level Output Voltage:	0.5 V
Maximum Output Current:	Low: 24 mA (sinking) High: 24 mA (sourcing)

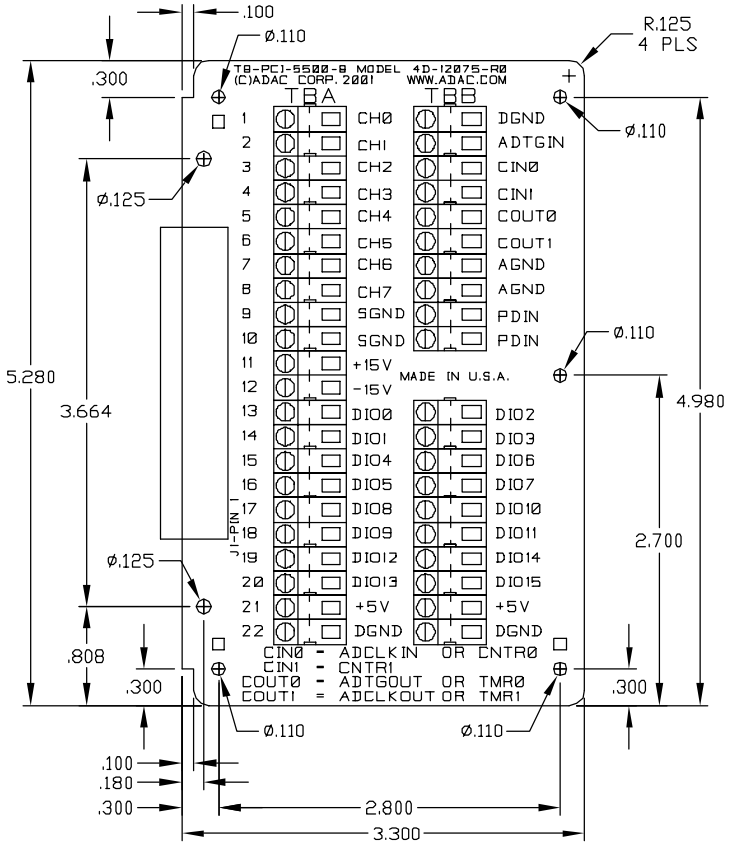
6.3.6 Physical & Environmental

Size:	4.2" (10.6cm) H x 5.57" (14.1cm) L
Connector:	68 pin standard "SCSI Type III" female connector brought to outside of PC.
Temp. Range of Operation:	0 °C – 55 °C
CE Conformity:	EN 55022 Class B EN50082-1 IEC801-2 IEC801-3 IEC801-4

6.4 TERMINATION BOARDS

6.4.1 ADAC-TB-8

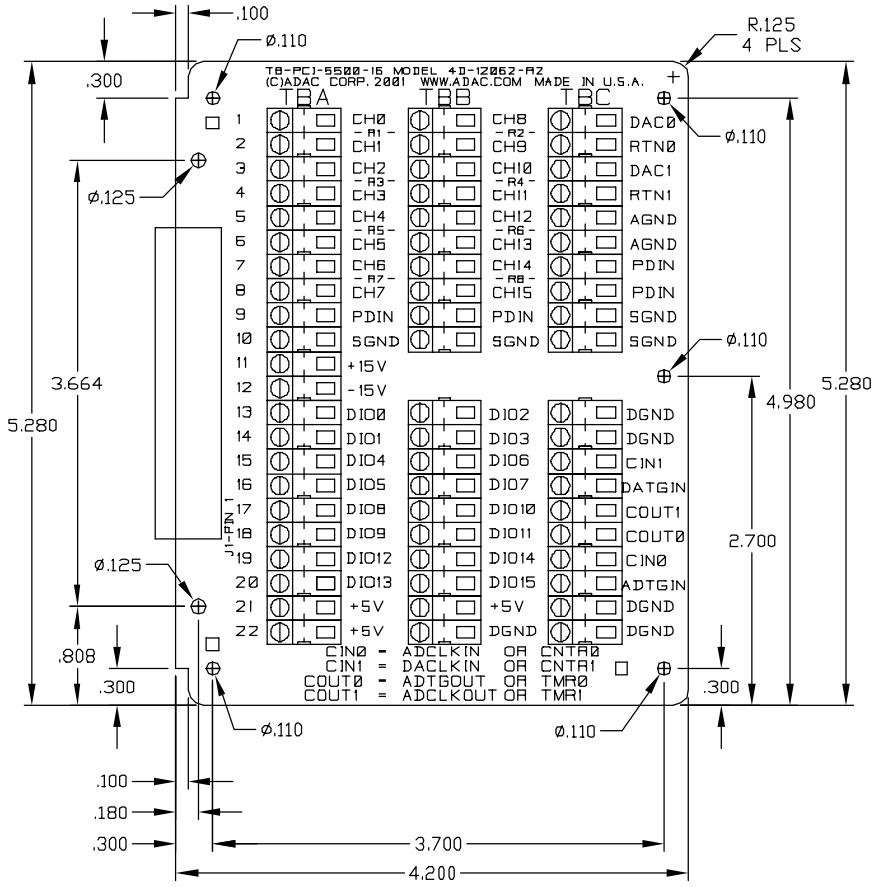
The ADAC-TB-8 terminal board provides a means of bringing the ADAC/5500MF signals out from its 68-pin connector and onto screw terminals. There is no active circuitry on the terminal board, thus the ADAC/5500MF board's specifications are not affected by its use.



Size:	3.30" L x 5.28" H
Connector:	68 pin standard "SCSI Type III" female connector
Temp. Range of Operation:	0 °C – 55 °C
Power Requirements:	none
Used with:	ADAC/5500MF
Connects to Board via:	CA-G55-ADAC, 68-conductor, 3 foot expansion cable

6.4.2 ADAC-TB-16

The ADAC-TB-16 terminal board provides a means of bringing board signals out from the 68-pin connector and onto screw terminals. There is no active circuitry on the terminal board, thus the specifications of the PCI boards do not change with use of the terminal board.



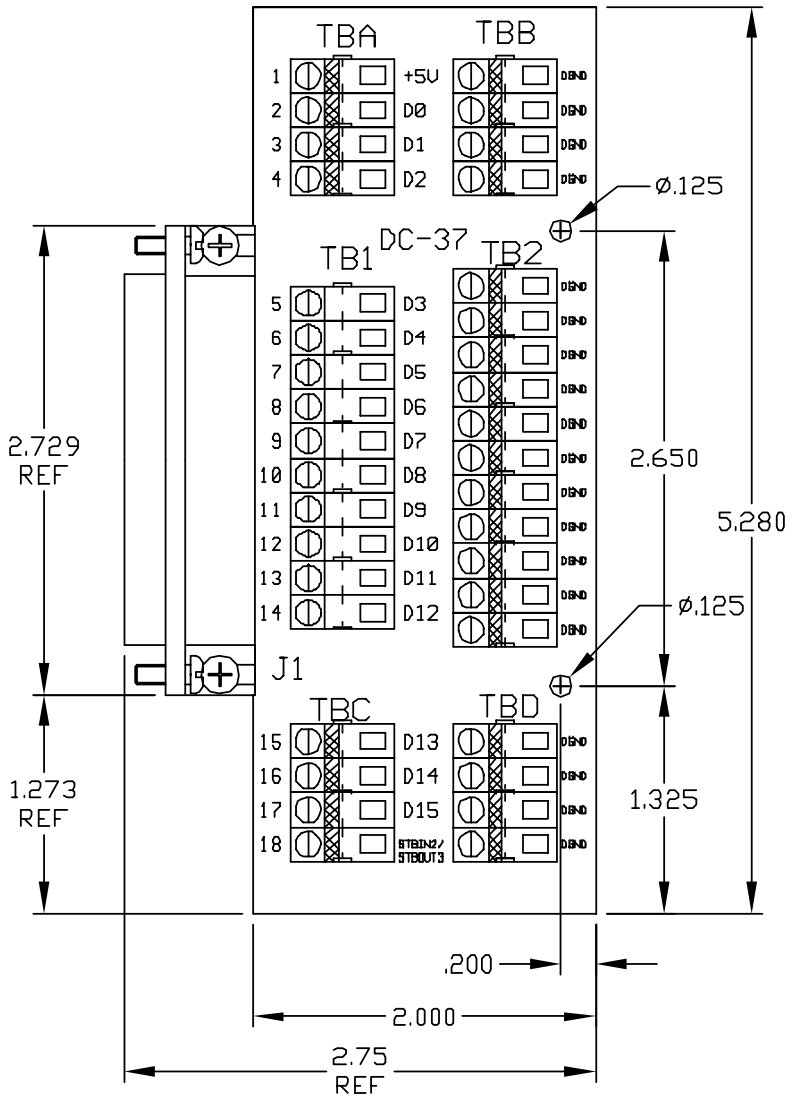
Size:	4.20” L x 5.28” H
Connector:	68 pin standard "SCSI Type III" female connector
Temp. Range of Operation:	0 °C – 55 °C
Power Requirements:	none
Used with:	ADAC/5501MF, ADAC/5501MF-V, ADAC/5503HR, and ADAC/5503HR-V
Connects to Board via:	CA-G55-ADAC, 68-conductor, 3 foot expansion cable

6.4.3 ADAC-DC-37

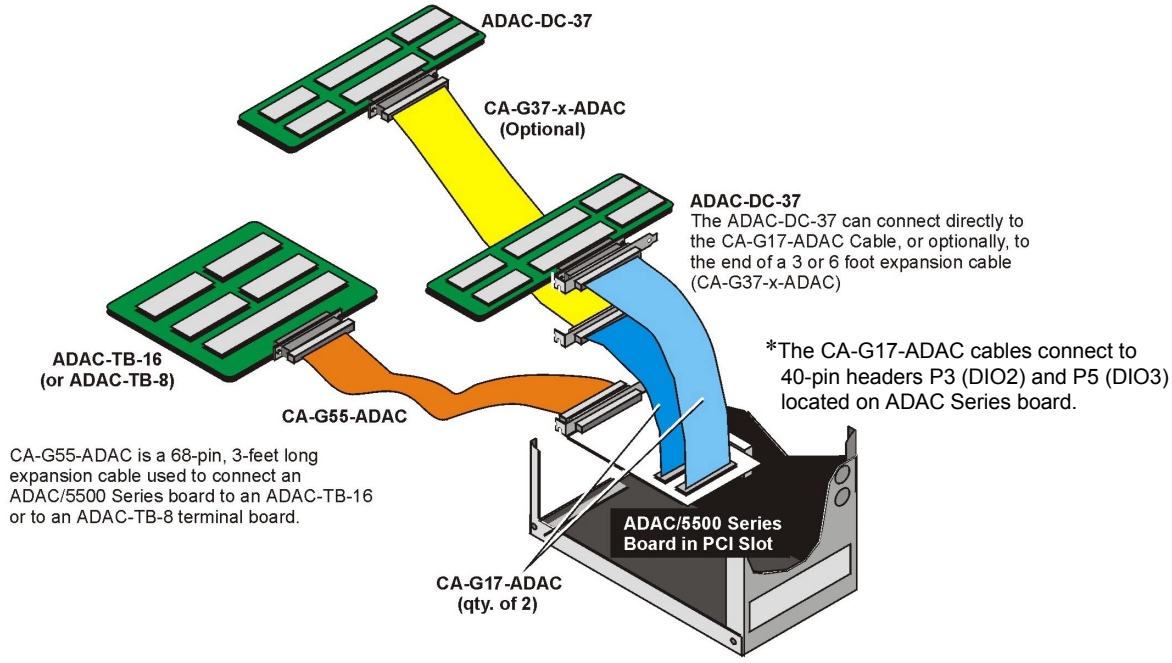
The ADAC-DC-37 provides access to 16 of the 32 available auxiliary digital I/O channels from ADAC/5501MF, ADAC/5501MF-V, ADAC/5503HR, and ADAC/5503HR-V boards. Two ADAC-DC-37 terminal boards are required to access all 32 digital I/O channels.

Each DC-37 terminal board can connect to an ADAC/5500 Series Board via a CA-G17-ADAC cable, or to an optional CA-G37-x-ADAC extension cable, which interfaces between a CA-G17 cable's orb and the ADAC-DC-37 board (see figure on following page).

There is no active circuitry on the terminal board, thus the specifications of the PCI boards do not change with use of the terminal board.



Size:	2.75”L x 5.28” H
Connector:	DB37
Temp. Range of Operation:	0 °C – 55 °C
Power Requirements:	none
Used with:	ADAC/5501MF, ADAC/5501MF-V, ADAC/5503HR, and ADAC/5503HR-V boards
Connects to Board via:	CA-G17-ADAC, 40-pin to DB37 (see figure); or connects to an optional CA-G37-x-ADAC cable, which connects to a CA-G17-ADAC (see figure).



ADAC/5500 Series, Possible Connections to Terminal Boards