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KEITHLEY

DAS-1700 Series

User's Guide



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DAS-1700 Series
User's Guide

Revision C - November 1999
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Safety Precautions

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read and follow all installation, operation, and maintenance information carefully before using the product. Refer to the manual for complete product specifications.

If the product is used in a manner not specified, the protection provided by the product may be impaired.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating properly, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the manual. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Keithley products are designed for use with electrical signals that are rated Installation Category I and Installation Category II, as described in the International Electrotechnical Commission (IEC) Standard IEC 60664. Most measurement, control, and data I/O signals are Installation Category I and must not be directly connected to mains voltage or to voltage sources with high transient over-voltages. Installation Category II connections require protection for high transient over-voltages often associated with local AC mains connections. Assume all measurement, control, and data I/O connections are for connection to Category I sources unless otherwise marked or described in the Manual.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable connector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Operators of this product must be protected from electric shock at all times. The responsible body must ensure that operators are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product operators in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, **no conductive part of the circuit may be exposed.**

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

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When installing equipment where access to the main power cord is restricted, such as rack mounting, a separate main input power disconnect device must be provided, in close proximity to the equipment and within easy reach of the operator.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

The instrument and accessories must be used in accordance with its specifications and operating instructions or the safety of the equipment may be impaired.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.

When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If  or  is present, connect it to safety earth ground using the wire recommended in the user documentation.

The  symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The  symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits, including the power transformer, test leads, and input jacks, must be purchased from Keithley Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be purchased from other suppliers as long as they are equivalent to the original component. (Note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

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Preface

The *DAS-1700 Series User's Guide* provides the information needed to install and use the following boards:

Series	Boards
DAS-1700ST	DAS-1701ST, DAS-1701ST-DA, DAS-1702ST, DAS-1702ST-DA
DAS-1700HR	DAS-1702HR, DAS-1702HR-DA
DAS-1700AO	DAS-1701AO, DAS-1702AO

The manual is intended for data acquisition system designers, engineers, technicians, scientists, and other users responsible for installing, starting up, and wiring signals to DAS-1700 Series boards. To follow the information and instructions contained in this manual, you must be familiar with the operation of an IBM PC or compatible in the Windows 95/98 or Windows NT environment. You must also be familiar with data acquisition principles and their applications.

The *DAS-1700 Series User's Guide* is organized as follows:

- Section 1 provides an overview of the features of DAS-1700 Series boards, including a description of supported software and accessories.
- Section 2 describes how to unpack, install, configure, and start up DAS-1700 Series boards and DriverLINX software.
- Section 3 describes how to attach accessories and how to wire signals to DAS-1700 Series boards.
- Section 4 describes how to use the DriverLINX Analog I/O Panel for testing the functions of DAS-1700 Series boards.
- Section 5 provides troubleshooting information.

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- Section 6 describes how to calibrate DAS-1700 Series boards.
- Section 7 provides a detailed description of the features of DAS-1700 Series boards.
- Appendix A lists the specifications for DAS-1700 Series boards.
- Appendix B lists the pin assignments for the main I/O connectors of DAS-1700 Series boards and for the connectors of DAS-1700 Series accessories.
- Appendix C contains DriverLINX configuration information for the DAS-1700 Series boards.
- Appendix D contains information on CE certification.

An index completes this manual.

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1

Overview

This section discusses the following subjects:

- **Features** — an overview of the features of DAS-1700 Series boards.
- **Supporting Software** — a description of the software available for DAS-1700 Series boards.
- **Accessories** — a description of the hardware accessories available for DAS-1700 Series boards.

Features

The DAS-1700 Series is a family of high-performance analog and digital I/O boards with DriverLINX software that requires:

- an IBM PC or compatible AT (386, or Pentium CPU) with minimum of 2 MB of memory
- at least one CD-ROM, floppy, and fixed disk drive
- Microsoft Windows 95/98, or Windows NT 4.0 or higher
- a computer supporting Microsoft Windows development
- a mouse is highly recommended

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The basic features of the DAS-1700 Series boards are listed in Table 1-1.

Table 1-1. Basic Features of DAS-1700 Series Boards

Series	Boards	Basic Features
DAS-1700ST	DAS-1701ST	Analog input: 16 single-ended or eight differential channels, 12-bit resolution, 166.67 ksamples/s maximum throughput, gains of 1, 5, 50, and 250 Digital I/O: four input lines, four output lines
	DAS-1701ST-DA	Analog input: 16 single-ended or eight differential channels, 12-bit resolution, 166.67 ksamples/s maximum throughput, gains of 1, 5, 50, and 250 Analog output: four 12-bit DACs, ±10 V range Digital I/O: four input lines, four output lines
	DAS-1702ST	Analog input: 16 single-ended or eight differential channels, 12-bit resolution, 166.67 ksamples/s maximum throughput, gains of 1, 2, 4, and 8 Digital I/O: four input lines, four output lines
	DAS-1702ST-DA	Analog input: 16 single-ended or eight differential channels, 12-bit resolution, 166.67 ksamples/s maximum throughput, gains of 1, 2, 4, and 8 Analog output: four 12-bit DACs, ±10 V range Digital I/O: four input lines, four output lines
DAS-1700HR	DAS-1702HR	Analog input: 16 single-ended or eight differential channels, 16-bit resolution, 50 ksamples/s maximum throughput, gains of 1, 2, 4, and 8 Digital I/O: four input lines, four output lines
	DAS-1702HR-DA	Analog input: 16 single-ended or eight differential channels, 16-bit resolution, 50 ksamples/s maximum throughput, gains of 1, 2, 4, and 8 Analog output: two 16-bit DACs, ±10 V range Digital I/O: four input lines, four output lines

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Table 1-1. Basic Features of DAS-1700 Series Boards (cont.)

Series	Boards	Basic Features
DAS-1700AO	DAS-1701AO	Analog input: 16 single-ended or eight differential channels, 12-bit resolution, 166.67 ksamples/s maximum throughput, gains of 1, 5, 50, and 250 Analog output: two 12-bit DACs, ±5 V or ±10 V range, waveform quality Digital I/O: four input lines, four output lines
	DAS-1702AO	Analog input: 16 single-ended or eight differential channels, 12-bit resolution, 166.67 ksamples/s maximum throughput, gains of 1, 2, 4, and 8 Analog output: two 12-bit DACs, ±5 V or ±10 V range, waveform quality Digital I/O: four input lines, four output lines

Additional features of DAS-1700 Series boards are as follows:

- The boards support up to 256 analog input channels using EXP-1800 or MB02 expansion accessories.
- Analog input channels are individually software-selectable for gain.
- A 256-location hardware channel-gain queue supports the sampling of analog input channels at the same or different gains, in sequential or nonsequential channel order.
- For analog input operations on DAS-1700ST Series and DAS-1700AO Series boards, burst mode emulates simultaneous-sample-and-hold (SSH) using the SSH-8 accessory.
- For analog input operations, dual-channel DMA (Direct Memory Access) allows the acquisition of more than 65,536 samples.
- For DAS-1700ST Series and DAS-1700HR Series boards, a hardware trigger/gate is supported for analog input operations; for DAS-1700AO Series boards, a hardware trigger/gate is supported for analog input and analog output operations. Pre-trigger, post-trigger, and about-trigger acquisitions are supported for analog input operations.
- All boards contain a 1024-word A/D FIFO (first-in, first-out data buffer for analog-to-digital operations) to ensure the continuous sampling of analog input data at higher conversion rates; DAS-1700AO Series boards also contain a 2048-word D/A FIFO

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(first-in, first-out data buffer for digital-to-analog operations) to support recycle-mode waveform generation.

- Pulsed interrupts allow multiple boards to share interrupt levels.
- All connections are made through the 50-pin main I/O (input/output) connector at the rear panel of the computer.
- The boards provide ±15 V and +5 V power for external circuitry.

For more information on these features, refer to Section 7

Supporting Software

The following software is available for operating DAS-1700 Series boards:

- **DAS-1700 Series standard software package** — Shipped with DAS-1700 Series boards. Includes DriverLINX for Microsoft Windows 95/98 or Windows NT and function libraries for writing application programs under Windows in a high-level language such as Microsoft Visual C++, Microsoft Visual Basic, Borland Delphi support files, LabVIEW, utility programs, and language-specific example programs.
- **DriverLINX** — the high-performance real-time data-acquisition device drivers for Windows application development includes:
  - *DriverLINX API DLLs* and drivers supporting the DAS-1700 Series hardware
  - *Analog I/O Panel* — A DriverLINX program that verifies the installation and configuration of DriverLINX to your DAS-1700 Series board and demonstrates several virtual bench-top instruments
  - *Learn DriverLINX* — an interactive learning and demonstration program for DriverLINX that includes a Digital Storage Oscilloscope
  - *Source Code* — for the sample programs
  - *DriverLINX Application Programming Interface files* — for the DAS-1700 Series
  - *LabVIEW* — support for DriverLINX

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  - *DriverLINX On-line Help System* — provides immediate help as you operate DriverLINX
  - *Supplemental Documentation* — on DriverLINX installation and configuration, analog and digital I/O programming, counter/timer programming; technical reference, and information specific to the DAS-1700 Series hardware.
- **DAS-1700 Series utilities** — The following utilities are provided as part of both the DAS-1700 Series standard software packages:
  - Analog I/O *Utility* — DriverLINX utility used for data acquisition and testing board operation.
  - *Test Utility* — DriverLINX utility used for testing board operation.
  - *Calibration Utility* — DriverLINX utility used for calibration.

Accessories

The following accessories are available for DAS-1700 Series boards:

- **STP-50 screw terminal panel** — Provides screw terminals that allow you to access the functions of a board; connects to the main I/O connector of a DAS-1700 Series board through a CDAS-2000 or SDAS-2000 cable.
- **STA-1800U screw terminal accessory** — Provides screw terminals that allow you to access the functions of a board and connectors that allow you to attach an MB01 backplane, MB02 expansion backplane, or SSH-8 accessory; connects to the main I/O connector of a DAS-1700 Series board through a CDAS-2000 or SDAS-2000 cable.
- **RMT-02 rack mount enclosure** — Allows you to mount the STA-1800U accessory.
- **SSH-8 accessory** — An 8-channel accessory that provides simultaneous sample-and-hold; you can use up to two SSH accessories with a DAS-1700ST Series or DAS-1700AO Series board. Refer to the *SSH-8 User's Guide* for more information.
- **MB01 backplane** — A 16-channel backplane; plug-in MB Series modules provide isolation and signal-conditioning. You can use one MB01 backplane with a DAS-1700 Series board. Refer to the *MB Series User's Guide* for more information.

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- **MB02 expansion backplane** — A 16-channel expansion backplane; plug-in MB Series modules provide isolation and signal-conditioning. You can use up to 16 MB02 expansion backplanes with a DAS-1700 Series board. Refer to the *MB Series User's Guide* for more information.
- **EXP-1800 expansion accessory** — A 16-channel expansion accessory; you can use up to 16 EXP-1800 expansion accessories with a DAS-1700 Series board. Refer to the *EXP-1800 User's Guide* for more information.
- **PG-408A DC/DC converter** — Required on EXP-1800 expansion accessories that use external power.
- **C16-MB1 cable** — A cable with a 37-pin, female D-type connector and a 26-pin, female header connector; allows you to connect an STA-1800U screw terminal accessory to an MB01 backplane.
- **C-2600 cable** — An 18-inch ribbon cable with a 26-pin female header connector at each end; allows you to connect an STA-1800U screw terminal accessory to an MB02 expansion backplane.
- **CDAS-2000 and SDAS-2000 cables** — The CDAS-2000 is a 24-inch ribbon cable with a 50-pin female header connector and a 50-pin female D-type connector; it allows you to connect a DAS-1700 Series board to an STA-1800U screw terminal accessory, an STP-50 screw terminal panel, or an EXP-1800 expansion accessory. The SDAS-2000 is a shielded version of the CDAS-2000; the SDAS-2000 is recommended for use with DAS-1700HR Series boards.
- **CAB-50 Series cable** — A ribbon cable with a 50-pin header connector on each end that allows you to daisy-chain EXP-1800 expansion accessories. The CAB-50 is 4 inches long and is recommended when the EXP-1800 is mounted in an ENCL enclosure; the CAB-50/1 is 18 inches long and is recommended when the EXP-1800 is mounted on a standoff.
- **CACC-2000** — A 24-inch ribbon cable with a 50-pin female header connector on each end; allows you to daisy-chain STA-1800U screw terminal accessories when attaching MB02 expansion backplanes.
- **C-1800** — An 18-inch ribbon cable with a 37-pin, female D-type connector on each end; allows you to connect an STA-1800U screw terminal accessory to an SSH-8 accessory.

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2

Setup and Installation

Read this section and all related DriverLINX document before you attempt to install and use your DAS-1700 Series board.

- **Unpacking the Board** — describes how to unpack and inspect a DAS-1700 Series board.
- **Installing the Software** — describes how to install the DriverLINX software package.
- **Configuring a Board** — describes how to set the base address switch on a DAS-1700 Series board.
- **Installing a Board** — describes how to install a DAS-1700 Series board.
- **Configuring DriverLINX** — describes how to configure DriverLINX to control a DAS-1700 Series board.

Unpacking the Board

To prevent any damage to your DAS-1700 Series board, perform the following steps when unpacking the board:

1. Remove the wrapped DAS-1700 Series board from its outer shipping carton.
2. If you are not equipped with a grounded wrist strap, discharge static electricity by holding the wrapped board in one hand while placing your other hand firmly on a metal portion of the computer chassis. (Your computer must be turned OFF, but grounded.)

   Note that if you are equipped with a grounded wrist strap, static electricity is discharged as soon as you hold the wrapped board.
3. Carefully remove the board from its anti-static wrapping material. (You may store the wrapping material for future use.)

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4. Inspect the board for signs of damage. If any damage is apparent, arrange to return the board to the factory; refer to page 5-6 for more information.
5. Check the remaining contents of your package against the packing list to ensure that your order is complete. Report any missing items immediately.
6. Once you have determined that the board is acceptable, install the software and configure the board, using the instructions in the following sections.

Note: DAS-1700 Series boards are factory calibrated; they require no further adjustment prior to installation. If at a later time you decide to recalibrate the board, refer to Section 6 for instructions.

Setting the Base Address Switch

DAS-1700ST Series and DAS-1700HR Series boards require 16 consecutive 8-bit locations in the I/O space of your computer starting at the base address. DAS-1700AO Series boards require 26 8-bit locations in the I/O space of your computer: 16 consecutive locations starting at the base address and 10 locations starting at the base address plus 400h.

DAS-1700 Series boards are shipped with a base address of 300h. If any of the required address locations starting at base address 300h are being used by another resource in your system (including another DAS-1700 Series board), you must reconfigure the base address using the base address switch. The base address switch is a 6-position DIP switch located as shown in Figure 2-1.

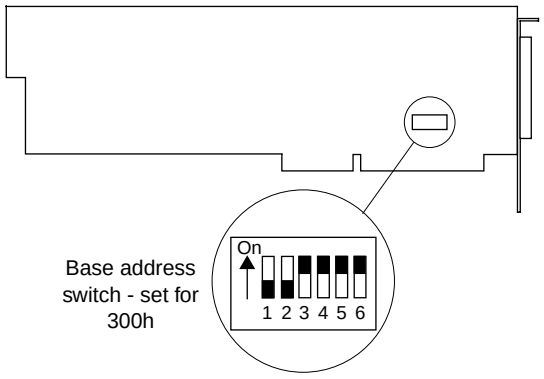


Figure 2-1. Location of the Base Address Switch

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To reset this switch to another base address, use the configuration utility to select a new base address and then view the corresponding switch settings in the menu box diagram. Make sure that the setting of the base address switch on the board matches the base address setting in the configuration file.

Installing the Software

Caution: As a precaution against a system crash the first time you install and test any new hardware, you should exit all other programs and, if you use a disk cache, disable write caching. If the system does crash and you're using disk compression software or a disk cache utility, as a precaution after any crash, run the utility that checks the directory structures.

Installing the DAS-1700 Series Standard Software Package

Important: Before you begin installing any hardware or software for the DAS-1700, read the *DriverLINX Installation and Configuration Guide* and the *Appendix F: Configuration and Implementation Notes—for Keithley DAS-1700* manuals that are packaged with the DriverLINX software. They are accessed from the DriverLINX CD-ROM after you have installed Adobe Acrobat.

Before Installing DriverLINX

1. Inventory your DAS-1700 board's configuration settings.
2. Determine the resources your DAS-1700 Series board requires.
3. Inventory your computer's resources already allocated to other installed devices.
4. Determine whether your computer has sufficient resources for your DAS-1700 board.

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5. Determine whether your DAS-1700 board can use your computer's free resources.
6. Set any jumpers/switches to configure your DAS-1700 board to use your computer's free resources.
7. Set any other jumpers/switches to configure your DAS-1700 board the way you want it to operate. Make a note of the switch and jumper settings in order to configure the board using DriverLINX.

Selecting the DriverLINX components to Install

For your convenience in installing and uninstalling just the DriverLINX components you need, the DriverLINX CD Browser will assist you in selecting the components to install:

- **Install Drivers** — This required component installs only the files you need for configuring your hardware and running third–party data–acquisition applications that require DriverLINX.
- **Install Interfaces** — This optional component installs the files and example programs that you will need to develop custom applications for DriverLINX using C/C++, Visual Basic, Delphi, and LabVIEW.
- **Install Documentation** — This optional component installs electronic documentation for DriverLINX that you can read, search, and print using the Adobe Acrobat Reader.
- **Install Acrobat** — This optional component installs the Adobe Acrobat Reader for the DriverLINX electronic documentation.

Installing DriverLINX

1. Insert the DriverLINX CD-ROM into your computer's CD-ROM Drive.
2. Start the DriverLINX setup program. On most systems, wait a few seconds for automatic startup. Otherwise, run the setup.exe program from the CD-ROM.
3. The DriverLINX CD-ROM Browser Map window appears on the screen. Click 'Install Drivers,' and follow the series of on-screen instructions.

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Note: To display an explanation of a menu option on the DriverLINX CD browser map that appears next and on subsequent setup screens, place the mouse pointer over the menu item. A star next to a menu item means that the item was selected previously.

4. Select ‘Read Me First,’ and follow the instructions.
5. Select ‘Install Documentation.’ If you do not have Adobe Acrobat installed on your computer, install it by selecting ‘Install Adobe Acrobat.’
6. Open the manuals appropriate to the DAS-1700 installation and read them before installing your DAS-1700 board or configuring DriverLINX:
   - *Installation and Configuration*
   - *Appendix F: Configuration and Implementation Notes—for Keithley DAS-1700.*
   - *DriverLINX Technical Reference Manual*
   - *DriverLINX Analog I/O Programming Guide*
   - *DriverLINX Digital I/O Programming Guide*
   - *DriverLINX Counter/Timer Programming Guide*
   - *Appendix, I/O Port, Interrupt, and DMA Channel Usage*
   - Other manuals appropriate to your installation.
7. Following the DriverLINX prompts, turn off your computer and install your DAS-1700 board into an appropriate free slot in your computer.

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Installing the Board

Caution: Make sure that power is turned OFF. Installing or removing a board while power is ON can damage your computer.

To install a DAS-1700 Series board, perform the following steps:

1. Turn power to the computer and all attached equipment OFF.
2. Remove the computer chassis cover.
3. Select an unoccupied accessory slot. DAS-1700 Series boards require a full-size slot.
4. Remove the corresponding blank plate from the I/O connector panel.
5. Make sure the setting of the base address switch matches the base address setting in the configuration utility.
6. Insert and secure the board in the selected slot.
7. Replace the computer cover.
8. Turn power to the computer ON.

After you install the DAS-1700 Series board in the computer, you can attach an accessory board and wire the appropriate signals to the board; refer to Section 3 for information. Before writing your program, you can test the functions of the board using the DAS-1700 Series Control Panel. Refer to Section 4 for more information about the control panel.

Refer to the documentation provided with your computer for more information on installing boards.

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Configuration of the DAS-1700 Board with DriverLINX

Note: Be sure to note and follow all programming differences between installations for Windows NT and Windows 95/98.

Be sure to make note of the configuration of all switches and jumpers on the board. You will use this information to enter the correct configuration parameters using DriverLINX. Also locate any information or notes about the interrupt and DMA channels used by the other hardware devices in your computer system.

Table 2-1 lists I/O addresses commonly used by IBM PC/XT, AT, and compatible computers. Determine an even boundary of eight I/O addresses within the range of 000H to 3F8H that are not being used by another resource in your system (including another DAS-1700 Series board), and set the switches to the appropriate base address.

Table 2-1. I/O Address Map (000H to 3FFH)

Address Range	Use
000H to 00FH	8237 DMA #1
020H to 021H	8259 PIC #1
040H to 043H	8253 timer
060H to 063H	8255 PPI (XT)
060H to 064H	8742 controller (AT)
060H to 06FH	8042 Keyboard controller
070H to 071H	CMOS RAM and NMI mask register (AT)
080H to 08FH	DMA page registers
0A0H to 0A1H	8259 PIC #2 (AT)
0A0H to 0AFH	NMI mask register (XT)
0C0H to 0DFH	8237 DMA #2 (AT - word-mapped)
0F0H to 0FFH	80287 numeric processor (AT)

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Table 2-1. I/O Address Map (000H to 3FFH) (cont.)

Address Range	Use
170H to 177H	Hard disk controller #1
1F0H to 1F8H	Hard disk controller #2
1F0H to 1FFH	Hard disk controller (AT)
200H to 2FFH	Game / control
210H to 21FH	Expansion unit (XT)
238H to 23BH	Bus mouse
23CH to 23FH	Alternate bus mouse
278H to 27FH	Parallel printer
2B0H to 2DFH	EGA
2E0H to 2EFH	GPIB (AT)
2E8H to 2EFH	Serial port
2F8H to 2FFH	Serial port
300H to 31FH	Prototype card
320H to 32FH	Hard disk (XT)
370H to 377H	Floppy disk controller #2
378H to 37FH	Parallel printer
380H to 38FH	SDLC
3A0H to 3AFH	SDLC
3B0H to 3BBH	MDA
3BCH to 3BFH	Parallel printer
3C0H to 3CFH	VGA EGA
3D0H to 3DFH	CGA
3E8H to 3EFH	Serial port
3F0H to 3F7H	Floppy disk controller #1
3F8H to 3FFH	Serial port

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The Expansion Board Configuration for Keithley DAS-1700 Series dialog in DriverLINX allows you to record the settings of your analog input multiplexers and enable the expansion channels. Make sure that the switch settings match the settings you define in DriverLINX. Refer to the *DriverLINX Appendix F: Configuration and Implementation Notes—Keithley DAS-1700 manual.*

After you have successfully installed the DAS-1700 Series board in your computer, start Windows.

Run "Learn DriverLINX" **(LearnDL.exe)** from the DriverLINX program group to tell DriverLINX how you configured your DAS-1700 Series board and to verify that everything is properly installed and configured.

1. Start Windows as you normally would and select the Program Manager window.
2. Either select the "Learn DriverLINX" icon created when you installed DriverLINX or enter "<drive>:/DRVLNX/LEARNDL" in the *Command Line* edit box. The Command Line edit box is activated by selecting the *Run...* option. <drive> is the letter of the hard disk drive where DriverLINX is installed.
3. Immediately after loading Learn DL, the Open DriverLINX DLL dialog box appears. Select the name of the hardware–specific DLL from the list for your DAS-1700 Series board. The name is an abbreviation of the board's model number.
4. From the main menu bar of Learn DL**,** select the *Device* menu and choose *Select...*.
5. Select the Logical Device you wish to configure and then click on the *OK* button (return).
6. Again select the *Device* menu and then choose the *Configure...* option to display the Device Configuration Dialog Box.
7. From the *Model* list, select the model name for your DAS-1700 Series board you are configuring.
8. If the value displayed in the *Address* edit box is not correct, type the correct value into the box. You may enter the address in decimal or hexadecimal using the c–notation for hex, (that is, 768 decimal = 0x300 hexadecimal).

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9. Choose the correct options for the *Analog, Digital,* and *Counter/Timer Sections* by first clicking on the appropriate radio button in the middle of the dialog box and then completing the group of dialog fields in the lower third of the dialog box. Be sure to click on both the *Input* and *Output* radio buttons for the *Analog* and *Digital* groups to see all the dialog fields.
10. After you have made all your selections, save the configuration parameters by clicking on the *OK* button. This will create or update the configuration file, <device>.INI, in the Windows directory.
11. Repeat the preceding steps, starting at step 5, for each Logical Device you wish to configure.

You can use DriverLINX to verify board operation.

1. To physically initialize the DAS-1700, select *Device/Initialize* from the main menu in Learn DriverLINX.
2. The first time the DAS-1700 is initialized, or after a configuration change, DriverLINX runs a diagnostic program to verify the operation and accuracy of the configuration settings.

You are now ready to make I/O connections. Refer to Section 3 for descriptions of common I/O accessories and connections for DAS-1700 Series boards.

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3

Cabling and Wiring

This section discusses the following subjects:

- **Attaching Accessories** — describes how to attach supported accessories to DAS-1700 Series boards.
- **Connecting Signals** — describes how to wire signals to DAS-1700 Series boards.
- **Synchronizing the Start of Operations on Multiple Boards** — describes how to synchronize the start of analog input operations on multiple DAS-1700 Series boards.

Attaching Accessories

The following sections describe how to attach accessories to DAS-1700 Series boards.

STA-1800U Screw Terminal Accessory

The STA-1800U screw terminal accessory contains the following components:

- Two 50-pin male connectors (J1 and J2). Use J1 for cabling to the main I/O connector of DAS-1700 Series boards; use J2 for cabling to a second STA-1800U.
- 53 labeled screw terminals for connections from sensor outputs and test equipment.

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- Four 26-pin male connectors (J4, J5, J6, and J7) for cabling to MB02 expansion backplanes.
- One 37-pin male connector (J3) for cabling to SSH-8 accessories or to an MB01 backplane.

Figure 3-1 shows the connector layout of an STA-1800U screw terminal accessory.

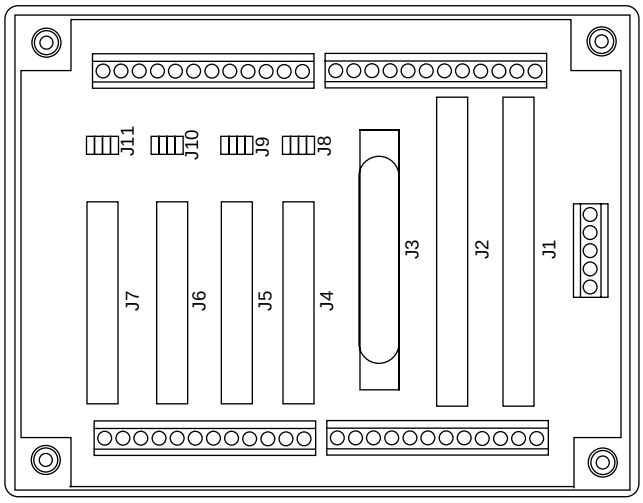


Figure 3-1. Connector Layout of an STA-1800U

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To attach an STA-1800U to a DAS-1700 Series board, use a CDAS-2000 or SDAS-2000 cable. Connect one end of the cable to the main I/O connector of the DAS-1700 Series board and the other end of the cable to connector J1 of the STA-1800U, as shown in Figure 3-2.

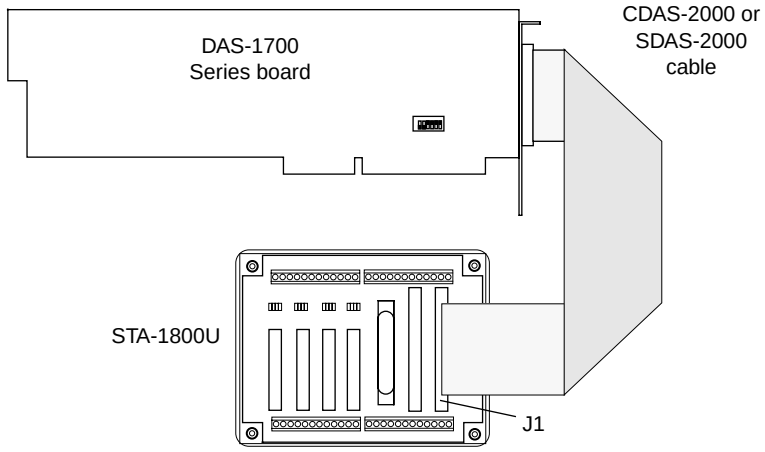
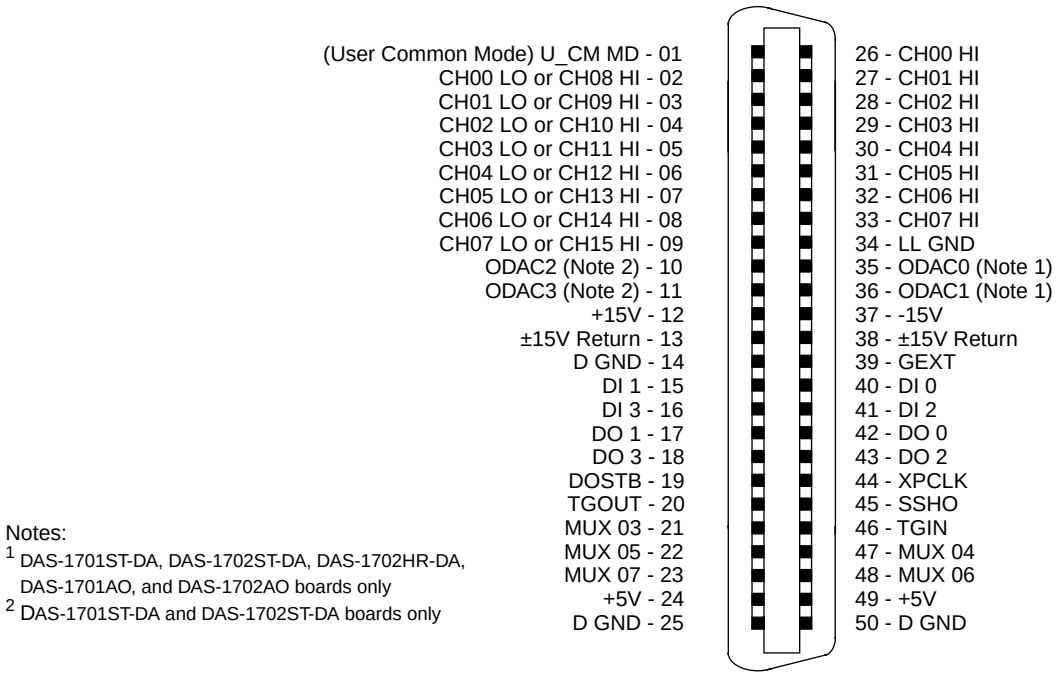


Figure 3-2. Attaching an STA-1800U to a DAS-1700 Series Board

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Pin assignments for the main I/O connector of a DAS-1700 Series board are shown in Figure 3-3.



Notes:
[1] DAS-1701ST-DA, DAS-1702ST-DA, DAS-1702HR-DA, DAS-1701AO, and DAS-1702AO boards only
[2] DAS-1701ST-DA and DAS-1702ST-DA boards only

Figure 3-3. Pin Assignments for the Main I/O Connector of a DAS-1700 Series Board

Pin assignments for connectors J1 and J2 of the STA-1800U are shown in Figure 3-4.

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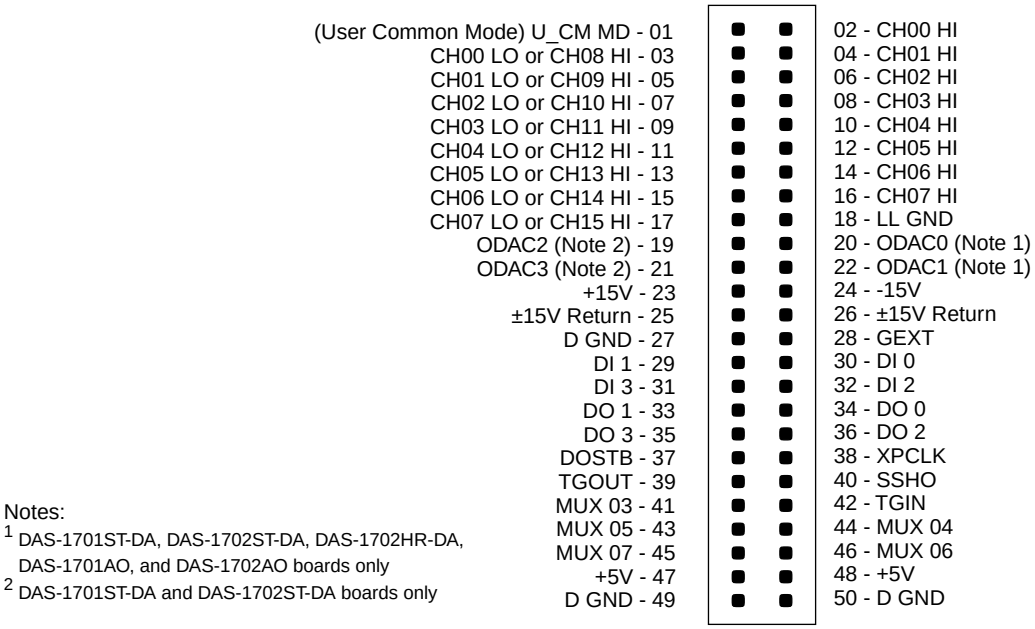


Figure 3-4. Pin Assignments for Connectors J1 and J2 of the STA-1800U

Note that the screw terminals for the DAC (digital-to-analog converter) outputs are labeled differently for Revisions 1 and 2 of the STA-1800U. These differences are shown in Table 3-1.

Table 3-1. STA-1800U Labels for DAC Outputs

DAC	Rev. 1 Label	Rev. 2 Label
0	DAC0 OUT	ODAC0
1	DAC1 OUT	ODAC1
2	DAC0 IN	ODAC2
3	DAC1 IN	ODAC3

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STP-50 Screw Terminal Panel

To attach an STP-50 screw terminal panel to a DAS-1700 Series board, use a CDAS-2000 or SDAS-2000 cable. Connect one end of the cable to the main I/O connector of the DAS-1700 Series board and the other end of the cable to the STP-50, as shown in Figure 3-5. Screw terminal assignments for the STP-50 are shown in Figure 3-6.

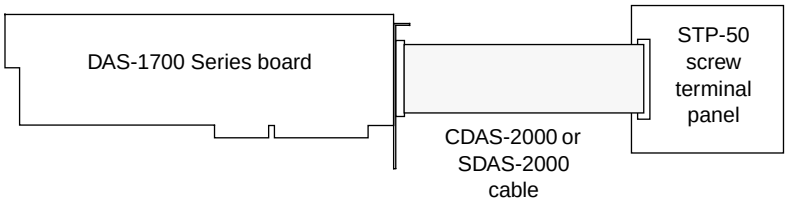


Figure 3-5. Attaching an STP-50 to a DAS-1700 Series Board

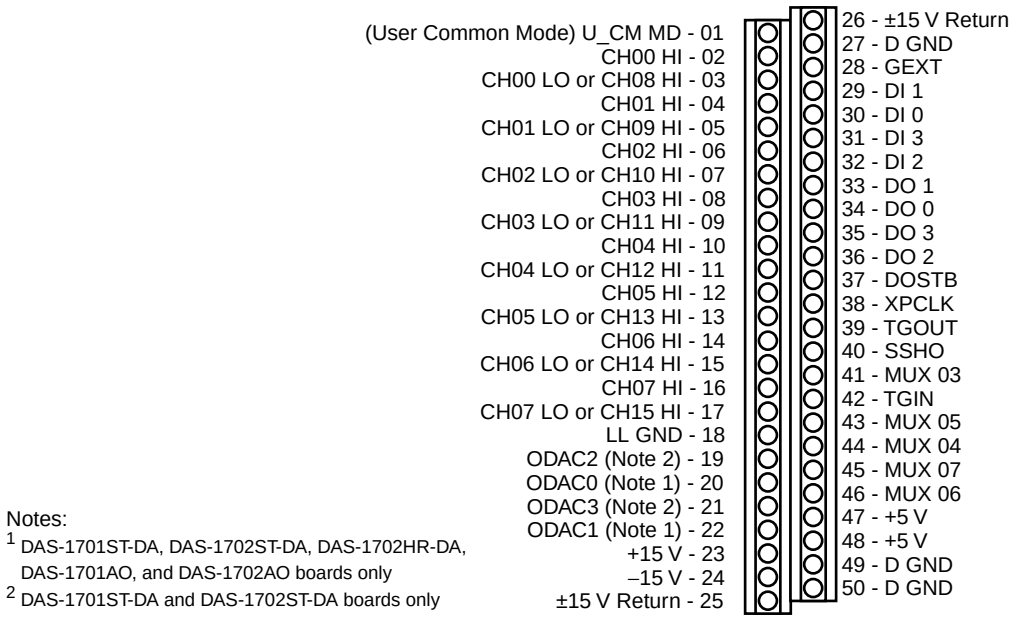


Figure 3-6. Screw Terminal Assignments for the STP-50

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SSH-8 Accessory

DAS-1700ST Series and DAS-1700AO Series boards can accept one or two SSH-8 accessories. (DAS-1700HR Series boards do not support SSH-8 accessories). You attach an SSH-8 to a DAS-1700ST Series or DAS-1700AO Series board through an STA-1800U screw terminal accessory. Note that attached SSH-8 accessories must be set as slaves.

To attach an SSH-8 to a STA-1800U, use a C-1800 cable, as shown in Figure 3-7. Refer to the *SSH-8 User's Guide* for more information about SSH-8 accessories.

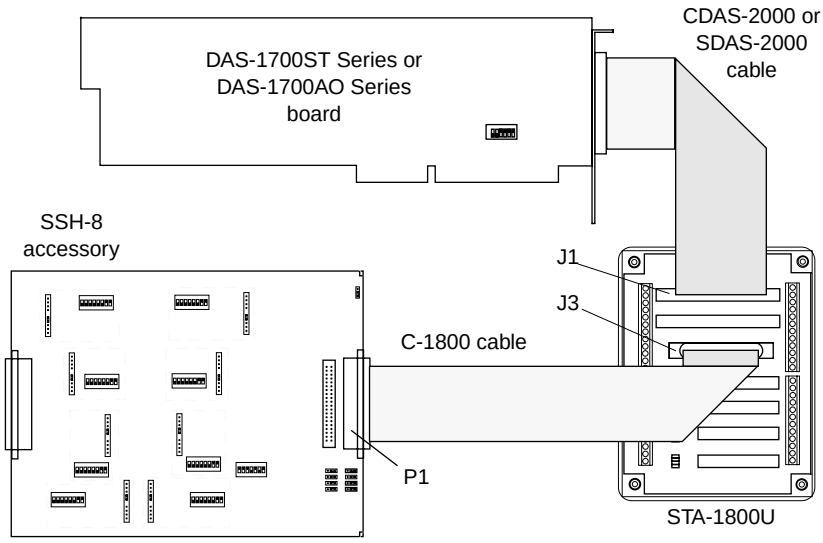


Figure 3-7. Attaching an SSH-8 to a DAS-1700ST or DAS-1700AO Series Board

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MB01 Backplane

A DAS-1700 Series board configured for single-ended inputs can accept one MB01 backplane through an STA-1800U screw terminal accessory. To attach an MB01 backplane to an STA-1800U, use a C16-MB1 cable, as shown in Figure 3-8. Refer to the *MB Series User's Guide* for more information about MB01 backplanes and modules.

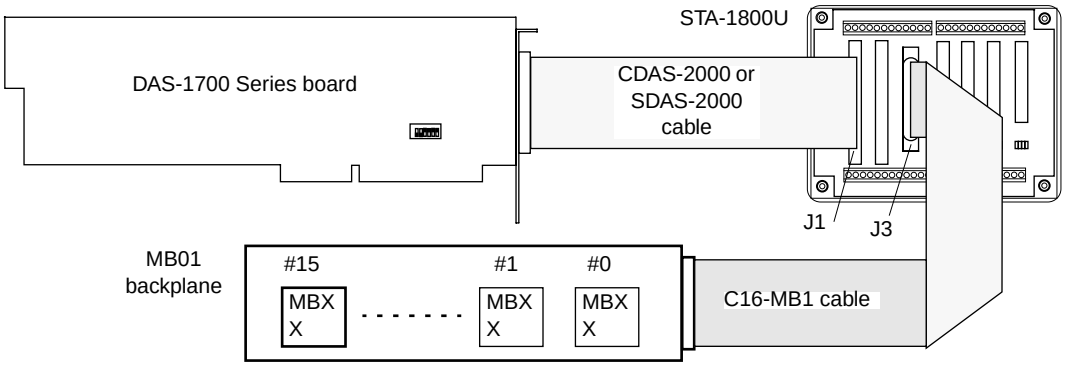


Figure 3-8. Attaching an MB01 Backplane to a DAS-1700 Series Board

MB02 Expansion Backplane

A DAS-1700 Series board configured for single-ended inputs and working through multiple STA-1800U screw terminal accessories can accept up to 16 MB02 expansion backplanes. Each STA-1800U contains four connectors (J4 to J7) for connecting up to four MB02 expansion backplanes. To attach MB02 expansion backplanes to an STA-1800U, use C-2600 cables, as shown in Figure 3-9. Refer to the *MB Series User's Guide* for more information about MB02 backplanes and modules.

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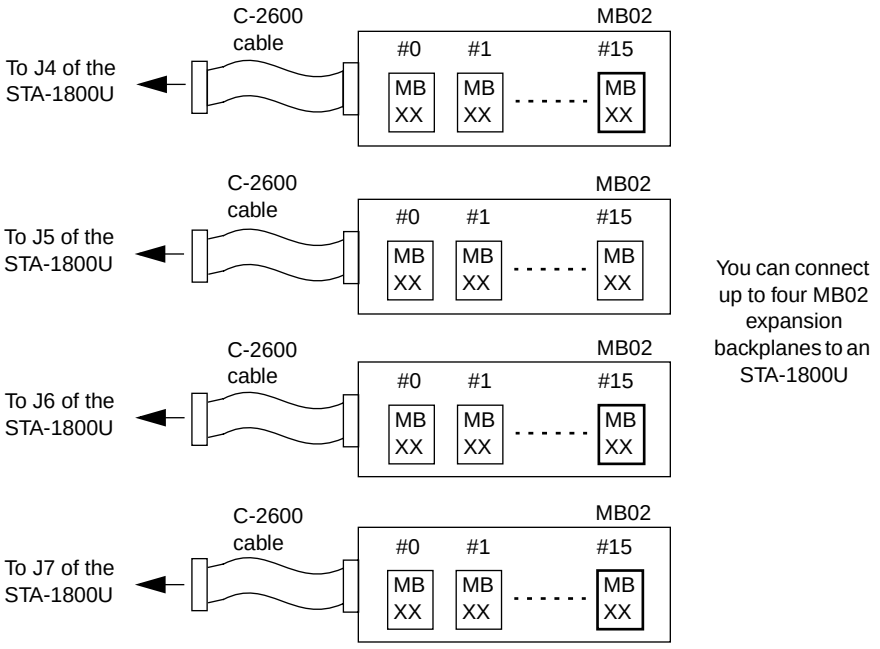


Figure 3-9. Attaching MB02 Expansion Backplanes to an STA-1800U

To attach additional MB02 expansion backplanes, daisy-chain additional STA-1800U screw terminal accessories to the first STA-1800U using CACC-2000 cables. Connect the J2 connector of one STA-1800U to the J1 connector of the next STA-1800U, as shown in Figure 3-10.

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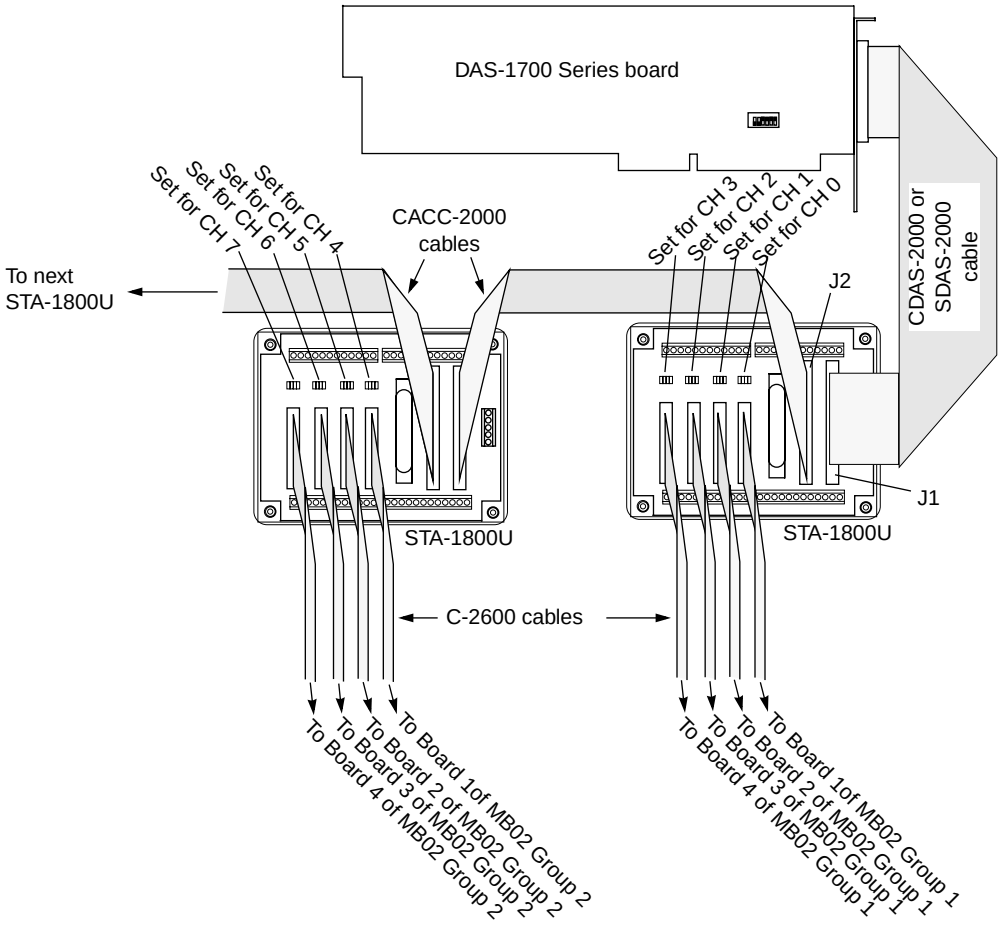


Figure 3-10. Daisy-Chaining STA-1800Us with Attached MB02s

The jumper pads beside connectors J4 to J7 on each STA-1800U screw terminal accessory select the channels of the DAS-1700 Series board that the attached MB02 expansion backplane is to use. On the first STA-1800U, the jumpers assign connectors J4 to J7 to DAS-1700 Series board channels 0 to 3, respectively (default settings), as shown in Figure 3-10. On the second STA-1800U, you must position the jumpers to assign connectors J4 to J7 to channels 4 to 7, respectively, and so on. Refer to Figure B-4 on page B-5 for a diagram of connectors J4 to J7 and their associated jumper pads.

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EXP-1800 Expansion Accessory

To attach an EXP-1800 expansion accessory to the main I/O connector of a DAS-1700 Series board, use a CDAS-2000 or SDAS-2000 cable, as shown in Figure 3-11. To connect additional EXP-1800s, use CAB-50 Series cables, as shown in Figure 3-11. Refer to the *EXP-1800 User's Guide* for more information about EXP-1800 expansion accessories.

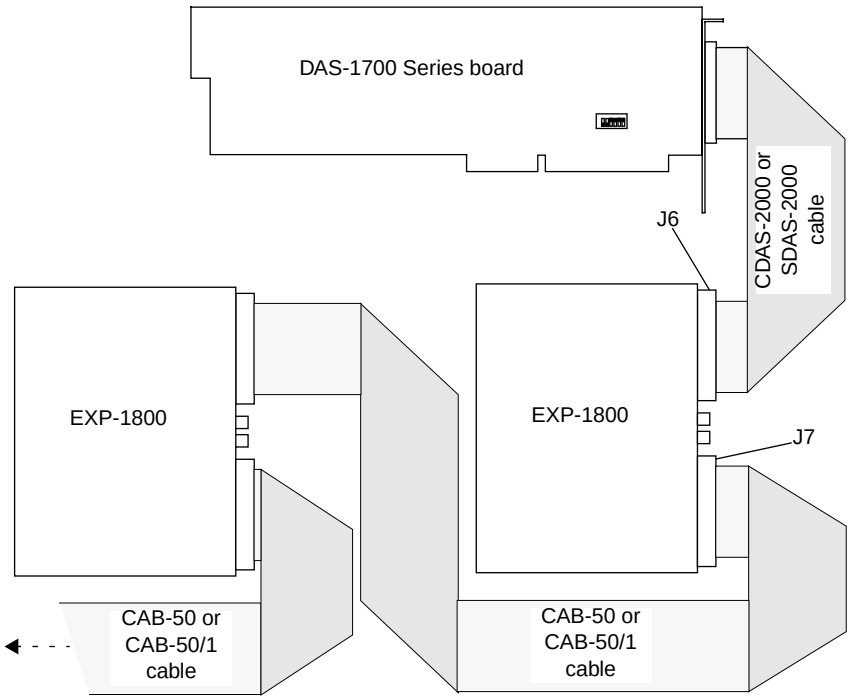


Figure 3-11. Daisy-Chaining EXP-1800s

You can attach up to 16 EXP-1800 expansion accessories to a DAS-1700 Series board; however, some of the added EXP-1800s will require external power. Each EXP-1800 contains screw terminals for attaching external power, a receptacle for a DC/DC converter, and a switch for changing between internal and external power.

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Note: The accuracy of a DAS-1700HR Series board exceeds the accuracy of an EXP-1800 expansion accessory. Data returned by a DAS-1700HR Series board attached to an EXP-1800 using a gain of 1 is appropriate; however, data returned by a DAS-1700HR Series board attached to an EXP-1800 using a gain of 50 includes additional noise and other information that may not be significant.

Connecting Signals

Caution: To avoid electrical damage, turn power to the computer and any attached accessories OFF before wiring signals to the board.

Keep the following in mind when wiring signals to a DAS-1700 Series board:

- You wire your signal to a screw terminal on an accessory that is connected to the board through the main I/O connector. Figure B-1 on page B-2 lists the functions associated with each pin on the main I/O connector.
- DAS-1700 Series boards contain separate grounds for low-level analog signals, ±15 V power return, and digital signals. Use an analog ground (LL GND or U_CM MD, depending on the input configuration) for analog signals; use a ±15 V return for analog power; use a digital ground (DGND) for digital signals and the +5 V power-supply return.

  If you are using a differential input configuration, use LL GND for analog ground. If you are using a single-ended input configuration, you can use LL GND or U_CM MD for analog ground; refer to page 7-6 for information on choosing between available analog grounds.
- When using a DAS-1701ST, DAS-1701ST-DA, or DAS-1701AO board at a gain of 50 or 250, take the following precautions to avoid analog noise and performance degradation:
  - Operate the board in 8-channel differential mode. Using the board in 16-channel single-ended mode at high gains introduces

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enough ground-loop noise to produce large fluctuations in readings.

  - Minimize noise from crosstalk and induced-voltage pickup in the flat cables and screw terminal accessories by using shielded cable. Connect the shield to LL GND and the inner conductors to CH LO and CH HI. CH LO and LL GND should have a DC return (or connection) at some point; this return should be as close to the signal source as possible. Induced noise from RF and magnetic fields can easily exceed tens of microvolts, even on 1-foot or 2-foot cables; shielded cable eliminates this problem.
  - Avoid bi-metallic junctions in the input circuitry. For example, the kovar leads, used on reed relays, typically have a thermal emf to copper of 40 µV/˚C. Thermals can introduce strange random variations caused by air currents and so on.
  - Provide filtering using either hardware (resistors, capacitors, and so on) or software. To provide software filtering, instead of reading the channel once, read it 10 or more times in quick succession and average the readings. If the noise is random and gaussian, the noise will be reduced by the square-root of the number of readings.

- Do not mix your analog input signals with the AC line. An inadvertent short between data and power lines can cause extensive and costly damage to your computer for which the manufacturer may not accept liability. To prevent this problem, use the following precautions:
  - Avoid direct connections to the AC line.
  - Make sure all connections are tight and sound so that signal wires are not likely to come loose and short to high voltages.
  - Use isolation amplifiers and transformers where necessary.

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Single-Ended Analog Input Signals

Figure 3-12 illustrates how to connect an analog input signal to channel *n* on a DAS-1700 Series board configured for single-ended inputs.

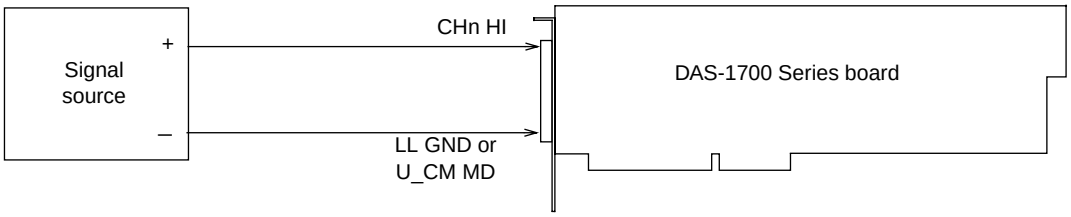


Figure 3-12. Single-Ended Inputs (SIngle Channel)

Notes: You specify the common-mode ground reference through software. If you specify a user-defined common-mode ground reference, use U_CM MD and make sure that the signal source is grounded. If you specify a low-level analog ground reference, use LL GND if the signal source is isolated; if the signal source is not isolated, make no connection.

It is recommended that you wire all unused channels to LL GND or U_CM MD to prevent the input amplifiers from saturating and to ensure the accuracy of your data.

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Figure 3-13 illustrates how to connect analog input signals to channels 0 through *n*, where all channels are referred to the same user-defined common-mode ground. Note that the fixed potential from signal common to ground must be within the common-mode operating range (±10 V).

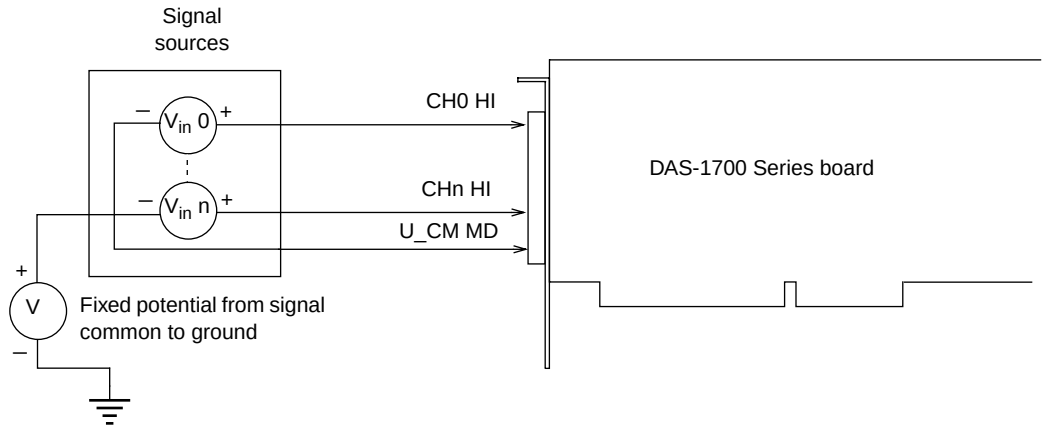


Figure 3-13. Single-Ended Inputs (Multiple Channels)

Differential Analog Input Signals

Figure 3-14 illustrates three ways to connect an analog input signal to channel *n* on a DAS-1700 Series board configured for differential inputs.

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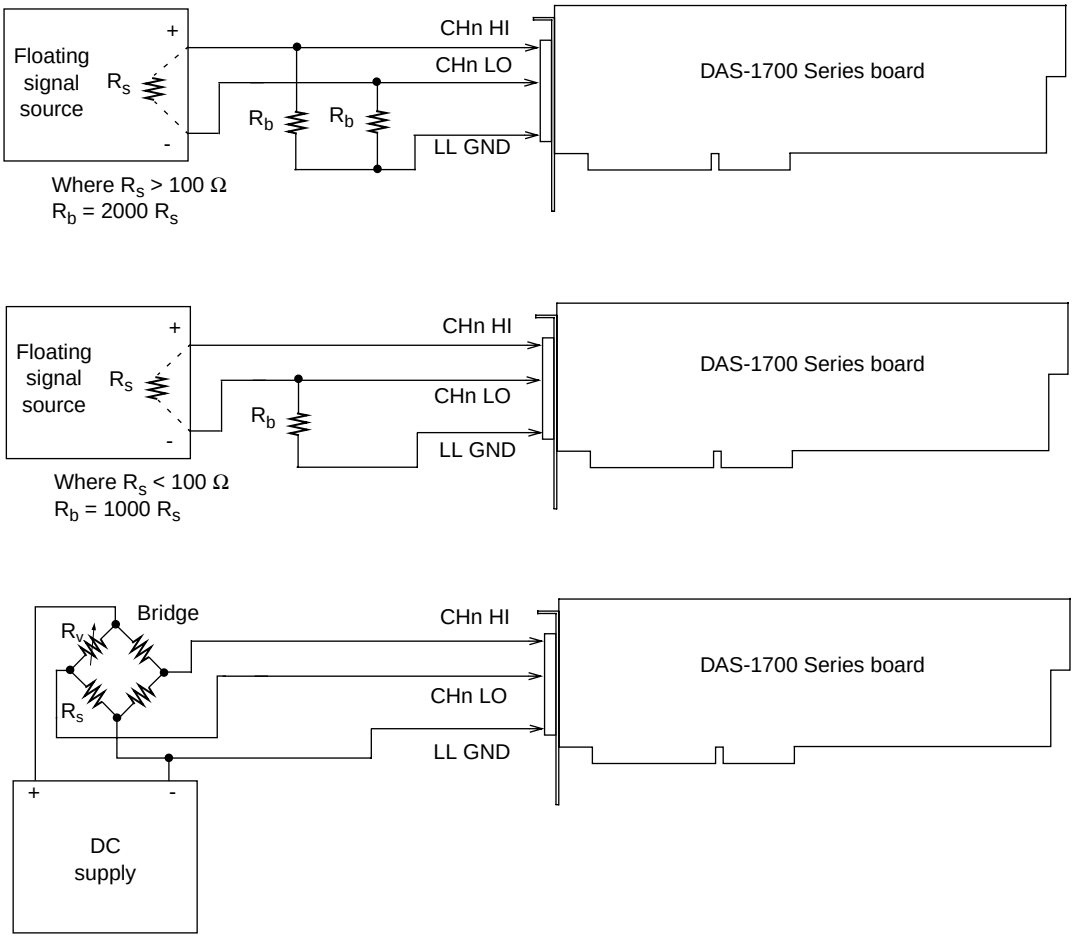


Figure 3-14. Differential Inputs

The upper two circuits of Figure 3-14 illustrate floating signal source connections. (A floating signal source is a voltage source that has no connection with earth ground; the signal is not referenced to the third wire on a 3-wire AC line outlet.) Floating signal sources require the addition of resistors to provide a bias current return.

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You can determine the value of the bias return resistors (R_b) from the value of the source resistance (R_s), using the following relationships:

- When R_s is greater than 100 Ω, use the connections in the upper circuit. The resistance of each of the two bias return resistors must equal 2000 R_s.
- When R_s is less than 100 Ω, use the connections in the middle circuit. The resistance of the bias return resistor must be greater than 1000 R_s.

In the lower circuit of Figure 3-14, bias current return is inherently provided by the source. The circuit requires no bias resistors. R_s is the signal source resistance while R_v is the resistance required to balance the bridge.

Avoiding a Ground Loop Problem

If your signal source is grounded, the signal-source ground and the DAS-1700 Series board ground may not be at the same voltage level because of the distances between equipment wiring and the building wiring. In this situation, ground loop problems can occur if you tie the two grounds together and the two grounds are not at the same potential. The difference in potential is referred to as a *common-mode voltage* (V_{cm}) because it is normally common to both sides of a differential input (it appears between each side and ground).

The most effective way to avoid common-mode voltage errors for single-ended inputs is to wire the inputs as shown in Figure 3-12, using the U_CM MD input.

Since a differential input responds only to the difference in the signals at its high and low inputs, its common-mode voltages cancel out and leave only the signal. However, if your input connections create a ground loop, you could see incorrect data readings resulting from the difference between the signal source's ground potential and the DAS-1700 Series board's ground.

Figure 3-15 shows the proper way to connect a differential input to a grounded signal source. Make sure that CH*n* LO is connected to ground at the signal source, not at the computer and make sure that you do not tie the two grounds together.

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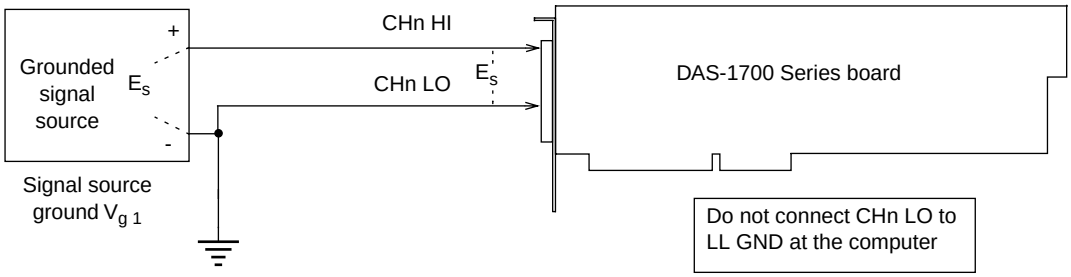


Figure 3-15. Avoiding a Ground Loop Problem

Analog Output Signals

Figure 3-16 illustrates how to connect a voltage output signal from DAC *n* on a DAS-1701ST-DA, DAS-1702ST-DA, DAS-1702HR-DA, DAS-1701AO, or DAS-1702AO board to your application.

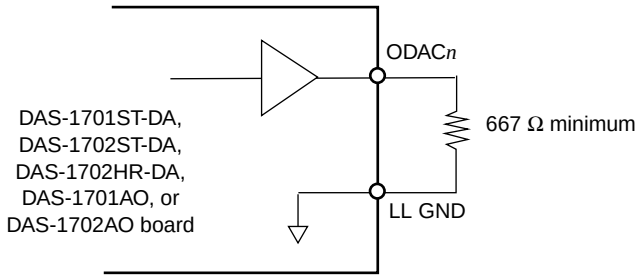


Figure 3-16. Voltage Output

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Digital Signals

You can connect the following digital signals to a DAS-1700 Series board:

- **Digital input signal** — Connect a digital input signal to the DI0, DI1, DI2, or DI3 pin of the main I/O connector.
- **Digital output signal** — Connect a digital output signal to the DO0, DO1, DO2, or DO3 pin of the main I/O connector.
- **External pacer clock** — Connect an external pacer clock to the XPCLK pin of the line of the main I/O connector.
- **External digital trigger** — Connect an external digital trigger to the TGIN pin of the main I/O connector.
- **Hardware gate** — Connect a hardware gate to the TGIN pin of the main I/O connector.
- **SSH output signal** — Connect the SSH output signal to the SSHO pin of the main I/O connector.
- **Trigger/gate output signal** — Connect the trigger/gate output signal to the TGOUT pin of the main I/O connector.
- **Strobe signal** — Connect the strobe signal to the DOSTB pin of the main I/O connector.

Make sure that all digital signals are TTL-level compatible. Use the D GND pin as the return for all digital signals. Refer to Figure B-1 on page B-2 for the location of each pin on the main I/O connector.

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Synchronizing the Start of Operations on Multiple Boards

You can synchronize the start of analog input operations on up to three DAS-1700 Series boards using trigger and gate signals from the main I/O connector. All boards can run at the same conversion rate or each board can run at a different conversion rate.

The internal A/D pacer clock is designed to be tightly coupled with trigger and gate operations. After a board receives the trigger or gate signal, conversions begin within a defined period of time. If each board is programmed for a different conversion rate, the first conversion on each board occurs after this time period and subsequent conversions occur at the programmed rate.

Figure 3-17 illustrates two ways to synchronize the start of analog input operations on multiple boards. Both use the internal A/D pacer clock to pace acquisitions.

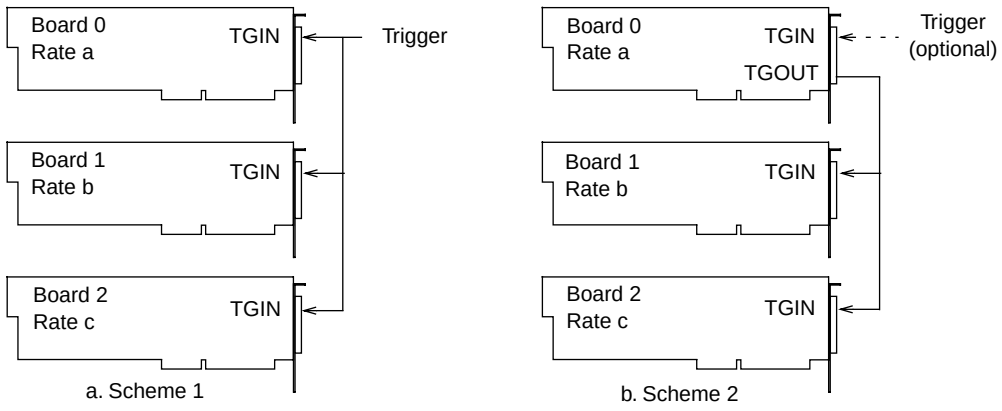


Figure 3-17. Synchronizing the Start of Operations on Multiple Boards

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In scheme 1, you connect the trigger/gate inputs of the three boards together and start the analog input operation when an external digital trigger event occurs. A/D conversions on each board start 400 ±100 ns from the time the active edge of the trigger signal is detected. All conversions start within 100 ±100 ns of each other from board to board. When using scheme 1, you can use the internal A/D pacer clock or an external pacer clock.

In scheme 2, you start conversions either by an external digital trigger or through software. The boards are connected in a master/slave relationship; board 0 is the master, and boards 1 and 2 are the slaves.

If you use software to start A/D conversions for board 0 of scheme 2, the board 0 pacer clock starts and triggers conversions in the slave boards. However, board 0 conversions do not begin until after conversions begin in the slave boards. The delay of board 0 conversions is caused by a protection feature built into the register that creates software-triggered conversions; the function of the protection feature is to prevent false conversions.

If you use an external digital trigger for board 0 of scheme 2, the trigger/gate output signal (TGOUT) from board 0 triggers conversions in all three boards immediately. Note that TGOUT is an active, high-going signal. Therefore, you must program the slave-board TGIN inputs for a positive-edge trigger. Refer to page 7-30 for more information about the TGOUT signal.

When using scheme 2, you must use the internal A/D pacer clock.

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4

Testing the Board

This section describes how to use DriverLINX to test functions of DAS-1700 Series boards.

DriverLINX Analog I/O Panel

The DriverLINX Analog I/O Panel is an application that demonstrates analog input/output using DriverLINX. With the Analog I/O Panel you can:

- Analyze analog signals using the two-channel Oscilloscope.
- Measure analog voltages using the Digital Volt Meter.
- Generate Sine, Square and Triangle waves using the SST Signal Generator.
- Output DC Level voltages using the Level Control.

The Analog I/O Panel is useful for:

- Testing the DAS-1700 DriverLINX installation and configuration.
- Verifying signal inputs to your DAS-1700 board.
- Sending test signals to external devices.

To access this DriverLINX Analog I/O Panel:

1. Start the Analog I/O Panel with the “AIO Panel” item on the Windows start menu. Then perform the following steps:
2. Click the [...] button in the Driver Selection section.
3. Select the driver for your board using the *Open DriverLINX* dialog.
4. Click *OK*.

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5. Select the Logical Device you want to operate by dragging the pointer in the Device Selection section. The Analog I/O Panel displays the Scope, Meter, SST, and Level control tabs, depending on the capabilities of your DAS-1700 board.
6. The Scope uses two analog input channels, referred to as ChA and ChB. Drag the channel selectors in the AI Channel Mapping section to map them to different channel numbers.
7. The SST Signal Generator uses two analog output channels, referred to as ChA and ChB. Drag the channel selectors in the AO Channel Mapping section to map them to different channel numbers.

You can now select the Scope, Meter, SST and Level Control tabs to operate your DAS-1700 board.

Test Panel Application

Depending upon the DriverLINX drivers you have installed on your system, you will have one or more of the following example applications:

- *Single–Value AI* for analog input
- *Single–Value AO* for analog output
- *PIO Panel* for digital input and output
- *CTM Test Bench* for counter/timer applications.

To access this DriverLINX Test Panel, select Test Panel with the “Test Panel” item on the Windows start menu.

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5

Troubleshooting

This section contains the following information:

- **Problem Isolation** — helps you use software tools to help isolate problems.
- **Identifying Symptoms and Possible Causes** — lists general symptoms and possible solutions for problems with DAS-1700 Series boards.
- **Testing the Board and the Computer** — helps you determine whether the problem is in the computer or in the DAS-1700 Series boards.
- **Testing the Accessory Slot and I/O Connections** — helps you determine whether the problem is in the accessory slot or in the I/O connections.
- **Technical Support** — describes how to contact Keithley Instruments for technical support.

Problem Isolation

If you encounter a problem with a DAS-1700 Series board, use the instructions in this section to isolate the cause of the problem before calling Keithley for technical support.

Using the DriverLINX Event Viewer

The DriverLINX Event Viewer displays the Windows system event log. Applications and hardware drivers make entries in the system event log to assist in predicting and troubleshooting hardware and software problems.

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DriverLINX uses the event log to report problems during driver loading or unexpected system errors. The event log can assist in troubleshooting resource conflicts and DriverLINX configuration errors. If you are having trouble configuring or initializing a Logical Device, check the event log for information from the DriverLINX driver.

Using the DriverLINX Event Viewer, you can view DriverLINX event log entries under Windows 95/98 or Windows NT. DriverLINX event log entries can help you or technical support troubleshoot data–acquisition hardware and software problems.

Device Initialization Error Messages

During device initialization, DriverLINX performs a thorough test of all possible subsystems on the DAS-1700 Series board as well as the computer interface. If DriverLINX detects any problems or unexpected responses, it reports an error message to help isolate the problem. The device initialization error messages fall into three basic categories:

- **"Device not found"** — Board address does not match hardware setting or conflicts with another board. Verify the board's address settings. Also, don't confuse hexadecimal with decimal addresses in the DriverLINX *Device Configure* dialog box.
- **"Invalid IRQ level"** or **"Invalid DMA level"** — Selected level does not match hardware setting, conflicts with another board's IRQ/DMA levels, or is dedicated to the computer's internal functions (COM port, disk drive controller, network adapter, etc.)
- **"Hardware does not match configuration"** — Operating mode/range switch or jumper setting does not match selection(s) made in the DriverLINX *Device Configuration* dialog box.

Identifying Symptoms and Possible Causes

Table 5-1 lists general symptoms and possible solutions for problems with DAS-1700 Series boards.

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Table 5-1. Troubleshooting Information

Symptom	Possible Cause	Possible Solution
Board does not respond	Base address is unacceptable.	Make sure that the base address specified in the configuration file matches the setting of the base address switch on the board. Make sure that no other system resource is using any of the 16 I/O locations beginning at the specified base address (all boards) and any of the 10 I/O locations beginning at the specified base address plus 400h (DAS-1700AO Series only). If necessary, reconfigure the base address. Refer to page 2-2 for instructions.
	The interrupt level is unacceptable.	Make sure no other system resource is using the interrupt level specified in the configuration file. If necessary, reset the interrupt level.
	The board configuration is incorrect.	Check the settings in the configuration file.
	The board is incorrectly aligned in the accessory slot.	Check the board for proper seating.
	The board is damaged.	Contact Keithley for technical support; refer to page 5-6.
Intermittent operation	The I/O bus speed is in excess of 8 MHz.	Reduce I/O bus speed to a maximum of 8 MHz (to change the I/O bus speed, run BIOS setup). See your computer documentation for instructions on running BIOS setup.
	Vibrations or loose connections exist.	Cushion source of vibration and tighten connections.
	The board is overheating.	Check environmental and ambient temperature. See the documentation for your computer.
	Electrical noise exists.	Provide better shielding or reroute unshielded wiring.

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Table 5-1. Troubleshooting Information (cont.)

Symptom	Possible Cause	Possible Solution
Data appears to be invalid	The I/O bus speed is in excess of 8 MHz.	Reduce I/O bus speed to a maximum of 8 MHz (to change the I/O bus speed, run BIOS setup). See the documentation for your computer for instructions on running BIOS setup.
	An open connection exists.	Check wiring to screw terminal.
	Another system resource is using the specified base address.	Reconfigure the base address of the board; refer to page 2-2 for information. Check the base address assignments of other system resources and reconfigure, if necessary.
	Transducer is not connected to the channel being read.	Check the transducer connections.
	Board is set for a single-ended input configuration while the transducer is set for a differential input configuration, or vice versa.	Check transducer specifications and board configuration.
Computer does not boot	Board not seated properly.	Check the installation of the board.
	The base address setting of the board conflicts with that of another system resource.	Check the base address settings of your system resources; each address must be unique.
	The power supply of the computer is too small to handle all the system resources.	Check the needs of all system resources and obtain a larger power supply.
System lockup	A timing error occurred.	Press **Ctrl + Break**.

If you cannot identify the problem using the information in Table 5-1, refer to the next section to determine whether the problem is in the computer or in the DAS-1700 Series board.

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Testing the Board and the Computer

To determine whether the problem is in the computer or in the DAS-1700 Series board, perform the following steps:

Caution: Removing a board with the power ON can cause damage to your board and/or computer.

---

1. Turn the power to the computer OFF, and remove power connections to the computer.
2. While keeping connections to accessories intact, unplug the cable to the main I/O connector of the DAS-1700 Series board.
3. Remove the board from the computer and visually check for damage. If the board is obviously damaged, refer to page 5-6 for information on returning the board.
4. With the board out of the computer, check the computer for proper operation. Power up the computer and perform any necessary diagnostics.

If you have another DAS-1700 Series board that you know is functional, refer to the next section to determine whether the problem is in the accessory slot or in the I/O connections. If you do not have another board, refer to page 5-6 for information on how to contact Keithley for technical support.

Testing the Accessory Slot and I/O Connections

To determine whether the problem is in the accessory slot or in the I/O connections, perform the following steps:

1. Turn the power to the computer OFF, and remove power connections to the computer.
2. Install a DAS-1700 Series board that you know is functional. Do not make any I/O connections.

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3. Turn computer power ON and check operation with the functional board in place. This test checks the accessory slot. If you are using more than one board, use the functional board to test the other slots as well.
4. If the accessory slots are functional, use the functional board to check the I/O connections by reconnecting and checking the operation of the I/O connections, one at a time.
5. If operation fails for an I/O connection, check the individual inputs one at a time for shorts and opens.
6. If operation is normal, the problem is in one of the DAS-1700 Series boards originally in the computer. If you were using more than one board, try each board, one at a time, to determine which is faulty.
7. If you cannot isolate the problem, refer to the next section for instructions on getting technical support.

Technical Support

Before returning any equipment for repair, call Keithley for technical support at:

1-888-KEITHLEY
Monday - Friday, 8:00 a.m. - 5:00 p.m., Eastern Time

An applications engineer will help you diagnose and resolve your problem over the telephone.

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Please make sure that you have the following information available before you call:

DAS-1700 Series board configuration	Model	_____
	Serial #	_____
	Revision code	_____
	Base address setting	_____
	Interrupt level setting	_____
	Number of channels	_____
	Input configuration	single-ended, differential
	Range type	unipolar, bipolar
	DMA chan(s)	_____
	Number of SSH-8s	_____
	Number of EXPs	_____
Computer	Manufacturer	_____
	CPU type	_____
	Clock speed (MHz)	_____
	KB of RAM	_____
	Video system	_____
	BIOS type	_____
Operating system	Windows version	_____
Software package	Name	_____
	Serial #	_____
	Version	_____
	Invoice/Order #	_____
Compiler (if applicable)	Language	_____
	Manufacturer	_____
	Version	_____
Accessories	Type	_____
	Type	_____
	Type	_____
	Type	_____
	Type	_____
	Type	_____
	Type	_____
	Type	_____

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If a telephone resolution is not possible, the applications engineer will issue you a Return Material Authorization (RMA) number and ask you to return the equipment. Include the RMA number with any documentation regarding the equipment.

When returning equipment for repair, include the following information:

- Your name, address, and telephone number.
- The invoice or order number and date of equipment purchase.
- A description of the problem or its symptoms.
- The RMA number on the **outside** of the package.

Repackage the equipment, using the original anti-static wrapping, if possible, and handle it with ground protection. Ship the equipment to:

ATTN.: RMA# _____
Repair Department
Keithley Instruments, Inc.
28775 Aurora Road
Cleveland, Ohio 44139-1891

Telephone 1-888-KEITHLEY
FAX (440) 248-6168

Note: If you are submitting your equipment for repair under warranty, you must include the invoice number and date of purchase.

To enable Keithley to respond as quickly as possible, you must include the RMA number on the outside of the package.

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6

Calibrating the Board

This section contains the following information:

- **Equipment Requirements** — lists the equipment you need to calibrate a DAS-1700 Series board.
- **Potentiometers and Test Points** — shows the location of the potentiometers and test points needed to calibrate a DAS-1700 Series board.
- **Calibration Utility** — describes how to use the DAS-1700 Series DriverLINX Calibration Utility.

Note: DAS-1700 Series boards and EXP expansion accessories are initially calibrated at the factory and should not require calibration when shipped. It is recommended that you check and, if necessary, readjust the calibration of your DAS-1700 Series board and EXP-1800 expansion accessories every six months.

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Equipment Requirements

You need the following equipment to calibrate a DAS-1700 Series board:

- For DAS-1700ST Series and DAS-1700AO Series boards, a digital voltmeter accurate to 6 1/2 digits, such as a Keithley Instruments Model 196
- For DAS-1700HR Series boards, a digital voltmeter accurate to 7 1/2 digits, such as a Keithley Instruments Model 2001
- An adjustable ±10 V voltage calibrator, such as a Keithley Instruments Model 236
- An STA-1800U with a CDAS-2000 or SDAS-2000 cable, an STP-50 with a CDAS-2000 or SDAS-2000 cable, or a user-designed interface
- The appropriate number of CDAS-2000 or SDAS-2000 cables for EXP-1800 accessories, if used

Potentiometers and Test Points

The locations of the potentiometers and test points needed to calibrate DAS-1700 Series boards are shown in the following figures:

Board	Figure
DAS-1701ST DAS-1702ST	Figure 6-1 on page 6-3
DAS-1702HR	Figure 6-2 on page 6-3
DAS-1701ST-DA DAS-1702ST-DA	Figure 6-3 on page 6-4
DAS-1702HR-DA	Figure 6-4 on page 6-4
DAS-1701AO DAS-1702AO	Figure 6-5 on page 6-5

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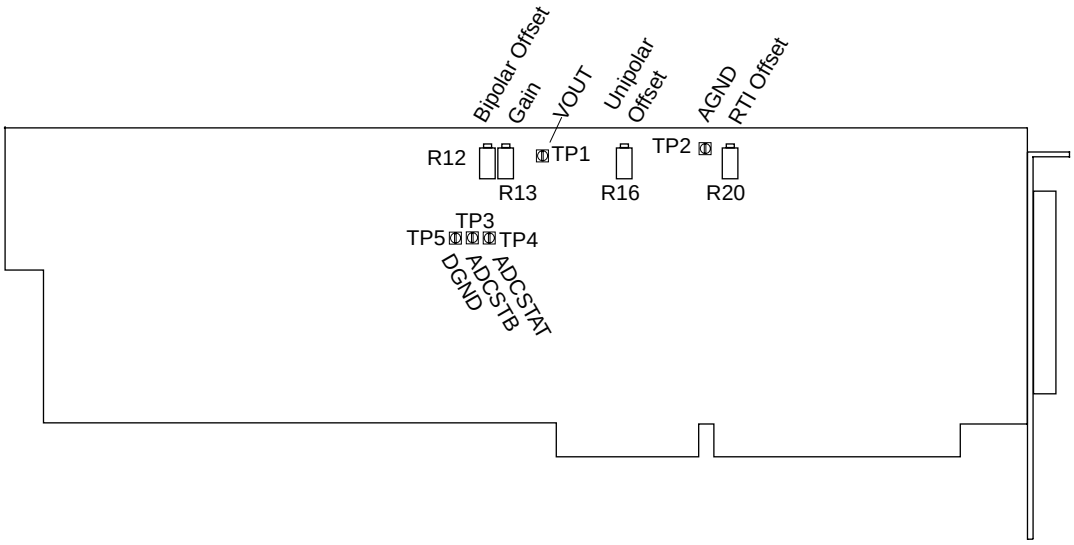


Figure 6-1. DAS-1701ST and DAS-1702ST

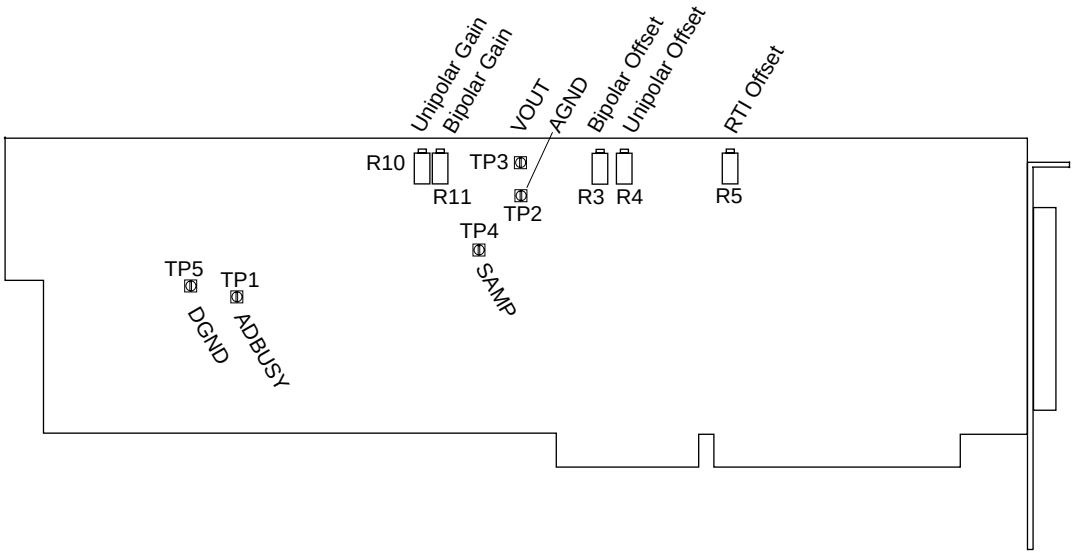


Figure 6-2. DAS-1702HR

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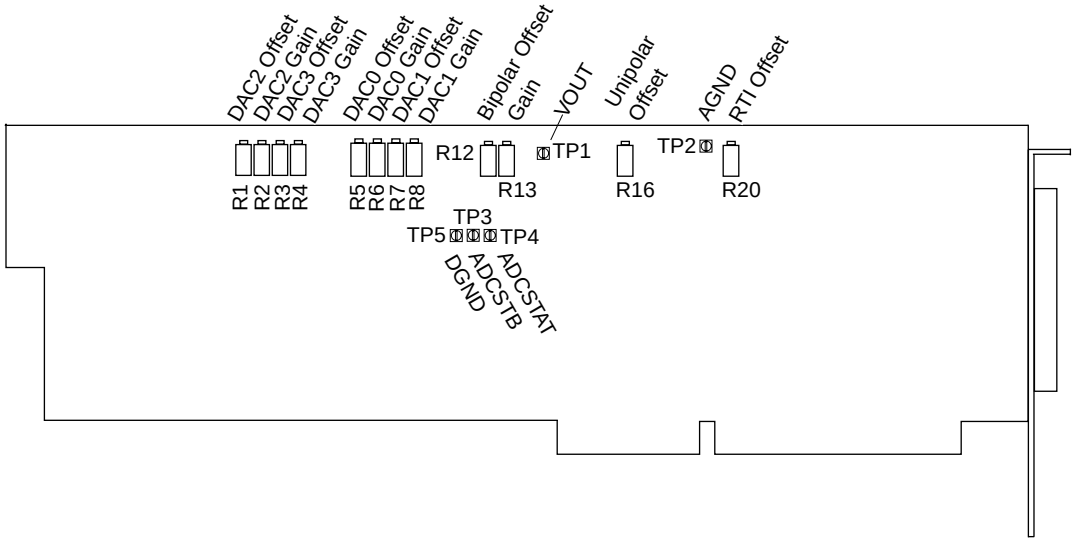


Figure 6-3. DAS-1701ST-DA and DAS-1702ST-DA

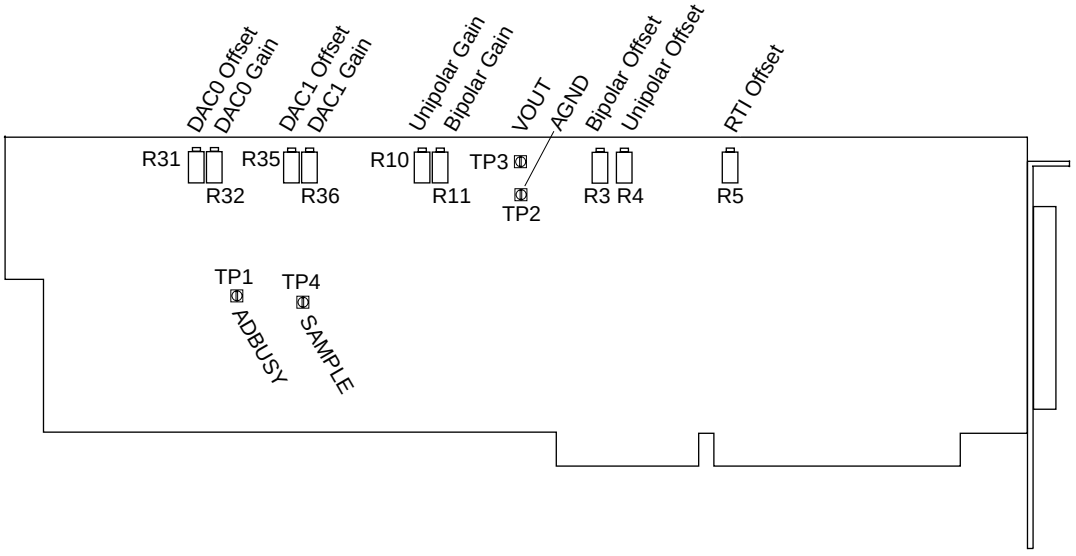


Figure 6-4. DAS-1702HR-DA

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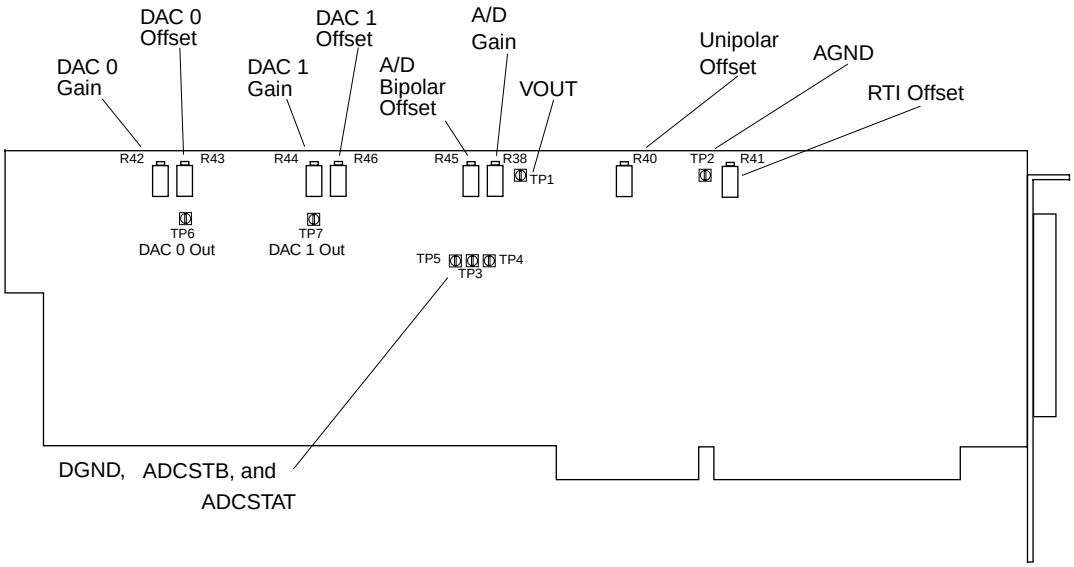


Figure 6-5. DAS-1701AO and DAS-1720AO

DriverLINX Calibration Utility

DriverLINX Calibration Utility will guide you through the calibration procedure. Before calibration, specify the following parameters in the setup panel to get the correct instructions:

- **Logical Device** — Board's device number, model and address.
- **Accessory** — Connection method used to connect the board to the calibration stimulus.
- **Shorted channel** — Input channel to be "shorted" high to low
- **Voltage Channel** — Input channel to use to apply the various calibration voltage levels
- **Calibration range** — Input range to be calibrated.

Note: If you are using EXP-1800 expansion accessories, it is recommended that you connect and calibrate one EXP-1800 at a time.

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7

Functional Description

This section describes the following:

- **Block Diagrams** — functional block diagrams of DAS-1700 Series boards.
- **Analog Input Features** — a detailed description of the analog input features of DAS-1700 Series boards.
- **Analog Output Features** — a detailed description of the analog output features of DAS-1700 Series boards.
- **Digital I/O Features** — a detailed description of the digital I/O features of DAS-1700 Series boards.
- **Interrupts** — a description of the use of interrupts on DAS-1700 Series boards.
- **Power** — a description of the power features of DAS-1700 Series boards.

Block Diagrams

This section contains block diagrams for the following boards:

Boards	Page Number
DAS-1701ST, DAS-1702ST, and DAS-1702HR	Figure 7-1 on page 7-2
DAS-1701ST-DA and DAS-1702ST-DA	Figure 7-2 on page 7-3
DAS-1702HR-DA	Figure 7-3 on page 7-4
DAS-1701AO and DAS-1702AO	Figure 7-4 on page 7-5

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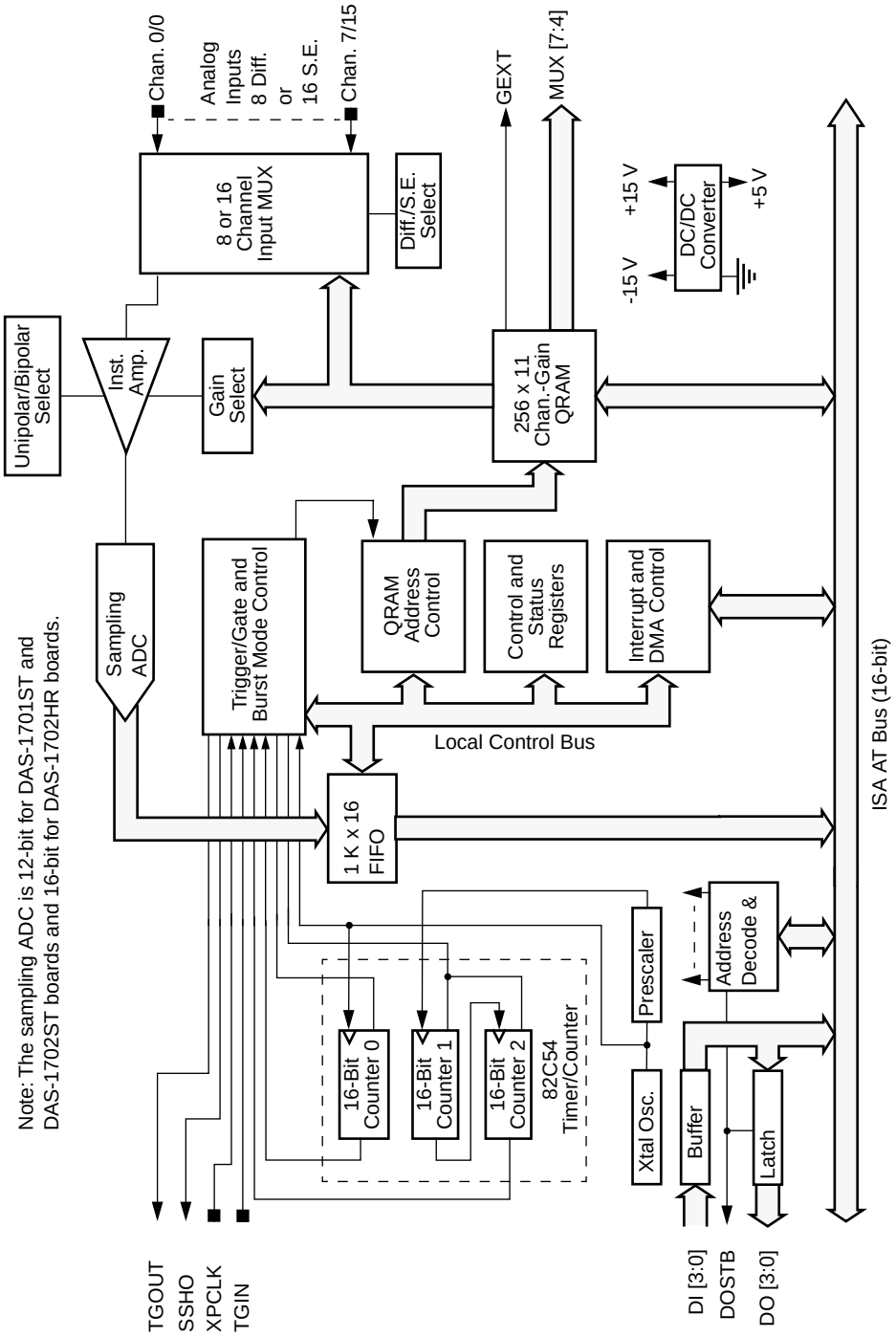


Figure 7-1. Block Diagram of DAS-1701ST, DAS-1702ST, and DAS-1702HR Board

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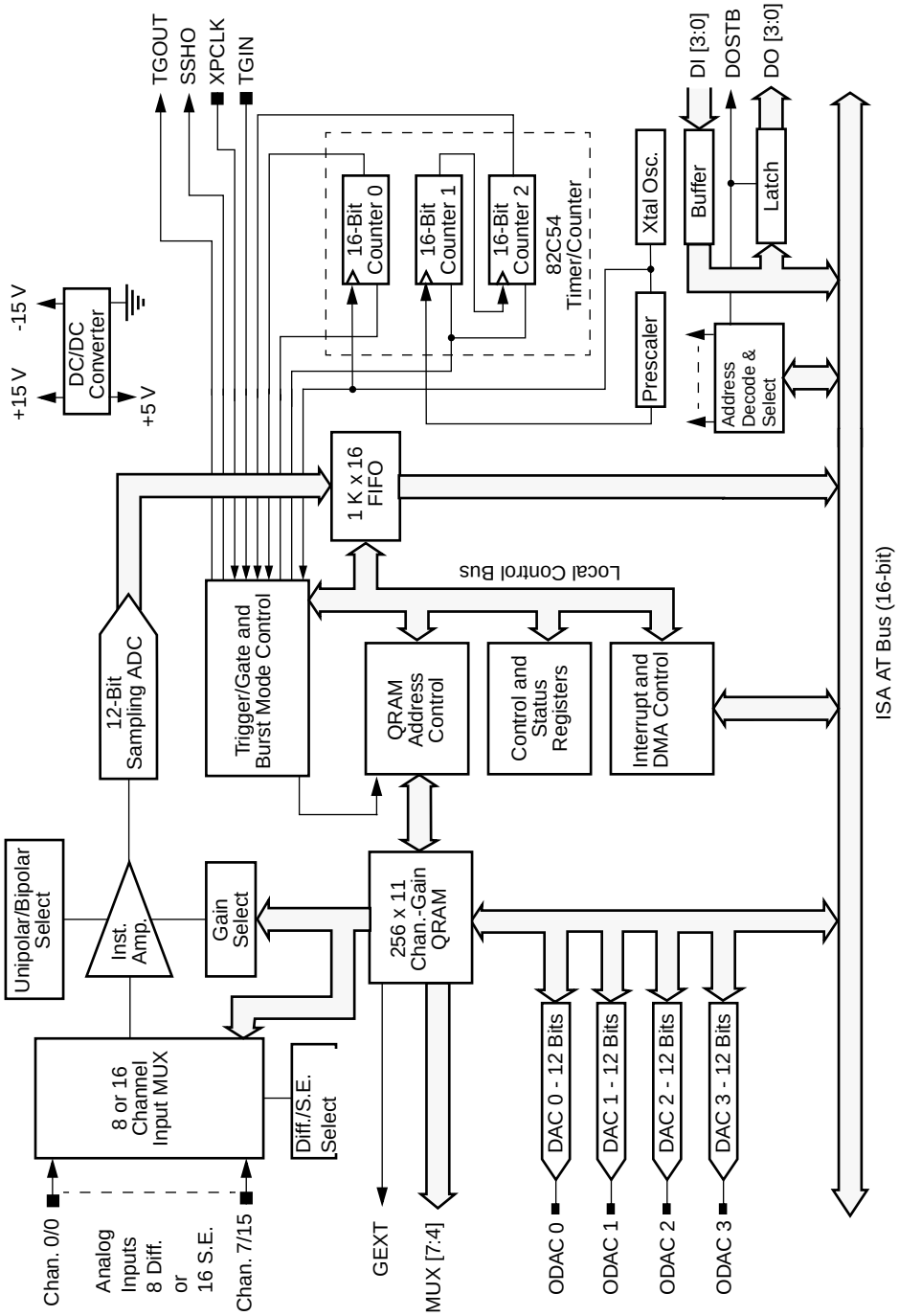


Figure 7-2. Block Diagram of DAS-1701ST-DA and DAS-1702ST-DA Board

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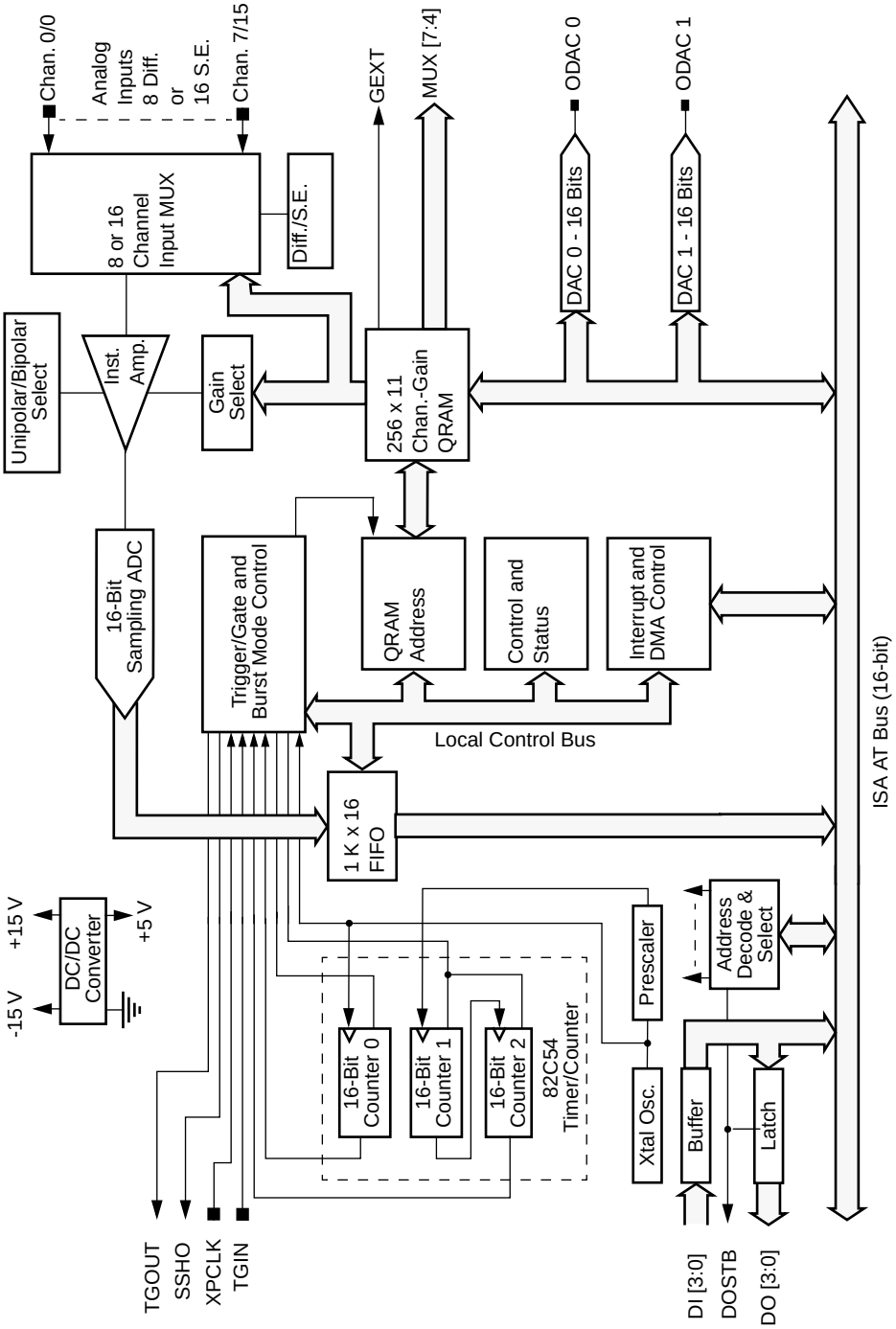


Figure 7-3. Block Diagram of DAS-1702HR-DA Board

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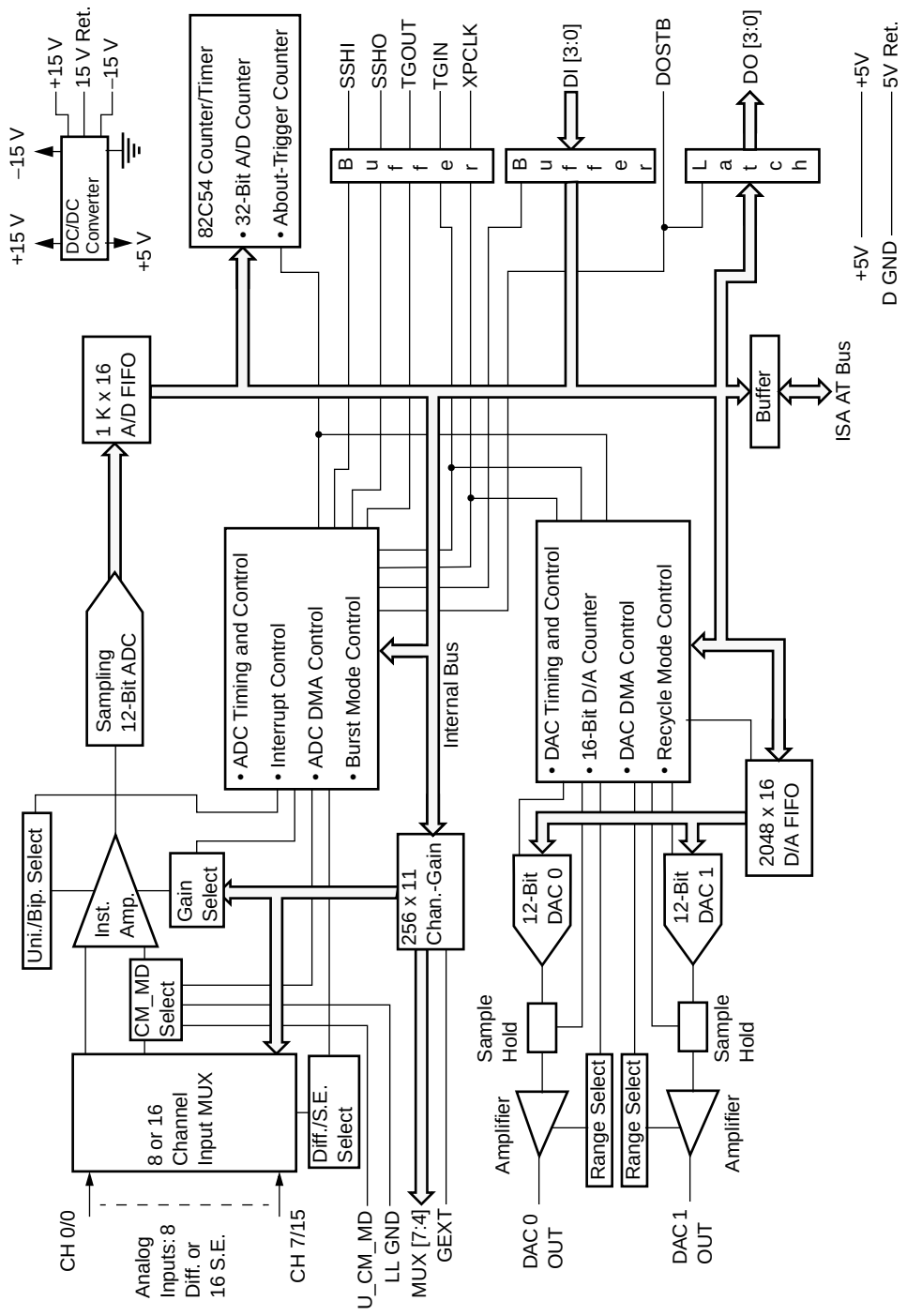


Figure 7-4. Block Diagram of DAS-1701AO and DAS-1702AO Board

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Analog Input Features

The analog input section of DAS-1700 Series boards multiplexes all the active input channels (up to 16 single-ended or eight differential) down to a single, sampling ADC (analog-to-digital converter). Sampling resolution of the ADC is 12 bits (one part in 4096) for DAS-1700ST and DAS-1700AO Series boards and 16 bits (one part in 65,536) for the DAS-1700HR Series boards. The analog input features are described in the following sections.

Channels

This section describes the input configurations supported, channel expansion, gains and input ranges supported, and channel selection.

Input Configuration

Through software, you configure DAS-1700 Series boards for either 16 single-ended or eight differential onboard analog input channels. The differences between a single-ended and a differential input configuration are described in the following sections.

Single-Ended Input Configuration

A single-ended input configuration is appropriate if you are measuring high-level signals where noise is not significant, if the source of the input signal is close to the board, and if all input signals are referred to the same common ground.

You can use either a low-level analog ground or a user-defined common mode as the common-mode ground reference. (You specify the ground reference through software.) If you use a low-level analog ground, the low side of the instrumentation amplifier is connected to the LL GND pin; if you use a user-defined common mode, the low side of the amplifier is connected to the U_CM MD pin.

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The user-defined common mode can eliminate ground loops in the system. Since the U_CM MD pin connects to the high input impedance of the instrumentation amplifier, the signal contains no power-supply return current.

The user-defined common mode is also useful when signals are referred to a voltage that is not ground or when the output range does not include ground. For example, a common way to perform 4 to 20 mA current monitoring is to connect a loop with a 250 Ω resistor to ground; the resistor yields a 1 to 5 V output in this current range. This method works but uses only 80% of the input range when connected to a 0 to 5 V range. A better way is to use a 312.5 Ω resistor and refer all measurements to 1.25 V. The actual output voltage then ranges from 1.25 V to 6.25 V; however, since the amplifier low side is connected to 1.25 V, the measurement range is now a span of 5 V, making the entire input range available and increasing resolution of the measurements by 20%.

It is recommended that you always use the user-defined common mode. Use analog ground only if you want the convenience of not having to connect a separate wire for low input.

Differential Input Configuration

A differential input configuration is appropriate if you are measuring low-level signals (less than 100 mV) where noise is a significant part of the signal or if common-mode voltages exist between the voltage source and the computer's chassis ground.

Channel Expansion

If you require additional analog input channels, you can use up to 16 EXP-1800 expansion accessories or up to 16 MB02 expansion backplanes to increase the number of available channels to 256. Refer to page 3-11 for more information on using EXP-1800 expansion accessories; refer to page 3-8 for more information on using MB02 expansion backplanes.

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DAS-1700 Series boards use the following control lines to determine the channel sequence and gain settings for expansion channels:

- **Multiplexer control lines MUX 4 to MUX 7** — MUX 4 to MUX 7 determine the order in which channels on EXP-1800 expansion accessories and MB02 expansion backplanes are sampled.
- **External gain control line GEXT** — GEXT sets the gain of each channel on a EXP-1800 expansion accessory to 1 or 50.

Notes: If you use EXP-1800 expansion accessories or MB02 expansion backplanes, channels on the DAS-1700 Series board must be configured as single-ended.

If you are using a DAS-1700HR Series board with an EXP-1800 expansion accessory, keep in mind that the accuracy of the DAS-1700HR Series board exceeds the accuracy of the EXP-1800; therefore, data returned by a DAS-1700HR Series board attached to an EXP-1800 using a gain of 50 includes additional noise and other information that may not be significant.

Gains and Ranges

Each channel on a DAS-1700 Series board can measure analog input signals in one of eight unipolar and bipolar ranges. A unipolar signal is always positive (0 to 5 V, for example), while a bipolar signal can swing up and down between positive and negative peak values (±5 V, for example). DAS-1700 Series boards use positive magnitude to represent unipolar input signals and 2's complement to represent bipolar input signals.

Through software, you specify the input range type (unipolar or bipolar) of the board and the gain of each channel on the board. Table 7-1 lists the gains supported by DAS-1700 Series boards and the analog input range for each gain. Note that for a given range with the same peak voltage, the unipolar input range type doubles the resolution of the ADC.

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Table 7-1. Analog Input Ranges

Board	Location of Channel	Gain	Analog Input Range	
			Bipolar	Unipolar
DAS-1701ST DAS-1701ST-DA DAS-1701AO	Either onboard or on an EXP-1800 using a gain of 1	1	±5 V	0 to 5 V
		5	±1 V	0 to 1 V
		50	±100 mV	0 to 100 mV
		250	±20 mV	0 to 20 mV
	On an EXP-1800 using a gain of 50	50	±0.1 V	0 to 0.1 V
		250	±20 mV	0 to 20 mV
		2500	±2 mV	0 to 2 mV
		12.5k	±0.4 mV	0 to 0.4 mV
DAS-1702ST DAS-1702ST-DA DAS-1702HR[1] DAS-1702HR-DA[1] DAS-1702AO	Either onboard or on an EXP-1800 using a gain of 1	1	±10 V	0 to 10 V
		2	±5 V	0 to 5 V
		4	±2.5 V	0 to 2.5 V
		8	±1.25 V	0 to 1.25 V
	On an EXP-1800 using a gain of 50	50	±0.2 V	0 to 0.2 V
		100	±0.1 V	0 to 0.1 V
		200	±50 mV	0 to 50 mV
		400	±25 mV	0 to 25 mV

Notes
[1] If you use these boards with an EXP-1800 using a gain of 50, the data returned includes additional noise and other information that may not be significant.

Channel Selection

DAS-1700 Series boards can acquire data from a single analog input channel, from a group of consecutive analog input channels using automatic channel scanning, or from a group of analog input channels using the hardware channel-gain queue. These methods of channel selection are described in the following sections.

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Selecting a Single Channel

You use software to specify a single channel and initiate a conversion.

Selecting Channels Using Automatic Channel Scanning

You use software to specify the first and last channels in a range of consecutive channels. The channels are sampled in order from first to last; the hardware automatically increments the analog input multiplexer address shortly after the start of each conversion. When the last address is reached, the multiplexer returns to the start address and the channels are sampled again. For example, assume that the start channel is 4, the stop channel is 7, and you want to acquire five samples. Your program reads data first from channel 4, then from channels 5, 6, and 7, and finally from channel 4 again.

The start channel can be higher than the stop channel. For example, assume that you are not using any expansion accessories, the board uses a differential configuration, the start channel is 7, the stop channel is 2, and you want to acquire five samples. Your program reads data first from channel 7, then from channels 0, 1, and 2, and finally from channel 7 again.

When using automatic channel scanning, all consecutive channels have the same gain (analog input range).

Selecting Channels Using the Channel-Gain Queue

You can use the hardware channel-gain queue to acquire samples from up to 256 logical channels. Through software, you specify the channels you want to sample, the order in which you want to sample them, and the gain for each channel.

You can set up the channels in the channel-gain queue either in consecutive order or in nonconsecutive order. You can also specify the same channel more than once. The channels are sampled in order from the first channel in the queue to the last channel in the queue.

Refer to Table 7-1 on page 7-9 for a list of the analog input ranges supported by DAS-1700 Series boards and the gains associated with each range.

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Note that the throughput is likely to drop if you group channels with varying gains in sequence. The drop occurs because the channels with low-level inputs (magnitude of 100 mV or less) are slower than those with high-level inputs and because the channels with low-level inputs must drive out the residual signals left by the high-level inputs. The best way to maximize throughput is to use a combination of appropriate channel grouping and external signal conditioning. When using the channel-gain queue, consider the following suggestions:

- Keep all channels configured for a particular range together, even if you have to arrange the channels out of sequence.
- If your application requires high-speed scanning of low-level signals, use external signal conditioning to amplify the signal to ±5 V or 0 to 5 V. This increases total system throughput and reduces noise.
- If you are not using all the channel-gain entries (256), make a particular channel-gain entry twice to allow for settling time. In this case, ignore the results of the first entry.
- If you are measuring steady-state signals, do not use the channel-gain queue. Instead, use software to step through the channels and perform single-channel acquisitions. For example, using software-controlled single-channel acquisitions to acquire 1000 samples on channel 0 at a gain of 1 and then 2000 samples on channel 1 at a gain of 250 virtually eliminates interference. This method is best for measuring steady-state signals even if all the channels are at the same gain.
- If you are measuring low-level signals (±20 mV, 0 to 20 mV, ±100 mV, or 0 to 100 mV ranges) with a DAS-1701ST or DAS-1701AO board, reduce the effects of noise by sampling the same channel multiple times and then averaging the readings from each channel. In addition, use low-level transducers with signal conditioning and use the ±20 mV, 0 to 20 mV, ±100 mV, and 0 to 100 mV ranges with a differential input configuration.

Table 7-2 lists the maximum throughput for channel-to-channel sampling with a fixed analog input range (0.024% maximum error).

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Table 7-2. Maximum Throughput with Fixed Range

Board	Range Type	Range	Maximum Throughput
DAS-1701ST DAS-1701ST-DA DAS-1701AO	Bipolar	±5 V	166.67 ksamples/s
		±1 V	166.67 ksamples/s
		±100 mV	166.67 ksamples/s
		±20 mV	60 ksamples/s
	Unipolar	0 to 5 V	166.67 ksamples/s
		0 to 1 V	166.67 ksamples/s
		0 to 100 mV	166.67 ksamples/s
		0 to 20 mV	60 ksamples/s
DAS-1702ST DAS-1702ST-DA DAS-1702AO	Bipolar	±10 V	166.67 ksamples/s
		±5 V	166.67 ksamples/s
		±2.5 V	166.67 ksamples/s
		±1.25 V	166.67 ksamples/s
	Unipolar	0 to 10 V	166.67 ksamples/s
		0 to 5 V	166.67 ksamples/s
		0 to 2.5 V	166.67 ksamples/s
		0 to 1.25 V	166.67 ksamples/s
DAS-1702HR DAS-1702HR-DA	Bipolar	±10 V	50 ksamples/s
		±5 V	50 ksamples/s
		±2.5 V	50 ksamples/s
		±1.25 V	50 ksamples/s
	Unipolar	0 to 10 V	50 ksamples/s
		0 to 5 V	50 ksamples/s
		0 to 2.5 V	50 ksamples/s
		0 to 1.25 V	50 ksamples/s

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Note that the throughputs are based on driving the input with an ideal voltage source. The output impedance and drive of the source are far more critical when making large gain changes between two channels whose inputs are at opposite extremes of their input ranges, as when a signal near –20 mV is measured after a signal at near +5 V. The source needs to be able to drive both the capacitance of the cable and the RC (resistor-capacitor) product of the multiplexer resistance and the output capacitance of the multiplexer and board. The multiplexer is typically about 360 Ω (1 kΩ maximum) in series with 90 pF output capacitance.

When changing the analog input range between channels, the maximum throughput for channel-to-channel sampling is the lower of the throughputs for the two channels (with less than 1 LSB of error for the DAS-1700ST Series and DAS-1700AO Series and less than 2 LSB of error for the DAS-1700HR Series). For example, on a DAS-1701AO board, if you are switching from a channel configured with a ±5 V input range to a channel configured with a ±100 mV input range, the maximum throughput is 166.67 ksamples/s; if you are switching from a channel configured with a ±5 V input range to a channel configured with a ±20 mV input range, the maximum throughput is 60 ksamples/s.

Conversion Modes

The conversion mode determines how the board regulates the timing of conversions when you are acquiring multiple samples from a single channel or from a group of multiple channels (known as a scan). Through software, you can specify paced mode, burst mode, or burst mode with SSH. These conversion modes are illustrated in Figure 7-5 and described in the following sections.

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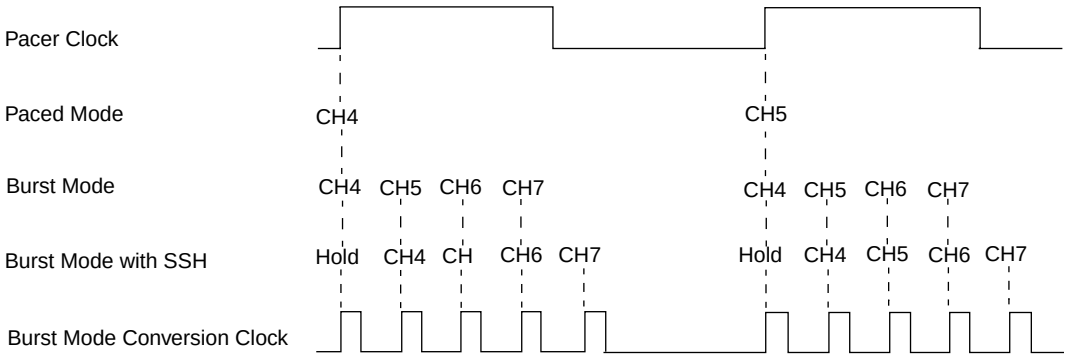


Figure 7-5. Conversion Modes

Paced Mode

Use paced mode if you want to accurately control the period between conversions of individual channels in a scan. The conversion rate equals the pacer clock rate. The sample rate, which is the rate at which a single channel is sampled, is the pacer clock rate divided by the number of channels you are sampling.

Burst Mode

Use burst mode if you want to accurately control both the period between conversions of individual channels in a scan and the period between conversions of the entire scan. Each pulse from the pacer clock starts a scan of channels. The conversion rate equals the rate of the burst mode conversion clock. The sample rate, which is the rate at which a single channel is sampled, equals the pacer clock rate.

The sample rate (pacer clock rate) should be no more than the burst mode conversion clock rate divided by the number of channels in the burst.

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Burst Mode with SSH

Use burst mode with SSH if you want to accurately control both the period between conversions of individual channels in a scan and the period between conversions of the entire scan and if you want to simultaneously sample all channels in a scan. Each pulse from the pacer clock starts a simultaneous scan of all channels. The conversion rate equals the rate of the burst mode conversion clock. The sample rate, which is the rate at which a single channel is sampled, equals the pacer clock rate.

One extra tick of the burst mode conversion clock is required to sample and hold the values. Therefore, the sample rate (pacer clock rate) can be no more than the burst mode conversion rate divided by the sum of one plus the number of channels in the burst.

You cannot use burst mode with SSH for DAS-1700HR Series boards.

For information on the signal interface between DAS-1700ST Series and DAS-1700AO Series boards and SSH hardware, refer to page 7-32.

Clock Sources

DAS-1700 Series boards provide two clocks: a pacer clock and a burst mode conversion clock. In paced mode, you use only a pacer clock, as shown in Figure 7-5 on page 7-14. In burst mode and burst mode with SSH, you use both a pacer clock and the burst mode conversion clock, as shown in Figure 7-5 on page 7-14. These clock sources are described in the following sections.

Pacer Clock

In paced mode, the pacer clock determines the period between the conversion of one channel and the conversion of the next channel. In burst mode and burst mode with SSH, the pacer clock determines the period between the conversions of one scan and the conversions of the next scan. Through software, you select either the internal A/D pacer clock or an external pacer clock. These pacer clocks are described in the following sections.

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Note: The rate at which the computer can reliably read data from a DAS-1700 Series board depends on a number of factors, including your computer, the operating system/environment, whether you are acquiring samples from multiple channels, the gains of the channels, whether you are using expansion accessories, and software issues. Make sure that the pacer clock does not initiate conversions too fast.

Internal A/D Pacer Clock

The internal A/D pacer clock uses two cascaded counters of the onboard 82C54 counter/timer and a crystal-controlled 5 MHz time base. The maximum available rate is 166.67 ksamples/s for DAS-1700ST and DAS-1700AO Series boards and 50 ksamples/s for DAS-1700HR Series boards; the minimum available rate is 0.0012 samples/s. When not used to pace analog input operations, you can use the internal A/D pacer clock to pace other events, such as digital I/O operations.

External Pacer Clock

The external pacer clock source is an externally applied TTL-compatible signal attached to the XPCLK pin (pin 44 of the board's main I/O connector or pin 38 of STA-1800U connectors J1 and J2). The polarity (active edge) of the external pacer clock is software-selectable.

An external pacer clock is useful if you want to pace at rates not available with the internal A/D pacer clock, if you want to pace at uneven intervals, or if you want to pace on the basis of an external event. By attaching the same external pacer clock to the XPCLK pins of multiple boards, you can synchronize all the boards to the external pacer clock.

Burst Mode Conversion Clock

In burst mode and burst mode with SSH, the burst mode conversion clock determines the period between the conversion of one channel in a scan and the conversion of the next channel in the scan. (The burst mode conversion clock is not used for paced mode.)

The maximum allowable rate is 166.67 ksamples/s for DAS-1700ST and DAS-1700AO Series boards and 50 ksamples/s for DAS-1700HR Series boards; the minimum available rate is 15.625 ksamples/s.

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Triggers

A trigger is an event that occurs based on a specified set of conditions. An operation must have a start trigger to determine when acquisitions start. In addition, you can use an optional second trigger, the about trigger, to determine when acquisitions stop.

The following sections describe the supported trigger sources and the ways to acquire data using triggers.

Trigger Sources

The start trigger can be a software trigger or an external digital trigger. The about trigger, if used, is always an external digital trigger.

Note: DAS-1700 Series boards do not provide a hardware-based analog trigger. However, you can program an analog start trigger through software, using one of the analog input channels as the trigger channel. The DAS-1700 Series Function Call Driver provides functions for an analog trigger; refer to the *DAS-1700 Series Function Call Driver User's Guide* for more information.

The software trigger and external digital trigger are described in the following sections.

Software Trigger

A software trigger event occurs when you start the analog input operation (the computer issues a write to allow conversions). The point at which conversions begin depends on the pacer clock; refer to page 7-15 for more information. Note that the delay between the point at which you start the analog input operation and the point at which the internal A/D pacer clock starts is less than 1 µs.

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External Digital Trigger

An external digital trigger event occurs when the DAS-1700 Series board detects either a negative edge or a positive edge at the TGIN pin (pin 46 of the board's main I/O connector or pin 42 of STA-1800U connectors J1 and J2). The trigger signal is TTL-compatible and the polarity (active edge) is software-selectable.

The point at which conversions begin depends on the pacer clock, as follows:

- **Internal A/D pacer clock** — The 82C54 counter/timer is idle until the trigger event occurs. Within 400 ns, the first conversion begins. Subsequent conversions are synchronized to the internal A/D pacer clock.
- **External pacer clock** — Conversions are armed when the trigger event occurs; conversions begin with the next active edge of the external pacer clock and continue with each subsequent active edge.

Figure 7-6 illustrates how conversions are initiated when using an external digital trigger.

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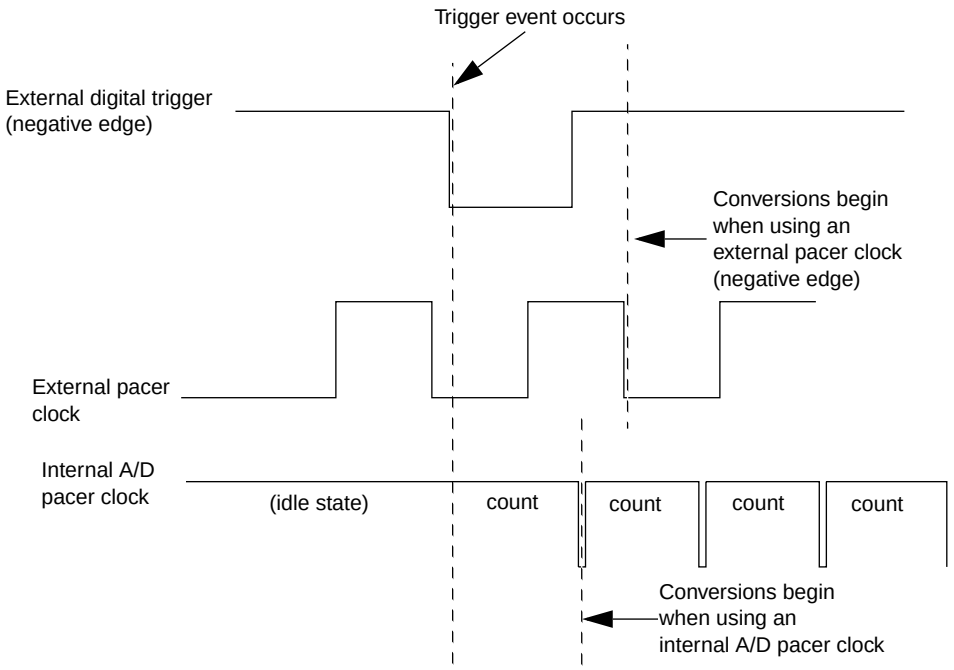


Figure 7-6. Initiating Conversions with an External Digital Trigger

The about trigger is always an external digital trigger. If you specify an about trigger, the operation stops when a specified number of samples has been acquired after the external digital trigger event.

Trigger Acquisition

The ways you can acquire data using triggers are described in the following sections.

Post-Trigger Acquisition

Use post-trigger acquisition in applications where you want to collect data after a specific trigger event. You specify a start trigger to determine when the operation starts. The operation stops either when the specified number of samples has been acquired or through a software command.

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Pre-Trigger Acquisition

Use pre-trigger acquisition in applications where you want to collect data before a specific trigger event. You specify a start trigger and an about trigger. The start trigger determines when the operation starts. The operation stops when the about-trigger event occurs. Pre-trigger acquisition is available only when you use the DMA resources of the board.

About-Trigger Acquisition

Use about-trigger acquisition in applications where you want to collect data both before and after a specific trigger event. You specify a start trigger and an about trigger. The start trigger determines when the operation starts. The operation stops after a specified number of samples has been acquired after the about-trigger event occurs. About-trigger acquisition is available only when you use the DMA resources of the board.

Hardware Gate

A hardware gate is an externally applied digital signal that determines whether conversions occur. You connect the gate signal to the TGIN pin (pin 46 of the board's main I/O connector or pin 42 of STA-1800U connectors J1 and J2).

If you specify a positive gate, conversions occur only if the signal to TGIN is high; if the signal to TGIN is low, conversions are inhibited. If you specify a negative gate, conversions occur only if the signal to TGIN is low; if the signal to TGIN is high, conversions are inhibited. The gate signal is TTL-compatible and the polarity of the hardware gate is software-selectable.

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The way conversions are synchronized depends on whether you are using the internal A/D pacer clock or an external pacer clock, as follows:

- **Internal A/D pacer clock** — The 82C54 counter/timer stops counting when the gate signal goes inactive. When the gate signal goes active, the 82C54 is reloaded with its initial count value and starts counting again; therefore, conversions are synchronized to the gate signal.
- **External pacer clock** — The signal from the external pacer clock continues uninterrupted while the gate signal is inactive; therefore, conversions are synchronized to the external pacer clock.

Figure 7-7 illustrates the use of a hardware gate.

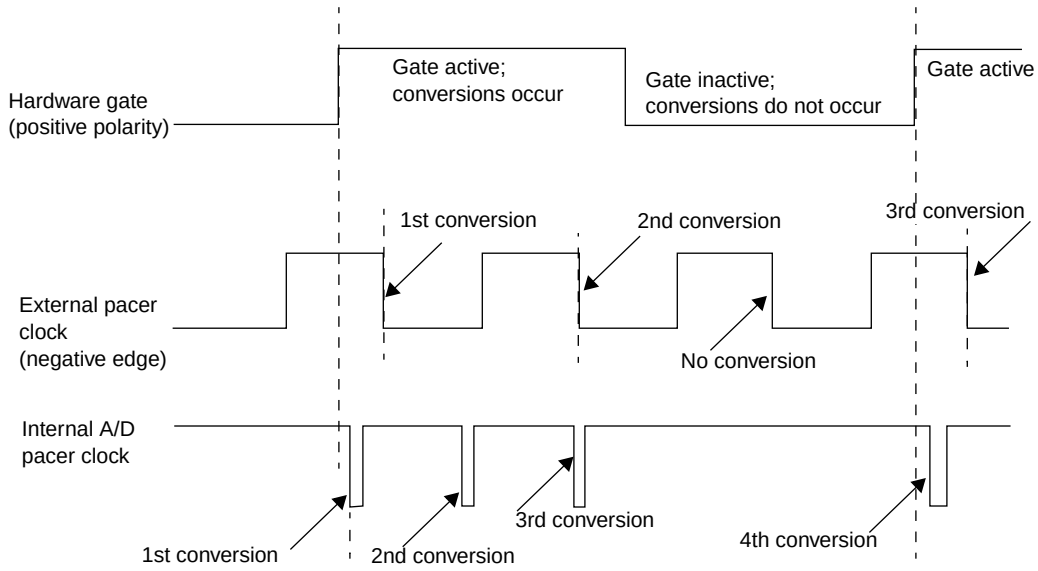


Figure 7-7. Hardware Gate

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Data Transfer

DAS-1700 Series boards contain a 1024-word A/D FIFO. The result of each A/D conversion is automatically stored in the FIFO. You can transfer data from the A/D FIFO to computer memory using either interrupts or the DMA resources of the board, as described in the following sections.

Using Interrupts

You can program the board to generate an interrupt anytime the A/D FIFO contains data (FIFO Not Empty) or after the A/D FIFO accumulates 512 A/D samples (FIFO Half Full). An interrupt service routine can then transfer data from the A/D FIFO to computer memory while the FIFO continues to fill. Refer to page 7-33 for more information about interrupts.

The interrupt level (3, 5, 7, 10, 11, or 15) is software-selectable. Refer to "AI IRQ" on page C-4.

Unpredictable interrupt latencies in Windows can make maximum board speeds unachievable; therefore, it is recommended that you use single-channel or dual-channel DMA instead of interrupts, if possible.

Using DMA Resources

You can use the DMA controller to bypass the CPU and transfer data directly from a DAS-1700 Series board to computer memory. The ability to run independent of the CPU and at high-transfer rates makes DMA an attractive method for transferring data in data acquisition systems.

DAS-1700 Series boards use DMA channel 5, 6, or 7 to perform single-channel DMA transfers or DMA channel pairs 5 and 6, 6 and 7, or 7 and 5 to perform dual-channel DMA transfers. The DMA channel(s) are software-selectable.

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Each DMA channel can transfer up to 65,536 samples before it has to be reprogrammed with a new memory address. When more than 65,536 samples are required by an application, the A/D FIFO automatically stores the samples while the DMA channel is being reprogrammed for another address. In most situations, the A/D FIFO allows you to acquire large amounts of gap-free data into multiple buffers at up to maximum board speed using a single DMA channel. However, if possible, you should use dual-channel DMA to acquire data reliably at maximum board speeds.

Analog Output Features

The following boards contain analog output circuitry:

- DAS-1701ST-DA and DAS-1702ST-DA
- DAS-1702HR-DA
- DAS-1701AO and DAS-1702AO

The analog output features of these board are described in the following sections.

DAS-1701ST-DA and DAS-1702ST-DA Boards

DAS-1701ST-DA and DAS-1702ST-DA boards contain four 12-bit digital-to-analog converters (DACs). Each DAC has a fixed voltage range of ±10 V and powers up to 0 V at reset. Data coding is 2's complement. The four DACs have a capacitive load drive up to 100 µF and an output current drive of up to ±5 mA.

You can use the internal A/D pacer clock to pace the analog output operation if no analog input operation is in progress or if the analog input operation is paced by an external pacer clock.

Note: You cannot use the DMA resources of DAS-1701ST-DA and DAS-1702ST-DA boards to perform an analog output operation. In addition, you cannot use an external trigger or an external pacer clock to perform an analog output operation.

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DAS-1702HR-DA Boards

DAS-1702HR-DA boards contain two 16-bit DACs. Each DAC has a fixed voltage range of ±10 V and powers up to 0 V at reset. Data coding is 2's complement. The two DACs have a capacitive load drive up to 100 µF and an output current drive of up to ±5 mA (short-circuit current is about 25 mA).

You can use the internal A/D pacer clock to pace the analog output operation if no analog input operation is in progress or if the analog input operation is paced by an external pacer clock.

Note: You cannot use the DMA resources of DAS-1702HR-DA boards to perform an analog output operation. In addition, you cannot use an external trigger or an external pacer clock to perform an analog output operation.

DAS-1701AO and DAS-1702AO Boards

DAS-1701AO and DAS-1702AO boards contain two 12-bit DACs with bipolar outputs. Each DAC is deglitched (a glitch is a transient that can occur during certain types of voltage changes). The DACs power up to 0 V at reset.

The analog output features of DAS-1701AO and DAS-1702AO boards are described in the following sections.

Output Ranges

Each DAC can have a bipolar output range of ±5 V or ±10 V. The range is software-selectable.

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Pacer Clock

The pacer clock determines the rate at which the board writes new values from the D/A FIFO to the DACs. Through software, you select either the internal D/A pacer clock or an external pacer clock. You can also use the internal A/D pacer clock or the burst mode conversion clock to synchronize D/A conversions with A/D conversions. The pacer clocks are described in the following sections.

Note: The rate at which the board can reliably write new values to the DACs depends on a number of factors, including your computer, the operating system/environment, the settling time of the DACs, the way data is transferred to the board, and software issues.

Internal D/A Pacer Clock

The internal D/A pacer clock consists of a 16-bit counter with an optional divide-by-ten prescaler driven by a 5 MHz crystal oscillator. The maximum available rate is 200 ksamples/s; the minimum available rate is 7.63 samples/s.

External Pacer Clock

The external pacer clock is an externally applied TTL-compatible signal attached to the XPCLK pin (pin 44 of the board's main I/O connector or pin 38 of STA-1800U connectors J1 and J2). Note that an external pacer clock for an analog input operation also uses the XPCLK pin. The active edge of the external pacer clock is software-selectable.

An external clock is useful if you want to pace at rates not available with the internal D/A pacer clock, if you want to pace at uneven intervals, or if you want to pace on the basis of an external event. By attaching the same external pacer clock to the XPCLK pins of multiple boards, you can synchronize all the boards to the external pacer clock.

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Clock Used for an Analog Input Operation

If you are using one of the onboard clocks (either the internal A/D pacer clock or the burst mode conversion clock) to pace an analog input operation, you can use the clock that paces the analog input operation to also determine the update rate for an analog output operation. Using the same clock to pace both D/A and A/D conversions allows you to perform tightly coupled stimulus-response operations at rates of up to 166.67 ksamples/s.

Note: You cannot synchronize an analog output operation to an analog input operation that is being paced by an external pacer clock.

Triggers

A trigger is an event that occurs based on a specified set of conditions. The trigger event determines when updates of the analog output channels begin and can be a software trigger or an external digital trigger, as described in the following sections.

Note: DAS-1701AO and DAS-1702AO boards do not provide a hardware-based analog trigger. However, you can program an analog start trigger through software, using one of the analog input channels as the trigger channel. The DAS-1700 Series Function Call Driver provides functions for an analog trigger; refer to the *DAS-1700 Series Function Call Driver User's Guide* for more information.

Software Trigger

A software trigger event occurs when you start the analog output operation (the computer issues a write to allow conversions). The point at which conversions begin depends on the pacer clock; refer to page 7-25 for more information. Note that the delay between the point at which you start the analog output operation and the point at which the internal D/A pacer clock starts is about 1 µs.

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External Digital Trigger

An external digital trigger event occurs when the DAS-1701AO or DAS-1702AO board detects either a negative edge or a positive edge at the TGIN pin (pin 46 of the board's main I/O connector or pin 42 of STA-1800U connectors J1 and J2). Note that an external digital trigger for an analog input operation also uses the TGIN pin. The trigger signal is TTL-compatible and the polarity (active edge) is software-selectable.

Conversions begin about 400 ns after the active edge of the external digital trigger if you are using the internal D/A pacer clock or on the next active edge of an external pacer clock. Refer to page 7-25 for more information about pacer clocks.

If you are using an external digital trigger and you are using the D/A FIFO to transfer data from the computer to the board (no more than 2048 values), you can use retrigger mode to start generating the waveform stored in the D/A FIFO from the beginning each time the external digital trigger event occurs. This allows you to synchronize the generation of a waveform to an external digital trigger event.

Hardware Gate

A hardware gate is an externally applied digital signal that determines whether conversions occur. You connect the gate signal to the TGIN pin (pin 46 of the board's main I/O connector or pin 42 of STA-1800U connectors J1 and J2).

If you specify a positive gate, conversions occur only if the signal to TGIN is high; if the signal to TGIN is low, conversions are inhibited. If you specify a negative gate, conversions occur only if the signal to TGIN is low; if the signal to TGIN is high, conversions are inhibited. Note that the hardware gate for an analog input operation also uses the TGIN pin. The gate signal is TTL-compatible and the polarity of the hardware gate is software-selectable.

When using the internal D/A pacer clock, D/A conversions begin about 400 ns after the gate signal becomes active and terminate when the gate signal becomes inactive. When using an external pacer clock, D/A conversions begin on the next active clock edge after the gate signal becomes active and terminate when the gate signal becomes inactive.

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Data Transfer

DAS-1701AO and DAS-1702AO boards contain a 2048-word D/A FIFO to store analog output values. You can transfer data from computer memory to the D/A FIFO using either interrupts or the DMA resources of the board. The analog output values are then written to the DACs, at a rate determined by the pacer clock.

If the output waveform you want to generate from a DAC is repetitive and contains 2048 values or fewer, you can use recycle mode to continuously generate the waveform.

The following sections contain more information on using interrupts, using the DMA resources of the board, and using recycle mode.

Using Interrupts

You can program the board to generate an interrupt if the D/A FIFO is no longer full of data (FIFO Not Full) or if the FIFO contains fewer than 1025 values (FIFO Not Half Full). An interrupt service routine can then transfer data from computer memory to the D/A FIFO while the FIFO continues to write values to the DACs. Refer to page 7-33 for more information about interrupts.

The interrupt level (3, 5, 7, 10, 11, or 15) is software selectable. Refer to “AI IRQ” on page C-4.

Using DMA Resources

You can use the DMA controller to bypass the CPU and transfer data directly from computer memory to the D/A FIFO.

DAS-1700 Series boards use DMA channel 5, 6, or 7 to perform single-channel DMA transfers. The DMA channel is software-selectable. Refer to “AI DMA 1, AO DMA 1” on page C-4 for information on specifying the DMA channel. (Note that you cannot perform dual-channel DMA transfers for analog output operations.)

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Using Recycle Mode

If you use a waveform of between 2 and 2048 values (all the values fit in the D/A FIFO), you can use recycle mode to continuously generate the waveform. The analog output values are transferred to the D/A FIFO once (using either interrupts or the DMA resources of the board) and then are continuously written to the DACs directly from the D/A FIFO. Recycle mode is the fastest way to transfer data because it does not require the use of the computer bus.

Digital I/O Features

DAS-1700 Series boards contain four digital input lines (DI0 to DI3) and four digital output lines (DO0 to DO3). Logic 1 on a digital I/O line indicates that the input/output is high (greater than 2.0 V); logic 0 on a digital I/O line indicates that the input/output is low (less than 0.8 V).

The digital input signals are TTL-compatible. The input signals are provided with 10 kΩ pull-up resistors to +5 V; therefore, the inputs appear high (logic 1) with no signal connected. DAS-1700 Series boards provide a latch strobe for digital output signals; refer to page 7-30 for information.

You can use the internal A/D pacer clock to pace the digital I/O operation if no analog input operation is in progress or if the analog input operation is paced by an external pacer clock.

Note: You cannot use the DMA resources of DAS-1700 Series boards to perform a digital I/O operation. In addition, you cannot use an external trigger or an external pacer clock to perform a digital I/O operation.

Digital Control Signals

The following sections describe the digital control signals provided on DAS-1700 Series boards.

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Strobe Signal

DAS-1700 Series boards provide a strobe signal DOSTB (pin 19 of the board's main I/O connector or pin 37 of STA-1800U connectors J1 and J2) for the purpose of strobing data through the digital output lines and latching the data into a register in external equipment. DAS-1700 Series boards use the positive edge of the strobe to strobe data out; however, you must use the negative edge to strobe data into other equipment because the negative edge provides a 300 ns lag to allow for delays. Data is valid until the next strobe, as shown in Figure 7-8.

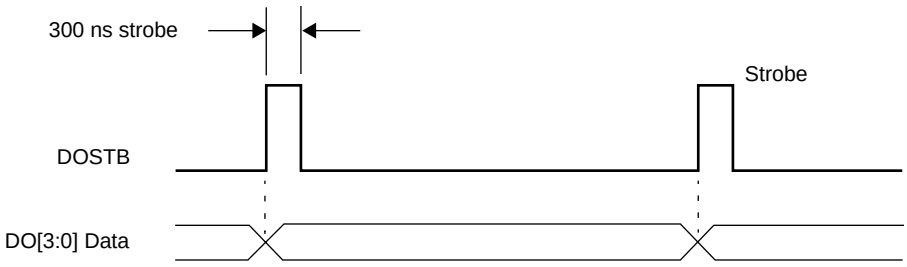


Figure 7-8. Timing Relationship between Data from DO0 to DO3 and Latch Strobe DOSTB

Trigger/Gate Output Signal

If you are using the internal A/D pacer clock to pace an analog input operation, you can use the trigger/gate output signal TGOUT (pin 20 of the board's main I/O connector or pin 39 of STA-1800U connectors J1 and J2) to synchronize the start of analog input operations on other DAS-1700 Series boards or to act as a trigger or gate for user-defined events, as follows:

- When using the TGIN pin as an external digital trigger, TGOUT behaves as shown in Figure 7-9a. Note that TGOUT does not retrigger and cannot be used with about-trigger acquisitions. Note also that a delay of about 200 ns occurs between the active edge of TGIN and the starting edge of TGOUT.

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- When using the TGIN pin as a hardware gate, TGOUT behaves as shown in Figure 7-9b. Note that a delay of about 200 ns occurs between the active edge of TGIN and the starting edge of TGOUT.
- When using a software trigger or when the hardware gate is disabled (TGIN pin is not used), TGOUT behaves as shown in Figure 7-9c. Note that the delay between the point at which software enables conversions and the starting edge of TGOUT is less than 1 µs.

Note: You cannot use TGOUT when an external pacer clock is pacing the analog input operation.

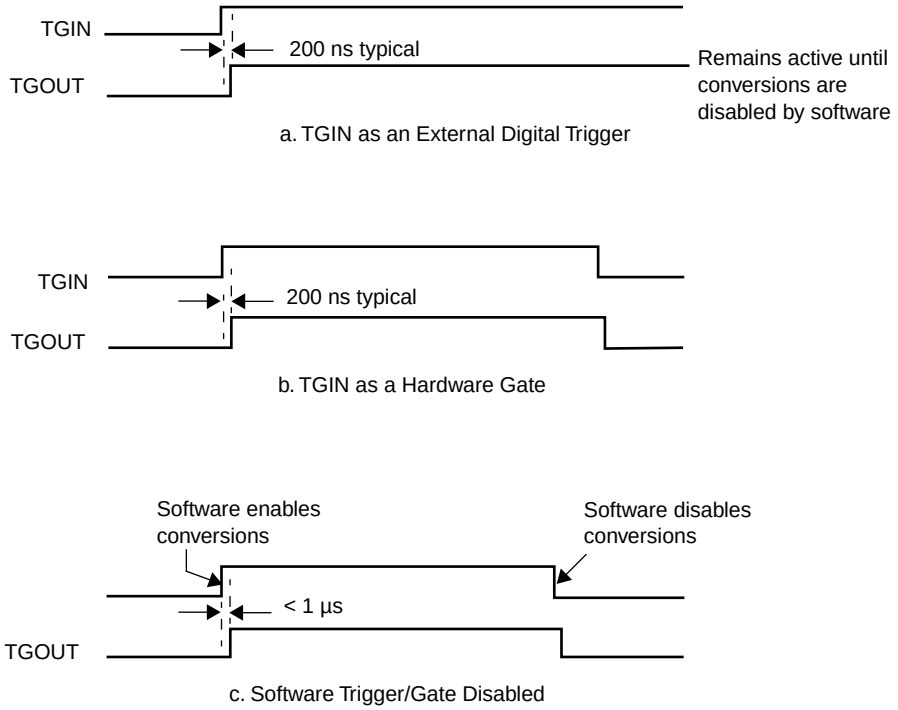


Figure 7-9. Timing for the TGOUT Signal

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SSH Output Signal

The SSH output signal SSHO (pin 45 of the board's main I/O connector or pin 40 of STA-1800U connectors J1 and J2) is normally generated by DAS-1700ST Series and DAS-1700AO Series boards to accommodate external SSH hardware. The SSHO signal is initiated by either the internal A/D pacer clock or an external pacer clock. Characteristics of the SSHO signal when used for SSH hardware control are as follows:

- SSHO is normally low, signifying that the SSH hardware is in sample mode.
- SSHO goes high (into the hold mode) about 50 ns after a pacer clock pulse.
- A/D conversion begins one burst period after the pacer clock pulse.
- SSHO remains high until 200 ns after the ADC starts conversion of the last channel in the burst.
- SSHO goes low and remains low until another pacer clock pulse.

To ensure adequate sample time for the SSH hardware, the pacer clock period should be set as follows:

$$\text{Pacer Clock Period} \geq (\text{Number of Channels} + 1) \infty (\text{Burst Period})$$

When you are not using the SSHO signal for SSH hardware control, you can use it as a converter clock output signal. SSHO is active only during A/D conversions. Figure 7-10 shows the timing for SSHO generation when DAS-1700 Series boards are not used for control of SSH hardware.

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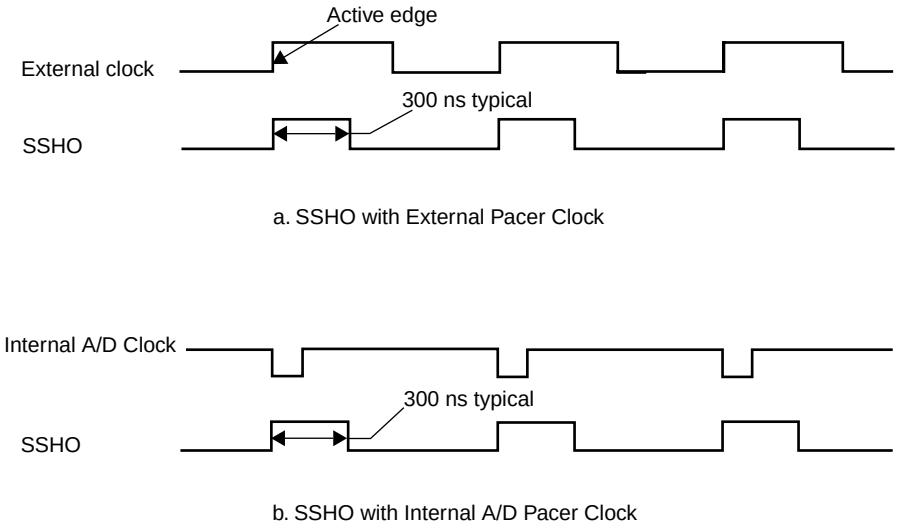


Figure 7-10. Timing for SSHO Signal When Not Used for SSH Hardware

Interrupts

You assign an interrupt level to a DAS-1700 Series board using DriverLINX (refer to “AI IRQ” on page C-4). When you install more than one board in a computer, you can assign a different interrupt level to each board (if enough levels are available), or you can assign the same interrupt level to some or all boards.

If a DAS-1700 Series board is sharing an interrupt level with one or more other DAS-1700 Series boards and requests an interrupt, the software determines the source of the request by scanning each board until the interrupt request flag is located. The software then signals the computer to respond accordingly.

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Power

DAS-1700 Series boards use the +5 V and the +12 V provided by your computer. An onboard DC/DC converter develops ±15 V at a maximum current output of 60 mA for external use. In addition to the ±15 V, DAS-1700 Series boards supply +5 V from the computer to the +5 V pins (pins 24 and 49 of the board's main I/O connector or pins 47 and 48 of STA-1800U connectors J1 and J2) at a maximum of 1.0 A.

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A

Specifications

This appendix contains the specifications for DAS-1700 Series boards, as follows:

Board	Features	Table
DAS-1701ST DAS-1702ST	Analog input	Table A-1 on page A-2
	Digital I/O	Table A-7 on page A-14
	Power supply	Table A-8 on page A-14
DAS-1702HR	Analog input	Table A-2 on page A-5
	Digital I/O	Table A-7 on page A-14
	Power supply	Table A-8 on page A-14
DAS-1701ST-DA DAS-1702ST-DA	Analog input	Table A-1 on page A-2
	Analog output	Table A-4 on page A-11
	Digital I/O	Table A-7 on page A-14
	Power supply	Table A-9 on page A-15
DAS-1702HR-DA	Analog input	Table A-2 on page A-5
	Analog output	Table A-5 on page A-12
	Digital I/O	Table A-7 on page A-14
	Power supply	Table A-9 on page A-15
DAS-1701AO DAS-1702AO	Analog input	Table A-3 on page A-8
	Analog output	Table A-6 on page A-12
	Digital I/O	Table A-7 on page A-14
	Power supply	Table A-10 on page A-15

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Table A-1. DAS-1700ST Series - Analog Input Specifications

Feature	DAS-1701ST/ST-DA	DAS-1702ST/ST-DA
Number of channels	Software-selectable as 8 differential or 16 single-ended	
Input range type	Software-selectable as unipolar or bipolar	
Resolution	12-bit (1 part in 4096 or 244 ppm)	
Data format	12-bit 2's complement	
A/D FIFO size	1024 word	
Channel-gain queue size	256 locations	
Channel-gain queue	Channels: 256 X 8 bits (256 channels maximum) Gains: 256 X 2 bits (four gain ranges)	
Range/gain	Unipolar • 0 to +5 V for gain = 1 • 0 to +1 V for gain = 5 • 0 to +100 mV for gain = 50 • 0 to +20 mV for gain = 250 Bipolar • ±5 V for gain = 1 • ±1 V for gain = 5 • ±100 mV for gain = 50 • ±20 mV for gain = 250	Unipolar • 0 to +10 V for gain = 1 • 0 to +5 V for gain = 2 • 0 to +2.5 V for gain = 4 • 0 to 1.25 V for gain = 8 Bipolar • ±10 V for gain = 1 • ±5 V for gain = 2 • ±2.5 V for gain = 4 • ±1.25 V for gain = 8
Absolute accuracy	Typical 0.01% of reading ±1 LSB for all ranges Maximum @ 25˚C • 0.02% of reading ±1 LSB for gain < 250 • 0.03% of reading ±1 LSB for gain = 250	
Temperature coefficient of accuracy (includes ADC)	Offset • ±20 µV/˚C ±(12 µV/˚C ÷ gain) maximum for bipolar • ±20 µV/˚C ±(14 µV/˚C ÷ gain) maximum for unipolar Gain • ±20 ppm/˚C for gain < 50 • ±30 ppm/˚C for gain = 50 • ±35 ppm/˚C for gain = 250	
Linearity[1]	• Integral: ±½ LSB typical, ±1 LSB maximum • Differential: ±1 LSB	
Throughput	166.67 ksamples/s, maximum	

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Table A-1. DAS-1700ST Series - Analog Input Specifications (cont.)

Feature	DAS-1701ST/ST-DA	DAS-1702ST/ST-DA
Dynamic parameters	• Acquisition time: 0.3 µs • Aperture delay: 13.0 ns • Aperture uncertainty: 150 ps rms • Conversion time: 3.0 µs maximum (includes acquisition time)	
Input bias current	• ±40 nA maximum @ 25˚C • ±60 nA maximum over operating range	
Common-mode rejection ratio	• 74 dB for gain = 1 • 80 dB for gain = 5 • 100 dB for gain = 50 • 100 dB for gain = 250	• 74 dB for gain = 1 • 80 dB for gain = 2 • 80 dB for gain = 4 • 86 dB for gain = 8
Input overvoltage	• ±15 V continuous, powered and unpowered	
Noise[2] (in counts)	Bipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 5 • p-p = 4, rms = 0.5 for gain = 50 • p-p = 8, rms = 1.0 for gain = 250 Unipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 5 • p-p = 6, rms = 0.9 for gain = 50 • p-p = 9, rms = 1.4 for gain = 250	Bipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 2 • p-p = 1, rms = 0.1 for gain = 4 • p-p = 1, rms = 0.1 for gain = 8 Unipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 2 • p-p = 1, rms = 0.1 for gain = 4 • p-p = 1, rms = 0.1 for gain = 8
DMA	• Burst demand mode DMA on FIFO NOT EMPTY • Programmable DMA channels (5, 6, and 7) • Single/dual DMA modes	
Interrupts	• On FIFO not empty (single/slow transfer) • On FIFO half full (REP MOV) • On Counter 2 terminal count • On data overflow • Programmable interrupt levels (3, 5, 7, 10, 11, and 15) • Shareable pulsed interrupts	
Burst-mode acquisition	Rate: programmable from 16 ksamples/s to 166.67 ksamples/s Length: programmable from 1 to 256 conversions per trigger Other: direct simultaneous sample-and-hold support	
Minimum external pacer clock pulse width	10 ns	

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Table A-1. DAS-1700ST Series - Analog Input Specifications (cont.)

Feature	DAS-1701ST/ST-DA	DAS-1702ST/ST-DA
Maximum external pacer clock rate	166.67 ksamples/s	
Minimum hardware trigger pulse width	10 ns	
Trigger	Sources • Internal A/D pacer clock, gate disabled • Internal A/D pacer clock, ext. digital trigger (programmable edge) • Internal A/D pacer clock, hardware gate (programmable level) • External pacer clock, gate disabled • External pacer clock, external digital trigger (programmable edge) • External pacer clock, hardware gate (programmable level) Types • Post-trigger • Pre-trigger • About-trigger (using counter 0)	
Pacer clock	Internal A/D: 32-bit counter (82C54) External: programmable edge (±)	

Notes

[1] Monotonicity is guaranteed over the operating range.

[2] Includes the electrical noise introduced by the analog front end but does not include the uncertainty inherent in the quantization process. The inherent quantization noise introduced by any ADC is due to uncertainty at code boundaries and adds a peak-to-peak value of 1 LSB to the electrical noise; it also makes the rms level 0.5 LSB.

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Table A-2. DAS-1700HR Series - Analog Input Specifications

Feature	DAS-1702HR/HR-DA
Number of channels	Software-selectable as 8 differential or 16 single-ended
Input range type	Software-selectable as unipolar or bipolar
Resolution	16-bits (1 part in 65,536 or 15 ppm)
Data format	16-bit 2's complement
A/D FIFO size	1024 word
Channel-gain queue	Channels: 256 X 8 bits (256 channels maximum) Gains: 256 X 2 bits (four gain ranges)
Range/gain	Unipolar • 0 to +10 V for gain = 1 • 0 to +5 V for gain = 2 • 0 to +2.5 V for gain = 4 • 0 to 1.25 V for gain = 8 Bipolar • ±10 V for gain = 1 • ±5 V for gain = 2 • ±2.5 V for gain = 4 • ±1.25 V for gain = 8
Absolute accuracy	Typical 0.005% of reading ±1 LSB for all ranges Maximum • 0.005% of reading ±1.5 LSB for gain = 1 • 0.01% of reading ±1.5 LSB for gain ≠ 1
Relative accuracy	Typical: 0.001% of reading ±1 LSB Maximum: 0.001% of reading ±1.5 LSB maximum range of 0 to 70˚C
Temperature coefficient of accuracy (includes ADC)	Offset • ±5 µV/˚C maximum for bipolar • ±5 µV/˚C maximum for unipolar Gain • ±7.5 ppm/˚C
Linearity[1]	Integral: ±1.5 LSB maximum Differential: ±1 LSB
Throughput	50 ksamples/s, maximum

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Table A-2. DAS-1700HR Series - Analog Input Specifications (cont.)

Feature	DAS-1702HR/HR-DA
Dynamic parameters	• Acquisition time: 2 µs • Aperture delay: 6.0 ns • Aperture uncertainty: - 100 ps rms when used with internal A/D pacer clock - 200 ns maximum with external pacer clock • Conversion time: 8.0 µs maximum
Input bias current	• ±2 nA maximum @ 25˚C • ±100 nA maximum over operating range
Input impedance	100 MΩ in parallel with 75 pF
Common-mode rejection ratio	• 100 dB for gain = 1 • 100 dB for gain = 2 • 100 dB for gain = 4 • 100 dB for gain = 8
Input overvoltage	• ±15.0 V continuous powered and unpowered
Noise[2] (in counts)	Bipolar electrical noise • p-p = ±2.0, rms = 0.5 for gain = 1 • p-p = ±2.0, rms = 0.5 for gain = 2 • p-p = ±2.5, rms = 0.6 for gain = 4 • p-p = ±2.5, rms = 0.7 for gain = 8 Unipolar electrical noise • p-p = ±2.0, rms = 0.6 for gain = 1 • p-p = ±2.0, rms = 0.6 for gain = 2 • p-p = ±2.5, rms = 0.7 for gain = 4 • p-p = ±3.0, rms = 0.8 for gain = 8
DMA	• Burst demand mode DMA on FIFO NOT EMPTY • Programmable DMA channels (5, 6, and 7) • Single/dual DMA modes
Interrupts	• On FIFO not empty (single/slow transfer) • On FIFO half full (REP MOV) • On Counter 2 terminal count • On data overflow • Programmable interrupt levels (3, 5, 7, 10, 11, and 15) • Shareable pulsed interrupts
Burst-mode acquisition	Rate: programmable from 16 ksamples/s to 50 ksamples/s Length: programmable from 1 to 256 conversions per trigger

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Table A-2. DAS-1700HR Series - Analog Input Specifications (cont.)

Feature	DAS-1702HR/HR-DA
Minimum external pacer clock pulse width	10 ns
Maximum external pacer clock rate	50 ksamples/s
Minimum hardware trigger pulse width	10 ns
Trigger	Sources • Internal A/D pacer clock, gate disabled • Internal A/D pacer clock, ext. digital trigger (programmable edge) • Internal A/D pacer clock, hardware gate (programmable level) • External pacer clock, gate disabled • External pacer clock, external digital trigger (programmable edge) • External pacer clock, hardware gate (programmable level) Types • Post-trigger • Pre-trigger • About-trigger (using counter 0)
Pacer clock	Internal A/D: 32-bit counter (82C54) External: programmable edge (±)

Notes
[1] Monotonicity is guaranteed to 16 bits.
[2] Includes the electrical noise introduced by the analog front end and includes the quantization noise.

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Table A-3. DAS-1700AO Series - Analog Input Specifications

Feature	DAS-1701AO	DAS-1702AO
Number of channels	Software-selectable as 8 differential or 16 single-ended	
Input range type	Software-selectable as unipolar or bipolar	
Resolution	12-bit (1 part in 4096)	
Data format	12-bit 2's complement	
A/D FIFO size	1024 word	
Channel-gain queue	Channels: 256 x 8 bits (256 channels maximum) Gains: 256 x 3 bits (four gain ranges; two external)	
Range/gain	Unipolar • 0 to +5 V for gain = 1 • 0 to +1 V for gain = 5 • 0 to +100 mV for gain = 50 • 0 to +20 mV for gain = 250 Bipolar • ±5 V for gain = 1 • ±1 V for gain = 5 • ±100 mV for gain = 50 • ±20 mV for gain = 250	Unipolar • 0 to +10 V for gain = 1 • 0 to +5 V for gain = 2 • 0 to +2.5 V for gain = 4 • 0 to 1.25 V for gain = 8 Bipolar • ±10 V for gain = 1 • ±5 V for gain = 2 • ±2.5 V for gain = 4 • ±1.25 V for gain = 8
Absolute accuracy	Typical 0.01% of reading ±1 LSB for all ranges Maximum @ 25˚C • 0.02% of reading ±1 LSB for gain < 250 • 0.03% of reading ±1 LSB for gain = 250	
Temperature coefficient of accuracy (includes ADC)	Offset • ±20 µV/˚C ±(12 µV/˚C ÷ gain) maximum for bipolar • ±20 µV/˚C ±(14 µV/˚C ÷ gain) maximum for unipolar Gain • ±20 ppm/˚C for gain < 50 • ±30 ppm/˚C for gain = 50 • ±35 ppm/˚C for gain = 250	
Linearity[1]	• Integral: ±½ LSB typical, ±1 LSB maximum • Differential: ±1 LSB	
Throughput	166.67 ksamples/s, maximum	

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Table A-3. DAS-1700AO Series - Analog Input Specifications (cont.)

Feature	DAS-1701AO	DAS-1702AO
Dynamic parameters	• Acquisition time: 0.3 µs • Aperture delay: 13.0 ns • Aperture uncertainty: 150 ps rms • Conversion time: 3.0 µs maximum (includes acquisition time)	
Input bias current	• ±40 nA maximum @ 25˚C • ±60 nA maximum over operating range	
Common-mode rejection ratio	• 74 dB for gain = 1 • 80 dB for gain = 5 • 100 dB for gain = 50 • 100 dB for gain = 250	• 74 dB for gain = 1 • 80 dB for gain = 2 • 80 dB for gain = 4 • 86 dB for gain = 8
Input overvoltage	• ±15 V continuous, powered and unpowered	
Noise[2] (in counts)	Bipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 5 • p-p = 2, rms = 0.2 for gain = 50 • p-p = 3, rms = 0.5 for gain = 250 Unipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 5 • p-p = 3, rms = 0.4 for gain = 50 • p-p = 5, rms = 0.9 for gain = 250	Bipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 2 • p-p = 1, rms = 0.1 for gain = 4 • p-p = 1, rms = 0.1 for gain = 8 Unipolar electrical noise • p-p = 1, rms = 0.1 for gain = 1 • p-p = 1, rms = 0.1 for gain = 2 • p-p = 1, rms = 0.1 for gain = 4 • p-p = 1, rms = 0.1 for gain = 8
DMA	• Burst demand mode DMA • Request on FIFO Not Empty • Programmable DMA channels (5, 6, and 7) • Single/dual DMA modes	
Interrupts	• On FIFO not empty • On FIFO half full • On A/D Counter 0 terminal count • On data overflow • Programmable interrupt levels (3, 5, 7, 10, 11, and 15)	
Burst-mode acquisition	• Rate: programmable 16 ksamples/s to 166.67 ksamples/s • Length: programmable 1 to 256 conversions • Other: simultaneous sample-and-hold support	
Minimum external pacer clock pulse width	10 ns	
Maximum external pacer clock rate	166.67 ksamples/s	

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Table A-3. DAS-1700AO Series - Analog Input Specifications (cont.)

Feature	DAS-1701AO	DAS-1702AO
Minimum hardware trigger pulse width	10 ns	
Trigger	Sources • Internal A/D pacer clock, gate disabled • Internal A/D pacer clock, ext. digital trigger (programmable edge) • Internal A/D pacer clock, hardware gate (programmable level) • External pacer clock, gate disabled • External pacer clock, external digital trigger (programmable edge) • External pacer clock, hardware gate (programmable level) Types • Pre-trigger • About-trigger (using A/D counter 0) • Post-trigger	
Pacer clock	• Internal A/D: 32-bit counter (82C54) • External: programmable edge (±)	

Notes

[1] Monotonicity is guaranteed over the operating range.

[2] Includes the electrical noise introduced by the analog front end but does not include the uncertainty inherent in the quantization process. The inherent quantization noise introduced by any ADC is due to uncertainty at code boundaries and adds a peak-to-peak value of 1 LSB to the electrical noise; it also makes the rms level 0.5 LSB.

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Table A-4. DAS-1701ST-DA and DAS-1702ST-DA - Analog Output Specifications

Attribute	Specification
Resolution	12-bit (one part in 4096 or 224 ppm)
Coding	12-bit 2's complement, right justified
Output range	–10.000 V to +9.9951 V
Integral nonlinearity	±¼ LSB typical, ±½ LSB maximum
Differential nonlinearity	±½ LSB typical, ±1 LSB maximum
Monotonicity	12 bits guaranteed
Settling time	6 µs typical, 30 µs maximum to ½ LSB
Output current drive	±15 mA maximum
Gain accuracy	Adjustable to 0
Offset accuracy	Adjustable to 0
Temperature drift	Offset: ±15 ppm/˚C maximum Gain: ±30 ppm/˚C maximum
Glitch energy	200 nV * seconds typical area; 200 mV peak
Capacitive load drive	100 µF
Power-up	DACs power up to 0.0 V at reset

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Table A-5. DAS-1702HR-DA - Analog Output Specifications

Attribute	Specification
Type	16-bit, voltage out DAC
Coding	16-bit 2's complement (signed 16-bit integer)
Output range	–10.0000 V to +9.999695 V
Integral nonlinearity	±1 LSB typical, ±2 LSB maximum
Differential nonlinearity	±1 LSB typical, ±2 LSB maximum
Monotonicity	16 bits typical, 15 bits worst-case
Absolute accuracy	±2 LSB @ 25˚C
Temperature drift	Offset: ±5 ppm/˚C maximum Gain: ±5 ppm/˚C maximum
Glitch energy	Area: 15 nV * seconds Peak: 15 mV
Capacitive load drive	100 µF
Settling time	100 µs to ±1 LSB of final value (less than 100 pF load)
Output current drive	±5 mA (25 mA short-circuit current)
Power-up	DACs power up to 0.0 V at reset

Table A-6. DAS-1700AO Series - Analog Output Specifications

Attribute	Specification
Channels	2, deglitched
Range	±5 V, ±10 V (software selectable for each DAC)
Resolution	12-bit (1 part in 4096 or 244 ppm)
Current output	±15 mA maximum
Output impedance	4 Ω (maximum @ 300 kHz)
Capacitive drive	100 µF maximum
Glitch energy	Zero glitch feedthrough
Hold error	1.5 nV * s, typical (i.e. 1 mV * 1.5 µs); 7.5 nV * s, maximum

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Table A-6. DAS-1700AO Series - Analog Output Specifications (cont.)

Attribute	Specification
Gain accuracy	Adjustable to 0
Offset accuracy	Adjustable to 0
Linearity	• Integral: ±0.25 LSB typical; ±0.75 LSB maximum • Differential: ±0.75 LSB maximum • Monotonicity: guaranteed over operating range
Settling time	• 3 µs for 20 V step, typical • 1.8 µs for LSB of major carry, typical
Slew rate	10 V/µs minimum
Throughput	200 ksamples/s, maximum
Output at reset or power-up	0 V
Data transfer size	16 bits (AT bus)
D/A FIFO	2048 word
Format	12-bit, 2’s complement, right-justified
DMA	• Burst demand mode DMA • Programmable DMA levels (levels 5, 6, and 7) • Request on FIFO Not Full
Interrupt	• On FIFO not full • On FIFO not half full • On data underflow • On DMA terminal count • Uses selected A/D interrupt level
Trigger sources	• Internal D/A pacer clock, gate disabled • Internal D/A pacer clock, ext. digital trigger (programmable edge) • Internal D/A pacer clock, hardware gate (programmable level) • External pacer clock, gate disabled • External pacer clock, external digital trigger (programmable edge) • External pacer clock, hardware gate (programmable level)
Pacer clock	• Internal D/A: 16-bit counter using 5 MHz clock (with selectable divide-by-10 prescaler) • External: programmable edge • Pacer clock used for analog input operation

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Table A-7. DAS-1700 Series - Digital I/O Specifications

Attribute	Specification
Digital output signals	DOSTB, SSHO, and TGOUT • V_{OH} (min.) = 2.4 V @ I_{OH} = -3 mA • V_{OL} (max.) = 0.5 V @ I_{OL} = 24 mA DO 0 to DO 3, GEXT, and MUX 3 to MUX 7 • V_{OH} (min.) = 2.7 V @ I_{OH} = –400 µA • V_{OL} (max.) = 0.5 V @ I_{OL} = 8 mA
Digital input signals	DI 0 to DI 3, XPCLK and TGIN[1] • V_{IH} (min.) = 2.0 V; I_{IH} (max.) = 20 µA • V_{IL} (max.) = 0.8 V; I_{IL} (max.) = –0.2 mA
Digital output strobe pulse width	300 ns typical; data is latched on the rising edge of DOSTB

Notes

[1] Digital inputs DI 0 to DI 3 are pulled up with a 10 kΩ resistor. On DAS-1701ST, DAS-1702ST, DAS-1702HR, DAS-1701AO, and DAS-1702AO boards, inputs TGIN and XPCLK are not pulled up; on DAS-1701ST-DA, DAS-1702ST-DA, and DAS-1702HR-DA boards, inputs TGIN and XPCLK are pulled up with 10 kΩ resistors.

Table A-8. DAS-1701ST, DAS-1702ST, and DAS-1702HR - Power Supply Requirements

Attribute	DAS-1701ST/DAS-1702ST	DAS-1702HR
+5 VDC input	520 mA typical; 870 mA maximum	500 mA typical; 870 mA maximum
+12 VDC input	190 mA typical; 550 mA maximum	200 mA typical; 550 mA maximum
Maximum current available at the ±15 V outputs[1]	70 mA	70 mA
Maximum current available at the +5 V output	1.0 A	1.0 A

Notes

[1] Subtract the current output of the DACs from the value given here.

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Table A-9. DAS-1701ST-DA, DAS-1702ST-DA, and DAS-1702HR-DA - Power Supply Requirements

Attribute	DAS-1701ST-DA/ DAS-1702ST-DA	DAS-1702HR-DA
+5 VDC input	483 mA typical; 768 mA maximum	610 mA typical; 850 mA maximum
+12 VDC input	378 mA typical; 700 mA maximum	350 mA typical; 550 mA maximum
Maximum current available at the ±15 V outputs[1]	70 mA	60 mA
Maximum current available at the +5 V output	1.0 A	1.0 A

Notes
[1] Subtract the current output of the DACs from the value given here.

Table A-10. DAS-1700AO Series - Power Supply Requirements

Attribute	Specification
+5 VDC input	510 mA typical; 835 mA maximum
+12 VDC input	455 mA typical; 690 mA maximum
Maximum current available at the ±15 V outputs	30 mA
Maximum current available at the +5 V output	1 A

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B

Connector Pin Assignments

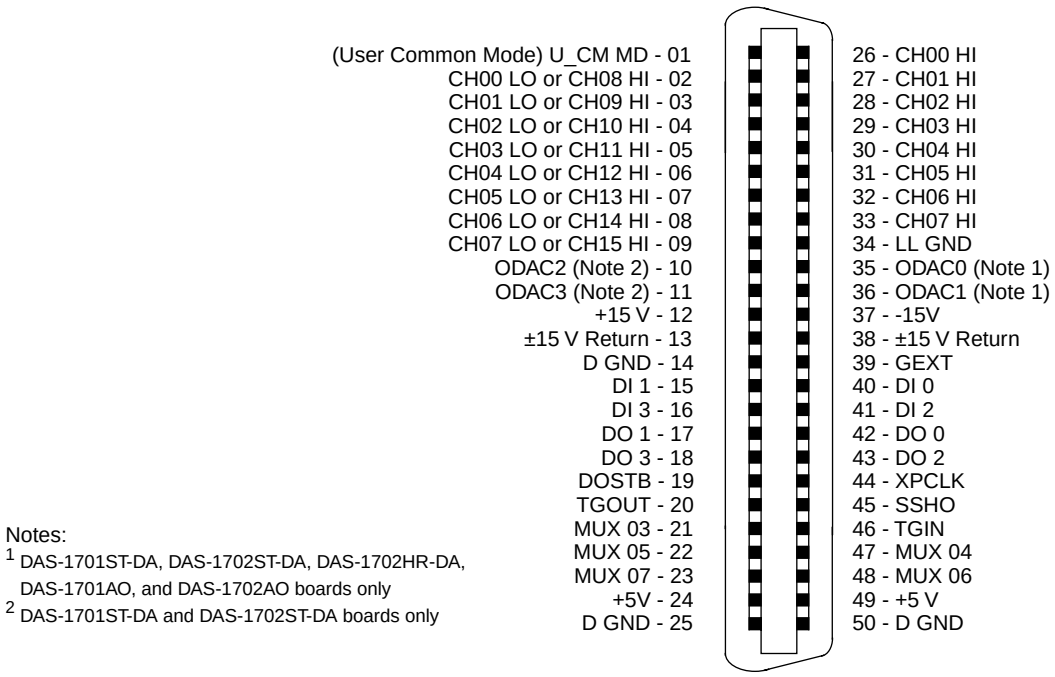
This appendix contains the following sections:

- **Main I/O Connector** — lists the pin assignments for the main I/O connector of the DAS-1700 Series board.
- **STA-1800U I/O Connectors J1 and J2** — lists the pin assignments for connectors J1 and J2 of the STA-1800U screw terminal accessory.
- **STA-1800U I/O Connectors J3** — lists the pin assignments for connector J3 of the STA-1800U screw terminal accessory.
- **STA-1800U I/O Connectors J4 to J7 and Jumper Pads J8 to J11** — lists the pin assignments for connectors J4 to J7 and jumper pads J8 to J11 of the STA-1800U screw terminal accessory.

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Main I/O Connector

Pin assignments for the main I/O connector of a DAS-1700 Series board are shown in Figure B-1.



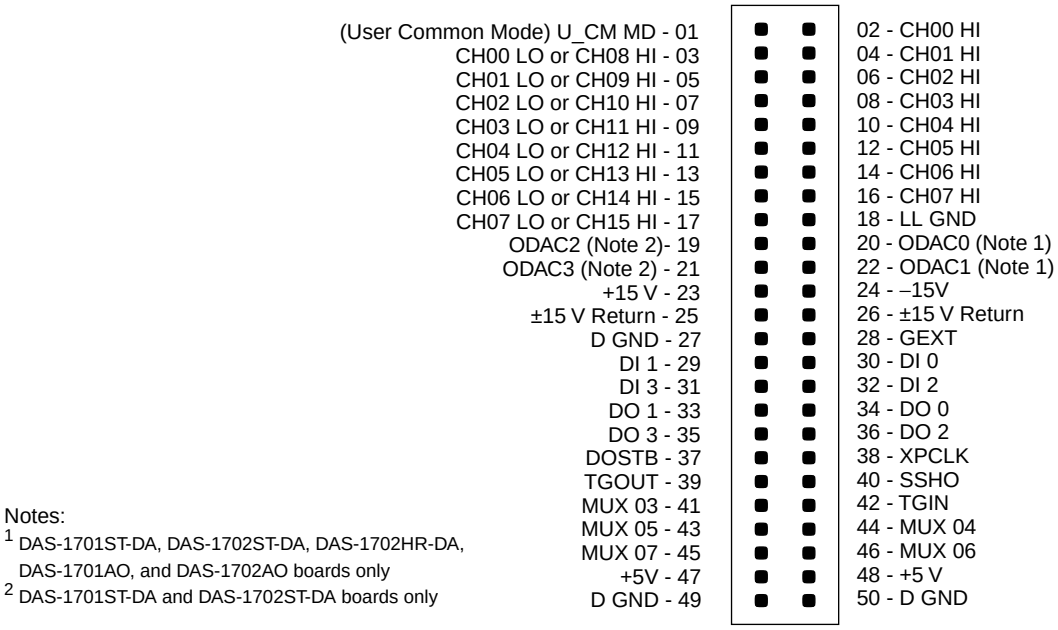
Notes:
[1] DAS-1701ST-DA, DAS-1702ST-DA, DAS-1702HR-DA, DAS-1701AO, and DAS-1702AO boards only
[2] DAS-1701ST-DA and DAS-1702ST-DA boards only

Figure B-1. Main I/O Connector

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STA-1800U I/O Connectors J1 and J2

Pin assignments for I/O connectors J1 and J2 of the STA-1800U screw terminal accessory are shown in Figure B-2.



Notes:
[1] DAS-1701ST-DA, DAS-1702ST-DA, DAS-1702HR-DA, DAS-1701AO, and DAS-1702AO boards only
[2] DAS-1701ST-DA and DAS-1702ST-DA boards only

Figure B-2. STA-1800U I/O Connectors J1 and J2

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STA-1800U I/O Connector J3

Pin assignments for I/O connector J3 of the STA-1800U screw terminal accessory are shown in Figure B-3.

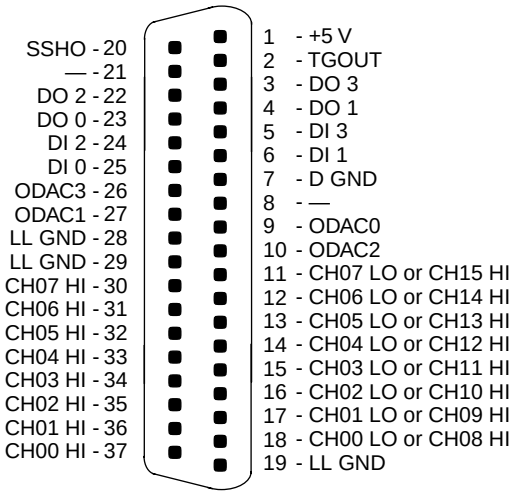


Figure B-3. STA-1800U I/O Connector J3

STA-1800U I/O Connectors J4 to J7 and Jumper Pads J8 to J11

Pin assignments for I/O connectors J4 to J7 and jumper pads J8 to J11 of the STA-1800U screw terminal accessory are shown in Figure B-4.

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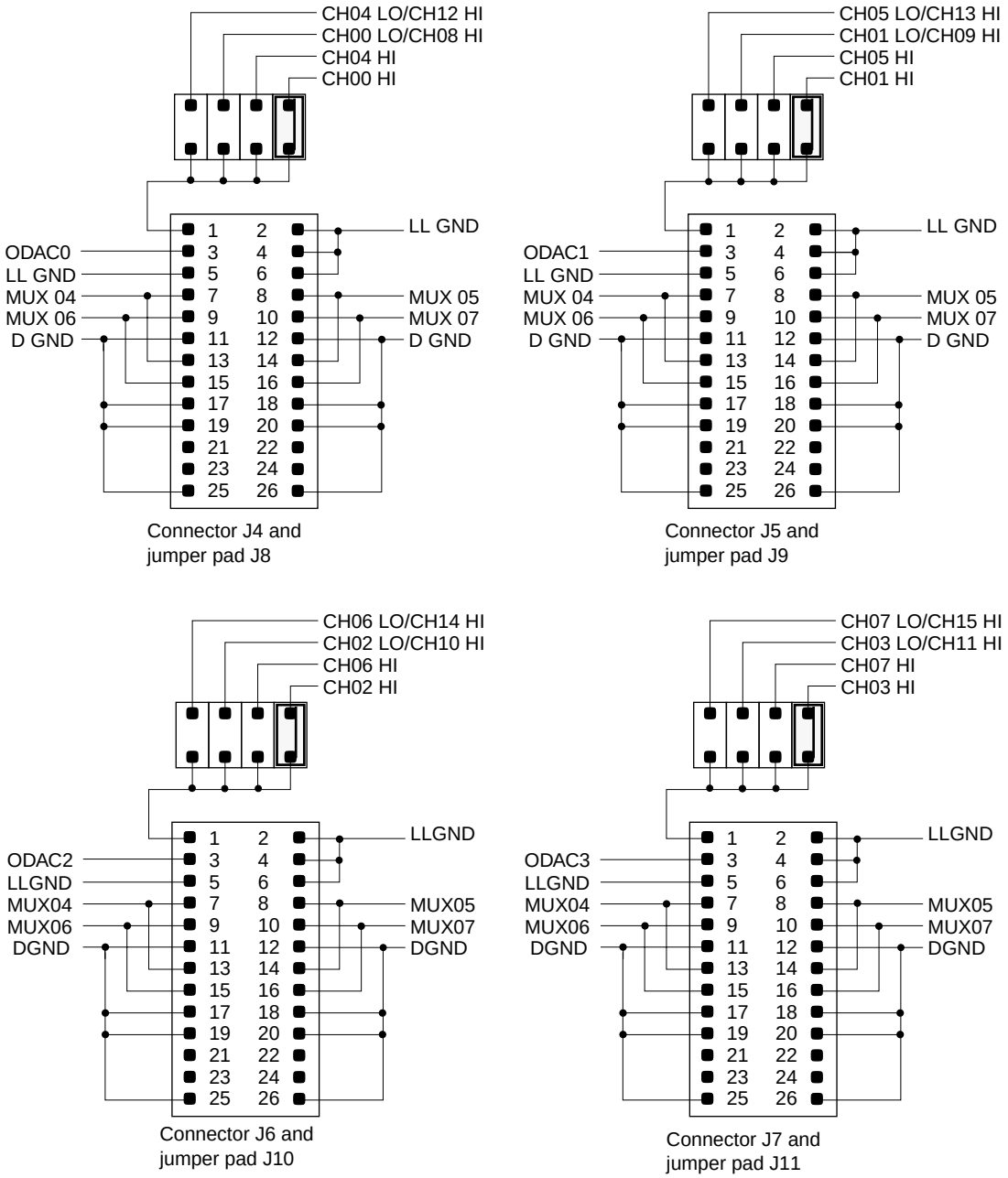


Figure B-4. STA-1800U I/O Connectors J4 to J7 and Jumper Pads J8 to J11

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C

DriverLINX Configuration Notes

This Appendix contains the following sections:

- **Configuration** — describes how DriverLINX works with DAS-1700 boards.
- **Special Device Settings** — describes settings used specifically for the DAS-1700 boards.
- **Implementation Notes** — describes how DriverLINX implements features of the DAS-1700 boards.
- **Analog Input Subsystem** — describes how to configure DAS-1700 analog inputs.
- **Analog Output Subsystem** — describes how DriverLINX is used to configure analog outputs.
- **Digital Input and Output Subsystems** — describes how DriverLINX is used for configuring digital inputs and outputs.
- **Counter/Timer Subsystem** — describes some of DriverLINX counter/timer functions.

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Configuration

The following section describes detailed information about how DriverLINX implements features of the Keithley DAS-1700 A/D boards.

Model

In this section, DAS-1700 refers to all models in the DAS-1700 Series. DAS-1701 refers to the models with low range analog output, while DAS-1702 refers to the models with high range analog output. A suffix, such as ST, designates models with certain features. The suffix XX-DA refers to both the ST-DA and HR-DA models. DriverLINX for the Keithley DAS-1700 supports the following models:

DAS-1701ST	DAS-1701ST-DA
DAS-1702ST	DAS-1702ST-DA
DAS-1702HR	DAS-1702HR-DA
DAS-1701AO	
DAS-1702AO	

The primary differences among these boards are number of input channels, A/D resolution, and analog output implementation. All DAS-1700 models are fully software programmable except for the base address. You must select the base address with a DIP switch. All 12-bit versions share the same maximum A/D conversion rate of 160 kHz. The 16-bit versions (DAS-1702HR and DAS-1702HR-DA) have a maximum A/D conversion rate of 50 kHz. All DAS-1700 models include a 1K sample FIFO buffer and support burst mode sampling, software programmable analog input gain and have a hardware channel/gain queue. The channel/gain queue supports out-of-sequence channels and different input channel gains.

The DAS-1701 boards have gains of 1, 5, 50, and 250 with unity gain input range of ±5V. The DAS-1702 boards have gains of 1, 2, 4, and 8 with unity gain input range of ±10V. The DAS-1700ST has 16 single-ended or eight differential analog input channels with 12-bit resolution, four digital input lines, and four digital output lines. The DAS-1702HR has 16-bit A/D resolution with a maximum sampling rate of 50 kHz and is otherwise the same as the ST. The DAS-1700AO features DMA data transfer and a 2K sample FIFO buffer for two 12-bit DACs and is otherwise the same as the ST. The DAS-1700ST-DA has four 12-bit DACs and the DAS-1702HR-DA has two 16-bit DACs.

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Address

The default address used by all DAS-1700 boards is 768 decimal or 0x300 hex. If you have more the one Keithley board or another peripheral card at the same address, you will have to change the DIP switch settings for the device address on the board.

Calibrate

The DAS-1700 does not support auto-calibration. The Device Configuration dialog box displays this setting as disabled.

A/D Channels

A/D channel configuration for the DAS-1700 boards is software programmable for 16 single-ended or 8 differential analog inputs.

A/D Volts

You must specify the minimum and maximum analog input, full-scale voltages at unity gain. For the DAS-1701 boards, the minimum voltage is -5V and the maximum voltage is +4.9976V. For the DAS-1702 boards, the minimum voltage is -10V. The maximum voltage is +9.9951V (12-bit A/D) and +9.9997V (16-bit DAS-1702HR).

D/A Volts

You must specify the minimum and maximum analog output, full-scale voltages at unity gain. Only the AO and XX-DA boards provide analog output. The output range for the XX-DA boards is bipolar only and is fixed at ±10 volts. For these boards, the minimum voltage is -10V. The maximum voltage is +9.9951V (12-bit DACs) and +9.9997V (16-bit DAS-1702HR-DA). The output range for the DAS-1700AO boards is bipolar only and is software programmable for ±10 volts or ±5 volts. For this board, unity gain minimum voltage is -5V and maximum voltage is +4.9976V.

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AI IRQ

You must select an interrupt request level to support IRQ or DMA mode data transfer. Valid IRQ levels are: 3, 5, 7, 10, 11, or 15. Two devices can share interrupt lines only if you don't use them at the same time.

AI DMA 1, AO DMA 1

You must select DMA and IRQ levels to support DMA mode data transfer for analog input. The DAS-1700AO also supports DMA operation for analog output. Valid DMA levels are: 5, 6, or 7. Two devices can share DMA levels only if you don't use them at the same time.

Clock

The counter/timer input from the master clock for analog input (and output for DAS-1700AO) has a fixed frequency of 5 MHz.

Special Device Settings

The DAS-1700 series driver has special settings. To specify these settings, you click the *Special* button on the *Device* property page and enter them in the *Configure DAS-1700 Options* dialog box.

Common-mode reference

The DAS-1700 has two options for the grounding single-ended analog inputs. They determine the ground reference for the A/D input amplifier.

- LL GND — references the analog ground
- U_CM MD — references the user-common ground

Use the U_CM MD setting to eliminate ground-loops.

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Number of EXP-1800s

You can expand the number of single-ended analog input channels connected to your DAS-1700 board by using one to sixteen EXP-1800 expansion boards. Each EXP-1800 is 1-to-16 multiplexer that replaces one onboard channel with sixteen expansion channels. Configure your DriverLINX Logical Device to use the additional channels by entering the number of EXP-1800s here. See “Analog Input Multiplexer” on page C-10 for details on accessing multiplexer channels.

Simultaneous sample and hold configuration

You can connect one to two external Simultaneous Sample and Hold (SSH-8) units to the DAS-1700 analog input subsystem. Enter the number of SSH-8s connected in the *Configure DAS-1700 Options* dialog box.

For each SSH-8 unit, select the number in the *SSH #* list box and enter the following configuration parameters:

- Base channel — specify which A/D input channel connects to an SSH-8 unit.
- Channel gain — click on the channel and then select its SSH-8 external amplifier gain.
- Channel offset — click on the channel and then select its channel offset.

Disable AO recycle mode

For the DAS-1700AO hardware, DriverLINX can automatically promote AO tasks meeting certain criteria to run from the DAC FIFO buffer in recycle mode. If the *Disable AO recycle mode* box is checked, DriverLINX will not use recycle mode. If the box is not checked, DriverLINX will use recycle mode for applicable tasks. See “Analog Output Subsystem” on page C-14 for details.

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Implementation Notes

The following section describes how DriverLINX implements features of the Keithley DAS-1700 A/D boards.

The following table summarizes the data acquisition modes that each subsystem on the Keithley DAS-1700 supports.

Table C-1. Modes Supported by DAS-1700 Models

Subsystem	Polled	Interrupt	DMA	Other
Analog Input	X	X	X	X
Analog Output	X	X	X[1]	X
Digital Input	X	X		X
Digital Output	X	X		X
Counter/Timer				X
Device				X

1. Only the DAS-1700AO boards support DMA transfer of data for Analog Output tasks.

The following table summarizes the operations implemented for each of the supported modes of the DriverLINX subsystem using the Keithley DAS-1700.

Table C-2. Allowed Operations and Events for Supported Subsystem Modes

Subsystem		Events		
Mode	Operation[1]	Timing	Start	Stop
Analog Input				
Polled	Start	rate, dig, null	cmd, dig, null	null, TC, dig
Interrupt	Start, Stop, Status	rate, dig	cmd, dig	cmd, TC, dig
DMA	Start, Stop, Status	rate, dig	cmd, dig	cmd, TC, dig
Other	Initialize			
Analog Output				
Polled	Start	null	null	null
Polled (1700AO)	Start	rate, dig, null	cmd, dig, null	null, TC, dig
Interrupt[2]	Start, Stop, Status	rate, dig	cmd, dig, null	cmd, TC, dig, null

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Table C-2. Allowed Operations and Events for Supported Subsystem Modes (cont.)

Subsystem Mode	Operation[1]	Events		
		Timing	Start	Stop
DMA (1700AO)	Start, Stop, Status	rate, dig	cmd, dig	cmd, TC, dig
Other	Initialize			
Digital Input				
Polled	Start	null	null	null
Interrupt	Start, Stop, Status	rate	cmd, dig	cmd, TC, dig
Other	Initialize			
Digital Output				
Polled	Start, Stop, Status	rate	cmd, dig	cmd, TC, dig
Interrupt	Start, Stop, Status	rate	cmd, dig	cmd, TC, dig
Other	Initialize			
Counter/Timer				
Other	Initialize			
Device				
Other	Initialize, Configure, Capabilities, Request, Release			

[1]All subsystems allow the MESSAGE operation and the Analog I/O subsystems allows the CONVERT operation which are not shown in this table.

[2]The DAS-1700AO does not support single value transfers in Interrupt mode and therefore null Start and Stop Events are not valid.

The following list explains the Event abbreviations in the preceding table:

null — Null or None Event when a Service Request doesn't require an event

cmd — Command Event when DriverLINX starts or stops a task on software command

TC — Terminal Count Event when DriverLINX processes all data buffers once

rate — Rate Event specifies how DriverLINX paces or clocks data transfer

dig — Digital Event specifies a trigger, clock, or other control signal to pace, start, or stop a task.

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Analog Input Subsystem

All the DAS-1700 models contain one A/D converter and a 16-channel multiplexer. You can configure the A/D inputs as 16 single-ended or 8 differential channels. The input channels, labeled **CH00HI** [26] and **CH00LO/CH08 HI** [2], etc., are located on the 50-pin Centronics-style male connector that projects through the rear panel of the computer.

All models provide software programmable input channel gain and a 256 location channel/gain queue. The hardware channel/gain queue enables high-speed sampling up to the maximum rate of channels out of sequence with different gain. You can also use it to sample the same channel more than once at different gains.

Analog Input Initialization

Initialization of the analog input subsystem aborts any active DMA or interrupt data acquisition tasks and stops the clock. Also, the driver checks for the presence of hardware and agreement with the configuration parameters.

Internal Clocking

Specify internal clocking using a Rate Timing Event as a rate generator (RATEGEN) on Logical Channel 0 with an internal source. For hardware independence, the application may specify the clock channel using the symbolic constant, DEFAULTTIMER, which always uses the Logical Channel assigned by hardware for analog input. With a 5MHz master clock, each tic is 200 ns.

Burst Mode Sampling

All DAS-1700 boards support burst mode sampling. To set up burst mode sampling, specify the *mode* field of a Rate Event as BURSTGEN. The *period* field is the time in clock tics between bursts. The *onCount* field is the time in clock tics between successive samples within a burst, and *pulses* specifies the number of samples in a burst. The number of pulses in a burst must equal the number of channels scanned in the burst. *POLLED*, *INTERRUPT*, and *DMA* modes can support burst mode sampling, but

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exceeding the maximum sustainable acquisition rate in each mode will cause loss of data. Also, the duration specified in the *onCount* field must be within the range of 6µs (30 tics) minimum (20µs for DAS-1700HR) to 64µs (320 tics) maximum.

Repeat Mode Sampling

The DAS-1702HR-DA provides an option to sample the same channel 1 to 4095 times before advancing to the next channel in the channel/gain queue. To set up repeat mode sampling, choose a rate or burst timing event as described above. Bit-wise OR the *pulses* field with PULSE_REPEAT_COUNT_FLAG to set the MSB. Specify the number of pulses in each burst in the low-order word of the *pulses* field by using a bit-wise AND with PULSE_COUNT_MASK. Specify the repeat count in the high-order word by using a bit-wise AND with PULSE_REPEAT_COUNT_MASK.

External Clocking

Specify external clocking using a Rate Timing Event on channel 0 with an external clock source specified. For hardware-independence, you can specify the hardware external clock channel by the symbolic constant, *DI_EXTCLK*. Connect the external clock source to **XPCLK** [44]. The hardware external clocking feature of the DAS-1700 supports positive or negative active edge clocking. BE SURE that external clock source is TTL compatible, 0V minimum to +5V maximum!

External Triggering

Specify external triggering using a Digital Start Event reading from the 4-bit digital input port (channel 0) or external trigger input (channel 2). For hardware-independence, you can specify the hardware external trigger channel by the symbolic constant, *DI_EXTTRG*. Digital Start Events contain *mask*, *pattern*, and *match* fields. The mask is logically AND with the digital input data on the Logical Channel and then compared against the *pattern* for a match/mismatch. DriverLINX will use hardware triggering if the Digital Start Event corresponds to a positive or negative edge at trigger input, **TGIN** [46].

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External Gating

DriverLINX implements external gates using a Timing Event with the Generator Gated by the **TGIN**[46] input. Acquisition is active while the **TGIN** input is at TTL high.

Simultaneous Sampling

The DAS-1700 hardware and DriverLINX support simultaneous sampling through the SSH-8 accessory. Specify the A/D channels connected to the SSH-8 and the SSH-8 amplifier gain values in the *Configure DAS-1700 Options* dialog box. See “Special Device Settings” on page C-4.

Select BURST mode for the Timing Event and set the *onCount* to 0. This represents zero time between sampling each channel (simultaneous sampling). Refer to the appropriate hardware user’s manual for cabling requirements.

Analog Input Multiplexer

The EXP-1800 Input Multiplexers can expand the number of physical channels to 256 single-ended analog input channels. The DAS-1700 hardware automatically switches the multiplexer channels. This feature allows acquisition from the multiplexer channels in DMA mode.

To enable DriverLINX to use multiplexer(s), select the “16 SE” option for Analog Input Channels in the Device Configuration dialog box. Then enter the number of EXP-1800s in the Special Device Settings dialog. With this configuration, DriverLINX treats the DAS-1700 as having a possible 272 Logical Channels, instead of 16 analog input channels. Channels 0-15 refer to the native analog input channels on the DAS-1700 while channels 16-271 address one of the 256 mux channels.

While a DAS-1700 with 16 external multiplexers has 272 logical channels, it still has only 256 physical channels. Each mux supports 16 channels and the hardware electronically switches the 16 mux inputs to the one physical channel on the DAS-1700 where you attached the mux. Therefore, addressing a native channel (0-15), which has a mux attached, is logically equivalent to directly addressing the lowest numbered channel on the attached mux.

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DriverLINX uses a static addressing scheme for attaching multiplexers that differs from how the hardware and Keithley's ASO software address a mux channel. In the DriverLINX scheme, removing an input from one native channel and attaching a mux to that input channel doesn't change the logical addresses of any other input channel. Also, if you reattach the input you removed from the native channel to the first mux channel, existing software can still read that input at its original logical address.

To determine the DriverLINX Logical Channel number for an EXP-1800 Multiplexer channel, use the following formula or refer to the following table. Note that DriverLINX uses a 0-based numbering scheme for all analog input channels and "a/d chan" refers to the native physical channel on a DAS-1700 where you attached the mux.

$$\text{logical chan} = (\text{a/d chan} + 1) \times 16 + \text{mux chan}$$

For example, the Logical Channel address for mux channel 4 attached to analog channel 3 is:

$$\mathbf{(3 + 1) \times 16 + 4 = 68.}$$

To specify multiplexer input channels 1, 2, and 3 for an EXP-1800 connected to native input channel 0, add 16, 32, and 48 to the channel/gain list.

Table C-3. Table of logical channel numbers for eight external EXP-1800 Multiplexers

	Native Chan **Mux #**	**0** **MUX #1**	**1** **MUX #2**	**2** **MUX #3**	**3** **MUX #4**	**4** **MUX #5**	**5** **MUX #6**	**6** **MUX #7**	**7** **MUX #8**	**etc.**
MUX Input Chan #										
0		16	32	48	64	80	96	112	128	
1		17	33	49	65	81	97	113	129	
2		18	34	50	66	82	98	114	130	
3		19	35	51	67	83	99	115	131	
4		20	36	52	68	84	100	116	132	
5		21	37	53	69	85	101	117	133	
6		22	38	54	70	86	102	118	134	

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Table C-3. Table of logical channel numbers for eight external EXP-1800 Multiplexers (cont.)

	Native Chan Mux #	0 MUX #1	1 MUX #2	2 MUX #3	3 MUX #4	4 MUX #5	5 MUX #6	6 MUX #7	7 MUX #8	etc.
MUX Input Chan #										
7		23	39	55	71	87	103	119	135	
8		24	40	56	72	88	104	120	136	
9		25	41	57	73	89	105	121	137	
10		26	42	58	74	90	106	122	138	
11		27	43	59	75	91	107	123	139	
12		28	44	60	76	92	108	124	140	
13		29	45	61	77	93	109	125	141	
14		30	46	62	78	94	110	126	142	
15		31	47	63	79	95	111	127	143	

Data Coding

The DAS-1700 converts the analog input signal data and returns its value in an integer format. For bipolar mode, the hardware returns A/D data as 2's complement in the range of -2048 to 2047 for 12-bit and -32768 to 32767 for 16-bit A/Ds. For unipolar mode, the hardware returns data as straight binary. The range is 0 to 4095 for 12-Bit ADCs and 0 to 65535 for 16-Bit ADCs.

The DAS-1700 returns data in integer format for all data transfer modes—*POLLED*, *INTERRUPT*, and *DMA*. The "native" data format of all DAS-1700 A/D boards is integer. There are no channel "tags." The 12 least significant bits of the word contain the 12-bit A/D data (right justified). In bipolar mode, the four most significant bits all contain the

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sign. For a 12-bit A/D at a gain of 1 in the ±10 V range (bipolar mode), the voltage resolution would be:

$$\frac{20V}{4096} = 4.88mV$$

Input Voltage	A/D Binary Value
-10.0V	-2048
0.0V	0
+0.00488V	1
+9.99512V	2047

For a 12-bit A/D at a gain of 1 in the 0 to +10 V range (unipolar mode), the voltage resolution would be:

$$\frac{10V}{4096} = 2.44mV$$

Input Voltage	A/D Binary Value
0.0V	0
+5.0V	2048
+0.00244V	2049
+9.99756V	4095

The values returned by the A/D converter range from -2048 to 2047 in bipolar mode and 0 to 4095 for unipolar mode independent of the gain or channel configuration. For a 12-bit A/D at a gain of 100 in the ±100 mV range (bipolar mode), the voltage resolution would be:

$$\frac{200mV}{4096} = 48.8\mu V$$

Input Voltage	A/D Binary Value
-100.0V	-2048
0.0V	0
48.8µV	2046
+99.9512V	2047

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A/D Conversion Delay

The maximum A/D conversion delay is 833 seconds (13 min, 53 sec) or a minimum sampling rate of 0.0012 Hz with a 5 MHz master clock input frequency.

The minimum A/D conversion delay is 30 clock tics at 200 ns per tic (5 MHz clock) or 6µs. The DAS-1700HR models (16-bit) can sample at a maximum rate of 50kHz. The other models (12-bit) can sample at a maximum rate of 160kHz.

A/D Data Lost

The DAS-1700 provides hardware monitoring of A/D data overruns. DriverLINX notifies applications that an overrun has occurred by posting an event message, DL_DATALOST. DriverLINX only posts this message the first time the board detects an overrun during an acquisition task. The DAS-1700 hardware will stop acquisition when an overrun has occurred.

Analog Output Subsystem

The DAS-1700ST-DA models offer four channels of multiplying 12-bit D/A converters, and DAS-1702HR-DA models offer two channels of multiplying 16-bit D/A converters. The DAS-1700ST and DAS-1702HR models do not provide analog output.

The DAS-1700AO models offer two channels of multiplying 12-bit D/A converters that support DMA mode of data transfer at continuous output rates of up to 250 kHz. A 2K sample FIFO buffer allows continuous, gap-free data transfer for data buffers larger than 2K. Alternatively, for data buffers smaller than 2K samples, the AO task can “free-run” entirely from the on-board DAC FIFO buffer using the board’s re-cycle mode.

For the DAS-1700AO hardware, DriverLINX can automatically promote AO tasks meeting the following criteria as specified in the Service Request to run from the DAC FIFO buffer in re-cycle mode:

Mode = INTERRUPT
Stop Event type = COMMAND
Notify flag (in buffer list) = FALSE
Data buffer samples < 2048

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The advantages of using the DAC FIFO buffer for free-run, re-cycle mode analog output are:

- traffic on the memory bus is significantly reduced at high output rates
- the system response latency will be noticeably shortened
- the analog output timing will be immune to traffic on the memory and I/O buses.

The disadvantages are:

- you can't change the analog output values while the analog output task is running
- there is a delay while DriverLINX loads the FIFO
- buffer-filled notification messages cannot be posted as the hardware does not permit detection of end-of-buffer conditions
- the *STATUS* operation cannot provide the "number of buffers processed" report.

You can disable automatic promotion to re-cycle mode by DriverLINX. This forces all AO tasks to run from computer memory instead of the DAC FIFO. See "Special Device Settings" on page C-4.

Analog Output Initialization

By default, the Analog Output subsystem loads zero into both D/A channels forcing the initial output voltage to zero. You can specify a different initial output voltage using the DriverLINX *Configuration Control Panel*.

Internal Clocking

Specify internal clocking using a Rate Timing Event as a rate generator (RATEGEN) on Logical Channel 0 (channel 1 for DAS-1700AO) with an internal source. For hardware independence, the application may specify the clock channel using the symbolic constant, DEFAULTTIMER, which always uses the Logical Channel assigned by hardware for analog output.

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Synchronous Analog Input/Output Clocking

The DAS-1700AO is ideal for use in “stimulus/response” type applications where a signal is applied to a “circuit” to determine its response characteristics (such as propagation delay time). The output response of the circuit must be measured simultaneously with the application of the stimulus to immediately capture the response for precise calculation of delay times and phase angles. This technique will eliminate the measurement errors caused by asynchronous analog I/O.

DriverLINX supports synchronous analog I/O using a shared pacing clock source. To synchronize analog input with analog output, set up two service requests as follows:

1. Analog Output Service Request (SR). The Timing Event should be a Rate Generator using Logical Channel 0 (AI clock). This specifies that the AO SR will use the same pacing source as the next, or currently active, AI SR. The Period must be 0.
2. Analog Input SR with any valid Timing Event. When the AI task starts sampling, the AO task will also sample using the same clock source (internal or external).

Although both SRs share the same clock source, they are otherwise logically independent of each other. Your application must manage and respond to each Service Request separately. If the AI task terminates before the AO task, the AO task will still be logically active, but the clock will send timing pulses to the AO task until the next AI task starts. If you want to terminate the AO task when the AI task stops, either set up both SRs with equal buffer sizes and Stop Events, or issue a Stop operation request for the AO task.

External Clocking

Specify external clocking using a Rate Timing Event on channel 0 with an external clock source specified. For hardware-independence, you can specify the hardware external trigger channel by the symbolic constant, *DI_EXTCLK*. Connect the external clock source to **XPCLK** [44]. The hardware external clocking feature of the DAS-1700 supports positive or negative active edge clocking. BE SURE that external clock source is TTL compatible, 0V minimum to +5V maximum!

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External Triggering

Specify external triggering using a Digital Start Event reading from the digital input port (channel 0) or external trigger input (channel 2). For hardware-independence, you can specify the hardware external trigger channel by the symbolic constant, *DI_EXTTRG*. Digital Start Events contain *mask*, *pattern*, and *match* fields. The mask is logically AND with the digital input data on the Logical Channel and then compared against the *pattern* for a match/mismatch. DriverLINX will use hardware triggering if the Digital Start Event corresponds to a positive or negative edge at input port line, **TGIN** [46]. During an AO task running in the recycle mode, if Simultaneous = TRUE, and the Start Event is a hardware Digital Input trigger, the DI event will restart the FIFO pointer to beginning.

Data Coding

The output range of each D/A channel is fixed at ±10V for all DAS-1700 boards except the DAS-1700AO which has two software programmable ranges; ±5V and ±10V.

The DAS-1700ST-DA uses 2's complement data coding for the four 12-bit D/A channels. The output range is fixed at ±10 volts. The minimum DAC code is -2048 (-10V) and the maximum code is +2047 (+9.9951V).

The DAS-1702HR-DA uses 2's complement data coding for the two 16-bit D/A channels. The output range is fixed at ±10 volts. The minimum DAC code is -32768 (-10V) and the maximum code is +32767 (+9.9997V).

The DAS-1700AO uses 2's complement coding. The two 12-bit DACs have two independently controllable, software programmable output ranges of ±5V and ±10V.

The minimum DAC code is -2048 (-5 or -10V) and the maximum code is +2047 (+4.9976 or +9.9951V).

Select the analog output range by using the Gain2Code support function that returns the hardware value to the *channelGain* field (*startGainCode* VB property) of the Service Request. Select a gain of -1 for ±5V and a

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gain of -2 for ±10V. The negative sign implies bipolar operation. (Unipolar mode is not available for analog output).

If you select the ±5V range, the D/A output range will be from -5 to +5V as follows:

$$\text{Voltage Resolution} = \frac{10\text{V}}{4096} = 2.4414\text{mV}$$

Binary Value	D/A Output Voltage
-2048	-5.0000V
0	0.0000V
1	+2.4414mV
+2047	+4.9976V

D/A Conversion Delay

The DAS-1700AO has a dedicated counter/timer for analog output, which provides the ability to pace D/A conversions in hardware. This board supports Polled, Interrupt, and DMA modes of data transfer. Minimum conversion delay is primarily a function of the D/A mode selected and operating parameters of other active tasks, if any. The DAC hardware is capable of converting data at 250 kHz. It will run at that rate under Windows with DriverLINX if the D/A task runs alone or in the re-cycle mode with an active analog input task. On a typical 486DX2/66-based computer, running in the synchronous analog input/output mode, a 50 kHz rate for each task is easily attainable without degrading overall system performance. If both AI and AO tasks use DMA (different channels), 160 kHz for each is achievable, but system response noticeably slows.

The other DAS-1700 models cannot support direct hardware timing of D/A output. D/A conversions are timed using either software polling of the analog input counter/timer or interrupts from A/D end-of-conversion signal. Either technique requires software to update the hardware registers with new values as rapidly as possible after a clock event occurs. Variations in interrupt latencies and bus timing will add noticeable jitter to D/A signals output at high rates. You should run empirical tests to determine suitability of D/A output for the intended purpose.

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The D/A conversion delay to output a periodic waveform with a given number of samples per period is simple to determine. For example, the conversion delay for a 200 Hz wave with 100 samples/cycle is

$$T = \frac{1}{\text{frequency}} = \frac{1}{200\text{Hz}} = 5\text{ms}$$

$$\text{D/A conversion delay} = \frac{5\text{ ms}}{100\text{ samples}} = 50\text{ ms}$$

D/A Data Lost

DAS-1700AO models provide hardware monitoring of DAC FIFO underflow in DMA and Interrupt modes only. DriverLINX notifies applications that data loss has occurred by posting an event message, DL_DATALOST. The task will become inactive once this error occurs and the hardware will stop data transfer.

Digital Input and Output Subsystems

Logical Channels

For logical channel 0, the digital input port is a composite of the signals **DI 0**, **DI 1**, **DI 2**, **DI 3** and the output port is a composite of the signals **DO 0**, **DO 1**, **DO 2**, **DO 3**.

Logical Channel	Physical Digital Input	Physical Digital Output
0	DI 0-3	DO 0-3
1		MUX4 - MUX7 + GEXT
2	TGIN	

You can use the external multiplexer outputs **MUX4-7** as pseudo digital outputs for applications requiring more than 4 digital outputs. Since the channel/gain QRAM controls the state of these outputs, changes to the state of these lines during active analog input tasks is not possible as it is for **DO 0-3**. You must output the data for logical channel 1 (MUX port) before starting an analog input task. The hardware maintains the last value written to this port until you change it with another task.

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The DAS-1700 implements digital hardware Stop Event triggers (**TGIN**) using a counter/timer to count the number of samples specified for the Stop Event *Delay*. The value must be greater than zero and is the number of samples acquired since the Start Event. If you specify a Digital Start Event and a Digital Stop Event, the Stop Event must be exactly the same as the Start Event.

DriverLINX implements all digital I/O on the DAS-1700 boards as immediate, single-value transfers on execution of the Service Request. All digital I/O is right-justified. DriverLINX ignores unused bits on output and returns zero on input. Logical Channel 0 Digital Inputs return 4-bit values.

Digital Input Initialization

Logical Channel 0 is unchanged by initialization.

Digital Output Initialization

Initialization of the Digital Output subsystem resets the value of all outputs to zero.

Digital I/O Conversion Delay

For Digital I/O on Logical Channel 0, you may use the same clocking technique as discussed for the analog output subsystem in Interrupt modes.

Digital I/O Data Lost

The hardware cannot detect Digital I/O data overruns so DriverLINX does not send the DL_DATALOST message when digital overruns occur.

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Counter/Timer Subsystem

The DAS-1700 uses an Intel 8254 Programmable Interval Timer that consists of 3 internal 16-bit counters, Counter 0, Counter 1, and Counter 2. For A/D pacing, the DAS-1700 boards operate Counters 1 and 2 in a fixed divider, 32-bit configuration. The input of Counter 1 connects to a 5 MHz crystal oscillator and the output of Counter 1 connects to the input of Counter 2. The DAS-1700 uses Counter 0 for trigger delay and its input, output, and gate control are not available.

Although the DAS-1700 uses a chip that has three counters, it ties two of them together internally (Counters 1 and 2) and dedicates the third to internal functions. Therefore, DriverLINX implements only one logical counter, Logical counter 0, which corresponds to the internal A/D pacing clock (8254 counters 1 and 2). You can use Logical counter 0 to pace Analog Output or Digital I/O tasks indirectly through hardware interrupts. The DAS-1700AO has an additional counter/timer for supporting timed Analog Output tasks in hardware. DriverLINX implements two logical counters in this case, Logical counter 0, which corresponds to the internal A/D pacing clock, and logical counter 1, which corresponds to the internal D/A pacing clock.

Counter/Timer Initialization

Power-up state of the counters is undefined. Initialization establishes the state of each counter as a binary rate generator with a down count of 65535.

Counter/Timer Interrupt

DriverLINX supports counter/timer interrupts indirectly. You can set up an INTERRUPT mode A/D task and use the interrupts to pace the counter/timer task.

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D

CE Information for the DAS-1700 Series

Note: Products that contain the CE mark are certified to meet European EMC directive 89/336 EEC. If this directive is not of importance to your application, please disregard the information in this document.

Keithley certifies that this product has been tested and found to be in compliance with the EMC directive and relevant harmonized standards.

This document describes the limitation of certification, the declaration of conformity, and the cabling instructions required for the CE configuration.

Limitation of Certification

This certification applies only to the operation of the product (with specified cables and accessories) in the stated configuration and under the stated operational and environmental specifications. Any modification, misuse, or improper or inadequate maintenance of the product by the user voids this certification.

Any deviation from the specific configuration may cause emissions or susceptibility not within the allowed limits required by the stated directive. It is the user's responsibility to demonstrate and maintain compliance with the directive and standards.

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Please read the next section, “Declaration of Conformity,” for the specific testing configuration for this product. Consult the Keithley Instruments GMBH office (European importer) or Technical Support in USA, for further information regarding the exact configuration details and testing.

Declaration of Conformity

Application of Council Directive(s)	89/336/EEC
Standard(s) to which Conformity is Declared	EN50081-1, EN50082-1
Manufacturer’s Name	Keithley
Importer’s Name	Keithley Instruments GMBH
Importer’s Address	Landsberger Str.65 D-82110 Germering, Munich
Type of Equipment	Data Acquisition Plug-in Boards
Model Numbers	DAS-1701ST, DAS-1702ST, DAS-1701ST-DA, DAS-1702ST-DA, DAS-1702HR, DAS-1702HR-DA, DAS-1701AO, or DAS-1702AO with EXP-1800, an ENCL Series enclosure, FWA-EXP, FWA-1800U, and SDAS-2000
Year of Manufacture	1996

I, the undersigned, hereby declare that the equipment specified above conforms to the above Directive(s) and Standard(s).

Place: Taunton, MA USA



(Signature)

Date: 01 August 1996

Mark Urban
(Name)

Quality Assurance Manager
(Position)

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Cabling Instructions for the CE Configuration

When using an EXP-1800 as part of the CE configuration, you must use an ENCL Series enclosure. The ENCL-1 supports one EXP-1800, the ENCL-2 supports two EXP-1800s, and the ENCL-4 supports four EXP-1800s.

Each version of the ENCL Series enclosure contains slotted board guides and a rear panel that accommodates the rear connectors of each installed EXP-1800. To install an EXP-1800 in an ENCL Series enclosure, perform the following steps:

1. Remove the four standoffs from each EXP-1800 to be installed.
2. Insert the EXP-1800 into the slots of a pair of board guides.
3. Gently push the EXP-1800 toward the rear of the desktop enclosure until the front-panel screws meet the tapped holes on the board guides.
4. Fasten the front-panel screws to the board guides.

An ENCL-4 containing four EXP-1800s is shown in Figure D-1.



Figure D-1. ENCL-4 Enclosure with Four EXP-1800s Installed

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Once the EXP-1800 is installed in the ENCL Series enclosure, connect the EXP-1800 directly to the main I/O connector of a DAS-1700 Series board through the SDAS-2000 cable, as shown in Figure D-2. Figure D-2 also shows where to attach the FWA-EXP and FWA-1800U. Refer to the *DAS-1700 Series User's Guide* and the *EXP-1800 User's Guide* for more information.

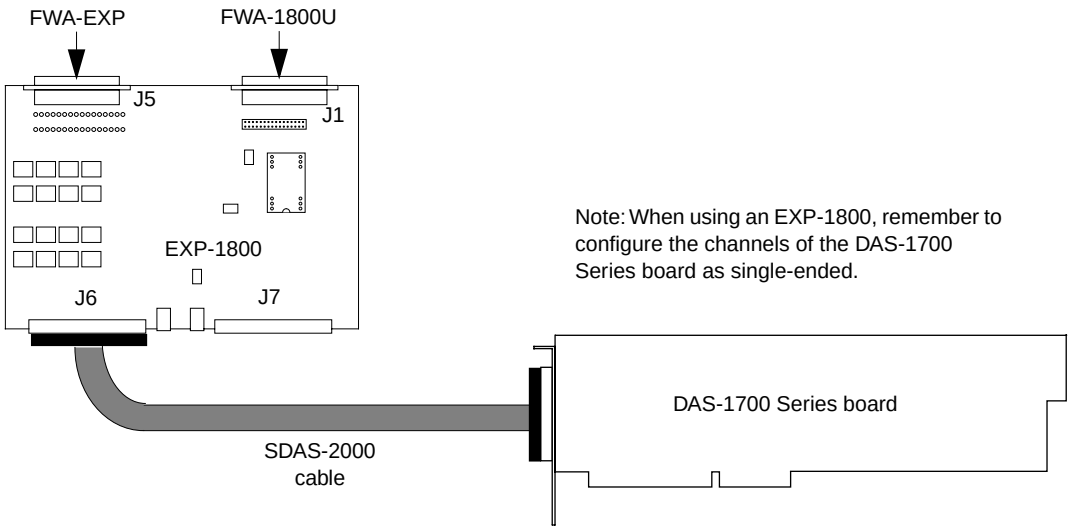


Figure D-2. Connecting the DAS-1700 Series Board to an EXP-1800, FWA-EXP, and FWA-1800U

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