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Data Acquisition

PowerDAS™ PAO Series

PCI Analog Output Boards

PAO 08/16: 16-bit, 8-Channel PCI Board
PAO 16/16: 16-bit, 16-Channel PCI Board
PAO 32/16: 16-bit, 32-Channel PCI Board
PAO 32HC/16: 16-bit, 32-Channel High Current PCI Board
PAO 96/16: 16-bit, 96-Channel PCI Board

USER'S MANUAL

VER. 3 • AUG 2001

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How to Use This Manual

Introduction

This manual describes the PowerDAS™ Analog Output boards. The following 32-bit, 33 MHz PCI boards are supported:

PAO 08/16
PAO 16/16
PAO 32/16
PAO 96/16

Who Should Read This Book?

This manual has been designed to benefit the user of PowerDAS PAO boards. To use the PowerDAS Analog Output Board, it is assumed that you have basic PC skills, and that you are familiar with Microsoft Windows NT/2000/95/98/Me and/or Linux/QNX operating environments.

Organization of This Manual

The PowerDAS PAO User's Manual is organized as follows:

Chapter 1 - Introduction

This chapter gives you an overview of the PowerDAS Analog Output board's features the various models available and what you need to get started.

Chapter 2 - Installation and Configuration

This chapter explains how to install and configure your PowerDAS Analog Output board.

Chapter 3 - Architecture

This chapter discusses the internal structure and subsystems of your PowerDAS Analog Output board.

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Chapter 4 – API and Third-Party Software Examples

This chapter explains how to use PowerDAS Analog Output boards using the PowerDAS API on Visual C++, VB, Delphi, C++ Builder or third-party software such as LabVIEW®, TestPoint®, DASYLab®, Agilent VEE®, etc.

Chapter 5 - Interconnections

This chapter describes the I/O connections to your PowerDAS Analog Output board.

Appendix A - Specifications

This chapter lists the PowerDAS Analog Output board hardware specifications.

Appendix B - Accessories

This appendix lists the PowerDAS Analog Output board accessories products.

Appendix C - Common Questions and Support

This appendix contains a list of commonly asked questions and their answers relating to usage and special features of your PowerDAS Analog Output board. Should you require assistance while installing or using the PowerDAS Analog Output board, support service details are also listed.

Appendix D - Warranty

This appendix contains a detailed explanation of the PowerDAS Analog Output board warranty.

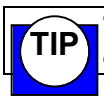
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The Index alphabetically lists topics covered in this manual.

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Conventions Used in This Manual

These are the main conventions used to help you get the most out of this manual:



Tips are designed to highlight quick ways to get the job done, or good ideas you might not discover on your own.

Note Notes alert you to important information.

CAUTION! Caution advises you of precautions to take to avoid injury, data loss, or system crash.

Text formatted in **bold** typeface may also represent type that should be entered verbatim or a command, as in the following example:

You can instruct users how to run setup using a command such as **setup.exe**.

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Introduction

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Introduction

This chapter describes the basic features of the PowerDAS™ PAO boards.

About the PowerDAS Analog Output Board

Thank you for purchasing a PowerDAS Analog Output board. The associated PowerDAS Software Suite (PD SDK) has been written specifically for these products.

Overview

The PowerDAS analog output boards are configured as 8, 16, 32 or 96 channels. The PowerDAS Analog Output board uses 16-bit DACs and allows you to configure the start up states for each channel (200ms maximum delay between system reset and power-on value loading). The on-board DSP/PCI interface allows you to use up to three 24-bit counter/timers, high-speed IRQ/External Clock lines, eight digital inputs and eight high-drive (-32/64mA) digital outputs. Additionally each board has a special calibration subsystem, which is used to calibrate each analog output channel.

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Features

The major features of the PowerDAS PAO boards are:

24-bit, 66/100 MHz Motorola 56301 DSP (Digital Signal Processor)

"Bus Master Ready" PCI Bus Host PC Interface (PCI 2.1 Compliant)

- 8/16/32/96 channel, 16-bit +/- 10V DACs
- DC-100kHz per D/A throughput
- 2MHz/board maximum update rate
- 1/2/4/8/16/32/64 Fixed/Unlimited channel list length
- Asynchronous/Simultaneous update modes for the all DACs
- Eight digital inputs
- Eight digital outputs
- Counters/Interrupt/Synchronization inputs
- Per-channel calibration
- Sense lines for the each DAC (optional)
- User-defined power-up states for the each DAC (200 ms maximum setup time after the system reset) Default is 0V.
- Three 24-bit counter timers (16.5/25MHz maximum)
- On-board 2K FIFO (located in the DSP memory)
- 32Ksamples FIFO upgrade option
- Software:

  PowerDAS for Windows95/98/Me/NT/2000/XP/Linux/QNX
  Visual C++, VB, Delphi, C++ Builder, Kylix
  Drivers for: LabVIEW®
  Agilent VEE®
  LabWindows/CVI®
  TestPoint®
  DASYLab®
  DiaDem®
  MATLAB DAQ Toolbox

Note For the full list of specifications, *see Appendix A: Specifications.*

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AO Applications

PowerDAS Analog Output boards provide a wide range of powerful features that cover a wide range of applications. The most common applications are:

- Process control
- ATE
- Closed-loop servo-control
- Motor control
- Individual DAC voltage output
- Telecommunications equipment control (micro mirrors)

The Digital Input and Digital Output Subsystems applications:

- Electro-mechanical relay control applications
- Solid-state relay applications
- Alarm system sensors
- Digital motion control

The Counter/Timer Subsystem applications:

- PWM modulator
- Frequency counter
- Pulse generator

Note The easiest way to expand the possibilities of the PAO board is to use the PMF or PMFS multifunction boards series in the same PC.

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PowerDAS PAO Models

PowerDAS PAO model numbers are derived as follows:

PAO Type Of Board]-[Channels]-[Speed]/[Resolution][Gain]

The types of boards are:

MF Multifunction
AO Analog Output
DIO Digital Input /Output
CTM Counter/Timer

Models	PAO Features
PAO 08/16	PCI bus Eight 16-bit Analog Output Channels
PAO 16/16	PCI bus Sixteen 16-bit Analog Output Channels
PAO 32/16	PCI bus Thirty-two 16-bit Analog Output Channels
PAO 96/16	PCI bus Ninety-six 16-bit Analog Output Channels

Table 1: PowerDAS PAO Models

All PowerDAS PAO boards have the following additional features:

Digital Input	Eight static digital inputs
Digital Output	Eight static digital outputs
Clock/Interrupt Lines	
Counter/Timers	Three 24-bit (33/50MHz Internal/16.5/25 MHz External)

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Getting Started

To get your PowerDAS PAO board up and running, ensure that you have the following:

A computer with PCI slots and the BIOS compliant to PCI Specifications 2.1 or greater. S*ee Appendix C: Common Questions and Support.*

PowerDAS PAO PCI board with user's manual.

Latest PowerDAS Software Suite CD (PD SDK) Software.

Minimum 16MB RAM for Windows® 9x and 32MB for Windows NT/98/Me and 64MB for Windows 2000

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Installation and Configuration

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Installation and Configuration

This chapter describes the hardware and software installation and configuration of the PowerDAS PAO board.

Unpacking

Your PowerDAS PAO board is wrapped in an anti-static bag to protect against electrostatic charges that might damage the board. To avoid damage, proceed as follows:

- Ground yourself with a grounded wrist strap or grounded source.
- Discharge the static electricity by taking the board in the anti-static bag and touching the metal part of your PC.
- Remove the board from the anti-static bag. We suggest you save the bag.
- Inspect the board for any damage. If any damage is found, notify your distributor to return the board to the manufacturer. *See Appendix C: Common Questions and Support.*

Note The PowerDAS PAO boards contain sensitive electronic components. Please make sure the proper grounding and electrostatic conditions are used.

Hardware

You can install your PowerDAS PAO board in any PCI slot. We recommend you use the first available slot and complete the following instructions:

PCI board installation:

1. Turn off your PC.
2. Remove the cover and make sure you have clear access to the PCI slots.
3. Connect all desired cables to the PAO board.
4. Insert the PowerDAS PAO board into a PCI slot. (If the PCI slots have not been used for a long time, insert the PowerDAS PAO board, then remove it and clean the edge connector with alcohol. After this has been done, replace the bard back into the slot.)
5. Screw the bracket and replace the cover.

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6. Turn the PC on.

The PowerDAS PAO board is now installed. All board configurations are controlled via software using the PD-SUITE.

Note For the Windows 95/98/Me/2000/XP platforms, you should install PowerDAS Software Suite prior the board installation.

Installing Multiple Boards

You can install multiple PowerDAS PAO boards in one PC. You are limited to the number of PCI slots in your PC.

Software

PowerDAS Software Suite CD contains drivers and software (example code with source code) for Windows®, Linux and QNX (optional).

Installation

From the CD, run the **SETUP.exe** program. The setup program will take you through the installation process.

As the installation process modifies your Windows registry, you must only install or uninstall the software using the appropriate programs.

Note Never delete the PowerDAS software from you PC directly. Always use Uninstall program from PowerDAS folder or Control Panel/Add-Remove Programs applet.

Note Once the installation is complete, the PC must be rebooted for proper operation.

Note Windows NT/2000/XP users must be logged in as an administrator or have equivalent access.

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Base Address, DMA, Interrupt settings

The PowerDAS PAO boards are configured automatically by the computer BIOS on power up. Usually you do not have to set any base address, DMA channels or interrupt levels. The PowerDAS driver is designed to share interrupts over PCI devices but very rarely will the BIOS assign same interrupt to mass-storage devices such as a SCSI controller or video card and a PowerDAS board. In this case it could be significant latency between the time when board fires an interrupt and the time the PowerDAS driver actually receives it. In this case we recommend changing your BIOS settings and assigning a dedicated interrupt for the PowerDAS board. Please refer to your motherboard/computer manual for the BIOS settings change procedure.

Diagnostics

In order to confirm board operation, install the PowerDAS Suite. This automatically installs the PowerDAS application control panel diagnostic program that will display all available PowerDAS boards in your system.

To access the PowerDAS control panel, select **START** > **Settings** > **Control Panel** and the icon will be displayed.

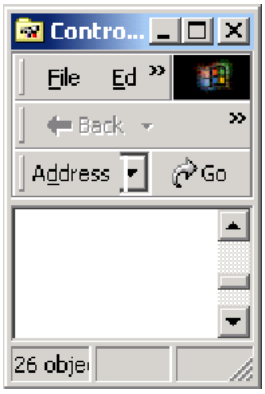


Figure 1: PowerDAS Control Panel Application

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An alternative test is to use the SimpleTest program installed by the Software Suite. Attached a oscilloscope of multimeter to the outputs of the PAO board. Run the **SimpleTest.exe** program by selecting **START** > **Programs > PowerDAS > Delphi Acquisition Demo**. This program shows all information about the board(s) installed and allows you to test all subsystems available on the board selected for the test.

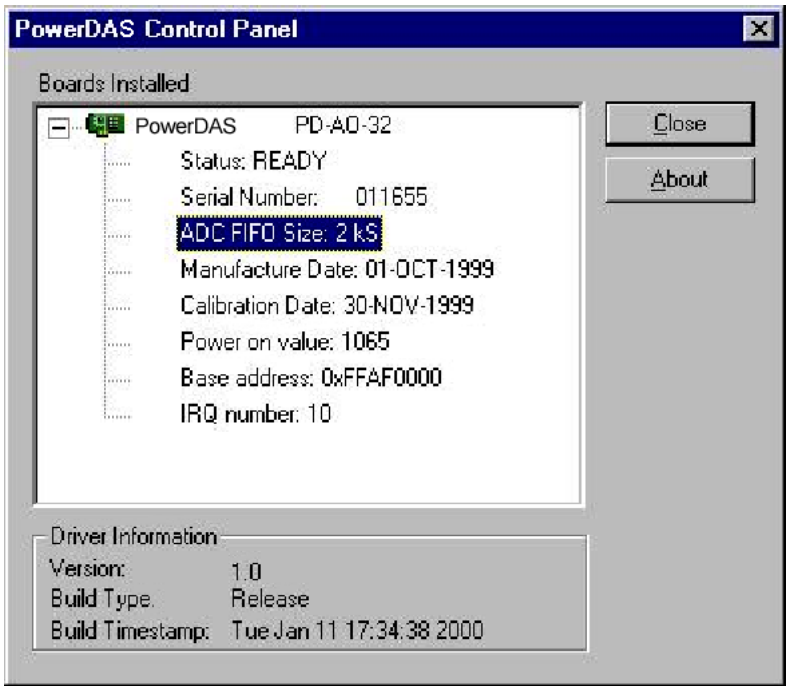


Figure 2: PowerDAS Control Panel Application Showing PAO 32 Board Installed

Please refer to the PowerDAS software manual for a complete set of ready to run example programs and the detailed API for programming of the PowerDAS PAO boards.

All PowerDAS PAO manuals are supplied in electronic Adobe Acrobat PDF format. If you require the PDF reader, this can be downloaded from the Internet from **www.adobe.com**

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Accessories

PowerDAS PAO boards have an extensive range of optional accessories:

- Cables (3-foot, 6-foot or 9-foot)
- Screw terminal panels
- Complete kits
- J1 high-density analog cable (PAO 08/16, 16/16, 32/16 only)
- J2 PD CBL3702K DIO connection kit
- J3-J8 IDC40 to DB-37 flat/twisted pair ribbon cable (PAO 96/16 only)
- J1 to J1/J2 splitter analog/digital cable

Cables

Digital Cable

PD CBL3704K: The J2 connector uses a 37-way ribbon connector set. It comprises of a 13" internal ribbon cable, which connects from the PowerDAS PAO board J2 internal digital connector (DIO/Counters/IRQs) to a 37-way D-SUB bracket. A 1-meter ribbon cable then connects from the bracket to the PAO STP accessory panels.

Analog Cable (PAO 08/16, 16/16, 32/16 boards only)

PD CBL9603: The J1 connector uses a 96-way shielded round 1-meter cable with a metal connector on either end. It connects to: PAO STP-16 or 32, PD-STP-BNC-16 or PD-STP-BNC-64 accessory panels.

Analog Cable (PAO 96/16 boards only)

PD CBL3740: The J3-J8 connector uses a 36-way flat or twisted pair ribbon cable (DB-37 to IDC40) to bring out the analog output signals. It connects to: CYSTP 37, so one PAO 96/16 board requires a set of six cables and terminals for all ninety-six channels.

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Note The PowerDAS PAO 08/16, 16//16, and 32/16 boards require a PD CBL9603 and the PAO 96/16 requires up to six PD CBL3740 cables. If digital IO/CTM is going to be used, an optional PD CBL37024 cable is required.

Custom cables are available. Please contact CyberResearch for more details.

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Screw Terminal Panels

The PAO STP-16/32 is a 16/32-channel screw terminal panel, which also includes connections for the counter timers, high-speed interrupt/synchronization lines and DIO ports. Using the jumpers, each sense line can be connected to the appropriate output directly on the screw terminal.

Because of compatible pin-outs, the PD BNC-xx terminals can be used with PAO 08/16, 16/16, and 32/16 boards. Custom terminal panels are available. Please contact CyberResearch for more details.

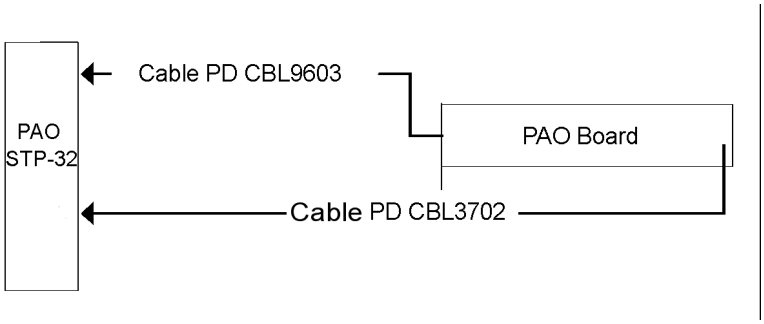


Figure 3: PAO STP-32 Wiring Diagram

The CYSTP 37 is a low-cost, 16-channel screw terminal panel, which can be used with the PAO 96/16 or PAO 08/16. This terminal contains analog signals only. For the digital signals, you will need the PD STP-DIO.

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Complete Kits

We have included the PD CBL9603 and PD AO16/AO32 into complete kits for the PAO 08/16, 16/16, and 32/16 boards. The product is available by ordering PD STP-AO16K or PD STP-AO-32K.

J1 Connector

If you wish to develop you own custom cable, you can purchase the connector and metal cover from CyberResearch. The part number is PD CONN.

The manufacturer is:

Fujitsu Takamisawa America, Inc.
Telephone: 408-745-4990 Fax: 408-745-4995

The manufacturers' part number for the connector is FCN-230C096-C/E and the metal cover FCN-247J096-G/E.

Custom terminal panels are available. Please contact your distributor or the factory.

J2 Connector

J2 connector is a 36-way boxed IDC header.

The manufacturer is Tomas & Betts (www.tnb.com) .

The manufacturers' part number for the connector is 609-3627.

J3-J8 Connector (PAO 96/16 only)

J3-J8 connectors are 40-way boxed IDC headers.

The manufacturer is 3M (http://www.mmm.com/esm/).

The manufacturers' part number for the connector is 2540-6002UB.

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3

Architecture

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Architecture

This chapter describes the functional operation of the PowerDAS PAO boards.

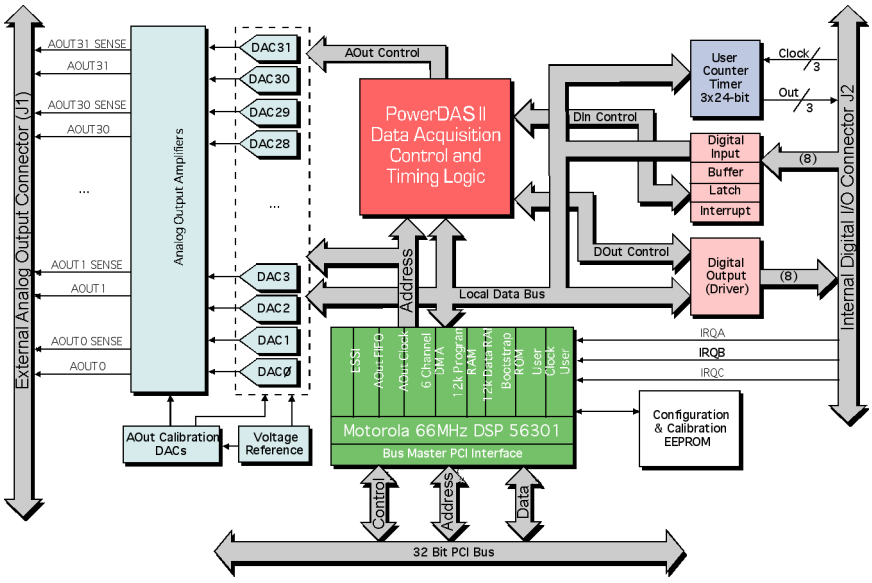


Figure 4: Block Diagram of the PowerDAS PAO Boards

Functional Overview

Analog Output Subsystem (PAO)

The PowerDAS analog output boards are configured as 8, 16, 32 or 96 sixteen-bit output channels. On the PAO 08/16, 16/16, and 32/16, each channel has an optional sense line to provide 16-bit accuracy at rated output current. The PAO 96/16 does not provide the sense line option.

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Note The default sense line option is not available on PAO boards because of noise considerations – high currents going through the cable induce more noise) and sense lines carry the same signal as corresponding output lines inside the cable. Please take this into consideration when configuring the sense lines (if required).

The PAO subsystem also includes input modes, channel queue, trigger and clocking control.

Interrupt (event) generation: You can use events to provide gap-free updates of the analog outputs.

There are three update modes for the analog subsystem:

- Single update
- Event (interrupt) – based waveform mode
- Continuous pulled-IO waveform mode and auto-regeneration waveform mode.

The user can define the power-on value of each channel (the default start-up value is set to zero). The included utility application "Start-Up Configuration Wizard" (StartUpState.exe) is installed by the SDK can be used to modify the start-up states.

Note The Power-On state will be loaded into the DACs with 200 ms maximum delay after the system reset. The calibration values will be loaded only when PowerDAS driver is loaded and up to +/-30 mV offset is possible on the outputs during the system boot process.

Note The quad output DACs has current limitations. Only one output of each quad can be continuously shorted to ground. Two, three and even four channels shorted to ground MUST NOT exceed five seconds.

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Analog Output Mode

Single Update

The PowerDAS PAO boards operate with either a single-update or streaming (waveform) output configuration. Single-update mode allows direct write access to any of the 16-bit DACs of the PowerDAS PAO board. The update frequency is at least 1kHz for the single update mode and can be as high as 15kHz in real-time operating environments. The single update speed is dependent on your PC system speed.

Note There is a special sub-mode of the single update mode when all or selected DACs outputs are updated simultaneously.

Event-Based Waveform

Event-based waveform mode allows continuous waveform generation and is not limited by the amount of data. Each time the DSP based FIFO is full an interrupt is fired to request additional data to be sent to the board. The PowerDAS advanced buffering mechanism hides those interrupts and allows you to work with big output arrays logically divided by frames. The end of each frame can generate an event, which will request more data from the application.

Note If the on-board FIFO is empty or the last value is outputted, the board will continue outputting the last DC value.

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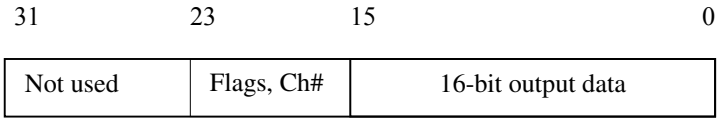
Auto-Regeneration Waveform (circular waveform)

Auto-Regeneration Waveform mode can be used to create fixed length waveforms without any host intervention of user software after the subsystem has initialized. An application writes data to the buffer of the PowerDAS PAO board and each time the end of buffer is reached, it starts to re-send the same buffer again. Note, that 2048 samples can fit into the on-board DSP memory and auto regeneration of up to 2048 samples will not require any intervention of the host PC.

Channel List

There are two ways do define a Channel List for the PowerDAS PAO board. First, when the output data and channel number are combined together to provide the output channel selection. In this situation, the lower 16 bits are data, the following upper 8, the channel number and special flags (see the picture below).

This mode supports update rates up to 455KS/sec



Bits 16~20 are used to define the output channel number on a **PAO 08/16/32** board.

Bit 21, when set is used as a Write and Hold Flag – this is used to write data to the DAC WITHOUT updating it on a **PAO 08/16, 16/16, or 32/16** board.

Bit 22, when set is used as an Update All Flag – all DACs will be updated by the previously written data on a **PAO PAO 08/16, 16/16, or 32/16** board.

PAO 96/16 board only:

Bits 16~22 are used to define the output channel number on **PAO PAO 08/16, 16/16, or 32/16** boards.

Bits 21, 22, & 23 when all set together are used as a Write and Hold Flag – written to DAC's data with this bit set will not update output.

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Bits 23, when set is used as Update All Flag – all DACs will be update by previously written data.

This is the default configuration, which provides an unlimited channel list length.

Another way to define the channel list is a series of continuous channel numbers (1/2/4/8/16/32/64), up to the number of ports available on the AO board, starting at any channel. For example, the PAO 32/16, channels 0 through 15 can be specified as a channel list of channels to be updated in Event-based Waveform mode and the remaining channels can be used in Single Update mode.

This mode is called DMA-based update mode and supports output rates up to 1.6 MS/sec.

Note There is a dedicated function in the PowerDAS API called _PdAO32SetUpdateChannel which can be used to specify the update channel number. Any write to this channel will force the update of all DACs.

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Digital Output Subsystem

There are eight static digital outputs on the PowerDAS analog output board. They are TTL/CMOS output level compatible, 2000V ESD protected. Due to the static nature of the outputs they can be updated at any time without any limitations. Digital outputs provide high current compatibility (-32/64 mA), which support drive relays or these lines can be used for control applications.

Digital Input Subsystem

There are eight static digital inputs on the PowerDAS analog output board. They are TTL/CMOS input-level compatible, 2000V ESD protected. Due to the static nature of the inputs they can be read at any time without any limitations.

Counter/Timer Subsystem

Depending on your PowerDAS PAO operation mode, the board can support up to the three DSP based 24-bit counter/timers with a maximum count rate up to 33 MHz for 66MHz DSP for an internal base clock and 16.5 MHz/25MHz for the external clock. The minimum count rate is 0.001 Hz for the internal clock and no low limits for the external clock.

Note For all waveform modes, only Timer0 and Timer1 are available for use.

Programming of the counter/timer subsystem of the PAO board requires a minimal understanding of the Triple Timer Module of the Motorola 56301 DSP. For this information please refer to the *Motorola DSP 56301 User Manual* (Motorola P/N DSP56301UM/AD).

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Each timer can be used for internal or external clocking and can interrupt the on-board DSP after a specified number of events (clocks) or signal an external device after counting internal events. Each timer can also be used to trigger DMA transfers after a specified number of events (clocks) have occurred. Each timer connects to the external world through one bi-directional pin TIO that is 7kV ESD protected. When TIO is configured as input the timer functions as an external event counter or can measure external pulse width/signal period. When TIO is used as output, it functions as a timer, watchdog or Pulse Width Modulator.

Some common timer/counter/output functions that microprocessors require are:

- Real time clock,
- Event counter
- Digital one-shot
- Programmable rate generator
- Square wave generator
- Binary rate multiplier
- Complex digital wave form generator
- Complex motor control

Note Each counter is a 24-bit count-up counter

After power-up, the count value and output of all counters are set to zero

Each counter must be programmed before it can be used

Unused counters need not to be programmed

Use the PowerDAS API to program counters.

Each counter is fully independent of the others. Only prescaler, when used, is a common part of the counter-timer subsystem. Each counter may operate in a different mode

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Calibration Subsystem

The calibration subsystem is used to calibrate **each** analog output zero offset (with 150-microvolt accuracy) and output range. The calibration data is stored in the on-board EEPROM. Additionally a PowerDAS PAO board provides an application for the user to configure the start-up output value of the any DAC. This value will be loaded immediately after a system reset or power-on with 200 ms maximum latency.

DSP Processor

All PowerDAS PAO boards are based on the Motorola 56301 DSP. This is a 24-bit 66/100 MHz processor with an integrated PCI interface. The PCI interface implements the PCI Local Bus Specifications so the board is fully auto-configured (base address, interrupt).

When the PowerDAS software is loaded, the PowerDAS PAO firmware is downloaded to the DSP via the PCI bus. This firmware contains all the code necessary to communicate with the board subsystems and the host PC driver.

Note The drivers from the PowerDAS web site always contain the latest versions of the DSP firmware.

Note Custom programming of the DSP is not available with the standard PowerDAS PAO product. However, should you require DSP processing, please contact CyberResearch.

PCI-Bus Interface

The PowerDAS PAO boards communicate via the PCI bus. The PCI bus interface is embedded in the Motorola 56301 DSP. On power up, the host PC automatically configures the boards base address and interrupt resources.

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Timing and Control

The PowerDAS PAO clocking and triggering features are extensive and can be configured in various different ways.

Analog Output Clocking

Clocking Comprises of Two Input Signals:

1. Clock In – used to clock analog output channels in channel list.
2. Trigger In – used to start/stop acquisition

.

You must load the channel list prior to starting this operation.

Clocking can be Controlled By:

Software Strobe
Internal Clock (DSP)
External Clock

Universal External Interrupt/Clock/Synchronization Inputs

Note You can only use these lines for Analog Output Clocking OR Triggering

Triggering is configured as follows:

Use the IRQB pin to asynchronously update all DACs.

Use the IRQC pin to supply your external trigger source.

Trigger modes:

Start trigger (acquisition starts on rising edge of the trigger signal)
Stop trigger (acquisition stops on rising edge of the trigger signal)

Trigger lines should be pulled-down to ground via 4.7 Kohm resistors.

Synchronizing two or more boards

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Note Using the PowerDAS PAO control panel application, please ensure the software driver recognizes the two or more PowerDAS PAO boards. No custom synchronization cables are required – all connections can be made directly on the screw terminal.

If internal connection between multiple boards is required, the following connections should be made:

The PowerDAS PAO J2 internal connector has a TMR2 Clock I/O pin. You can connect this pin to the TMR2 pin of the next board you wish to synchronize acquisition. It is preferable to use a 100~200 ohm series resistor for the clock connection.

For a custom cable contact CyberResearch.

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4

API and Third-Party Software Examples

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API and Third-Party Software Examples

The PowerDAS Software Suite API and third party software drivers support all PowerDAS PAO board features. This chapter provides an overview on how to use the API calls and examples using third-party software.

API Function calls

Please refer to PowerDAS SDK and programmer manual for the details about Analog Output board programming.

Generally Analog Output subsystem works in the same way as all other paced subsystems. The following command sequence should be used to program the PowerDAS PAO board in a low-level language such as C/C++/VB/Delphi:

- Open Driver. This allows you to check that the driver is installed properly and started and also gets a number and parameters of the PowerDAS boards installed in the system.
- Open Adapter. After the adapter is opened the PowerDAS SDK return a special handle that should be used for all calls referring to a specific PowerDAS board installed. This call locks the specific PowerDAS board by the specific application.
- Open Subsystem. This call grants access to one of the available PowerDAS board subsystems. The following subsystems can be accessed on a PowerDAS Analog Output board: Analog Output, Digital Input, Digital Output, DSP Counter and Calibration.
- Work with subsystem. There are two different ways to use a subsystem – in synchronous and asynchronous mode.
- In Synchronous Mode (known as Single Update on the PAO subsystem) there is a set of calls available which gives direct and immediate access to the DACs (DIO ports and DSP Timers). Timed access can be made using the operating system based timing loops.

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- In Asynchronous Mode (which has two sub-modes on PowerDAS PAO boards – event-based and regenerate mode) , a dedicated acquisition buffer is allocated in host PC memory. This buffer is divided by the number of logical blocks called frames, usually between 4 and 16 frames should be allocated. The following steps should be considered when Asynchronous acquisition mode is used:
  - User application uses API calls to allocate the acquisition buffer and fill it with initial data for all output subsystems.
  - Subsystem configuration word should be assembled using the API constants provided.
  - The user application should define a set of events from the board. A typical set of events include data availability events and error events
  - Start of asynchronous operation
  - WaitForSingleObject operating system function call or an equivalent should be used to check for events from the board. It is preferable to put this call into a separate thread. After an event, the application should re-initialize it and process the data.
  - Terminate asynchronous operation
  - Auto-regenerate mode user application can allocate one or more frames in the buffer, fill it with data and start acquisition. The PowerDAS driver will control event handling and supply more data into the on-board FIFO as requested. Note, that frame size cannot exceed 64Mbytes. The size of the buffer itself is limited by the amount of Physical memory installed on your PC.
- Close subsystem. When the application closes the subsystem it's frees-up resources.
- Close adapter. After the adapter is closed it is accessible from other applications.
- Close driver.

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API Examples

The PowerDAS Software Suite contains a complete set of self-documented examples dedicated to PowerDAS PAO boards programming. The best way to write your own program is to use a ready-to-run example and modifiy it as required by your application.

The examples are available in the following languages:

C/C++/Delphi/VisualBASIC:

- Single Update Example (Separate example available for the PAO 96/16 board)
- Buffered output Example (Event-based)

Please refer to the example sources for extensive programming details.
All examples are located in
<Program Files Dir>\PowerDAQ\SDK\Examples\<Language>\<Example>

Third-Party Examples

All third-party drivers, supplied by CyberResearch include a set of examples, which support all of the PowerDAS Analog Output board features. They are usually installed during the SDK installation process into the folders defined by third-party software vendors. Please refer to the readme file of the SDK version to find an exact location of the examples you need.

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Interconnections

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Interconnections

PAO 08/16, 16/16, and 32/16 Connectors

The PowerDAS PAO 08/16, 16/16, and 32/16 boards have two connectors and one header:

96-contact high-density Fujitsu header – analog output connector (J1)

36-way boxed IDC header (DIO/Timer and IRQ lines)

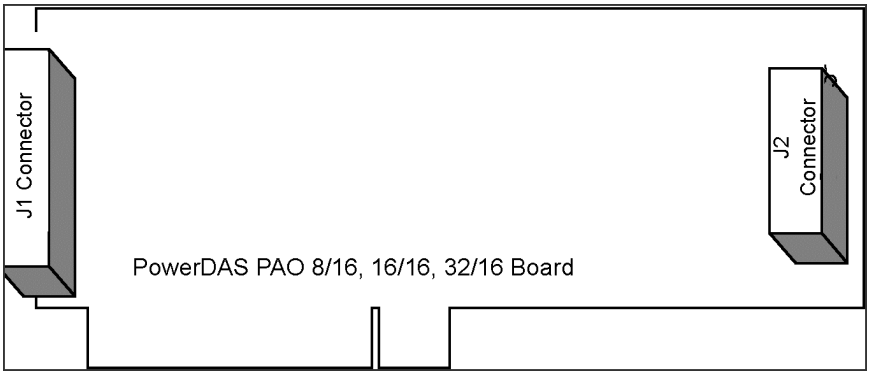


Figure 5: PowerDAS PAO 08/16, 16/16, and 32/16 Connectors

Note For manufacturers part numbers, *see Appendix A: Specifications*.

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PAO 96/16 Connectors

The PowerDAS PAO 96/16 boards have seven headers on it:

40-way boxed IDC header – analog output connectors (J3-J8)
36-way boxed IDC header (DIO/Timer and IRQ lines)

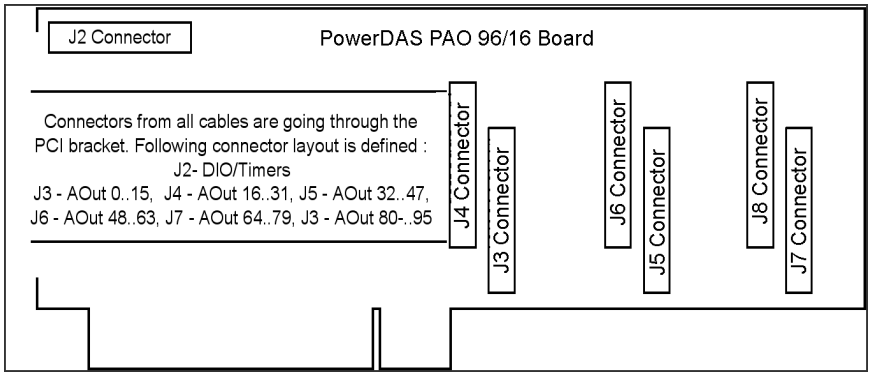


Figure 6: PowerDAS™ PAO 96/16 Connectors

Note For manufacturers part numbers, *see Appendix A: Specifications*.

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PAO 08/16/32 J1 Analog Connector

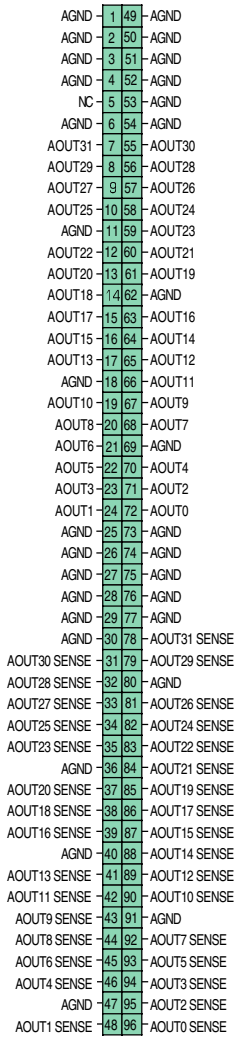


Figure 7: Connector Pin Assignment for J1

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The compatible pin out was used for the PAO 08/16, 16/16, & 32/16 and the PMF(S) J1 connector to provide the ability to use common accessories. For the details see conversion table in Appendix B. Note, that on PAO 08/16, 16/16 AOUT16..31 and AOUT16..31 SENSE are connected to the ground.

PAO J2 DIO/Counter/Timers/IRQx Connector

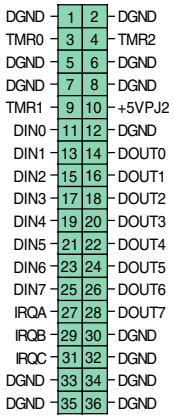


Figure 8: Connector Pin Assignment for J2

J1-J2 Connection Example

The example below shows how to connect PAO board to the PAO STP screw terminal.

Note For the PAO 08/16, 16/16 board lines OUT16-OUT31 and OUT16S-OUT32S are tied to the analog ground.

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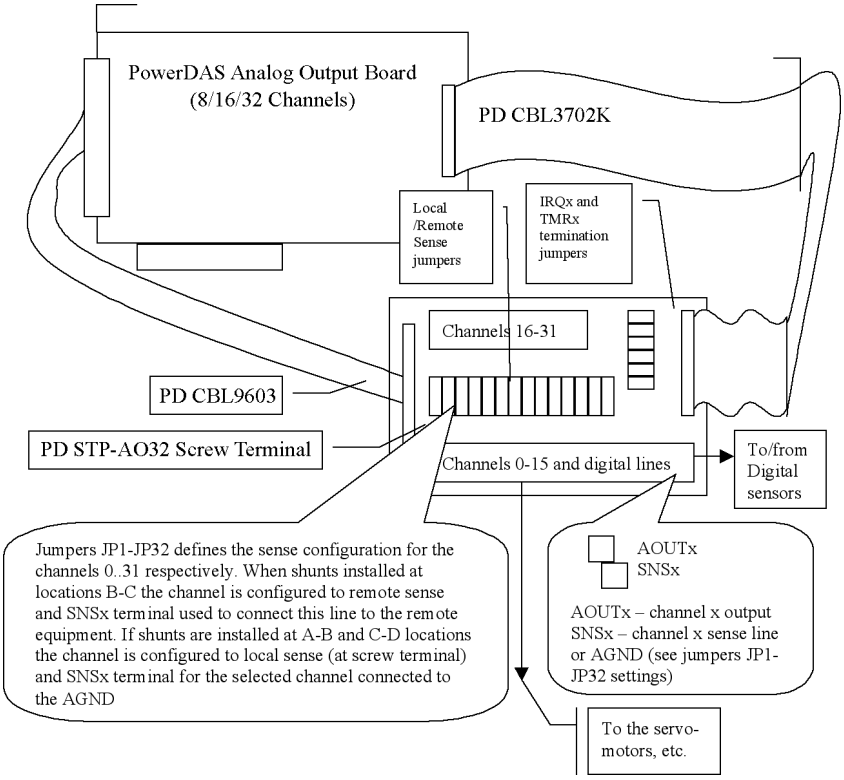


Figure 9: Configuring the PD STP-AO with PAO 08/16, 16/16, and 32/16

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Appendix A: Specifications

PAO Specifications:

The following conditions apply:
TA = 0_C to +85_C

PAO Subsystem

Parameter	Value
Number of Channels	8, 16, 32 or 96
Resolution	16 bits
Update Rate	100 KS/s channel, up to 1600 KS/s aggregate throughput in DMA mode, 455 KS/s in unlimited channel list mode.
Buffer Size	2k samples
Type of D/A	Double-buffered
Accuracy	+/- 3 LSB max
DNL	+/- 3 LSB max
Monotonicity Over Temperature	15 bits
Gain Error	0.05%
Range	+/- 10V fixed, 0..10V factory-installed option available for PAO 96/16 board
Output Coupling	DC
Output Impedance	0.15 Ohm max
Current Drive	+/-5mA (PAO 96) +/-20mA(PAO 08/16/, 16/16, 32/16)
Capacitive Loads	180 pF min
Settling Time	10uS to 0.003%
Slew Rate	10V/uS
Gain Bandwidth	1 MHz
Noise	2LSB RMS, 0-10000Hz
Output Protection	Short to ground, +/- 15 Volts
Power-On State, Default, User-programmable	0.0000V +/-25mV (PAO 08/16/32) 0.0000V +/-5mV (PAO 96)
Gain Drift	25ppm/deg C

Note Due to the quad DACs, the current is limited. Only one output of each may be continuously shorted to ground. The current is limited to 40 mA for PAO 08/16, 16/16, & 32/16 boards & 20 mA for all other models.

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Digital Input and Output

Parameter	Value
Number of Channels	8 inputs and 8 outputs
Compatibility	CMOS/TTL, 2KV ESD protected
Power-On State	Logic Zero
Input Termination	4.7Kohm pull-up to 5V
Output High Level	3.0V min @ -32 mA, 3.4V min @ -16 mA, 4.2V min @ -2 mA
Output Low Level	0.55V max @ 64 mA
Input Low Voltage	0.0 - 0.8 V
Input High Voltage	2.0 - 5.0 V
Input Current	1uA

DSP – Based Subsystems

There are two DSP-based subsystems available on the PowerDAS DIO boards:

- Counter/timers
- High-speed interrupts

DC Electrical Characteristics for DSP-Based Subsytems

Counter/Timers

Parameter	Value
Number of Channels	3
Resolution	24 bits
Maximum Frequency	16.5/25MHz for the external, 33/50 MHz for the internal clock (see notes)
Minimum Frequency	DC for input, 0.001Hz for output
Minimum Pulse Width	20 nS
Output High Level	2.0V min @ -4 mA
Output Low Level	0.5V max @ 4 mA
Input Low Voltage	0.0 - 0.8 V
Input High Voltage	2.0 - 5.0 V
Input Current	1uA

- External Event Counter
- Input Width Measurement
- Input Period Measurement

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- Event Capture
- Pulse Width Modulation (PWM)
- Watchdog Pulse
- Watchdog Toggle

Note The external clock frequency should be less than the internal operating frequency divided by 4 (i.e.. 16.33/25.00 MHz for 66/100 MHz DSP). The standard PowerDAS boards ships with a 66 MHz DSP.

Counter/Timer Specifications:

Note The maximum timer frequency is 16.33 MHz for external clock and 33 MHz for internal clock (66 MHz DSP core). TIO assumes timer I/O pin, CLKOUT – DSP clock. The minimum pulse width is 20 ns for an external clock/event.

The following conditions apply:
T_A = 0_C to +100_C; C load = 50pF + 2 TTL loads

Connectors Specifications

Connector	Description/Manufacturer/P/N
J1 (PAO 08/16/32,)	Fujitsu Takamisawa America, Inc. 408-745-4990 Fax: 408-745-4995. Connector p/n FCN-230C096-C/E and the metal cover p/n FCN-247J096-G/E.
J2 (PAO)	J2 connector is a 36-way boxed IDC header. The manufacturer is Tomas & Betts (www.tnb.com), p/n for the connector is 609-3627.
J3-J8 (PAO 96)	J3-J8 connectors are 40-way boxed IDC headers. The manufacturer is 3M (http://www.mmm.com/esm/), p/n for the connector is 2540-6002UB.

Environment

Operating Temperature	0°C to 70°C

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Appendix B: Accessories

Overview

The PowerDAS PAO boards can connect to a variety of stand-alone or 19" rack-mount accessory panels. A complete range of cables and options are available.

If you require a custom accessory, please contact CyberResearch.

These are following options available for use with PowerDAS PAO boards:

- The universal screw terminal PD STP-AO32 includes both analog and digital terminals and allows you to connect Analog Output and Sense lines directly at the screw terminal. May be used with all PowerDAS PAO boards except PAO 96 (note, that digital part of this screw terminal still can be utilized)
- PD-STP-BNC-16 & PD-STP-BNC-64. This BNC terminal connects each Analog Output line using the BNC-terminated cable that allows eliminating or reducing external noise. PD-STP-BNC-16 may be used with PAO 08 boards only. PD-STP-BNC-64 may be used with all PowerDAS PAO boards except PAO 96.
- PD-CONN96-PCB – This small terminal panel is useful in OEM applications but does not provide the ability to connect the digital signals to/from the board
- CYSTP 37. This terminal connects sixteen analog output channels to PAO 08/16 or PAO 96/16 board. May be considered as a low cost termination option

Cables: (PD CBLxxxx)

PD CBL9603: The J1 connectors use a 96-way shielded round 1-meter cable with a metal connector on either end. It connects to: PD STP-AOxx, PD STP-BNC-xx accessory panels. Used with all PAO boards except PAO 96/16.

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PD CBL3702: This is a 37-way ribbon connector set. It comprises of a 13" internal ribbon cable which connector from the PowerDAS PAO board J2 internal digital connector (DIO/Counters/IRQx) to a 37-way D-SUB bracket. A 1-meter ribbon cable then connects from the bracket to the PAO STP accessory panels. The PD CBL-37 is available as an option.

PD CBL3702K: This is a 36-way ribbon cable which connects from the PowerDAS PAO 96/16 channel board J3-J8 internal analog connector to a 37-way D-SUB bracket. A 1-meter ribbon cable then connects from the bracket to the CYSTP 37 accessory panels. Used with PAO 96/16 boards only.

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Screw Terminal Panels: (PD STP-AOxx)

The PD STP-AO32 is a 32-channel screw terminal panel, which includes connections to the counter timers, high-speed interrupt/synchronization lines and DIO ports.

Custom terminal panels are available. Please contact your distributor or the factory.

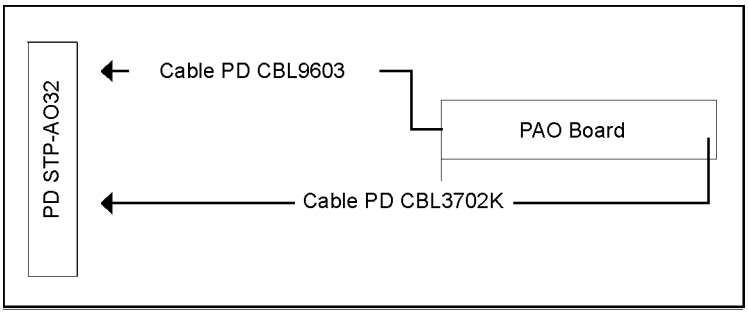


Figure 10: PD STP-AO32 Wiring Diagram

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Screw Terminal Panels: (CYSTP 37)

The CYSTP 37 is a simple 16-channel screw terminal panel, which includes connections to the analog signals only. This terminal panel can be used with PAO 96 and PAO 08 boards only. Note, that different cables are required for the different boards:

- PD CBL9637 – used with PAO 08/16
- PD CBL3740 – used with PAO 96/16

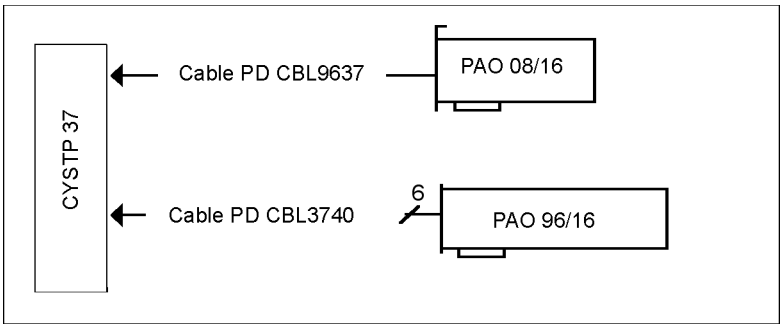


Figure 11: CYSTP 37 Wiring Diagram

Note That if Sense lines are available on PAO should be connected to ASensex line on the screw terminal.

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Terminal Pin	PAO 08/16	PAO 96/16	Terminal Pin	PAO 08/16	PAO 96/16
1	OUT0	Clk. In.	20	SNS0	Clk.Out
2	AGND	Ext. Trig	21	OUT1	DGND
3	SNS1	DGND	22	AGND	AGND
4	AGND	OUT0	23	OUT2	AGND
5	SNS2	OUT1	24	AGND	AGND
6	AGND	OUT2	25	OUT3	AGND
7	SNS3	OUT3	26	AGND	AGND
8	AGND	OUT4	27	OUT4	AGND
9	SNS4	OUT5	28	AGND	AGND
10	AGND	OUT6	29	OUT5	AGND
11	SNS5	OUT7	30	AGND	AGND
12	AGND	OUT8	31	OUT6	AGND
13	SNS6	OUT9	32	AGND	AGND
14	AGND	OUT10	33	OUT7	AGND
15	DNC	OUT11	34	SNS7	AGND
16	DNC	OUT12	35	DNC	AGND
17	DNC	OUT13	36	DNC	AGND
18	DNC	OUT14	37	DNC	N/C
19	DNC	OUT15		DNC= Do not connect	

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OEM Header Distribution Connector

For the OEM the PAO board provides the PD CONN96-PCB – a small terminal panel. The PD CONN96-PCB allows you to connect both PMF/PMFS and PAO boards. See table on the next page for the pinout conversion.

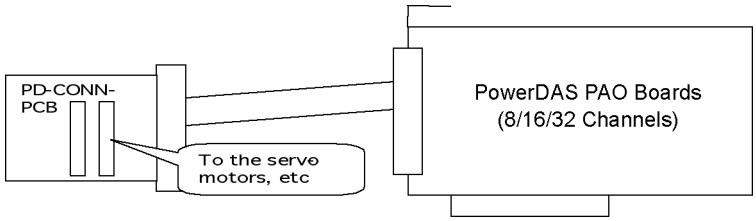


Figure 12: PD CONN96-PCB wiring diagram

Custom terminal panels are available. Please contact CyberResearch.

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Accessory Board Connections

PMFx	PAO 32/16	J1	J1	PAO 32/16	PMFx
		Pin	Pin		
AGND	AGND	1	49	AGND	AGND
AGND	AGND	2	50	AGND	AOUT0
AGND	AGND	3	51	AGND	AGND
AGND	AGND	4	52	AGND	AOUT1
DGND	DGND	5	53	AGND	AGND
AGND	AGND	6	54	AGND	AGND
AIN55	AOUT31	7	55	AOUT30	AIN54
AIN53	AOUT29	8	56	AOUT28	AIN52
AIN51	AOUT27	9	57	AOUT26	AIN50
AIN49	AOUT25	10	58	AOUT24	AIN48
AGND	AGND	11	59	AOUT23	AIN39
AIN38	AOUT22	12	60	AOUT21	AIN37
AIN36	AOUT20	13	61	AOUT19	AIN35
AIN34	AOUT18	14	62	AGND	AGND
AIN33	AOUT17	15	63	AOUT16	AIN32
AIN23	AOUT15	16	64	AOUT14	AIN22
AIN21	AOUT13	17	65	AOUT12	AIN20
AGND	AGND	18	66	AOUT11	AIN19
AIN18	AOUT10	19	67	AOUT9	AIN17
AIN16	AOUT8	20	68	AOUT7	AIN7
AIN6	AOUT6	21	69	AGND	AGND
AIN5	AOUT5	22	70	AOUT4	AIN4
AIN3	AOUT3	23	71	AOUT2	AIN2
AIN1	AOUT1	24	72	AOUT0	AIN0
AGND	AGND	25	73	AGND	AGND
Ext. Trig In	AGND	26	74	AGND	+5V
CV Clock Out	AGND	27	75	AGND	CV Clock In
N/C	AGND	28	76	AGND	AGND
AGND	AGND	29	77	AGND	N/C
CL Clock In	AGND	30	78	AOUT 31 SENSE	AIN63
AIN62	AOUT 30 SENSE	31	79	AOUT 29 SENSE	AIN61
AIN60	AOUT 28 SENSE	32	80	AGND	AGND
AIN59	AOUT 27 SENSE	33	81	AOUT 26 SENSE	AIN58
AIN57	AOUT 25 SENSE	34	82	AOUT 24 SENSE	AIN56
AIN47	AOUT 23 SENSE	35	83	AOUT 22 SENSE	AIN46
AGND	AGND	36	84	AOUT 21 SENSE	AIN45
AIN44	AOUT 20 SENSE	37	85	AOUT 19 SENSE	AIN43
AIN42	AOUT 18 SENSE	38	86	AOUT 17 SENSE	AIN41
AIN40	AOUT 16 SENSE	39	87	AOUT 15 SENSE	AIN31
AGND	AGND	40	88	AOUT 14 SENSE	AIN30
AIN29	AOUT 13 SENSE	41	89	AOUT 12 SENSE	AIN28
AIN27	AOUT 11 SENSE	42	90	AOUT 10 SENSE	AIN26
AIN25	AOUT 9 SENSE	43	91	AGND	AGND
AIN24	AOUT 8 SENSE	44	92	AOUT 7 SENSE	AIN15
AIN14	AOUT 6 SENSE	45	93	AOUT 5 SENSE	AIN13
AIN12	AOUT 4 SENSE	46	94	AOUT 3 SENSE	AIN11
AGND	AGND	47	95	AOUT 2 SENSE	AIN10
AIN9	AOUT 1SENSE	48	96	AOUT 0 SENSE	AIN8

Table 2: Conversion between the PMF(S) and PAO board J1 connector Pinout.

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Dimensions:

The following table contains the dimensions of the PowerDAS PAO and accessory products.

Accessory	Dimensions (W x L x H)
PAO 96/16	4.2”x13.275”x0.5”
PAO 32/16	4.2”x11”x0.5”
PAO 16/16	4.2”x8.2”x0.5”
PAO 08/16	4.2”x8.2”x0.5”
PD STP-AO32	4.2”x7.0”x2.1”
CYSTP 37	2.8”x4.4”x0.5”
PD CONN96-PCB	3.3”x3.33”x0.4”

Table 3: Dimensions of PowerDAS PAO Accessory Products

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Appendix C: Common Questions and Support

Q What is PCI Specification 2.1?

A The PCI Local Bus is a high-performance bus that provides a processor-independent data path between the CPU and high-speed peripherals. PCI is a robust interconnect mechanism designed specifically to accommodate multiple high performance peripherals for graphics, full motion video, SCSI, LAN, etc.

The PCI Local Bus Specifications, Rev 2.1 includes the protocol, electrical, mechanical and configuration specification for the PCI Local Bus components and expansion boards.

The Rev 2.1 was published June 1, 1995 by the PCI Special Interest Group.PO Box 14070, Portland, OR 97214.

Calibration Questions

Q How often should I calibrate my board?

A The PAO series board should be calibrated once a year.

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Service and Support

If you have technical problems using PowerDAS PAO, our Technical Support department can be reached by:

Telephone: 203-483-8815 or 1-800-341-2525

Fax: 203-483-9024

Email: techsupport@cyberresearch.com

Web Site: www.cyberresearch.com

For the most efficient service, please be available at your computer and be prepared to answer several questions listed on the following page when you call for technical support. This information helps us identify specific system and configuration-related problems.

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Technical Support Form

Photocopy this form and update it each time you make changes to your software or hardware. Completing this form accurately before contacting us for technical support helps our application engineers answer your questions more efficiently.

What is the name and version number of the product?

_____

What version of Windows are you using?

_____

What programming language and version?

_____

Is the board set at factory configuration?

_____

Have you run the board diagnostics? What were the results?

_____

Did the system ever work ? If so, what changed (moved location, installed other boards, software etc..)

_____

Have you run the sample programs? What were the results?

_____

Have you verified that all your connections are made properly and are secure?

_____

Have you been able to isolate the source of your problem: input or output device, board, software?

_____

What other boards or applications are installed in your system?

_____

How much RAM do you have?

_____

What size hard disk are you using?

_____

How fast is your CPU?

_____

How fast is your host data bus?

_____

If you are on a network, what type of network are you using and approximately how many users are on the network?

_____

Please specify whether or not the problem occurred more than once

_____

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Appendix D: Warranty

Overview

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All PowerDAS™ PAO boards have received CE Mark certification according to the following:

EN55011
EN50082-1

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to effect its safety or effectiveness.

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Upon request by CyberResearch, the product or part claimed to be defective shall immediately be returned at the customer's expense to CyberResearch.

There shall be no warranty or liability for any products or parts which have been subject to misuses, accident, negligence, failure or electrical power or modification by the Customer CyberResearch's approval. Final determination of warranty eligibility shall be made CyberResearch. If a warranty claim is considered invalid for any reason, the Customer will be charged for services performed and expenses incurred by CyberResearch in handling and shipping the return item.

As to replacement parts supplied or repairs made during the original warranty period, the warranty period of the replacement or repaired part shall terminate with the termination of the warranty period with respect to the original product or part.

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