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KEITHLEY

DAS-1800ST/HR Series

User's Guide



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User's Guide

Revision H - June 2002
Part Number: 90090

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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

This guide is intended to help you understand the installation, interface requirements, functions, and operation of the DAS-1801ST, DAS-1802ST, DAS-1802HR boards and their D/A (digital-to-analog) versions, the DAS-1801ST-DA, DAS-1802ST-DA, and DAS-1802HR-DA. Unless this guide refers specifically to one of these boards, the guide refers to all boards collectively as the DAS-1800ST/HR Series boards. At the same time, the term *DAS-1800 Series* refers to all members of the DAS-1800 family of data acquisition boards.

This guide focuses primarily on describing the DAS-1800ST/HR Series boards and their capabilities, setting up the boards and their associated software, making typical hookups, and operating the DriverLINX software. There are also chapters on calibration and troubleshooting. 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-1800ST/HR Series User's Guide* is organized as follows:

- Section 1 describes features, accessories, and software options of the boards.
- Section 2 describes operating features of the boards in more detail. This section contains a block diagram and brief descriptions of the features as they relate to your options for setting up and using the boards.
- Section 3 contains instructions for inspection, software installation, configuration, and board installation.
- Section 4 shows the preferred methods for making I/O (Input/Output) connections, using the available accessories and cables.

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- Section 5 briefly describes the DriverLINX Analog I/O program and Test program.
- Section 6 describes calibration requirements and gives instructions for starting the DriverLINX calibration program.
- Section 7 contains information on isolating and determining the source of operating problems. This section also contains instructions for obtaining technical support.
- Appendix A lists the specifications for DAS-1800ST/HR Series boards.
- Appendix B lists the pin assignments for the main I/O connectors of DAS-1800ST/HR Series boards and for the I/O and accessory connectors of STA-1800U screw terminal accessories.
- Appendix C contains DriverLINX configuration information for the DAS-1800 Series boards.
- An index completes this manual.

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1

Overview

The DAS-1800ST/HR Series of data acquisition boards consists of the following basic models: DAS-1801ST, DAS-1802ST, and DAS-1802HR. The basic models all accept analog input signals and perform A/D (analog-to-digital) conversions. If analog output is also required, these models are available with a D/A (digital-to-analog) conversion option under the following designations: DAS-1801ST-DA, DAS-1802ST-DA, and DAS-1802HR-DA.

The DAS-1800ST/HR Series boards are high-performance data acquisition boards that operate 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 drive, one fixed disk drive, and one floppy disk drive
- Microsoft Windows 95/98, or Windows NT 4.0 or higher
- a compiler supporting Microsoft Windows development
- a mouse is highly recommended.

The DAS-1801ST is a 12-bit, high-gain board, while the DAS-1802ST is a 12-bit, low-gain board. The DAS-1802HR is a 16-bit, low-gain board.

Major features of these boards are as follows:

- The boards make 16-bit data transfers on the AT bus.
- The boards are software-configurable for 16 single-ended or eight differential onboard analog input channels or up to 256 analog input channels using expansion accessories.
- Channels are individually software-configurable for gain.
- DAS-1800ST Series boards acquire data at up to 333 ksamples/s and 12-bit resolution.

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- DAS-1802HR boards acquire data at up to 100 ksamples/s and 16-bit resolution.
- DAS-1800ST-DA Series boards contain four 12-bit DACs (digital-to-analog converters) whose channels are updated simultaneously.
- DAS-1802HR-DA boards contain two 16-bit DACs that are updated simultaneously.
- A 1024-location FIFO (first-in, first-out data buffer) ensures data integrity at all sampling rates.
- A 256-location channel-gain queue supports high-speed sampling at the same or different gains, in sequential or non-sequential channel order, and at the board's maximum acquisition rate.
- Burst-mode data acquisition emulates simultaneous-sample-and-hold (SSH) capability.
- The DAS-1800ST Series boards support external SSH hardware; DAS-1800ST Series boards support EXP-1800 expansion accessories operated at gains of 1 and 50, while DAS-1802HR boards support EXP-1800 accessories at a gain of one only.
- External expansion accessories allow a board to acquire data from up to 256 channels at the board's maximum acquisition rate.
- Dual-channel DMA (Direct Memory Access) operation allows the acquisition of more than 64 ksamples.
- Pulsed interrupts allow multiple boards to share interrupt levels.
- Hardware trigger and gate for A/D conversions have software-selectable polarity.
- Triggering capabilities support pre-, post-, and about-trigger acquisitions.
- The boards have four digital inputs.
- The boards have four digital outputs with a latch strobe.
- All user connections are made through the 50-pin main I/O connector at the rear panel of the computer.
- All features are software-programmable except for a board's base address switch.
- The boards provide ±15V and +5V power for external circuitry.

For more information on these features, refer to the Functional Description in Section 2.

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Supporting Software

The following software for DAS-1800ST/HR Series boards supports all currently available DAS-1800 Series boards:

- **DAS-1800ST/HR Series standard software package** — Shipped with DAS-1800ST/HR 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-1800ST/HR Series hardware.
  - *Analog I/O Panel* — A DriverLINX program that verifies the installation and configuration of DriverLINX to your DAS-1800ST/HR 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* — application programming interface files for the DAS-1800ST/HR Series.
  - *LabVIEW support for DriverLINX* — application programming interface files for the DAS-1800ST/HR Series.
  - *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-1800ST/HR Series hardware.

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- **DAS-1800ST/HR Series utilities** — The following utilities are provided as part of the DAS-1800ST/HR Series standard software package:
  - *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-1800ST/HR Series boards.

- **STA-1800U** — Screw terminal accessory. This accessory connects to the main I/O connector of DAS-1800ST/HR Series boards through a CDAS-2000 cable to make all I/O signals accessible through labeled screw terminals.
- **STP-50** — Screw terminal panel. This accessory provides general-purpose screw-terminal connections in a compact form factor.
- **RMT-02** — Rack mount enclosure for the STA-1800U accessory.
- **SSH-8** — An 8-channel, 12-bit, simultaneous sample-and-hold accessory for DAS-1800ST Series boards. Refer to the *SSH-8 User's Guide* for more information.
- **MB Series modules and MB01/02 backplanes** — Plug-in, isolated, signal-conditioning modules and backplanes. Refer to the *MB Series User's Guide* for more information.
- **EXP-1800** — A 16-channel expansion accessory that connects directly to DAS-1800ST/HR Series boards. Refer to the *EXP-1800 User's Guide* for more information.
- **PG-408A** — DC/DC converter. This accessory must be installed on EXP-1800 accessories that use external power.
- **C16-MB1** — A cable with a 37-pin, female, D-type connector and a 26-pin, female header connector for connecting an STA-1800U to an MB01 backplane.

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- **C-2600** — A 24-inch cable for connecting an STA-1800U to an MB02 signal-conditioning backplane.
- **CDAS-2000 Series** — The CDAS-2000 is a 24-inch ribbon cable for connecting a DAS-1800ST/HR Series board to an STA-1800U, an STP-50, or an EXP-1800. The CDAS-2000/S is a 24-inch shielded version of the CDAS-2000; this cable is recommended for use with a DAS-1800HR Series board.
- **CAB-50 Series** — The cable you use to form a daisy chain of EXP-1800s; this cable is available in two lengths, as follows: the CAB-50 is 4 inches long, and the CAB-50/1 is 18 inches long.
- **CACC-2000** — A 24-inch ribbon cable for daisy chaining additional STA-1800U accessories to the first STA-1800U or additional EXP-1800 accessories to the first EXP-1800.
- **C-1800** — An 18-inch ribbon cable with two 37-pin, female, D-type connectors for connecting an STA-1800U to an SSH-8.

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2

Functional Description

This section describes the features of the analog input, analog output (when applicable) and digital I/O sections of the DAS-1800ST/HR Series boards. The intent of these descriptions is to familiarize you with the operating options and to enable you to make the best use of your board. The block diagram in Figure 2-1 represents the basic DAS-1800ST/HR Series boards. Figure 2-2 is a block diagram of the DAS-1800ST-DA Series boards, and Figure 2-3 is a block diagram of the DAS-1802HR-DA board.

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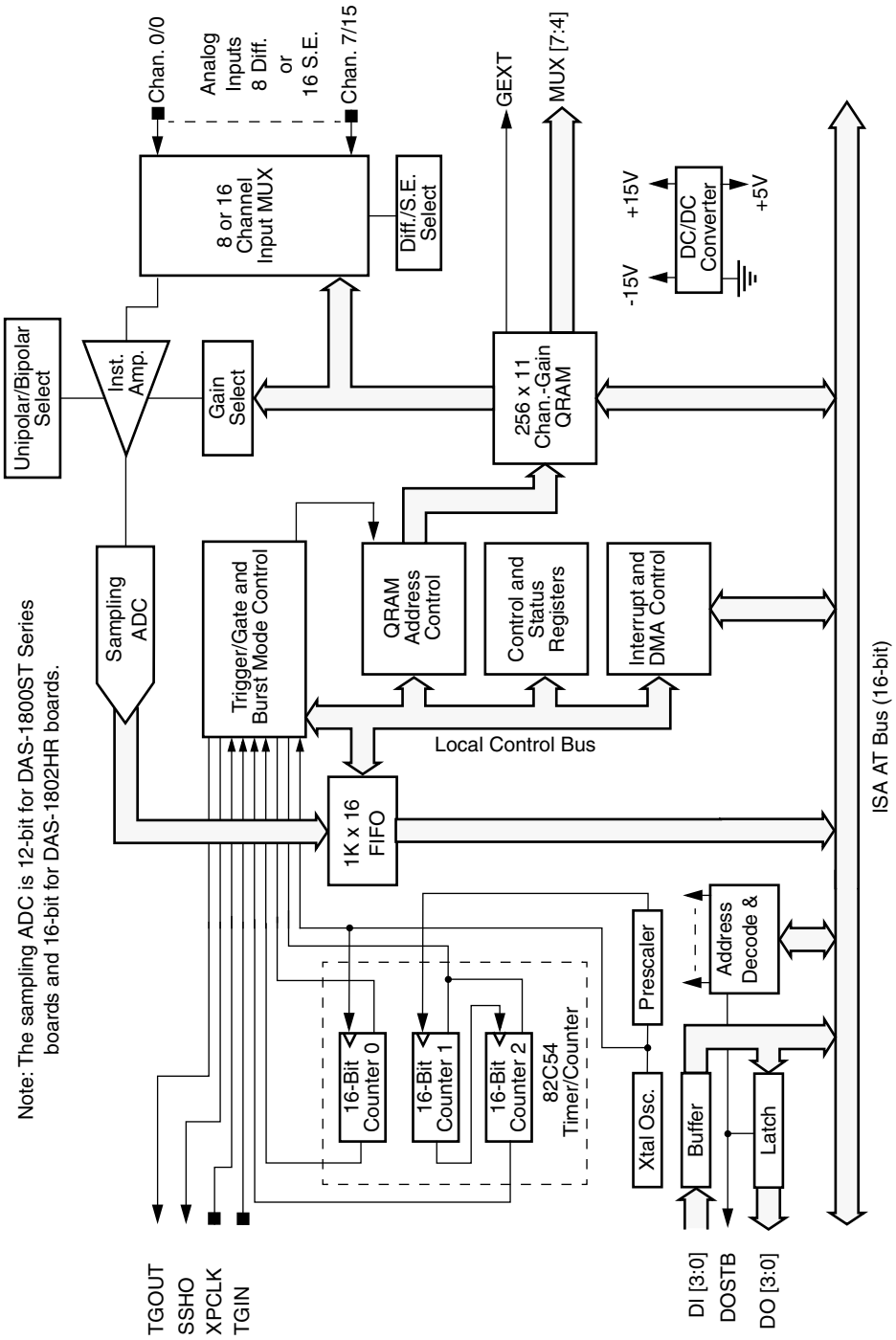


Figure 2-1. Block Diagram of Basic DAS-1800ST/HR Series Boards

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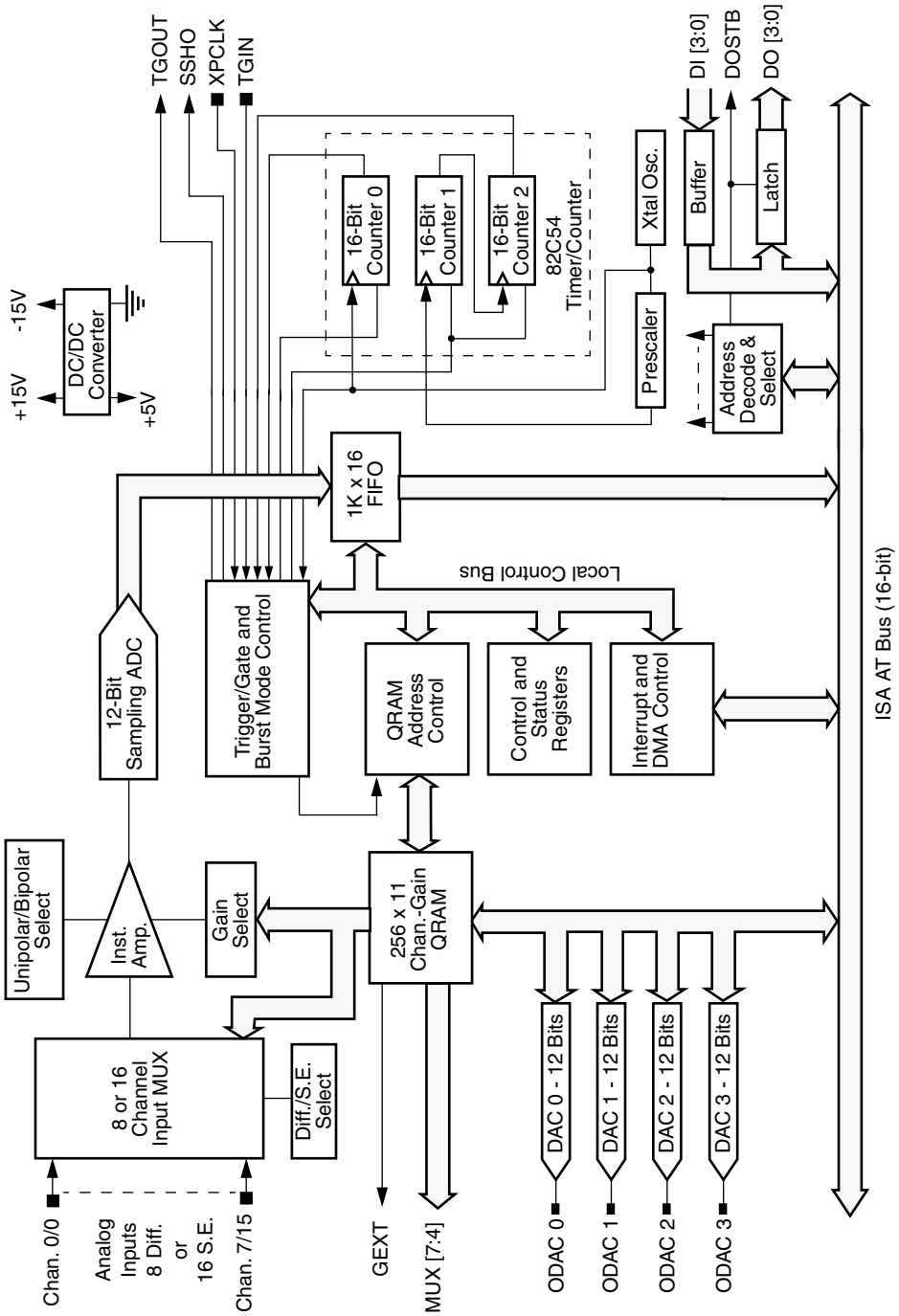


Figure 2-2. Block Diagram of DAS-1800ST-DA Series Boards

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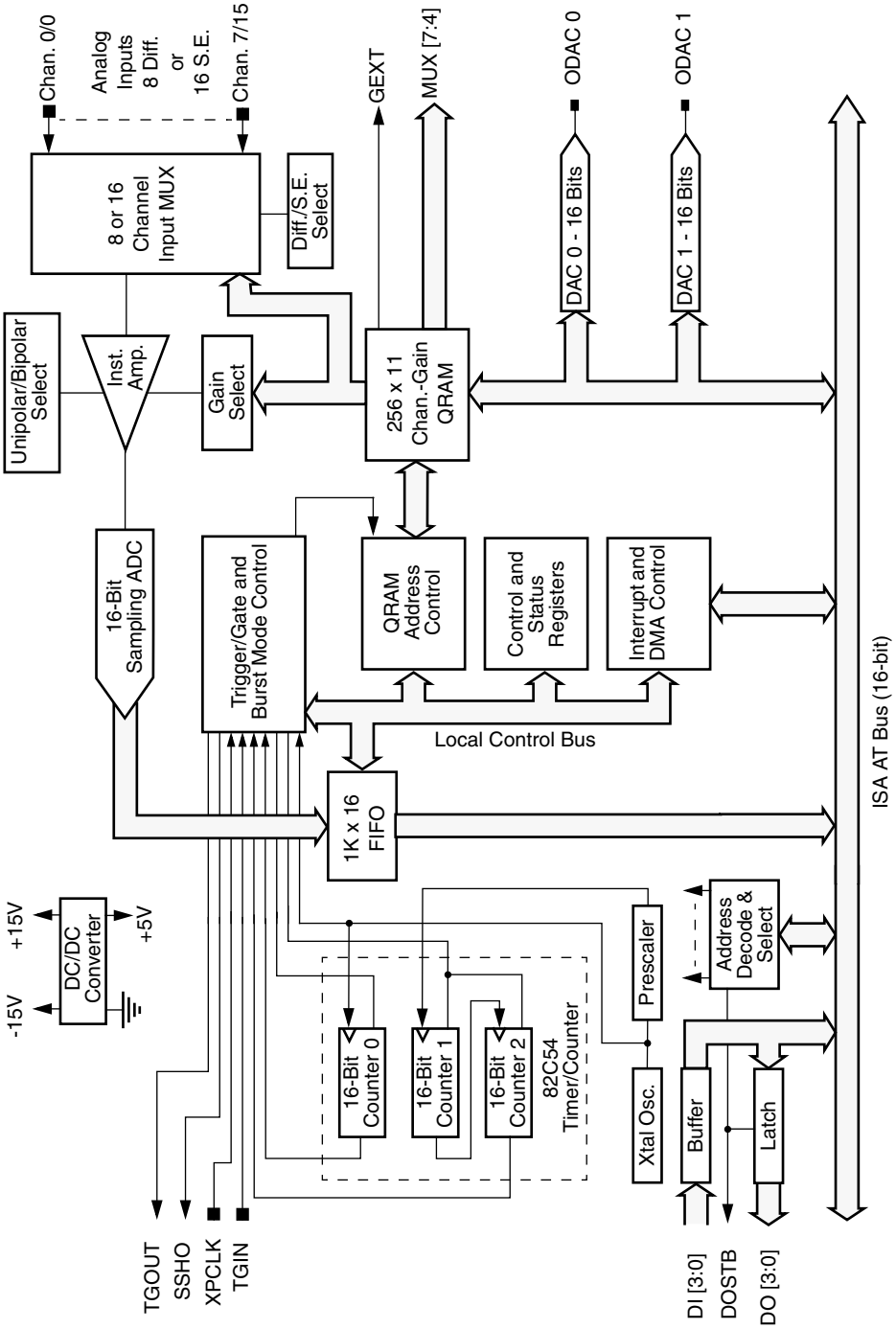


Figure 2-3. Block Diagram of DAS-1802HR-DA Boards

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Analog Input Features

The analog input section of DAS-1800ST/HR 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-1800ST Series boards and 16 bits (one part in 65,536) for DAS-1802HR boards. Other features of the analog input section include software-configurable inputs, a channel-gain queue, data conversion modes, data transfer modes, trigger and gate control, and clock sources. These features are described in the following sections.

Differential/Single-Ended Selection

Using DriverLINX software, you can set DAS-1800ST/HR Series boards to operate at either differential or single-ended inputs (see “DriverLINX Configuration Notes” on page C-1). Differential inputs measure the difference between two signals. Single-ended inputs are referred to a common ground, also called *common-mode ground reference*.

When you connect single-ended inputs to an STA-1800U accessory, you can use the accessory’s LL GND or U_CM MD screw terminals for your common-mode ground reference. You specify your choice using DriverLINX software (see “DriverLINX Configuration Notes” on page C-1).

Generally, you want to use differential inputs for low-level signals whose noise component is a significant part of the signal or if the signal has a non-ground common mode. You want to use single-ended inputs for high-level signals whose noise component is not significant.

The specific level at which one of these input configurations becomes more effective than the other depends on the application. However, you should use differential inputs for voltage ranges of 100mV and below.

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Low-Side Reference Selection for Single-Ended Inputs

When you use single-ended inputs, you have two ways of connecting the low side of the amplifier: the analog ground (default) and a user-defined common mode. The two schemes differ in how the low side of the instrumentation amplifier is connected. In the default mode, the low side of the amplifier is connected to analog ground (LL GND). In the user-defined common mode, the low side of the amplifier is connected to a pin on the connector for user-defined common mode (U_CM MD).

The user-defined common mode provides a means for eliminating ground loops in the system by connecting the reference ground for inputs to the U_CM MD input pin. Since the U_CM MD connection connects to the high input impedance of the instrumentation amplifier, the signal contains no power-supply return current.

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

If you use single-ended input configurations, the user-defined common mode is the recommended alternative. Use the default mode only if you want the convenience of not having to connect a separate wire for low input.

Unipolar/Bipolar Selection

Using DriverLINX, you can set the DAS-1800ST/HR Series boards to operate in either unipolar or bipolar input mode (see “DriverLINX Configuration Notes” on page C-1). A unipolar signal is always positive (0 to 5V, for example), while a bipolar signal can swing up and down between positive and negative peak values (±5V, for example).

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DAS-1800ST/HR Series boards use positive magnitude to represent unipolar input signals and 2's complement for bipolar input signals. In a given input range with the same peak voltage capacity for both modes, the unipolar mode doubles the converter's resolution.

Channel-Gain Selection

DAS-1800ST/HR Series boards offer up to 16 single-ended or eight differential onboard analog input channels. Using expansion accessories, you can increase the number of available channels to 256. To accommodate channel and gain settings for up to 256 channels, DAS-1800ST/HR Series boards contain a RAM storage circuit (QRAM) for a 256-position channel-gain queue. Each of the 256 queue positions holds your choice of a channel number and a corresponding gain. You can enter multiple channels sequentially or non-sequentially and with the same or different gain codes. Channel expansion, channel sequencing control, and available gains and input ranges for DAS-1800ST/HR Series boards are discussed in the following sections.

Channel Expansion

If you require additional analog input channels, you can configure your DAS-1800ST/HR Series boards for single-ended inputs and attach up to 16 EXP-1800 expansion accessories or up to 16 MB02 backplanes. Either option can increase your input capacity to 256 channels.

You can daisy-chain EXP-1800 expansion accessories to a DAS-1800ST/HR Series board using CDAS-2000 or CDAS-2000/S cables (see Section 4). Since a DAS-1800ST/HR Series board cannot power a full complement of EXP-1800 expansion accessories, 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.

If you use MB02 backplanes, use one STA-1800U for every four backplanes. Connect each group of four backplanes to an STA-1800U as shown in Section 4, and daisy chain any additional STA-1800U accessories to the first STA-1800U.

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Sampling sequences and gain settings for all expansion channels are communicated through the control lines described in the following two sections.

Multiplexer Control Lines MUX 4 to MUX 7

Multiplexer lines MUX 4 to MUX 7 control the channel sequencing of EXP-1800 expansion accessories and MB02 backplanes. These lines carry the channel-sequencing information from the channel-gain QRAM through the main I/O connector of DAS-1800ST/HR Series boards.

External Gain Control Line GEXT

External gain line GEXT sets channel gains on EXP-1800 accessories to 1 or 50 (you should not use a gain of 50 with a DAS-1802HR board, as you may get less than satisfactory resolution). This line carries the channel gain settings from the channel-gain QRAM through the main I/O connector of DAS-1800ST/HR Series boards.

Gains and Ranges

The available input gains and their corresponding ranges are listed in Table 2-1 for the DAS-1801ST boards and in Table 2-2 for the DAS-1802ST/HR boards.

Table 2-1. DAS-1801ST Input Gains and Ranges for Unipolar and Bipolar Modes

Gain	Unipolar Range	Bipolar Range
1	0 to 5V	–5.0 to +5.0V
5	0 to 1V	–1.0 to +1.0V
50	0 to 100mV	–100 to +100mV
250	0 to 20mV	–20 to +20mV

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Table 2-2. DAS-1802ST/HR Input Gains and Ranges for Unipolar and Bipolar Modes

Gain	Unipolar Range	Bipolar Range
1	0.0 to +10.0V	–10 to +10V
2	0.0 to +5.0V	–5.0 to +5.0V
4	0 to 2.5V	–2.5 to + 2.5V
8	0 to 1.25V	–1.25 to +1.25V

Maximum Achievable Throughput Rates

Because you can change input ranges on a per-channel basis, 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 100mV 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 sensible 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 ±5V or 0 to 5V. This method offers the advantages of increasing total system throughput and reducing noise.
- If you are not using all the channels, you can make a particular channel-gain entry twice to allow for settling time. Consequently, you will 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.

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You must give special consideration to the direct measurement of low-level signals with the DAS-1801ST board. When using the ±20mV, 0 to 20mV, ±100mV, or 0 to 100mV ranges, measurement throughput drops for two reasons:

- The amplifier cannot settle quickly enough (particularly the ±20mV and 0 to 20mV ranges).
- Noise in the measurements is higher and thus can require post-acquisition filtering (averaging) to achieve accurate results.

The DAS-1801ST has best noise performance if presented with a perfect signal in these ranges, but perfect signals are virtually non-existent in the real world. Since the DAS-1801ST has a very high bandwidth (bandwidth for low-level signals is about 8 to 10MHz), any noise is amplified and digitized. As a result, you must carry out the measurement of low-level signals carefully to minimize noise effects.

Low-level transducers are best used with signal conditioning. Use the ±20mV, 0 to 20mV, ±100mV, and 0 to 100mV ranges with the differential input mode.

The following tables show throughput for various configurations. Note that these 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 –20mV is measured after a signal at near +5V. You will get better performance driving adjacent channels at the same gain. 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 360Ω (1kΩ maximum) in series with 90pF output capacitance.

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On DAS-1800ST Series boards, the maximum throughput for sampling one channel at any gain is 333 ksamples/s. The throughput for channel-to-channel sampling with fixed gain in bipolar mode (0.024% maximum error) is shown in Table 2-3.

Table 2-3. Maximum Throughput for DAS-1800ST Series Boards (Bipolar Mode - Fixed Gain)

DAS-1801ST Input Range	DAS-1802ST Input Range	Maximum Throughput
—	±10.0V	312.5 ksamples/s
±5.00V	±5.00V	312.5 ksamples/s
—	±2.50V	312.5 ksamples/s
—	±1.25V	312.5 ksamples/s
±1.00V	—	312.5 ksamples/s
±100mV	—	312.5 ksamples/s
±20mV	—	75 ksamples/s

The throughput for channel-to-channel sampling with fixed gain in unipolar mode (0.024% maximum error) is shown in Table 2-4.

Table 2-4. Maximum Throughput for DAS-1800ST Series Boards (Unipolar Mode - Fixed Gain)

DAS-1801ST Input Range	DAS-1802ST Input Range	Maximum Throughput
—	0 to 10.0V	312.5 ksamples/s
0 to 5.00V	0 to 5.00V	312.5 ksamples/s
—	0 to 2.50V	312.5 ksamples/s
—	0 to 1.25V	312.5 ksamples/s
0 to 1.00V	—	312.5 ksamples/s
0 to 100mV	—	250 ksamples/s
0 to 20mV	—	60 ksamples/s

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The maximum throughput for a DAS-1801ST board, operating in bipolar mode and having less than 1 LSB of error when driven from an ideal voltage source, is shown in Table 2-5.

Table 2-5. Maximum Throughput for DAS-1801ST Boards (Bipolar Mode - Change of Gain)

	Maximum Throughput			
	To ±5.0V	**To ±1.0V**	**To ±100mV**	**To ±20mV**
From ±5.0V	312.5 ksamples/s	250 ksamples/s	200 ksamples/s	70 ksamples/s
From ±1.0V	250 ksamples/s	312.5 ksamples/s	312.5 ksamples/s	70 ksamples/s
From ±100mV	200 ksamples/s	312.5 ksamples/s	312.5 ksamples/s	70 ksamples/s
From ±20mV	70 ksamples/s	70 ksamples/s	70 ksamples/s	75 ksamples/s

The maximum throughput for a DAS-1801ST board, operating in unipolar mode and having less than 1 LSB of error when driven from an ideal voltage source, is shown in Table 2-6.

Table 2-6. Maximum Throughput for DAS-1801ST Boards (Unipolar Mode - Change of Gain)

	Maximum Throughput			
	To 0 to 5.0V	**To 0 to 1.0V**	**To 0 to 100mV**	**To 0 to 20mV**
From 0 to 5.0V	312.5 ksamples/s	200 ksamples/s	200 ksamples/s	50 ksamples/s
From 0 to 1.0V	200 ksamples/s	312.5 ksamples/s	250 ksamples/s	60 ksamples/s
From 0 to 100mV	200 ksamples/s	250 ksamples/s	250 ksamples/s	60 ksamples/s
From 0 to 20mV	50 ksamples/s	60 ksamples/s	60 ksamples/s	60 ksamples/s

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The maximum throughput for a DAS-1802ST board, operating in bipolar mode and having less than 1 LSB of error when driven from an ideal voltage source, is shown in Table 2-7.

Table 2-7. Maximum Throughput for DAS-1802ST Boards (Bipolar Mode - Change of Gain)

	Maximum Throughput			
	To ±10.0V	**To ±5.0V**	**To ±2.50V**	**To ±1.25V**
From ±10.0V	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s
From ±5.0V	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s
From ±2.50V	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s
From ±1.25V	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s

The maximum throughput for a DAS-1802ST board, operating in unipolar mode and having less than 1 LSB of error when driven from an ideal voltage source, is shown in Table 2-8.

Table 2-8. Maximum Throughput for DAS-1802ST Boards (Unipolar Mode - Change of Gain)

	Maximum Throughput			
	To 0 to 10.0V	**To 0 to 5.0V**	**To 0 to 2.5V**	**To 0 to 1.25V**
From 0 to 10.0V	312.5 ksamples/s	312.5 ksamples/s	250 ksamples/s	200 ksamples/s
From 0 to 5.0V	312.5 ksamples/s	312.5 ksamples/s	250 ksamples/s	200 ksamples/s
From 0 to 2.5V	250 ksamples/s	250 ksamples/s	312.5 ksamples/s	200 ksamples/s
From 0 to 1.25V	200 ksamples/s	200 ksamples/s	200 ksamples/s	312.5 ksamples/s

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On DAS-1802HR boards, the maximum throughput for single-channel operation is 100 ksamples/s. The maximum throughput for a DAS-1802HR board, operating in bipolar mode and having less than 2 LSBs of error when driven from an ideal voltage source, is shown in Table 2-9.

Table 2-9. Maximum Throughput for DAS-1802HR Boards (Bipolar Mode - Change of Gain)

	Maximum Throughput			
	To ±10.0V	**To ±5.0V**	**To ±2.50V**	**To ±1.25V**
From ±10.0V	98 ksamples/s	60 ksamples/s	60 ksamples/s	60 ksamples/s
From ±5.0V	60 ksamples/s	98 ksamples/s	60 ksamples/s	60 ksamples/s
From ±2.50V	60 ksamples/s	60 ksamples/s	98 ksamples/s	60 ksamples/s
From ±1.25V	60 ksamples/s	60 ksamples/s	60 ksamples/s	98 ksamples/s

The maximum throughput for a DAS-1802HR board, operating in unipolar mode and having less than 2 LSBs of error when driven from an ideal voltage source, is shown in Table 2-10.

Table 2-10. Maximum Throughput for DAS-1802HR Boards (Unipolar Mode - Change of Gain)

	Maximum Throughput			
	To 0 to 10.0V	**To 0 to 5.0V**	**To 0 to 2.5V**	**To 0 to 1.25V**
From 0 to 10.0V	98 ksamples/s	60 ksamples/s	60 ksamples/s	60 ksamples/s
From 0 to 5.0V	60 ksamples/s	98 ksamples/s	60 ksamples/s	60 ksamples/s
From 0 to 2.5V	60 ksamples/s	60 ksamples/s	98 ksamples/s	60 ksamples/s
From 0 to 1.25V	60 ksamples/s	60 ksamples/s	60 ksamples/s	98 ksamples/s

The worst-case error limit is the sum of the front-end settling time and the effect of converter non-linearity. In many measurement situations, this error is tolerable. Note, however, that driving the inputs of channels to a reasonable level of accuracy is often impractical because of the effects of transducer output impedance and cable and interconnect impedance. For best results, particularly with 16-bit systems, you should acquire all data without changing the channel.

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Data Conversion Modes

DAS-1800ST/HR Series boards support three modes of data conversion: paced, burst, and burst with SSH. The data conversion modes are described as follows:

- **Paced mode** — Paced mode is best-suited for continuous scanning of channels at a constant rate. In the paced mode, 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** — In burst mode, 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. The maximum burst mode conversion clock rate is gain-sensitive, as explained in “Maximum Achievable Throughput Rates” on page 2-9.
- **Burst mode with SSH** — In burst mode with SSH, 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 a DAS-1800HR Series board.

  For information on the signal interface between a DAS-1800ST Series board and SSH hardware, refer to “Using Digital Control Signal SSHO” on page 2-26.

Figure 2-4 shows the timing relationships of the data conversion modes for a scan of channel 4 to channel 7.

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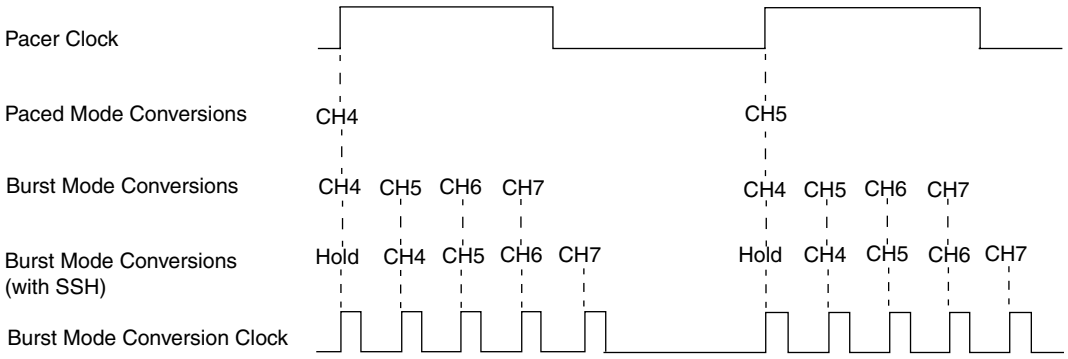


Figure 2-4. Timing of Data Conversion Modes for Channels 4 to 7

Clock Sources

DAS-1800ST/HR Series boards provide two clocks: a pacer clock and a burst mode conversion clock. In paced mode, the pacer clock works alone to time interrupt-mode and DMA-mode operations, as shown in Figure 2-4. In burst mode and burst mode with SSH, the pacer clock and the burst mode conversion clock work together to time interrupt-mode and DMA-mode operations, also shown in Figure 2-4. These clock sources are described in the following sections.

Pacer Clock

In paced mode, the pacer clock determines the conversion rate. In burst mode and burst mode with SSH, the pacer clock determines the sample rate (the rate at which a single channel is sampled). The following pacer clock sources are available for DAS-1800ST/HR Series boards:

- **Software** — DAS-1800ST/HR Series boards allow you to acquire a single sample under program control.
- **Hardware (internal clock source)** — The internal pacer clock source uses the onboard 82C54 counter/timer and a crystal-controlled 5MHz time base. The onboard pacer clock uses two cascaded counters of the 82C54. The maximum allowable rate is 333kHz for DAS-1800ST Series boards and 100kHz for the DAS-1802HR; the minimum available rate is 0.0012Hz. When not used to pace the

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analog input, the internal clock source can serve to pace other events such as the digital I/O through the use of interrupts.

- **Hardware (external clock source)** — The external pacer clock source must be an externally applied TTL-compatible signal attached to XPCLK (pin 44 of the main I/O connector or pin 38 of STA-1800U connectors J1 and J2). The active edge for this clock is software-selectable.

  An external clock source is useful if you want to pace at rates not available with the 82C54 counter/timer, if you want to pace at uneven intervals, or if you want to pace on the basis of an external event. An external clock also allows you to synchronize multiple boards with a common timing source.

Note: The ADC acquires samples at a maximum of 333 ksamples/s (one sample every 3.0µs) for DAS-1800ST Series boards and 100 ksamples/s (one sample every 10µs) for the DAS-1800HR Series. If you are using an external clock, make sure that it does not initiate conversions at a faster rate than the ADC can handle.

If you are acquiring samples from multiple channels, the maximum sampling rate for each channel is equal to the maximum allowable conversion rate divided by the number of channels (see "Maximum Achievable Throughput Rates" on page 2-9).

Burst Mode Conversion Clock

In burst mode and burst mode with SSH, the burst mode conversion clock determines the conversion rate. (The burst mode conversion clock is not used for paced mode.)

The burst mode conversion clock frequency is programmable for a range of 15.625kHz to 333kHz (64µs to 3µs in 1µs increments) for the DAS-1800ST Series boards and 15.625kHz to 100kHz (64µs to 10µs in 1µs increments) for the DAS-1800HR Series boards.

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Triggers

A trigger starts or stops an interrupt-mode or DMA-mode analog input operation. An operation can use either one or two triggers. Every operation must have a *start trigger* that marks the beginning of an operation. You can use an optional second trigger, the *about trigger*, to define when an operation stops. Use one of the following trigger sources to start an analog input operation:

- **Internal** — When you enable the analog input operation, conversions begin immediately.
- **External Analog** — While an analog trigger is not a hardware function of the DAS-1800ST/HR Series boards, you can program an analog trigger using one of the analog input channels as the trigger channel. The DAS-1800ST/HR Series DriverLINX software provides functions for an analog trigger; refer to "DriverLINX Configuration Notes" on page C-1 and the DriverLINX on-line documentation provided with your DAS-1800ST/HR Series board.
- **External Digital** — Connect the digital trigger to TGIN (pin 46 of the main I/O connector or pin 42 of STA-1800U connectors J1 and J2). Trigger types are as follows:
  - *Positive-edge trigger* - Triggering occurs on the rising edge of the trigger signal.
  - *Negative-edge trigger* - Triggering occurs on the falling edge of the trigger signal.

The actual points at which conversions begin depend on whether the clock source is internal or external, as follows:

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

The polarity of external triggers in DAS-1800ST/HR Series boards is software-selectable. Figure 2-5 illustrates the enabling of conversions with a software trigger and with internal and external clock sources. In the diagram, the software enabling of the conversion process represents the point at which the computer issues a write to allow conversions. The

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delay shown between that point and startup of the onboard clock is less than 1µs. Figure 2-6 illustrates the enabling of conversions with a hardware trigger.

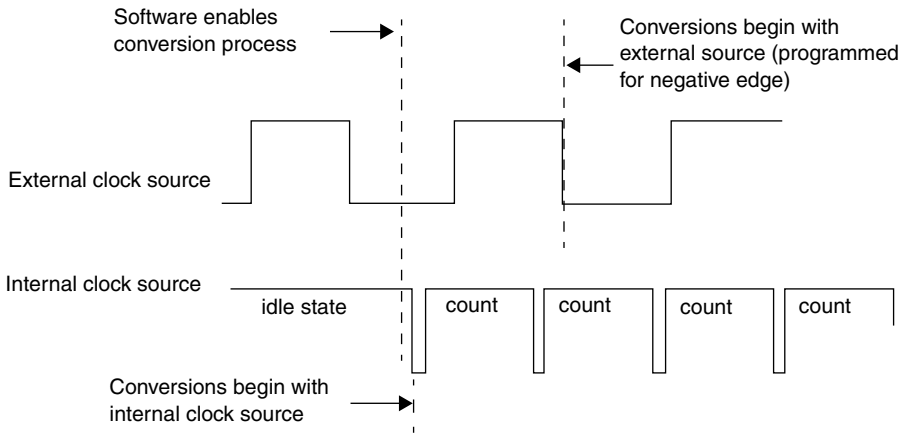


Figure 2-5. Enabling Conversions with a Software Trigger

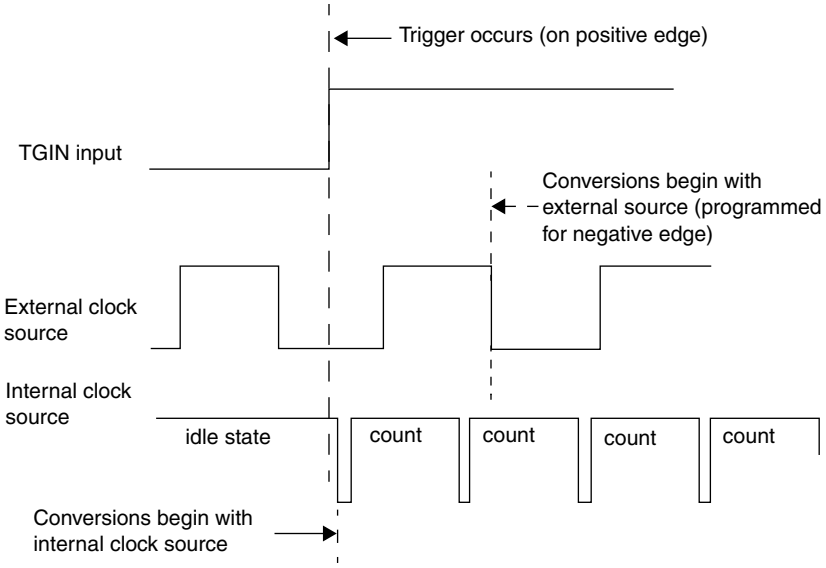


Figure 2-6. Enabling Conversions with a Hardware Trigger

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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 occurrence of the about-trigger event. As described in the following sections, the availability of the about trigger provides the capability to define operations that acquire data before a trigger event (pre-trigger acquisition), operations that acquire data about (before and after) a trigger event, and operations that acquire data after a trigger event (post-trigger acquisition).

Pre-Trigger Acquisition

In pre-trigger acquisition, the data of interest appears before a specific digital trigger event. Acquisition starts on an internal, external analog, or external digital trigger event and continues until the digital trigger event. Pre-trigger acquisition is available with DMA-mode operations only.

About-Trigger Acquisition

In about-trigger acquisition, the data of interest appears both before and after a specific digital trigger event. Acquisition starts on an internal, external analog, or external digital trigger event and continues until a specified number of samples has been acquired after the digital trigger event. About-trigger acquisition is available with DMA-mode operations only.

Post-Trigger Acquisition

In post-trigger acquisition, the data of interest appears after a specific event. Acquisition starts on an internal, external analog, or external digital trigger event and continues until a specified number of samples has been acquired or until the operation is stopped by software.

Gates

A gate allows conversions to proceed while in the active state. (The active state is software-selectable.) Connect the external gate to TGIN (pin 46 of the main I/O connector or pin 42 of STA-1800U connectors J1 and J2).

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The way conversions are synchronized depends on whether you are using an internal or an external clock, as follows:

- **With internal clocking** — The 82C54 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, with internal clocking, conversions are synchronized to the gate signal.
- **With external clocking** — The signal from the external clock continues uninterrupted while the gate signal is inactive; therefore, with external clocking, conversions are synchronized to the external clock.

Figure 2-7 illustrates the use of a positive-polarity hardware gate with both a negative-edge external clock and an internal clock.

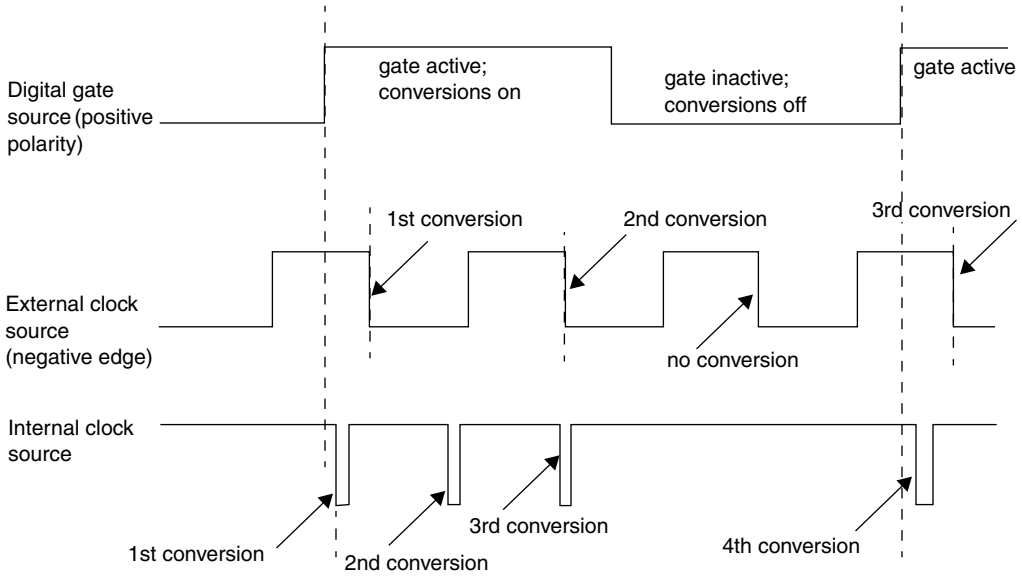


Figure 2-7. Hardware Gate

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Data Transfer Modes

Using the provided software, you can transfer data from DAS-1800ST/HR Series boards to the computer using the following data transfer modes:

- **Interrupt** — You can program the board to generate an interrupt for events such as *FIFO Half Full* or *FIFO Not Empty*. FIFO Half Full occurs after the FIFO accumulates 512 A/D samples for transfer to computer memory. FIFO Not Empty occurs anytime the FIFO buffer contains data.

  An interrupt occurs in the background, allowing the CPU to execute other instructions. The interrupt level is software-selectable.

  Unpredictable interrupt latencies in the Windows environment tend to make maximum board speeds unachievable in interrupt mode. When in the Windows environment, you are advised to use single- or dual-channel DMA instead of the interrupt transfer mode.

- **DMA** — DMA is a method of bypassing the CPU to transfer data directly between an I/O device and computer memory. In the IBM PC AT family, DMA is directed by the DMA controllers and can run in the background while the CPU is executing other instructions. 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-1800ST/HR Series boards use DMA channels 5, 6, and 7 to perform single- or dual-channel DMA transfers of A/D data from the board to memory. When you set up your configuration file, you can specify these channels individually for single-channel DMA or in pairs for dual-channel DMA.

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

  Generally, if you are programming operations in Windows, you should use dual-channel DMA to acquire data reliably at maximum board speeds.

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Analog Output Features

DAS-1800ST-DA Series and DAS-1802HR-DA boards contain an analog output section. The following sections discuss the features of the analog output sections for each of these board types.

DAS-1800ST-DA Series Boards

The analog output section of a DAS-1800ST-DA Series board contains four 12-bit DACs. Each DAC has a fixed voltage range of ±10V and powers up to 0V at reset. Data coding is 2's complement. The four DACs have a capacitive load drive up to 100µF and an output current drive of up to ±5mA. You can use interrupts generated by the onboard pacer clock to pace the analog output when the analog inputs are either disabled or timed by an external pacer clock. You can also write single values to the DACs. The analog output section of DAS-1800ST-DA Series boards does not support DMA operations.

DAS-1802HR-DA Boards

The analog output section of a DAS-1802HR-DA board contains two 16-bit DACs. Each DAC has a fixed voltage range of ±10V and powers up to 0V at reset. Data coding is 2's complement. The two DACs have a capacitive load drive up to 100µF and an output current drive of up to ±5mA (short-circuit current is about 25mA). You can use interrupts generated by the onboard pacer clock to pace the analog output when the analog inputs are either disabled or timed by an external pacer clock. You can also write single values to the DACs. The analog output section of DAS-1802HR-DA boards does not support DMA operations.

Digital I/O Features

DAS-1800ST/HR Series boards contain four digital inputs (DI 0 to DI 3) and four digital outputs (DO 0 to DO 3). Logic 1 on an I/O line indicates that the input/output is high (greater than 2.0V); logic 0 on an I/O line indicates that the input/output is low (less than 0.8V). The digital inputs are compatible with TTL-level signals. These inputs are provided with

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10kΩ pull-up resistors to +5V; therefore, the inputs appear high (logic 1) with no signal connected.

Using Digital Control Signal DOSTB

DAS-1800ST/HR Series boards provide a strobe signal DOSTB (pin 19 of the main I/O connector or pin 37 of STA-1800U connectors J1 and J2) for the purpose of strobing data through the digital outputs and latching the data into a register in external equipment. Where DAS-1800ST/HR Series boards use the positive edge of the strobe to strobe data out, you must use the negative edge to strobe data into other equipment because the negative edge gives you a 300ns lag to allow for delays. Data is valid until the next strobe, as shown in Figure 2-8.

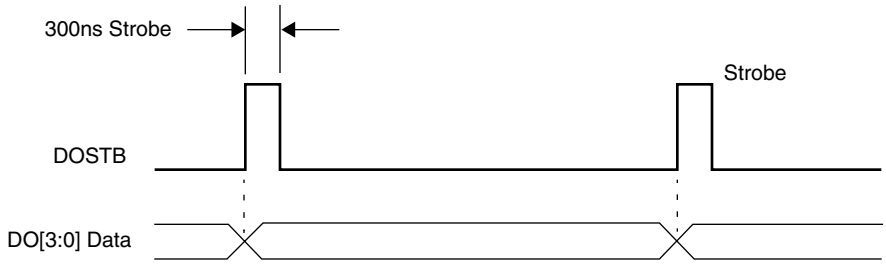


Figure 2-8. Timing Relationship between Data from DO0 to DO3 and Latch Strobe DOSTB

Using Digital Control Signal TGOUT

When using the onboard internal pacer clock, you can use the trigger/gate output signal TGOUT (pin 20 of the main I/O connector or pin 39 of STA-1800U connectors J1 and J2) to synchronize other DAS-1800 Series boards or to trigger or gate user-specific events as follows:

- When using digital control signal TGIN as a trigger, TGOUT behaves as shown in Figure 2-9a. Note that when you use this option, TGOUT does not retrigger and thus cannot be used with about-trigger acquisitions. Note also that there is a delay of about 200ns between the active edge of TGIN and the starting edge of TGOUT.

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- When using digital control signal TGIN as a gate, TGOUT behaves as shown in Figure 2-9b. Note that there is a delay of about 200ns between the active edge of TGIN and the starting edge of TGOUT.
- When using an internal trigger/gate, TGOUT behaves as shown in Figure 2-9c. Note that the delay between the active edge of the internal trigger/gate and the starting edge of TGOUT is less than 1µs.

Note: You can use TGOUT only when the onboard internal pacer clock is timing conversions.

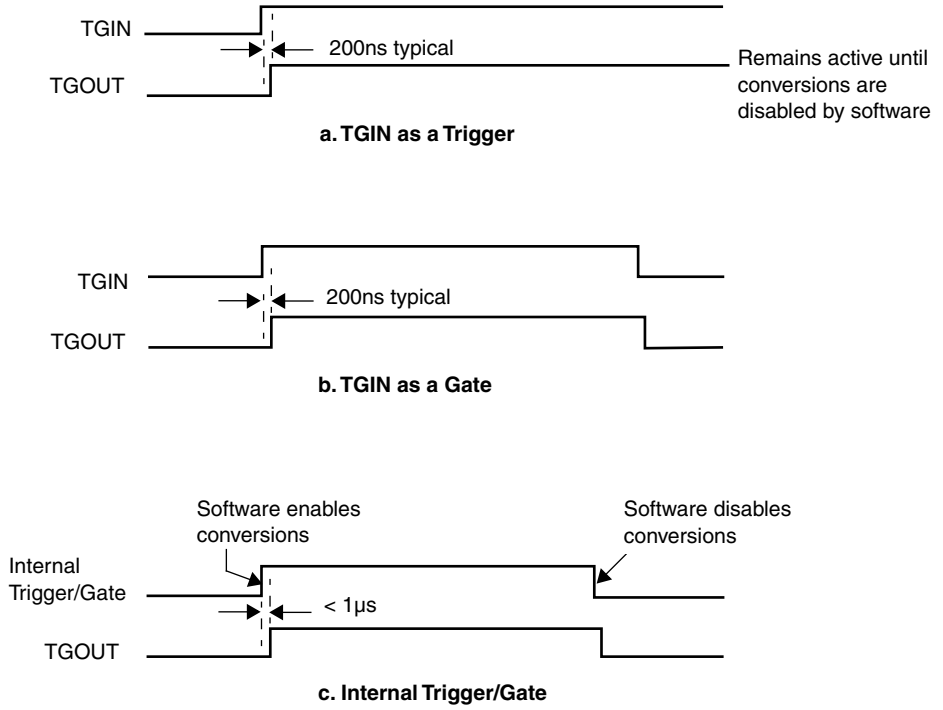


Figure 2-9. Timing for the TGOUT Signal

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Using Digital Control Signal SSHO

The SSHO digital control signal is normally generated by DAS-1800ST Series boards to accommodate external SSH hardware. The SSHO signal is initiated by either the onboard internal 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 50ns after a pacer clock pulse.
- A/D conversion begins one burst period after the pacer clock pulse.
- SSHO remains high until 200ns after the ADC starts conversion of the last channel in the burst.
- SSHO goes low and remains low until another pacer clock pulse.

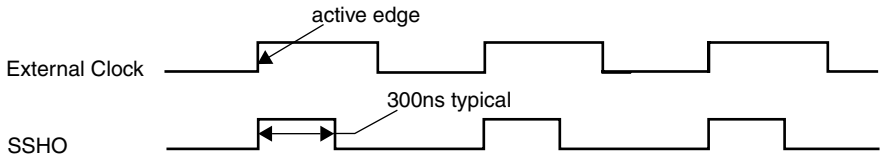
To ensure adequate sample time for the SSH hardware, the pacer clock period should be set as follows:

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

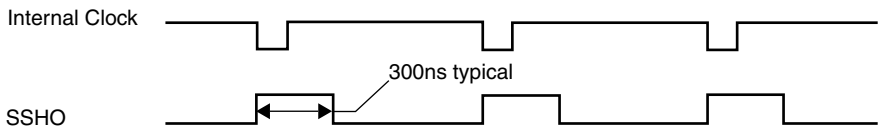
When you are not using the SSHO signal for SSH hardware control, you can use it as a converter clock output signal. SSHO is active only during A/D conversions. The timing for SSHO generation when the DAS-1800ST/HR Series boards are not used for control of SSH hardware is shown in Figure 2-10.

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a. SSHO with External Pacer Clock



b. SSHO with Internal Pacer Clock

Figure 2-10. Timing for SSHO Signal When Not Used for SSH Hardware

Assigning an Interrupt

Assign an interrupt level to a DAS-1800 Series board through the DriverLINX software configuration (see “DriverLINX Configuration Notes” on page C-1). When you install more than one board in a computer, assign interrupt levels to the boards in one of the following ways:

- Assign a different interrupt level to each board (if enough levels are available).
- Assign the same interrupt level to some boards and different interrupt levels for each of the remaining boards.

Note: Some computers can accept as many as three DAS-1800 Series boards.

- Assign one interrupt level to be shared by all boards.

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If a DAS-1800 Series board is sharing an interrupt level with one or more other DAS-1800 Series boards and requests an interrupt, the DriverLINX software determines the source of the request by scanning each board until the interrupt request flag is located. DriverLINX then signals the computer to respond accordingly.

Power

DAS-1800ST/HR Series boards use the +5V and the +12V provided by your computer. An onboard DC/DC converter develops ±15V at a maximum current output of 60mA for external use. In addition to the ±15V, the DAS-1800ST/HR Series boards supply +5V from the computer to a pin on the main I/O connector at up to a maximum of 1.0A.

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3

Setup and Installation

This section describes inspection, software installation, configuration, and hardware installation for DAS-1800ST/HR Series boards. Read this section before you attempt to install and use your board.

Unwrapping and Inspecting Your Board

After you remove the wrapped board from its outer shipping carton, proceed as follows:

1. The board is packaged at the factory in an anti-static wrapper that must not be removed until you have discharged any static electricity by either of the following methods:
   - If you are equipped with a grounded wrist strap, you discharge static electricity as soon as you hold the wrapped board.
   - 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).
2. Carefully unwrap your board from its anti-static wrapping material. (You may store the wrapping material for future use.)
3. Inspect the board for signs of damage. If damage is apparent, arrange to return the board to the factory (see “Technical Support” on page 7-6).
4. Check the remaining contents of your package against the packing list to be sure your order is complete. Report any missing items immediately.

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5. When you are satisfied with the inspection, proceed with the software and hardware setup instructions.

Note: DAS-1800ST/HR 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.

Installing the Software

Caution: To prevent a system crash the first time you install and test any new hardware, exit all other programs. If you are using a disk cache, disable write caching. If the system does crash and you are using disk compression software or a disk cache utility, run the utility that checks the directory structures.

Installing the DAS-1800ST/HR Series Standard Software Package

Important: Before you begin installing any hardware or software for the DAS-1800ST/HR, read the *DriverLINX Installation and Configuration Guide* and the *Appendix F: Configuration and Implementation Notes—for Keithley DAS-1800* 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 the DAS-1800ST/HR board's configuration settings.
2. Determine the resources your DAS-1800ST/HR Series board requires.
3. Inventory your computer's resources already allocated to other installed devices.

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4. Determine whether your computer has sufficient resources for the DAS-1800ST/HR board.
5. Determine whether your DAS-1800ST/HR board can use your computer's free resources.
6. Set any jumpers/switches to configure the DAS-1800ST/HR board to use your computer's free resources.
7. Set any other jumpers/switches to configure the DAS-1800ST/HR 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 only 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 needed 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 needed to develop custom applications for DriverLINX using C/C++, Visual Basic, Delphi, and LabVIEW.
- **Install LabVIEW** — This component installs the files and programs needed to develop applications for DriverLINX using 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.

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3. The DriverLINX CD-ROM Browser Map window appears on the screen. Click ‘Install Drivers,’ and follow the series of on-screen instructions.

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-1800 installation and read them before installing your DAS-1800 board or configuring DriverLINX:

- *Installation and Configuration*
- *Appendix F: Configuration and Implementation Notes—for Keithley DAS-1800*.
- *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 the DAS-1800ST/HR board into an appropriate free slot in your computer.

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Setting the Base Address

The base address switch on DAS-1800ST/HR Series boards is preset at the factory for a value of 300h (768 decimal). If this address appears to conflict with the address of another device in the computer (including another DAS-1800 Series board), you must reset the base address switch. The base address switch is a 7-position DIP switch located as shown in Figure 3-1.

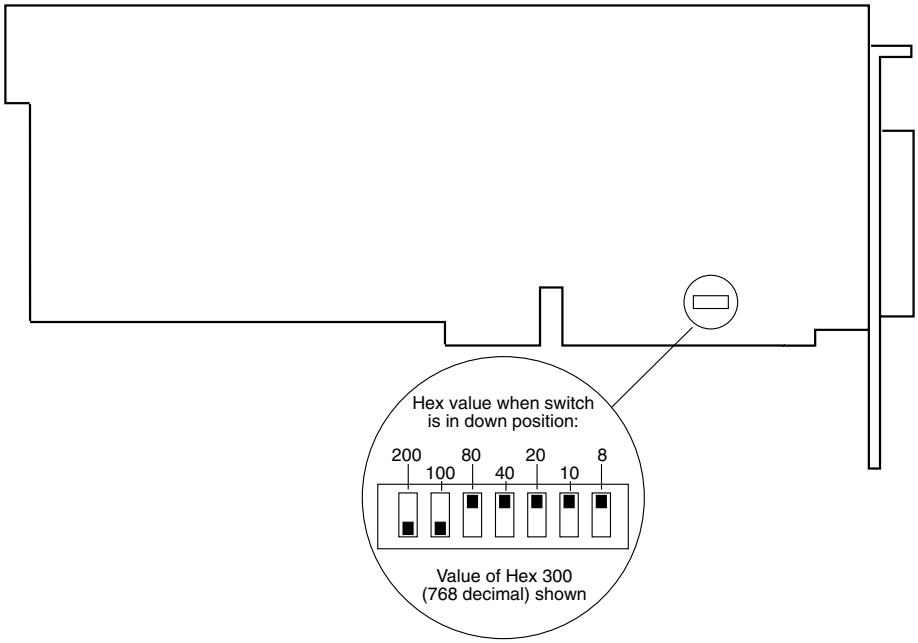


Figure 3-1. Location of Base Address Switch

To reset this switch for another address, use DriverLINX software configuration (see “DriverLINX Configuration Notes” on page C-1) to determine the new switch settings. The settings for the base address switch must match the settings in the DriverLINX program.

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Installing the Board

Caution: Installing or removing a board with the power ON can damage your computer.

Use the following steps to install a DAS-1800ST/HR Series board in an accessory slot of your computer:

1. Turn power OFF to the computer and all attached equipment.
2. Remove the computer chassis cover.
3. Select an unoccupied accessory slot, and remove the corresponding blank plate from the I/O connector panel.
4. Make sure the setting of the base address switch matches the setting shown in the configuration utility switch diagram.
5. Insert and secure the board in the selected slot.
6. Replace the computer cover.
7. Turn on power to the computer.

You can use the DAS-1800 Series DriverLINX Analog I/O Panel (see Section 5) to check board operation.

Configuring the DAS-1800ST/HR 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

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the interrupt and DMA channels used by the other hardware devices in your computer system.

Table 3-1 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-1800 Series board), and set the switches to the appropriate base address.

Table 3-1. 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)
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

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

Address Range	Use
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

The Expansion Board Configuration for Keithley DAS-1800 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-1800 Manual*.

After you have successfully installed the DAS-1800ST/HR 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-1800ST/HR

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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-1800 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-1800 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).
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 want to configure.

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You can use DriverLINX to verify board operation

1. To physically initialize the DAS-1800ST/HR, select *Device*/*Initialize* from the main menu in Learn DriverLINX.
2. The first time the DAS-1800ST/HR 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 4 for descriptions of common I/O accessories and connections for DAS-1800ST/HR Series Boards.

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4

Cabling and Wiring

This section describes the cabling and wiring required for attaching accessories and I/O lines to your DAS-1800ST/HR Series boards.

Caution: To avoid electrical damage, turn off power to the computer and any attached accessories before making connections to your boards.

Attaching an STA-1800U

The STA-1800U screw terminal accessory is an interface for I/O connections to DAS-1800ST/HR Series boards. The STA-1800U contains the following components:

- Two 50-pin male connectors (J1 and J2). Use J1 for cabling to the main I/O connector of DAS-1800ST/HR Series board; use J2 for cabling to a second STA-1800U.
- 53 labeled screw terminals for connections from sensor outputs and test equipment.
- Four 26-pin male connectors for cabling to MB02 backplanes.
- One 37-pin male connector for cabling to SSH-8 accessories or to an MB01 backplane.

Figure 4-1 shows the connector layout of an STA-1800U screw terminal accessory.

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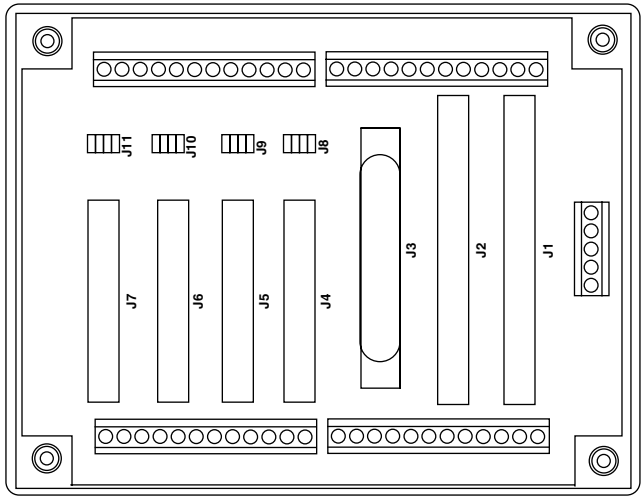


Figure 4-1. Connector Layout of an STA-1800U Accessory

To attach an STA-1800U to a DAS-1800ST/HR Series board, use a CDAS-2000 Series cable. Connect the cable from the main I/O connector of the DAS-1800ST/HR Series board to connector J1 of the STA-1800U, as shown in Figure 4-2.

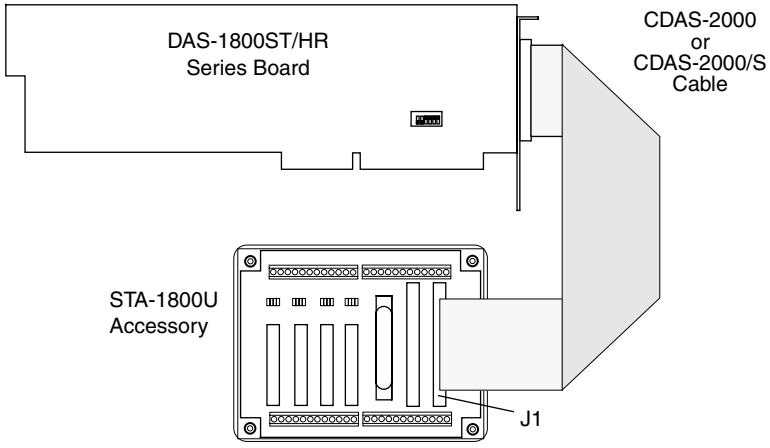
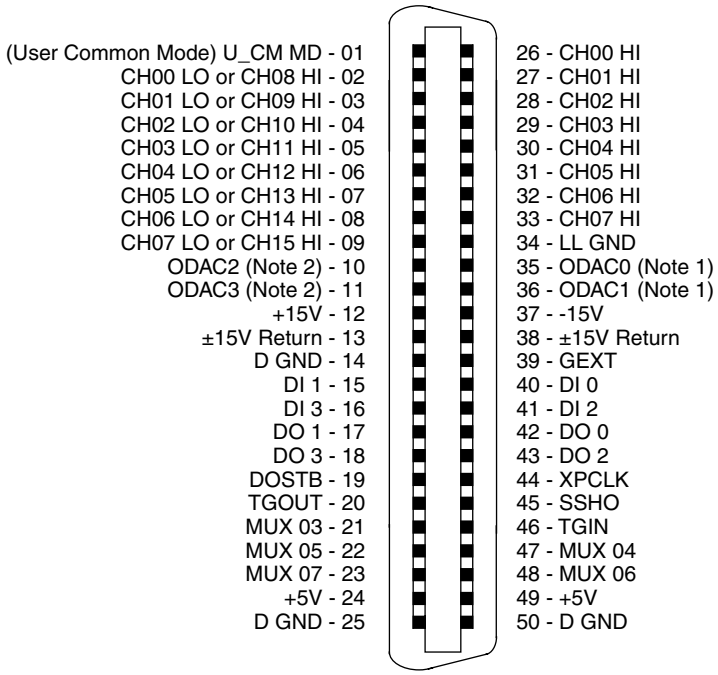


Figure 4-2. Attaching an STA-1800U Accessory to a DAS-1800ST/HR Series Board

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Pin assignments for the main I/O connector of a DAS-1800ST/HR Series board are shown in Figure 4-3.

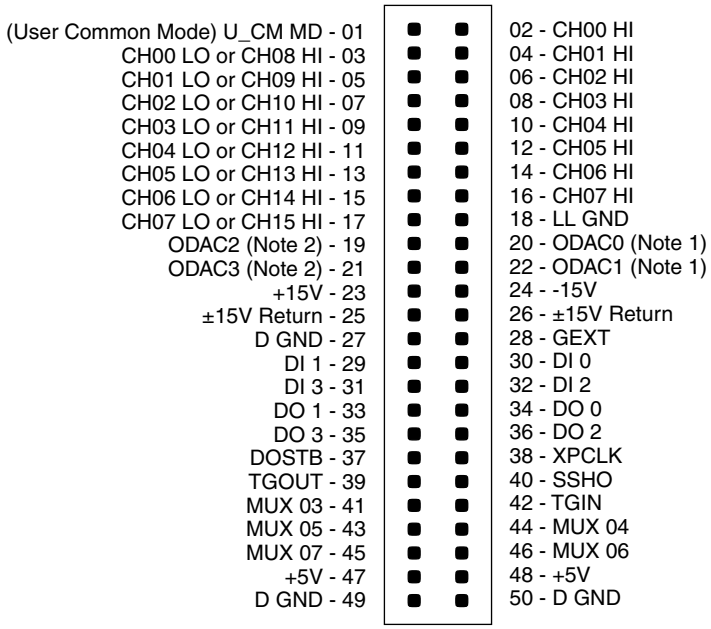


Notes:
[1] DAS-1800ST-DA Series and DAS-1802HR-DA boards
[2] DAS-1800ST-DA Series boards only

Figure 4-3. Pin Assignments for the Main I/O Connector of a DAS-1800ST/HR Series Board

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

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Notes:
[1] DAS-1800ST-DA Series and DAS-1802HR-DA boards
[2] DAS-1800ST-DA Series boards only

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

Note that the screw terminals for the DAC outputs are labeled differently for Revisions 1 and 2 of the STA-1800U. These differences are shown in Table 4-1.

Table 4-1. STA-1800U Labels for DAC Outputs

DAC Output Number	Rev. 1 Label	Rev. 2 Label
0 (for DAS-1800ST/HR-DA Series)	DAC0 OUT	ODAC0
1 (for DAS-1800ST/HR-DA Series)	DAC1 OUT	ODAC1
2 (for DAS-1800ST-DA Series only)	DAC0 IN	ODAC2
3 (for DAS-1800ST-DA Series only)	DAC1 IN	ODAC3

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Attaching an STP-50

The STP-50 is a compact screw terminal panel that you cable to the main I/O connector of a DAS-1800ST/HR Series board using a CDAS-2000 Series cable, as shown in Figure 4-5. Pin assignments for the screw terminals of this panel are shown in Figure 4-6.

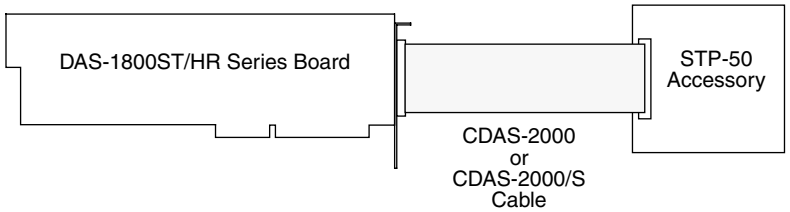
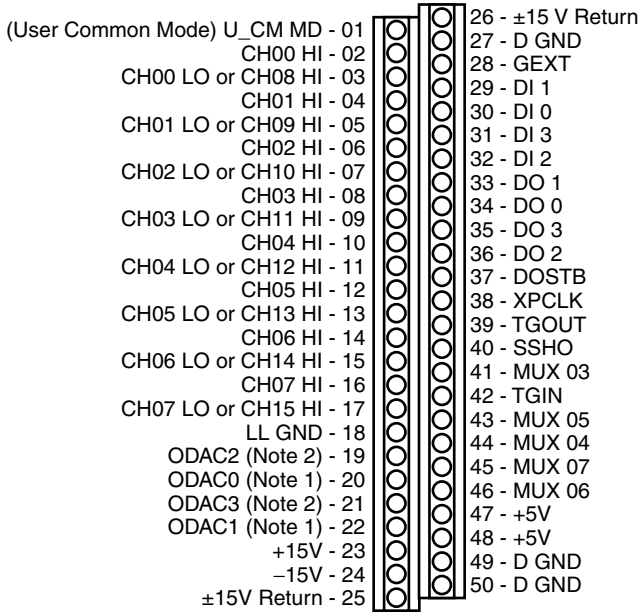


Figure 4-5. Attaching an STP-50 to a DAS-1800ST/HR Series Board



Notes:
[1] DAS-1800ST-DA Series and DAS-1802HR-DA boards
[2] DAS-1800ST-DA Series boards only

Figure 4-6. Pin Assignments for Screw Terminals of the STP-50

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Attaching SSH-8 Accessories

DAS-1800ST Series boards can accept one or two SSH-8 accessories. (The DAS-1802HR does not support SSH-8 accessories). The SSH-8 is a simultaneous-sample-and-hold accessory whose functions and capabilities are described in the *SSH-8 User's Guide*. This accessory can serve as a front-end analog interface for DAS-1800ST Series boards when connected through an STA-1800U. Note that attached SSH-8 accessories must be set as slaves. Attach an SSH-8 to a STA-1800U using a C-1800 cable, as shown in Figure 4-7. Refer to the *SSH-8 User's Guide* for more information.

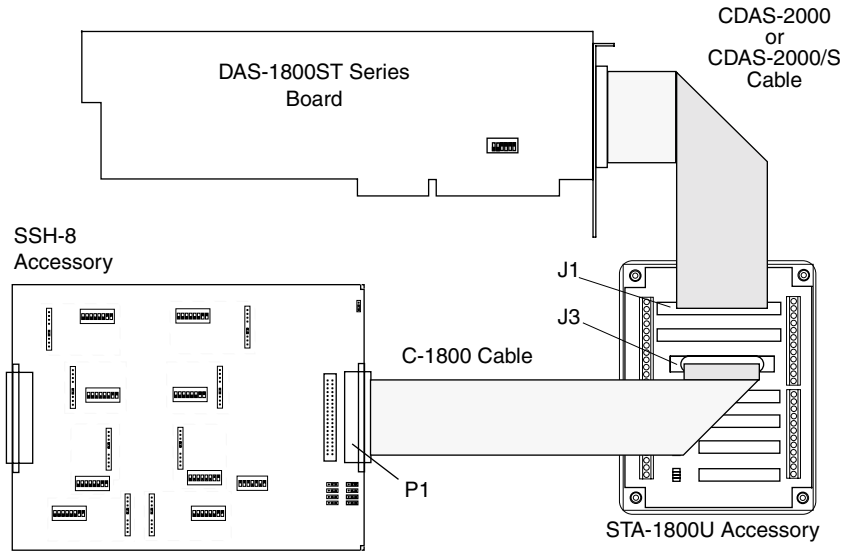


Figure 4-7. Attaching an SSH-8 to a DAS-1800ST Series Board through an STA-1800U

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Attaching an MB01 Backplane

A DAS-1800ST/HR Series board configured for single-ended inputs accepts one MB01 backplane through an STA-1800U accessory. Cabling for attaching an MB01 backplane to an STA-1800U is shown in Figure 4-8.

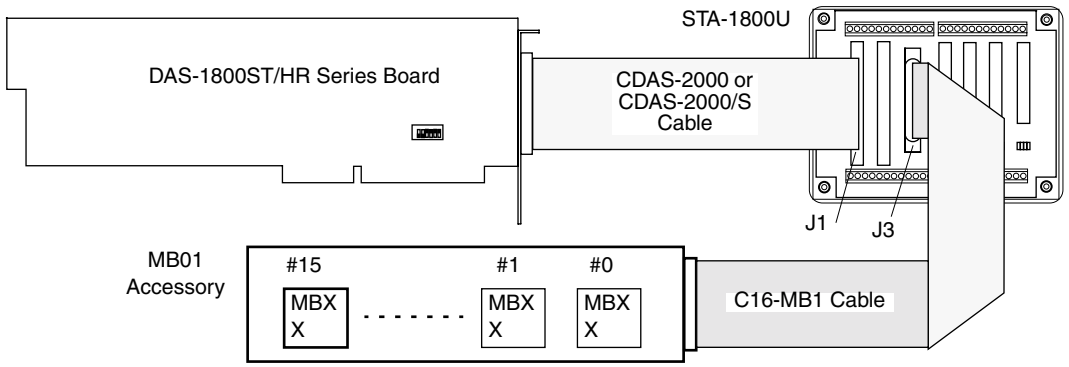


Figure 4-8. Attaching an MB01 Backplane to a DAS-1800ST/HR Series Board through an STA-1800U

For more information on MB01 backplanes and modules, refer to the *MB Series User's Guide*.

Attaching MB02 Backplanes

A DAS-1800ST/HR Series board configured for single-ended inputs and working through multiple STA-1800U accessories can support up to 16 MB02 backplanes. A single STA-1800U contains receptacles (J4 to J7) for up to four MB02 backplane cables. Cabling for the four MB02 backplanes attached to an STA-1800U accessory is shown in Figure 4-9.

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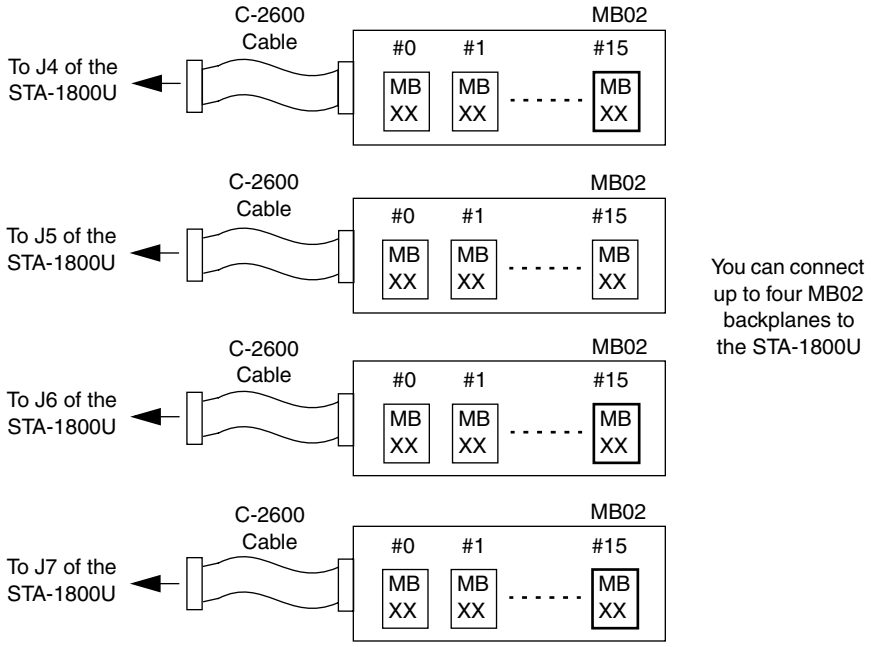


Figure 4-9. Attaching MB02 Backplanes to an STA-1800U Accessory

Use one STA-1800U for every four MB02 backplanes. Additional STA-1800U accessories are daisy-chained to the first STA-1800U, using CACC-2000 cables to connect J2 of one STA-1800U to J1 of the next, as shown in Figure 4-10.

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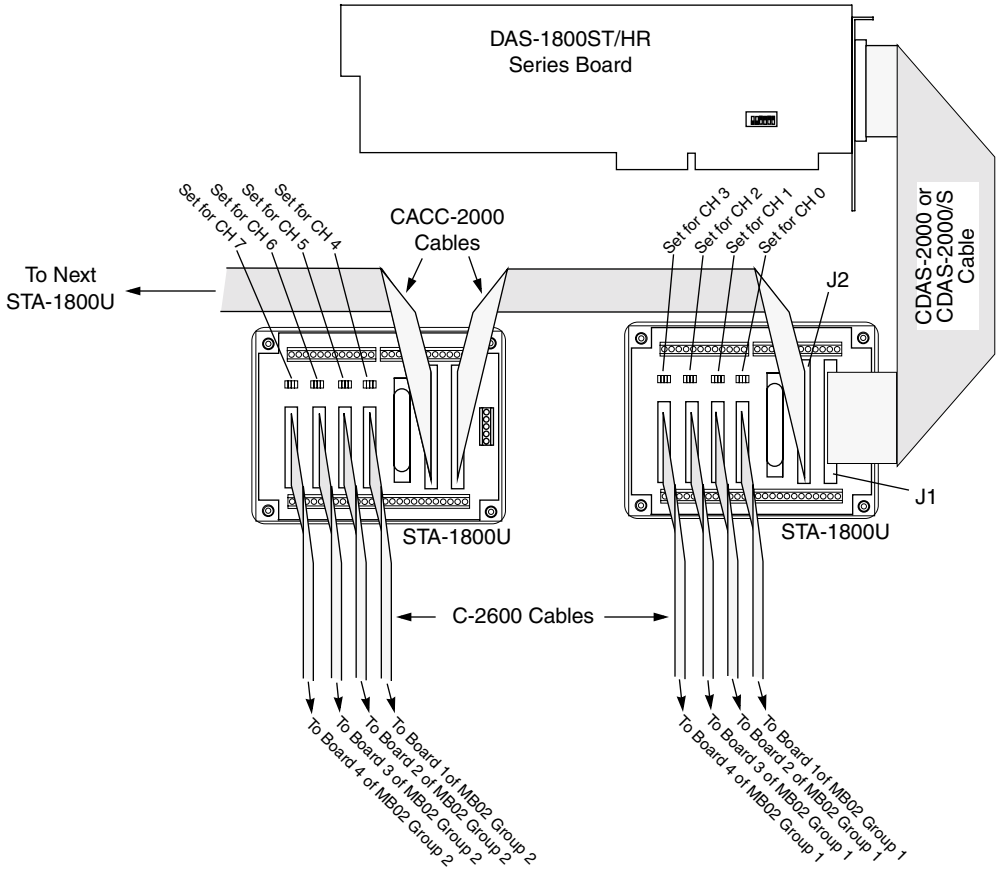


Figure 4-10. Daisy-Chaining STA-1800U Accessories with Attached MB02 Backplanes

The jumper pad beside each STA-1800U receptacle (J4 to J7) selects the channel of a DAS-1800ST/HR Series board that the attached MB02 backplane is to use. On the first STA-1800U, the jumpers connect STA-1800U receptacles J4 to J7 to DAS-1800ST/HR Series board channels 0 to 3, respectively (default settings), as shown in the diagram. On a second STA-1800U, position the jumpers to connect receptacles J4 to J7 to channels 4 to 7, respectively; and so on. Refer to Figure B-3, in Appendix B, for a diagram of receptacles J4 to J7 and their associated jumper pads.

For more information on MB02 backplanes and modules, refer to the *MB Series User's Guide*.

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Attaching EXP-1800 Expansion Accessories

An EXP-1800 expansion accessory connects to the main I/O connector of a DAS-1800ST/HR Series board through a CDAS-2000 Series cable, as shown in Figure 4-11. To connect an additional EXP-1800, use a CAB-50 Series cable as shown in Figure 4-11.

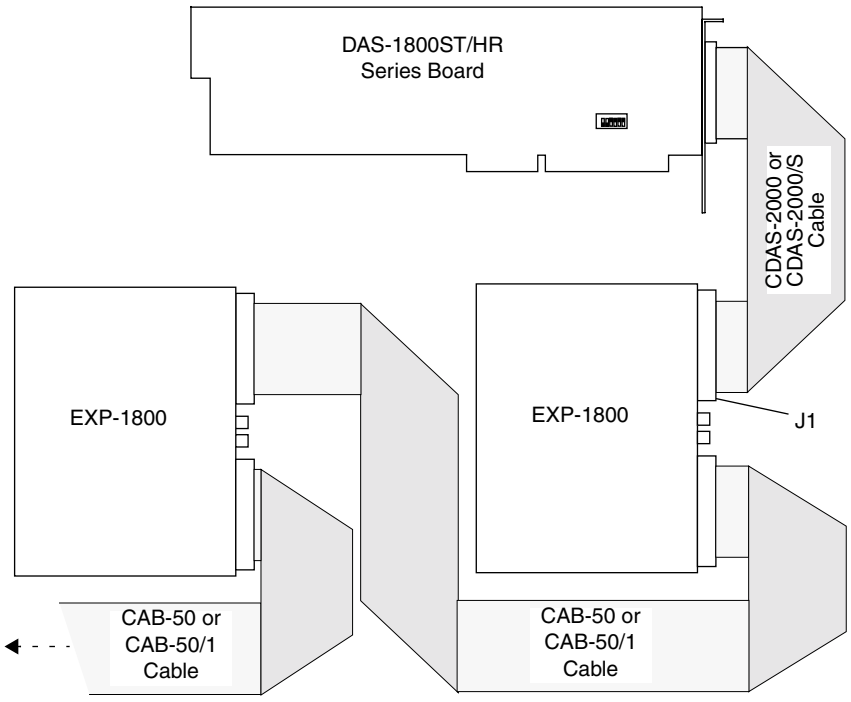


Figure 4-11. Daisy-Chaining EXP-1800 Expansion Accessories

You can attach up to 16 EXP-1800 expansion accessories to a DAS-1800ST/HR Series board; however, some of the added EXP-1800s require external power. For more information on the EXP-1800, refer to the *EXP-1800 User's Guide*.

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Notes: If you are using a DAS-1802HR or DAS-1802HR-DA board with an EXP-1800 expansion accessory, it is recommended that you use the EXP-1800 at a gain of 1 only; using the EXP-1800 at a gain of 50 can produce less than satisfactory resolution.

If you are using a DAS-1802HR or DAS-1802HR-DA board, it is recommended that you use only one EXP-1800 expansion accessory; using more than one EXP-1800 can reduce the performance of the board.

Connecting Signals

This section contains precautionary advice to consider before making I/O connections. The section also shows some circuits for wiring signal sources to input channels of DAS-1800ST/HR Series boards.

The circuit diagrams represent a single signal source wired to a single channel (channel *n*). In reality, you can wire eight separate signal sources to eight differential inputs or 16 separate signal sources to 16 single-ended inputs.

DAS-1800ST/HR Series boards contain separate grounds for low-level analog, ±15V power return, and digital signals. An analog ground (LL GND or U_CM MD, depending on the input configuration) is for analog signals, a ±15V return is for analog power, and a digital ground (DGND) is for digital signals and the +5V power-supply return. If using a differential input configuration, use LL GND for your analog ground. If using a single-ended input configuration, use LL GND or U_CM MD for your analog ground; refer to “Low-Side Reference Selection for Single-Ended Inputs” on page 2-6 for information on choosing between available analog grounds.

Precautions

If you expect to use a DAS-1801ST or DAS-1801ST-DA board at high input gain, read the precautionary information in the following section. Other considerations for I/O connections are offered under “Additional Precautions” on page 4-12.

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Precautions for Using a DAS-1801ST Board at High Gains

Operating a DAS-1801ST board at input gains of 50 or 250 can lead to problems if your application is unable to cope with noise. At a gain of 250, each bit of A/D output corresponds to 10µV of analog input. Thus, with the high speed and bandwidth of this board, analog noise and performance degradation come easily unless you take precautions to avoid them. The following collection of ideas and suggestions is aimed at avoiding these problems.

- Operate a DAS-1801ST board in 8-channel differential mode. Using the board in 16-channel, single-ended mode at high gains introduces 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 Channel LO and HI. Channel 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 one- or two-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 40µV/°C. Thermals can introduce strange random variations caused by air currents, and so on.
- Consider filtering. This approach can use hardware (resistors, capacitors, and so on) but is often accomplished more easily with software. 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, it will be reduced by the square-root of the number of readings.

Additional Precautions

Do NOT mix your data acquisition inputs with the AC line, or you risk damaging the computer. Data acquisition systems give users access to inputs of the computer. An inadvertent short between data and power lines can cause extensive and costly damage to your computer. The manufacturer can accept no liability for this type of accident.

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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 will not come loose and short to high voltages.
- Use isolation amplifiers where necessary.

Connecting a Signal to a Single-Ended Analog Input

Figure 4-12 shows the connections between a signal source and a channel of a DAS-1800ST/HR Series board configured for single-ended inputs. For information on single-ended ground connections, refer to “Low-Side Reference Selection for Single-Ended Inputs” on page 2-6.

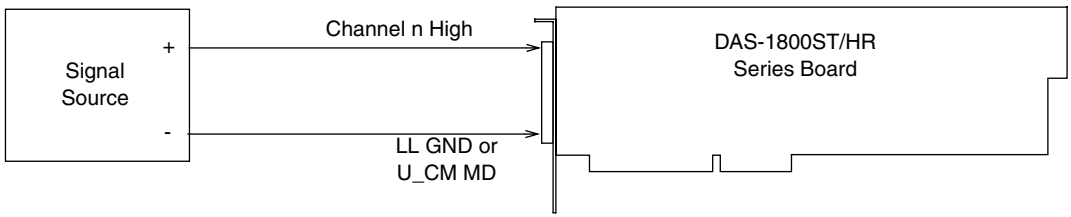


Figure 4-12. Wiring a Signal Source to a DAS-1800ST/HR Series Board Configured for Single-Ended Inputs

Note: When wiring signals to the analog input channels, you are advised to wire all unused channels to LL GND or U_CM MD to prevent the input amplifiers from saturating and ensure the accuracy of your data.

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Connecting a Signal to a Differential Analog Input

Figure 4-13 shows three connection schemes for wiring a signal source to a channel of a DAS-1800ST/HR Series board configured for differential inputs.

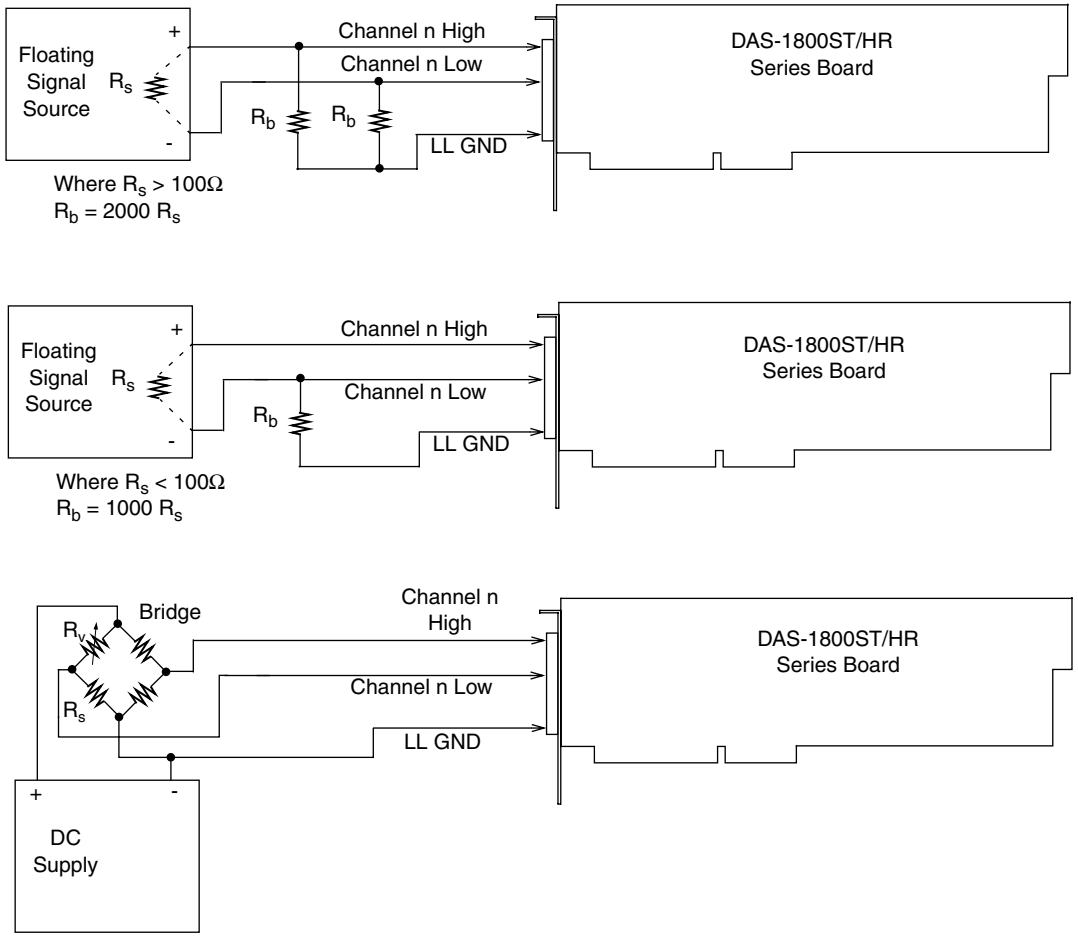


Figure 4-13. Wiring a Signal Source to DAS-1800ST/HR Series Board Configured for Differential Inputs

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The upper two circuits of the diagram 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. 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 100Ω, 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 100Ω, 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 4-13, 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-1800ST/HR 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 4-12 on page 4-13, 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-1800ST/HR Series board's ground.

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Figure 4-14 shows the proper way to connect a differential input to a grounded signal source. Make sure that Channel *n* Low is connected to ground at the signal source, not at the computer and make sure that you do not tie the two grounds together.

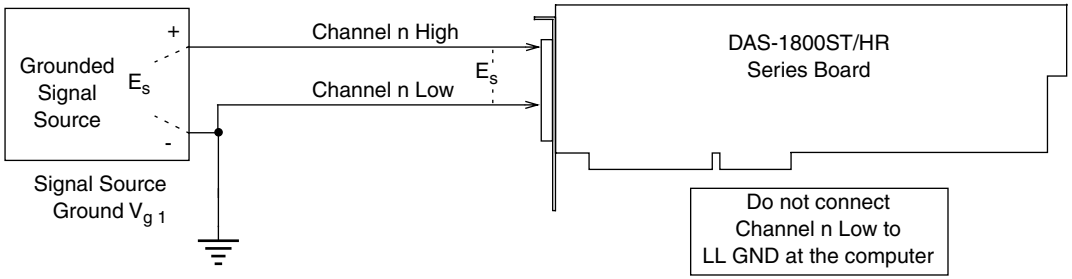


Figure 4-14. Differential Input Configuration that Avoids a Ground Loop Problem

Connecting Analog Output Signals

DAS-1802HR-DA boards have outputs for each of two DACs while DAS-1800ST-DA Series boards have outputs for each of four DACs. Refer to Table A-3 in Appendix A for voltages, current, and other loading specifications. Make your connections to the DAC output terminals through corresponding screw terminals of an STA-1800U.

Note that the screw terminals for the DAC outputs are labeled differently for Revisions 1 and 2 of the STA-1800U. These differences are shown in Table 4-2.

Table 4-2. STA-1800U Labels for DAC Outputs

DAC Output Number	Rev. 1 Label	Rev. 2 Label
0 (for DAS-1800ST/HR-DA Series)	DAC0 OUT	ODAC0
1 (for DAS-1800ST/HR-DA Series)	DAC1 OUT	ODAC1
2 (for DAS-1800ST-DA Series only)	DAC0 IN	ODAC2
3 (for DAS-1800ST-DA Series only)	DAC1 IN	ODAC3

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Connecting Digital I/O Signals

DAS-1800ST/HR Series boards have four digital inputs and four digital outputs, as described in "Digital I/O Features" on page 2-23. Make your connections to the digital I/O terminals through corresponding terminals of the STA-1800U. The terminals are labeled as follows:

- **Digital input** — The digital input terminals are DI 0 to DI 3.
- **Digital output** — The digital output terminals are DO 0 to DO 3.

Connecting Digital Control Signals

DAS-1800ST/HR Series boards use five digital control signals. Make your connections to the digital control terminals through corresponding terminals of the STA-1800U. The terminals are labeled as follows:

- **SSHO** — The simultaneous-sample-and-hold output terminal. The SSHO signal is described in "Using Digital Control Signal SSHO" on page 2-26. Use the SSHO terminal for connecting the SSHO signal.
- **TGIN** — The trigger/gate input, described in the next section and in "Using Digital Control Signal TGOUT" on page 2-24. Refer also to "Triggers" on page 2-18 and to "Gates" on page 2-20. Use the TGIN terminal for connecting an external digital trigger or hardware gate signal.
- **TGOUT** — The trigger/gate output, described in the next section and in "Using Digital Control Signal TGOUT" on page 2-24. Use the TGOUT terminal for connecting the TGOUT signal.
- **XPCLK** — The external pacer clock input, described in the next section and in "Clock Sources" on page 2-16. Use the XPCLK terminal for connecting the external pacer clock signal.
- **DOSTB** — The digital output strobe, described in "Using Digital Control Signal DOSTB" on page 2-24. Use the DOSTB terminal for connecting the DOSTB signal.

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Connecting and Synchronizing Multiple Boards

You can synchronize up to three DAS-1800 Series boards using trigger and gate signals from the main I/O connector. Each board can run at the same conversion rate as the other boards in the system or at a different conversion rate from other boards in the system.

The onboard pacer clock is designed to be tightly coupled with trigger and gate operations. After each board receives the trigger or gate, 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 4-15 shows two connection schemes for synchronizing multiple boards. Both schemes use the onboard internal pacer clock to time acquisitions.

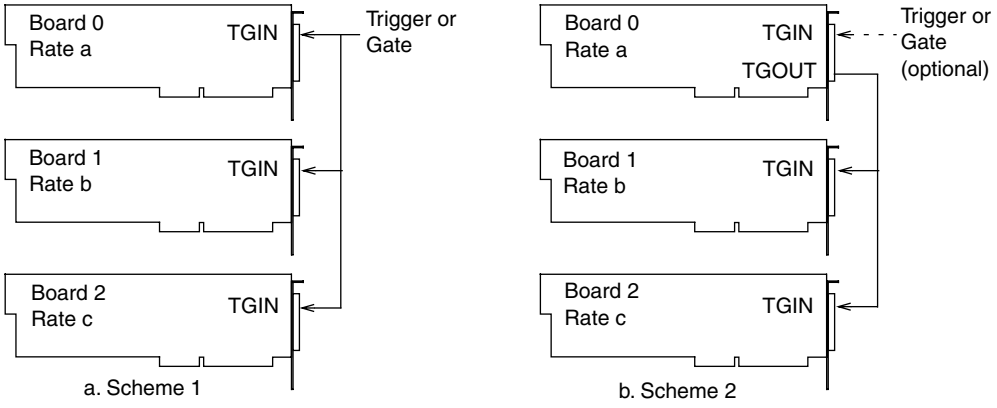


Figure 4-15. Two Connection Schemes for Synchronizing Multiple Boards

In scheme 1, you connect the trigger/gate inputs of the three boards together and supply the trigger or gate input. A/D conversions on each board start 400 ±100ns from the active edge of the trigger input. All conversions start within 100 ±100ns of each other from board to board. When using scheme 1, you can use the onboard internal pacer clock or an external pacer clock.

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In scheme 2, you can start conversions in either of two ways: by a hardware trigger/gate input or by software. The board connections are in a master/slave relationship; board 0 is the master, and boards 1 and 2 are the slaves.

If you use a software enable 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 a hardware trigger for board 0 of scheme 2, 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 or gate.

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5

Testing the Board

This section describes how to use DriverLINX to test functions of DAS-1800ST/HR 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-1800ST/HR DriverLINX installation and configuration.
- Verifying signal inputs to your DAS-1800ST/HR 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.
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-1800ST/HR 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-1800ST/HR 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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6

Calibration

DAS-1800ST/HR Series boards are initially calibrated at the factory. You are advised to check the calibration of a board every six months and calibrate again if necessary. This section provides the information needed to calibrate a DAS-1800ST/HR Series board.

Equipment Requirements

The equipment requirements for calibrating a DAS-1800ST/HR Series board are as follows:

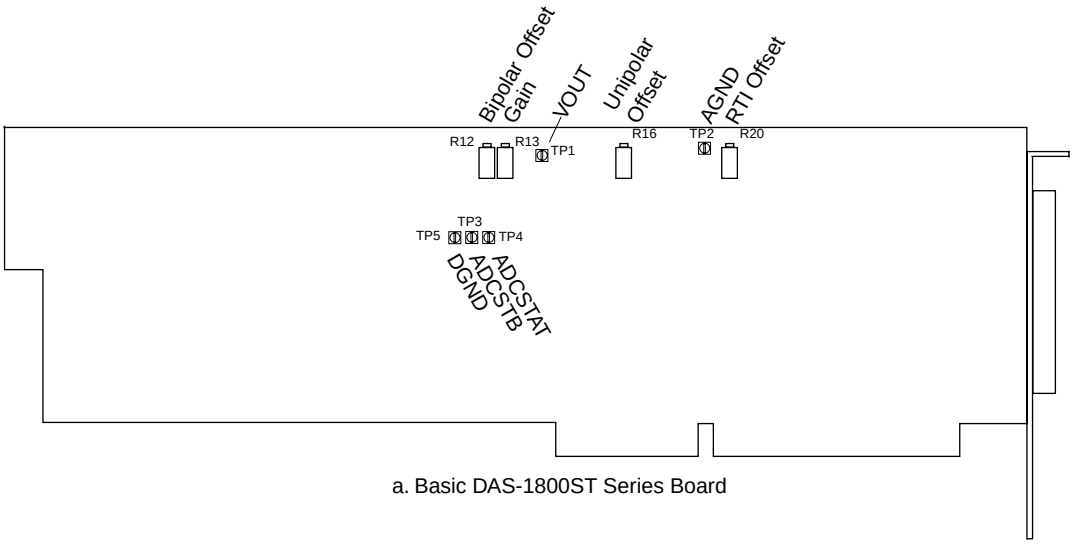
- A digital voltmeter for the DAS-1800ST Series boards accurate to 6½ digits, such as a Keithley Instruments Model 196.
- A digital voltmeter for the DAS-1800HR Series boards accurate to 7½ digits, such as a Keithley Instruments Model 2001.
- An adjustable ±10 V voltage calibrator, such as a Keithley Instruments Model 236.
- An STA-1800U with a CDAS-2000 cable, an STP-50 with a CDAS-2000 cable, or a user-designed interface.
- The appropriate number of CDAS-2000 cables for EXP-1800 accessories, if used.

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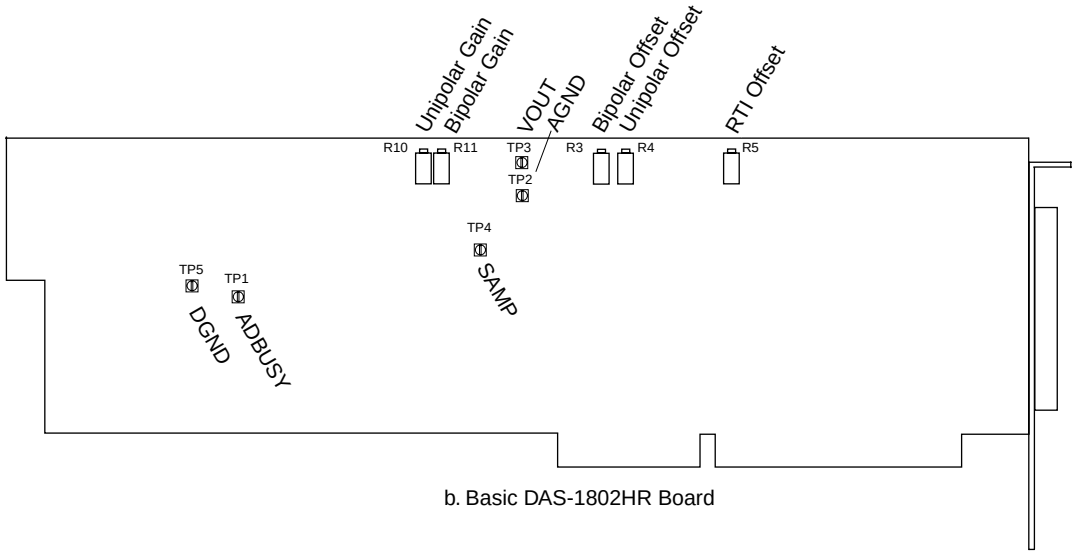
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Potentiometers and Test Points

Figure 6-1 shows the locations of the potentiometers and test points involved with the calibration of a basic DAS-1800ST/HR Series board.



a. Basic DAS-1800ST Series Board



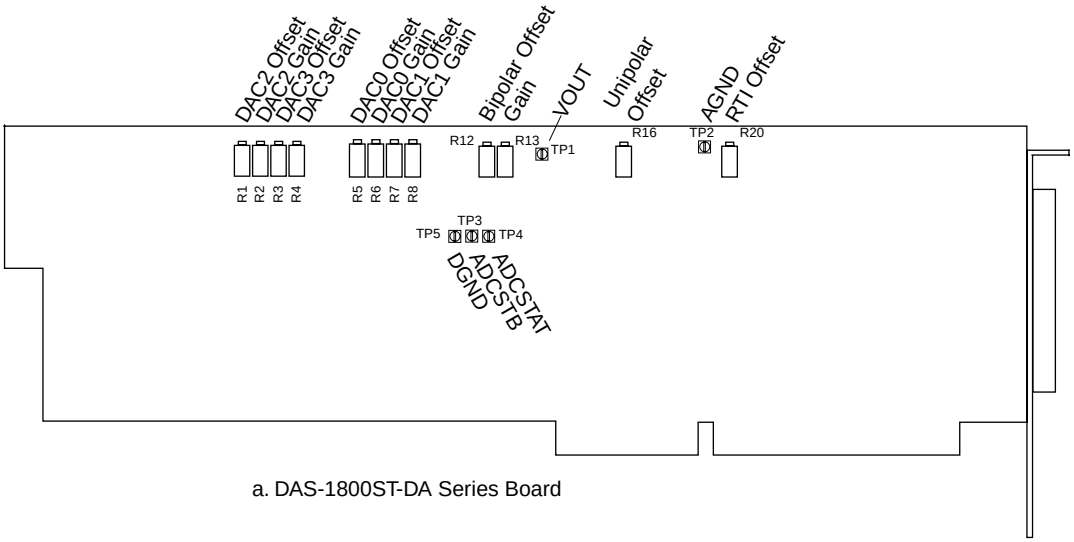
b. Basic DAS-1802HR Board

Figure 6-1. Potentiometers and Test Points on Basic DAS-1800ST/HR Series Boards

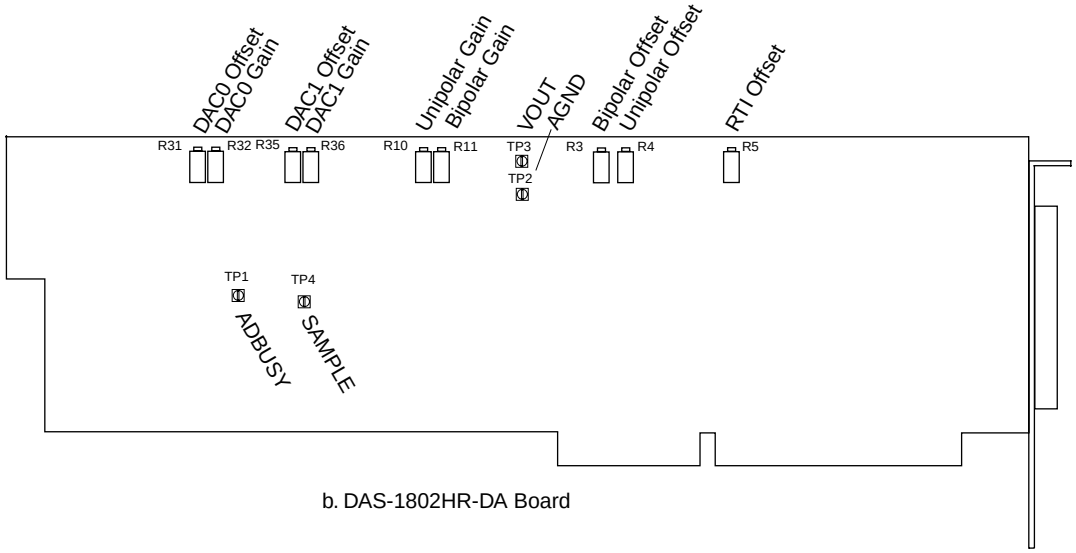
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Figure 6-1 shows the locations of the potentiometers and test points involved with the calibration of a DAS-1800ST-DA Series or DAS-1802HR-DA board.



a. DAS-1800ST-DA Series Board



b. DAS-1802HR-DA Board

Figure 6-2. Potentiometers and Test Points on DAS-1800ST-DA/HR-DA Series Boards

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In both diagrams, the term RTI is *Referred to Input*. The calibration utility, described in the next section, directs you to these components and explains what to do with them during the calibration process.

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.

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7

Troubleshooting

If your DAS-1800ST/HR Series board is not operating properly, use the information in this chapter to isolate the problem. If the problem appears serious enough to warrant technical support, refer to “Technical Support” on page 7-6 for information on how to contact an applications engineer.

Problem Isolation

If you encounter a problem with a DAS-1800ST/HR Series board, use the instructions in this section to isolate the cause of the problem before calling 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.

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 and save 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.

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Device Initialization Error Messages

During device initialization, DriverLINX performs a thorough test of all possible subsystems on the DAS-1800ST/HR 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

Use the troubleshooting information in Table 7-1 to try to isolate the problem. Table 7-1 lists general symptoms and possible solutions for problems with DAS-1800ST/HR Series boards.

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Table 7-1. Troubleshooting Information

Symptom	Possible Cause	Possible Solution
Board does not respond	Base address is incorrect or not consistent with what the program is addressing.	Check the base address switch setting on the board against the setting shown in the configuration utility. If the base address is set correctly, make sure no other computer device is using any 16 of the I/O locations beginning at the specified base address. If necessary, reconfigure the base address. Refer to page 3-5 for instructions on setting the base address.
	The interrupt level is incorrect or not consistent with what the program is addressing.	Make sure no other computer device is using the interrupt level specified in your program. If necessary, reset the interrupt level.
	The board configuration is incorrect.	Check the remaining 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; see page 7-6.
Intermittent operation	The most common cause of this problem is that the I/O bus speed is in excess of 8MHz.	Reduce I/O bus speed to a maximum of 8MHz (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 7-1. Troubleshooting Information (cont.)

Symptom	Possible Cause	Possible Solution
Data appears to be invalid	The most common cause of this problem is that the I/O bus speed is in excess of 8MHz.	Reduce I/O bus speed to a maximum of 8MHz (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 DAS-1800ST/HR Series board; refer to page 3-5 for more information. Check the I/O assignments of other system resources and reconfigure, if necessary.
	Transducer is not connected to channel being read.	Check the transducer connections.
	Board is set for single-ended mode while transducer is a differential type, 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 DAS-1800ST/HR Series 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 host 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 your board is not operating properly after using the information in Table 7-1, continue with the next two sections to further isolate the problem.

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Testing the Board and Host Computer

To isolate the problem to the DAS-1800ST/HR Series board or to the host computer, use 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 host 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-1800ST/HR Series board.
3. Remove the board from the computer and visually check for damage. If a board is obviously damaged, refer to "Technical Support" on page 7-6 for information on returning the board.
4. With the DAS-1800ST/HR Series board out of the computer, check the computer for proper operation. Power up the computer and perform any necessary diagnostics.

At this point, if you have another DAS-1800ST/HR Series board that you know is functional, you can test the slot and I/O connections using the instructions in the next section. If you do not have another board, refer to the instructions on page 7-6 before calling Keithley for technical support.

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Testing the Accessory Slot and I/O Connections

When you are sure that the computer is operating properly, test the computer accessory slot and I/O connections using another DAS-1800ST/HR Series board that you know is functional. To test the computer accessory slot and the I/O connections, follow these steps:

1. Remove computer power again, and install a DAS-1800ST/HR Series board that you know is functional. Do not make any I/O connections.
2. Turn computer power ON and check operation with the functional board in place. This test checks the computer accessory slot. If you were using more than one board when the problem occurred, use the functional board to test the other slot, as well.
3. If the accessory slots are functional, use the functional board to check the I/O connections. Reconnect and check the operation of the I/O connections, one at a time.
4. If operation fails for an I/O connection, check the individual inputs one at a time for shorts and opens.
5. If operation remains normal to this point, the problem is in the DAS-1800ST/HR Series board(s) originally in the computer. If you were using more than one board, try each board one at a time in the computer to determine which is faulty.
6. If you cannot isolate the problem, refer to the next section for instructions on obtaining assistance.

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

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An applications engineer will help you diagnose and resolve your problem over the telephone. Please make sure that you have the following information available before you call:

DAS-1800ST/HR Series Board Configuration	Model	_____
	Serial #	_____
	Revision code	_____
	Base address setting	_____
	Interrupt level setting	_____
	Number of channels	_____
	Input (S.E. or Diff.)	_____
	Mode (uni. or bip.)	_____
	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	DOS version	_____
	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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A

Specifications

Tables A-1 to A-7 list specifications for the DAS-1800ST/HR Series boards.

Table A-1. Analog Input Specifications for DAS-1800ST Series

Feature	DAS-1801ST/ST-DA	DAS-1802ST/ST-DA
Number of channels	Software-selectable as 8 differential or 16 single-ended	
Input mode	Software-selectable as unipolar or bipolar	
Resolution	12-bit (1 part in 4096)	
Data format	16-bit 2's complement	
FIFO size	1024 word	
Channel-gain QRAM size	256 locations	
Gain		
Unipolar	• 0.0 to +5.0V for gain = 1 • 0.0 to +1.0V for gain = 5 • 0.0 to 100mV for gain = 50 • 0.0 to +20mV for gain = 250	• 0.0 to +10V for gain = 1 • 0.0 to +5.0V for gain = 2 • 0.0 to +2.5V for gain = 4 • 0.0 to 1.25V for gain = 8
Bipolar	• ±5.0V for gain = 1 • ±1.0V for gain = 5 • ±100mV for gain = 50 • ±20mV for gain = 250	• ±10V for gain = 1 • ±5.0V for gain = 2 • ±2.5V for gain = 4 • ±1.25V for gain = 8
Absolute accuracy		
Typical:	0.01% of reading ±1 LSB for all ranges	
Maximum error:	• 0.02% of reading ±1 LSB max @ 25°C for gain < 250 • 0.03% of reading ±1 LSB max @ 25°C for gain = 250	

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Table A-1. Analog Input Specifications for DAS-1800ST Series (cont.)

Feature	DAS-1801ST/ST-DA	DAS-1802ST/ST-DA
Temperature coefficient of accuracy (includes ADC) Offset Gain	• ±20µV/°C ±(12µV/°C ÷ gain) maximum for bipolar • ±20µV/°C ±(14µV/°C ÷ gain) maximum for unipolar • ±20ppm/°C for gain < 50 • ±30ppm/°C for gain = 50 • ±35ppm/°C for gain = 250	
Linearity[1] (relative accuracy)	• Integral: ±½ LSB typical, ±1 LSB maximum • Differential: ±1 LSB	
Throughput	333 ksamples/s Refer to "Maximum Achievable Throughput Rates" on page 2-9	
Dynamic parameters	• Acquisition time: 0.3µs • Aperture delay: 13.0ns • Aperture uncertainty: 150ps rms • Conversion time: 3.0µs max. (includes acquisition time)	
Input bias current	• ±40nA max. @ 25°C • ±60nA max. 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	• ±15V continuous powered • ±15V continuous unpowered	
Noise[2] Bipolar electrical noise (in counts) Unipolar electrical noise (in counts)	 • 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 • 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	 • 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 • 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 levels	5, 6, and 7	

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Table A-1. Analog Input Specifications for DAS-1800ST Series (cont.)

Feature	DAS-1801ST/ST-DA	DAS-1802ST/ST-DA
Interrupt levels	3, 5, 7, 10, 11, and 15	
Minimum external pacer clock pulse width	10ns	
Maximum external pacer clock rate	333kHz	
Minimum hardware trigger pulse width	10ns	

[1] Monotonicity is guaranteed over the operating range.
[2] The figures in the table show the electrical noise introduced by the analog front end *but do 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 LSBs.

Table A-2. Analog Input Specifications for DAS-1800HR Series

Feature	DAS-1802HR/HR-DA
Number of channels	Software-selectable as 8 differential or 16 single-ended
Input mode	Software-selectable as unipolar or bipolar
Resolution	16-bits (1 part in 65,536 or 15 ppm)
Data format	16-bit 2's complement
FIFO size	1024 word
Channel-Gain Control: Channel QRAM Gain QRAM	 256 X 8 bits (256 channels maximum) 256 X 2 bits (four gain ranges)

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Table A-2. Analog Input Specifications for DAS-1800HR Series (cont.)

Feature	DAS-1802HR/HR-DA
Range/gain	
Unipolar	• 0.0 to +10V for gain = 1 • 0.0 to +5.0V for gain = 2 • 0.0 to +2.5V for gain = 4 • 0.0 to 1.25V for gain = 8
Bipolar	• ±10V for gain = 1 • ±5.0V for gain = 2 • ±2.5V for gain = 4 • ±1.25V 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 maximum all others
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	• ±5µV/˚C maximum for bipolar • ±5µV/˚C maximum for unipolar
Gain	• ±7.5 ppm/˚C
Linearity[1]	Integral: ±1.5 LSBs maximum Differential: ±1 LSB
Throughput	• Single channel: 100 ksamples/s • Multiple channels (no gain change): 98 ksamples/s • Multiple channels (w/gain change): 60 ksamples/s for gains of 1 to 8 Refer to “Maximum Achievable Throughput Rates” on page 2-9
Input Impedance	100MΩ in parallel with 75pF
Input bias current	• ±2nA max. @ 25˚C • ±100nA max. over operating range

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Table A-2. Analog Input Specifications for DAS-1800HR Series (cont.)

Feature	DAS-1802HR/HR-DA
Dynamic parameters	• Acquisition time: 2µs • Aperture delay: 6.0ns • Aperture uncertainty: - 100ps rms when used with internal pacer clock - 200ns maximum with external pacer clock • Conversion time: 8.0µs maximum
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	• ±15.0V continuous powered and unpowered
Noise[2]	
Bipolar electrical noise (in counts)	• 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 (in counts)	• 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 levels 5, 6, and 7 • Single/dual DMA modes
Interrupt levels	• On FIFO NOT EMPTY (single/slow transfer) • On FIFO HALF FULL (REPL 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 Control:	
Rate	Programmable from 16kHz to 100kHz
Length	Programmable from 1 to 256 conversions per trigger
Other	Direct simultaneous-sample-and-hold support

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Table A-2. Analog Input Specifications for DAS-1800HR Series (cont.)

Feature	DAS-1802HR/HR-DA
Minimum external pacer clock pulse width	10ns
Maximum external pacer clock rate	98kHz
Minimum hardware trigger pulse width	10ns
Triggering: Source Types	 • Internal clock, internal gate • Internal clock, external trigger (edge) • Internal clock, external gate (level) • External clock, internal gate • External clock, external trigger (edge) • External clock, external gate (level) • All the above with programmable edge/level sense • Post-trigger • Pre-trigger • About-trigger (using counter 0)
Pacer Clock: Internal External	 32-bit counter (82C54) Programmable edge sense (±)
Support for board-to-board synchronization (XTRIG input)	• 4-bit digital input port • 4-b latched digital output port (with latch strobe)

[1] Monotonicity is guaranteed to 16 bits.
[2] The figures in the table show the electrical noise introduced by the analog front end and include the quantization noise.

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Table A-3. Analog Output Specifications for DAS-1800ST-DA Series

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

Table A-4. Analog Output Specifications for DAS-1802HR-DA

Attribute	Specification
Type	16-bit, voltage out DAC
Coding	16-bit 2's complement (signed 16-bit integer)
Output range	–10.0000V to +9.999695V
Integral non-linearity	±1 LSB typical, ±2 LSBs maximum
Differential non-linearity	±1 LSB typical, ±2 LSBs maximum
Monotonicity	16 bits typical, 15 bits worst-case

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Table A-4. Analog Output Specifications for DAS-1802HR-DA (cont.)

Attribute	Specification
Absolute accuracy	±2 LSB @ 25˚C
Temperature drift	Offset: ±5ppm/˚C maximum Gain: ±5ppm/˚C maximum
Glitch energy	Area: 15nV * seconds Peak: 15mV
Capacitive load drive	100µF
Settling time	100µs to ±1 LSB of final value (less than 100pF load)
Output current drive	±5mA (25mA short-circuit current)
Power up	DACs power up to 0.0V at reset

Table A-5. Digital I/O Specifications

Attributes	DAS-1800ST/HR Series
Digital output signals	DOSTB, SSHO, and TGOUT: • V_{OH} (min.) = 2.4V @ I_{OH} = -3mA • V_{OL} (max.) = 0.5V @ I_{OL} = 24mA
Digital output signals	DO 0 to DO 3, GEXT, and MUX 3 to MUX 7: • V_{OH} (min.) = 2.7V @ I_{OH} = –400µA • V_{OL} (max.) = 0.5V @ I_{OL} = 8mA
Digital input signals	DI 0 to DI 3[1], XPCLK and TGIN[2]: • V_{IH} (min.) = 2.0V; I_{IH} (max.) = 20µA • V_{IL} (max.) = 0.8V; I_{IL} (max.) = –0.2mA
Digital output strobe pulse width	300ns typical; data is latched on the rising edge of DOSTB

[1] Digital inputs DI 0 to DI 3 are pulled up with a 10kΩ resistor.
[2] On the DAS-1800ST/HR Series basic models, inputs TGIN and XPCLK are not pulled up; on the DA models, inputs TGIN and XPCLK are pulled up with 10kΩ resistors.

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Table A-6. Power Supply Requirements for the DAS-1801ST, DAS-1802ST, and DAS-1802HR

Attribute	DAS-1801ST/DAS-1802ST	DAS-1802HR
+5VDC input	520mA typical; 870mA maximum	500mA typical; 870mA maximum
+12VDC input	190mA typical; 550mA maximum	200mA typical; 550mA maximum
Maximum current available at the ±15V outputs[1]	70mA	70mA
Maximum current available at the +5V output	1.0A	1.0A

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

Table A-7. Power Supply Requirements for the DAS-1801ST-DA, DAS-1802ST-DA, and DAS-1802HR-DA

Attribute	DAS-1801ST-DA/ DAS-1802ST-DA	DAS-1802HR-DA
+5VDC input	483mA typical; 768mA maximum	610mA typical; 850mA maximum
+12VDC input	378mA typical; 700mA maximum	350mA typical; 550mA maximum
Maximum current available at the ±15V outputs[1]	70mA	60mA
Maximum current available at the +5V output	1.0A	1.0A

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

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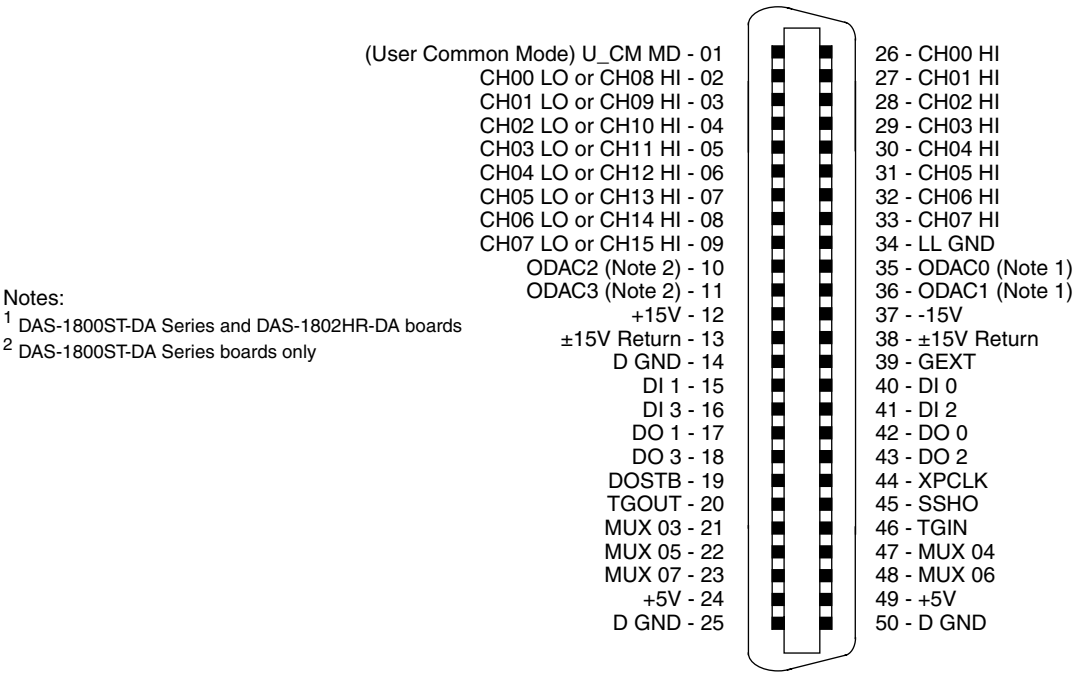
B

Connector Pin Assignments

This appendix contains pin assignments for connectors of a DAS-1800ST/HR Series board and a STA-1800U accessory.

Main I/O Connector

Pin assignments for the main I/O connector of a DAS-1800ST/HR Series board are shown in Figure B-1.



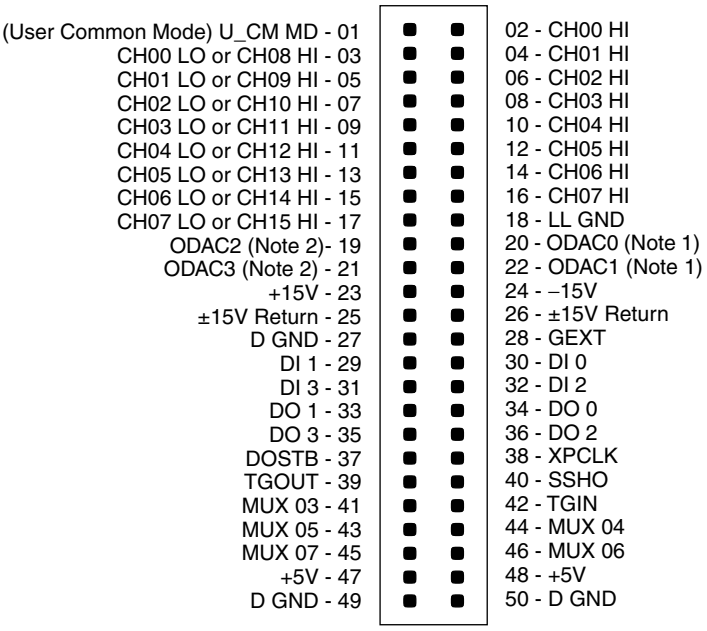
Notes:
[1] DAS-1800ST-DA Series and DAS-1802HR-DA boards
[2] DAS-1800ST-DA Series boards only

Figure B-1. Pin Assignments for the Main I/O Connector

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I/O Connectors J1 and J2 of the STA-1800U Accessory

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



Notes:
[1] DAS-1800ST-DA Series and DAS-1802HR-DA boards
[2] DAS-1800ST-DA Series boards only

Figure B-2. Pin Assignments for Main I/O Connectors J1 and J2 of the STA-1800U Accessory

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Connector J3 of the STA-1800U Accessory

Connector J3 of the STA-1800U accessory is a 37-pin male D connector that accepts a C-1800 cable from an SSH-8 accessory. Pin assignments for J3 are shown in Figure B-3.

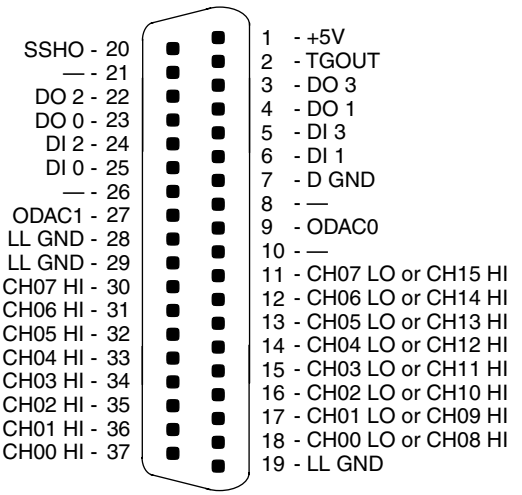


Figure B-3. Pin Assignments for STA-1800U Connector J3

Connectors J4 to J7 and Jumper Pads J8 to J11 of the STA-1800U Accessory

Connectors J4 to J7 of the STA-1800U accessory are 26-pin male connectors that each accept a C-2600 cable from an MB02 backplane. The pin assignments for J4 to J7 are shown in Figure B-4.

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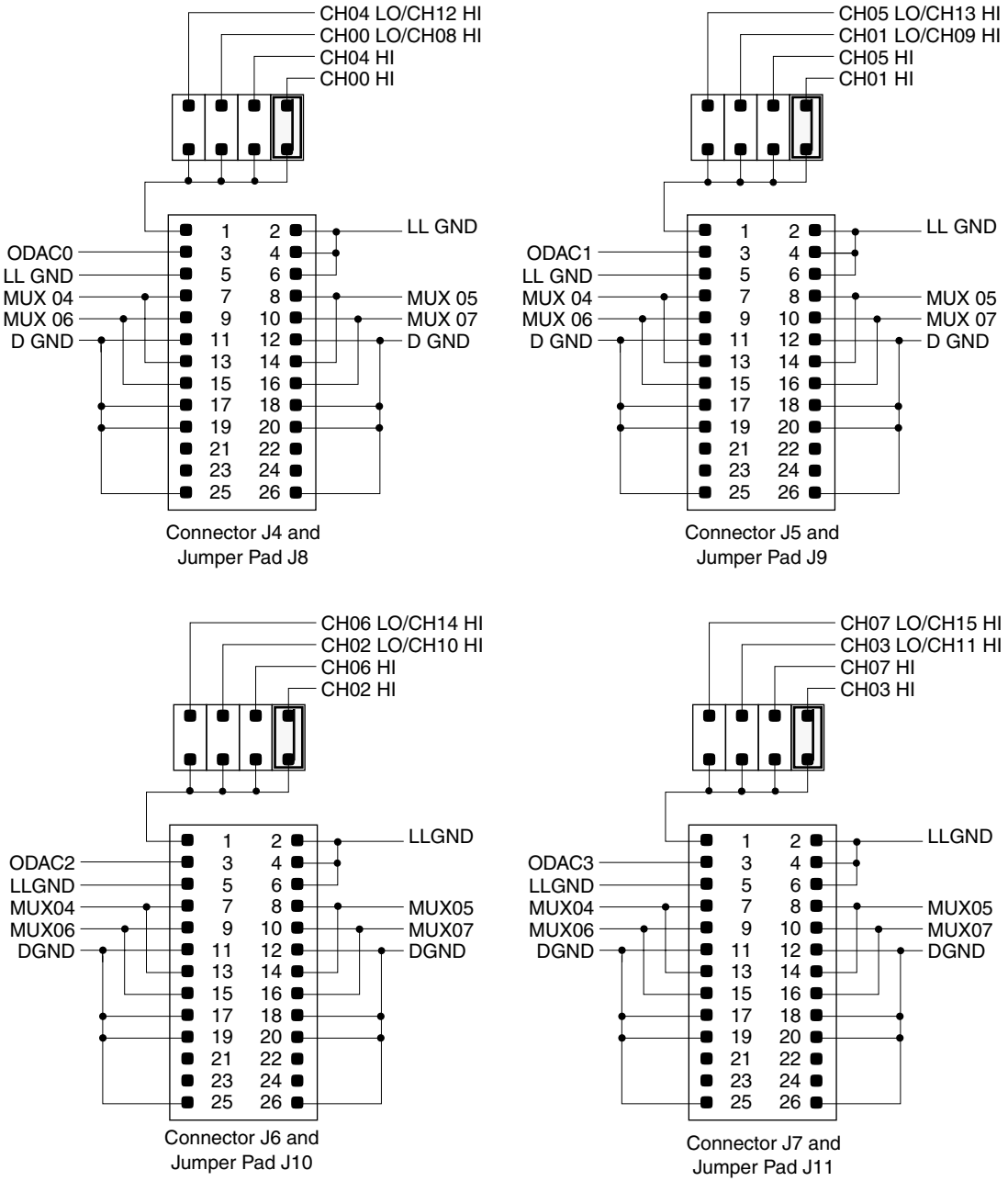


Figure B-4. Pin Layouts and Assignments for STA-1800U Connectors J4 to J7 and Jumper Pads J8 to J11

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C

DriverLINX Configuration Notes

This appendix contains the following sections:

- **Configuration** — describes how DriverLINX works with DAS-1800ST/HR boards.
- **Special Device Settings** — describes settings used specifically for the DAS-1800ST/HR boards.
- **Implementation Notes** — describes how DriverLINX implements features of the DAS-1800ST/HR boards.
- **Analog Input Subsystem** — describes how to configure DAS-1800ST/HR 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-1800 boards.

Model

Note: In this section, "DAS-1800" refers to all models in the DAS-1800 Series. "DAS-1801" refers to the models with low range analog input, while "DAS-1802" refers to the models with high range analog input. 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-1800HC supports the following models:

DAS-1801ST	DAS-1801AO
DAS-1802ST	DAS-1802AO
DAS-1802HR	**DAS-1801ST-DA**
DAS-1801HC	**DAS-1802ST-DA**
DAS-1802HC	**DAS-1802HR-DA**

The primary differences among these boards are number of input channels, A/D resolution, and analog output implementation. All DAS-1800 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 333kHz. The 16-bit versions (DAS-1802HR and DAS-1802HR-DA) have a maximum A/D conversion rate of 100kHz. All DAS-1800 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-1801 boards have gains of 1, 5, 50, and 250 with unity gain input range of ±5V. The DAS-1802 boards have gains of 1, 2, 4, and 8 with unity gain input range of ±10V. The DAS-1800ST has 16 single-ended or 8 differential analog input channels with 12-bit resolution, 4 digital input lines, and 4 digital output lines. The DAS-1802HR has 16-bit A/D resolution with a maximum sampling rate of 100kHz and is otherwise the same as the ST. The DAS-1800HC is the

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same as the ST except for 64 single-ended or 32 differential input channels, two 12-bit DAC's, and 8 digital outputs. The DAS-1800AO 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-1800ST-DA has four 12-bit DACs and the DAS-1802HR-DA has two 16-bit DACs.

Address

The default address used by all DAS-1800 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-1800 does not support auto-calibration. The Device Configuration dialog box displays this setting as disabled.

A/D Channels

On most DAS-1800 boards, A/D channel configuration is software programmable for 16 single-ended or 8 differential analog inputs. (On the DAS-1800HC, A/D channel configuration is software programmable for 64 single-ended or 32 differential analog inputs.)

A/D Volts

You must specify the minimum and maximum analog input, full-scale voltages at unity gain. For the DAS-1801 boards, the minimum voltage is -5V and the maximum voltage is +4.9976V. For the DAS-1802 boards, the minimum voltage is -10V. The maximum voltage is +9.9951V (12-bit A/D) and +9.9997V (16-bit DAS-1802HR).

D/A Volts

You must specify the minimum and maximum analog output, full-scale voltages at unity gain. Only the XX-DA, HC, and AO boards provide analog output. The output range for the XX-DA and HC boards is bipolar only and is fixed at ±10 volts. For these boards, the minimum voltage is

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-10V. The maximum voltage is +9.9951V (12-bit DACs) and +9.9997V (16-bit DAS-1802HR-DA). The output range for the DAS-1800HC 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.

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 do not 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-1800AO also supports DMA operation for analog output. Valid DMA levels are: 5, 6, or 7. Two devices can share DMA levels only if you do not use them at the same time.

Clock

The counter/timer input from the master clock for analog input (and output for DAS-1800AO) has a fixed frequency of 5MHz.

Special Device Settings

The DAS-1800 series driver has special settings. To specify these settings, click the *Special* button on the *Device* property page and enter them in the *Configure DAS-1800 Options* dialog box.

Common-mode reference

The DAS-1800 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-1800 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-11 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-1800 analog input subsystem. Enter the number of SSH-8s connected in the *Configure DAS-1800 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-1800AO 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-16 for details.

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Implementation Notes

The following section describes how DriverLINX implements features of the Keithley DAS-1800 A/D boards.

The following table summarizes the data acquisition modes that each subsystem on the Keithley DAS-1800 supports.

Table C-1. Modes Supported by DAS-1800 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-180AO 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-1800 boards

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

Subsystem Mode	Operation[1]	Events		
		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 (1800AO)	Start	rate, dig, null	cmd, dig, null	null, TC, dig
Interrupt[2]	Start, Stop, Status	rate, dig	cmd, dig, null	cmd, TC, dig, null
DMA (1800AO)	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 the table.

[2] The DAS-1800AO does not support single value transfers in Interrupt mode and therefore **null** Start and Stop Events are not valid.

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

null — Null or None Event when a Service Request does not 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.

Analog Input Subsystem

Most DAS-1800 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/H08 HI** [2], etc., are located on the 50-pin Centronics-style male connector that projects through the rear panel of the computer. (The DAS-1800HC boards contain one A/D converter and a 64-channel multiplexer. You can configure the A/D inputs as 64 single-ended or 32 differential channels. The input channels, labeled **CH00HI** [B2] and **CH00LO/CH32 HI** [B3], etc., are located on the 100-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 (64 locations for DAS-1800HC). 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.

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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 200ns.

Burst Mode Sampling

All DAS-1800 boards support burst mode sampling. To setup 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 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-1800HR) to 64µs (320 tics) maximum.

Repeat Mode Sampling

The DAS-1802HR-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 setup 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,

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DI_EXTCLK. Connect the external clock source to **XPCLK** [44]. The hardware external clocking feature of the DAS-1800 supports positive or negative active edge clocking. Note that the DAS-1800HC models use **DI 0/XPCLK** for both external clocking and digital input. 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, **DI 1/TGIN** [B40] for DAS-1800HC and **TGIN** [46] for other DAS-1800 models.

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. Use **DI 1/TGIN** [B40] for DAS-1800HC and **TGIN** [46] for other DAS-1800 models.

Simultaneous Sampling

The DAS-1800 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-1800 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.

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Analog Input Multiplexer

The EXP-1800 Input Multiplexers can expand the number of physical channels to 256 single-ended analog input channels. The DAS-1800 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-1800 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-1800 while channels 16 - 271 address one of the 256 mux channels.

While a DAS-1800 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-1800 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.

DriverLINX uses a static addressing scheme for attaching multiplexers. Removing an input from one native channel and attaching a mux to that input channel does not 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.

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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-1800 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

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

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	
7		23	39	55	71	87	103	119	135	
8		24	40	56	72	88	104	120	136	

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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 #										
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-1800 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.

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The DAS-1800 returns data in integer format for all data transfer modes—*POLLED*, *INTERRUPT*, and *DMA*. The "native" data format of all DAS-1800 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 4 most significant bits all contain the sign. For a 12-bit A/D at a gain of 1 in the ±10V range (bipolar mode), the voltage resolution would be.

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

Table C-4. Input Voltage and A/D Binary Value

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 +10V range (unipolar mode), the voltage resolution would be

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

Table C-5. Input Voltage and A/D Binary Value

Input Voltage	A/D Binary Value
0.0V	0
+5.0V	2048
+5.00244V	2049
+9.99756V	4095

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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 ±100mV range (bipolar mode), the voltage resolution would be

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

Table C-6. Input Voltage and A/D Binary Value

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

A/D Conversion Delay

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

The minimum A/D conversion delay is 30 clock tics at 200ns per tic (5MHz clock) or 3µs. The DAS-1800 series can sample at a maximum rate of 333kHz for one channel and 312kHz for multiple channels.

A/D Data Lost

The DAS-1800 provides hardware monitoring of A/D data overruns. DriverLINX notifies applications that an overrun has occurred by posting an event message, DL_DATALOST. DriverLINX posts this message only the first time the board detects an overrun during an acquisition task. The DAS-1800 hardware will stop acquisition when an overrun has occurred.

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Analog Output Subsystem

The DAS-1800ST-DA models offer four channels of multiplying 12-bit D/A converters and DAS-1802HR-DA models offer two channels of multiplying 16-bit D/A converts. The DAS-1800ST and DAS-1802HR models do not provide analog output.

The DAS-1800HC models contain two channels of multiplying 12-bit D/A converters. The outputs, labeled **D/A 0 OUT** [9] and **D/A 1 OUT** [27], are located on the D-type male connector that projects through the rear panel of the computer.

The DAS-1800AO 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 500kHz. 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 recycle mode.

For the DAS-AO 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 recycle mode:

Mode = INTERRUPT

Stop Event type = COMMAND

Notify flag (in buffer list) = FALSE

Data buffer samples < 2048

The advantages of using the DAC FIFO buffer for free-run, recycle 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.

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The disadvantages are:

- You cannot 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 recycle 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-1800AO) 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.

Synchronous Analog Input/Output Clocking

The DAS-1800AO 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.

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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 be 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 **DI 0/XPCLK** [B39] for DAS-1800HC or **XPCLK** [44] for other DAS-1800 models. The hardware external clocking feature of the DAS-1800 supports positive or negative active edge clocking. Note that the DAS-1800HC models use **DI 0/XPCLK** for both external clocking and digital input. 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 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

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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, **DI 1/TGIN** [B40] for DAS-1800HC and **TGIN** [46] for other DAS-1800 models. 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-1800 boards except the DAS-1800AO which has two software programmable ranges; ±5V and ±10V.

The DAS-1800ST-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-1802HR-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-1800HC uses split binary data coding for the two 12-bit D/A channels. The output range is fixed at ±10 volts. The minimum DAC code is 0 (–10V) and the maximum code is 4095 (+98.9951V).

The DAS-1800AO 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 gain of -2 for ±10V. The negative sign implies bipolar operation. (Unipolar mode is not available for analog output).

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

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

Table C-7. Binary Values and D/A Voltage

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

D/A Conversion Delay

The DAS-1800ST/HR and the other DAS-1800 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.

The DAS-1800AO 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 500kHz. It will run at that rate under Windows with DriverLINX if the D/A task runs alone or in the recycle mode with an active analog input task. On a typical 486DX2/66-based computer, running in the synchronous analog input/output mode, a 100kHz rate for each task is easily attainable without degrading overall system performance. If both AI and AO tasks use DMA (different channels), 200kHz for each is achievable, but system response noticeably slows.

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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 200Hz 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-1800AO 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.

Table C-8. Logical Channels and Physical Digital I/O

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 four digital outputs. Since the channel/gain QRAM controls the state of these outputs, changes to the

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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.

The DAS-1800 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-1800 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-1800 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-1800 boards operate Counters 1 and 2 in a fixed divider, 32-bit configuration. The input of Counter 1 connects to a 5MHz crystal oscillator and the output of Counter 1 connects to the input of Counter 2. The DAS-1800 uses Counter 0 for trigger delay and its input, output, and gate control are not available.

Although the DAS-1800 uses a chip that has 3 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-1800AO 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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