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KEITHLEY

DAS-1800HC Series

User's Guide



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DAS-1800HC Series
User's Guide

Revision F - August 2000
Part Number: 77150

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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 for persons needing to understand the installation, interface requirements, functions and operation of the DAS-1801HC and DAS-1802HC boards. The two models differ only in gain. Unless this manual refers specifically to the DAS-1801HC board or the DAS-1802HC board, it refers to the two models collectively as the DAS-1800HC Series boards.

This guide focuses primarily on describing the DAS-1800HC Series boards and their capabilities, setting up the boards and their associated software, making typical hookups, and operating the DriverLINX software. There are also sections 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-1800HC 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.
- Section 5 briefly describes the DriverLINX Analog I/O program and Test program.

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- 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-1800HC Series boards.
- Appendix B lists the pin assignments for the main I/O connectors of DAS-1800HC Series boards and for the four 37-pin accessory connectors of the STA-1800HC and CONN-1800HC 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-1800HC 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 a 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-1801HC is a high-gain board, while the DAS-1802HC is a 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 64 single-ended or 32 differential analog input channels.
- Channels are individually software-configurable for gain.
- The boards measure inputs at up to 333 ksamples/s with 12-bit resolution.
- A 1024-location FIFO (First In First Out) data buffer ensures data integrity at all sampling rates.
- A 64-location channel/gain queue supports high-speed sampling at the same or different gains and in sequential or non-sequential channel order.
- Burst-mode data acquisition emulates simultaneous-sample-and-hold (SSH) capability.
- The boards support external SSH hardware.

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- Single- or dual-DMA (Direct Memory Access) operation is software-configurable.
- Interrupt levels are software-configurable.
- Pulsed interrupts allow multiple DAS-1800 Series boards to share interrupt levels.
- Hardware A/D (analog-to-digital) trigger and gate have software-selectable polarity.
- Triggering capabilities support pre-, post-, and about-trigger acquisitions.
- Dual 12-bit DAC (digital-to-analog converter) outputs have simultaneous updates.
- The boards have four digital inputs.
- The boards have eight digital outputs with latch strobe.
- A 100-pin I/O connector requires only one slot on rear panel of the PC AT.

For more information on these features, refer to the functional description in Section 2.

Supporting Software

The following software is available for operating DAS-1800HC Series boards:

- **DAS-1800HC Series standard software package** — Shipped with DAS-1800HC 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 include:
  - *DriverLINX API DLLs* and drivers supporting the DAS-1800HC Series hardware

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  - *Analog I/O Panel* — A DriverLINX program that verifies the installation and configuration of DriverLINX to your DAS-1800HC 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-1800HC Series
  - *LabVIEW support for DriverLINX* — application programming interface files for the DAS-1800HC 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-1800HC Series hardware.
- **DAS-1800HC Series utilities —** The following utilities are provided as part of the DAS-1800HC 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 use with the DAS-1800HC Series boards:

- **STA-1800HC** is a screw terminal accessory. This accessory connects to the DAS-1800HC Series main I/O connector through a CAB-1800 cable to bring all the I/O signals out to labeled screw terminals for easy access. Refer to Section 4 for connections.

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- **CONN-1800HC** is a connector panel. This accessory connects to the DAS-1800HC Series main I/O connector through a CAB-1800 Series cable to provide a 4-connector interface for SSH-8s, MB modules, or custom hookups.
- **STP-100** is a screw terminal panel. This accessory provides general-purpose screw-terminal connections in a compact form factor.
- **RMT-04** is a rack mount enclosure for the STA-1800HC.
- **SSH-8** is an 8-channel simultaneous-sample-and-hold accessory for the DAS-1800HC Series boards.
- **MB Series modules and MB01 backplanes** are plug-in, isolated, signal-conditioning modules and the backplanes that hold them.
- **C-16MB1** is a cable for connecting an STA-1800HC to an MB01 signal-conditioning backplane.
- **CAB-1800 Series** are cables for connecting a DAS-1800HC Series board to an STA-1800HC, STP-100, or CONN-1800HC. This series consists of the following cable models:
  - *CAB-1800* is an 18-inch ribbon cable.
  - *CAB-1801* is a 36-inch ribbon cable.
  - *CAB-1800/S* is an 18-inch shielded, ribbon cable.
  - *CAB-1801/S* is a 36-inch shielded, ribbon cable.
- **C-1800** is an 18-inch ribbon cable with two 37-pin female type D connectors for connecting an STA-1800HC to an SSH-8.

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2

Functional Description

This section describes features of the following DAS-1800HC Series board components: the analog input, the analog output, and the digital I/O. These descriptions are offered 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 both the DAS-1801HC and the DAS-1802HC.

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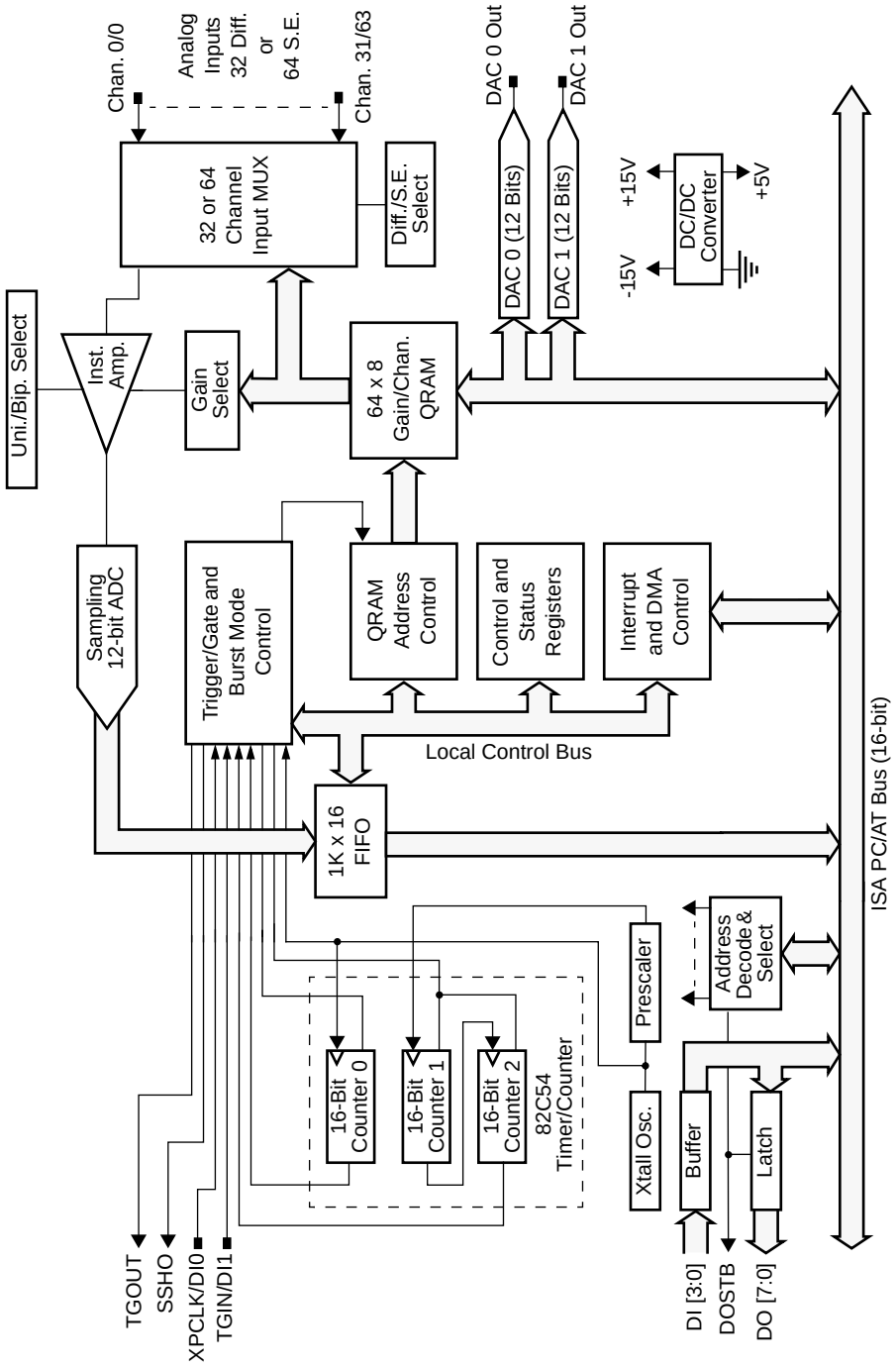


Figure 2-1. Block Diagram of DAS-1800HC Series Board

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Analog Input Features

The analog input section of a DAS-1800HC Series board multiplexes all the active input channels (up to 64 single-ended or 32 differential) down to a single, 12-bit sampling ADC (analog-to-digital converter). Other features of this section include software-configurable input modes, a channel-gain queue, data conversion modes, data transfer modes, and trigger and gate control. These features are described in the following subsections.

Differential/Single-Ended Selection

Using DriverLINX software, you can set DAS-1800HC 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.* 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.

There is no specific level at which one of these input configurations becomes more effective than the other. However, you should generally use differential inputs for voltage ranges of 100mV and below.

Unipolar/Bipolar Selection

Using DriverLINX, you can set the DAS-1800HC 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).

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

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Channel-Gain Selection

The channel-gain queue is a RAM storage circuit for a 64-position queue. Each of the 64 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. Available gains and input ranges for both DAS-1800HC Series boards are listed in the following subsection.

Gains and Ranges

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

Table 2-1. DAS-1801HC 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

Table 2-2. DAS-1802HC 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

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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:

- Put all channels that use the same range in the same group, 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 the maximum input range of the board. This method offers the advantages of increasing total system throughput and reducing noise.
- In the common case where the low-level inputs are relatively slow-speed and the high-level inputs are high-speed, you should maintain two channel lists: one for low-speed inputs, the other for high-speed inputs.
- If you are not using all the channels, you can make a particular channel-gain entry twice to allow for settling time. In this case, you want to ignore the results of the first entry.

You must give special consideration to the direct measurement of low-level signals with the DAS-1801HC. 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 requires post-acquisition filtering (averaging) to achieve accurate results.

The DAS-1801HC would have better 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-1801HC has very high bandwidth (bandwidth for low-level signals is about 8 to 10MHz) any

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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. Always use the ±20mV, 0 to 20mV, ±100mV, and 0 to 100mV ranges with the differential input mode.

The tables below 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 is 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.

The maximum throughput for sampling one channel at one gain (any gain) is 333 ksamples/s. The throughput for channel-to-channel sampling with fixed gain in bipolar mode (0.024% maximum error) is as shown in Table 2-3.

Table 2-3. Throughput for Channel-to-Channel Sampling in Bipolar Mode with Fixed Gain

DAS-1801HC Range	DAS-1802HC Range	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

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

Table 2-4. Throughput for Channel-to-Channel Sampling in Unipolar Mode with Fixed Gain

DAS-1801HC Range	DAS-1802HC Range	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	—	200 ksamples/s
0 to 20mV	—	60 ksamples/s

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

Table 2-5. Maximum Throughput for DAS-1801HC in Bipolar Mode

Range	Maximum Throughput			
	To ±5V	**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

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

Table 2-6. Maximum Throughput for DAS-1801HC in Unipolar Mode

Range	Maximum Throughput			
	To 0 to 5V	**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

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

Table 2-7. Maximum Throughput for DAS-1802HC in Bipolar Mode

Range	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

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

Table 2-8. Maximum Throughput for DAS-1802HC in Unipolar Mode

Range	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

Data Conversion Modes

DAS-1800HC Series boards support two modes of data conversion: paced and burst. The conversion rate for each of these two modes is controlled by its own clock: the pacer clock for paced mode and the burst mode conversion clock for burst mode. Other differences between the two data conversion modes are as follows:

- **Paced mode** — Paced mode is the default data conversion mode and is the mode best-suited for continuous scanning of a queue 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 in the queue. The internal pacer clock is programmable from 0.0012Hz to 333kHz.
- **Burst mode** — In the burst mode, each pulse from the pacer clock starts a scan of an entire queue of channels. The conversion rate during a burst mode scan is equal to the rate of the burst mode conversion clock. The sample rate, which is the rate at which a single channel is sampled, is equal to the pacer clock rate.

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Burst mode can also be used for pseudo-simultaneous sample-and-hold (SSH) in conjunction with DMA or interrupt operations.

Figure 2-2 shows the timing relationships of the paced and burst modes for a queue of channel 4 to channel 7.

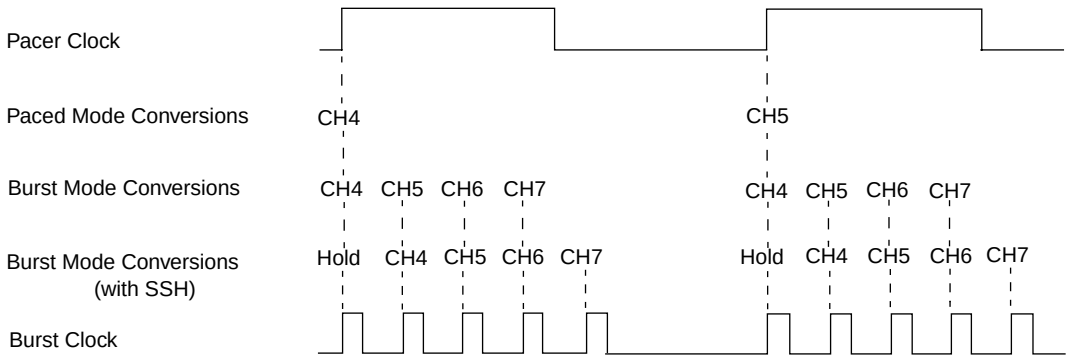


Figure 2-2. Timing of Conversion Modes for a Queue of Channels 4 to 7

Clock Sources

DAS-1800HC 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 2-2. 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, as shown in Figure 2-2. These clock sources are described in the following subsections.

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Pacer Clock

In paced mode, the pacer clock determines the conversion rate. The following clock sources are available for paced mode conversions on DAS-1800HC Series boards:

- **Software** — DAS-1800HC Series boards allow you to acquire single samples under program control.
- **Hardware (internal clock source)** — The internal pace clock source uses the onboard 82C54 counter/timer and a crystal-controlled 5MHz time base. The internal pacer clock uses two cascaded counters of the 82C54 and is programmable between a maximum allowable rate of 333kHz and a minimum available rate of 0.0012Hz. When not used to pace the analog input, the internal clock source can serve to pace other events such as the digital I/O and analog outputs through the use of interrupts.
- **Hardware (external clock source)** — The external pacer clock source must be an externally applied TTL-compatible signal attached to the DI0/XPCLK pin (B39) of the main I/O connector, J1. The active edge for this clock is programmable.

  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). If using an external clock, make sure that it does not initiate conversions at a faster rate than the ADC can handle.

If acquiring samples from multiple channels, the maximum sampling rate for each channel is equal to 333 ksamples/s divided by the number of channels.

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Burst Mode Conversion Clock

In burst mode and burst mode with SSH, the burst mode conversion clock determines the conversion rate, while the pacer clock determines the rate at which bursts occur. In this manual, the conversion rate during burst mode conversion is referred to as the *burst mode conversion rate*, and the rate at which bursts occur is referred to as the *scan rate*.

DAS-1800 Series software utilities allow you to program the pacer clock to adjust the interval between burst mode scans. This software also allows you to adjust the burst mode conversion rate. The burst mode conversion clock frequency is programmable for a range of 15.625Hz to 333kHz.

Without SSH hardware attached to the DAS-1800HC Series board, the sample rate (pacer clock rate) should be set for 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 2-5.

With SSH hardware attached to the DAS-1800HC Series board, 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. For information on the signal interface between a DAS-1800HC Series board and SSH hardware, refer to “Using Digital Control Signal SSHO” on page 2-20.

Triggers

A trigger starts an analog input operation. The polarity of external triggers in the DAS-1800HC Series boards is software-selectable. You can 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-1800HC Series boards, you can program an analog trigger using one of the analog input channels as the trigger channel. The DAS-1800HC 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 the DAS-1800HC Series board.

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- **External Digital** — Connect the digital trigger to the digital input DI1 pin (B40) of the 100-pin connector, J1. 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.

Figure 2-3 illustrates conversions enabled with software triggering/gating and with internal and external clock sources. In the diagram, the delay between the start of the conversion process by software and the start of the onboard clock is less than 1µs. Figure 2-4 illustrates the enabling of conversions with a hardware trigger.

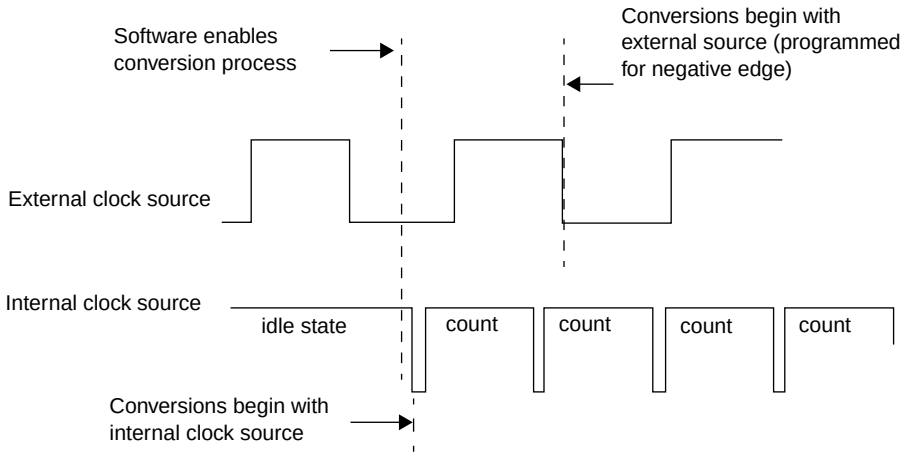


Figure 2-3. Enabling Conversions with Software Triggering/Gating and with Internal and External Clock Sources

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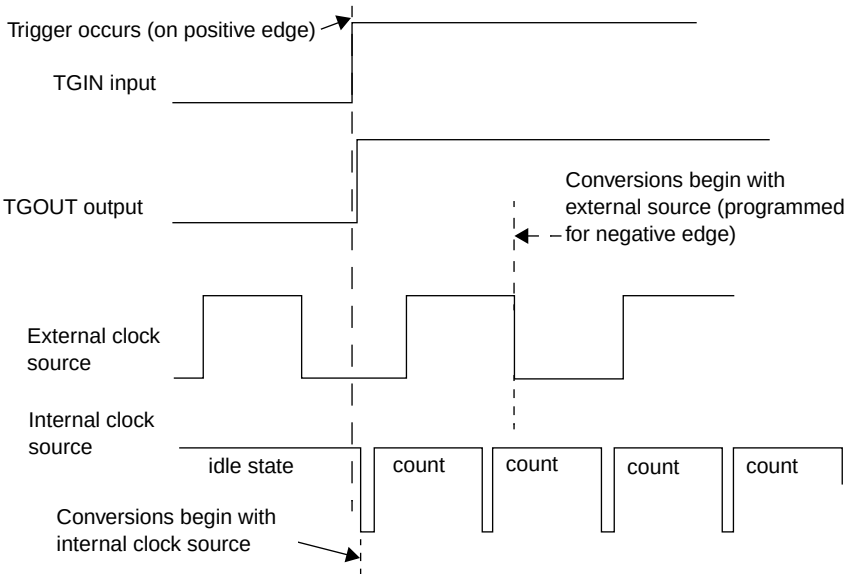


Figure 2-4. Enabling Conversions with a Hardware Trigger

Pre-Trigger Acquisition

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

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Post-Trigger Acquisition

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

Gates

A gate in the active state allows conversions to proceed. You can use software to select a signal on the digital input DI1 pin (B40) of the main I/O connector as a hardware gate.

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 2-5 illustrates the use of the hardware gate with both an external clock and an internal clock. For information on the TGIN and TGOUT signals, refer to “Digital I/O Features” on page 2-18.

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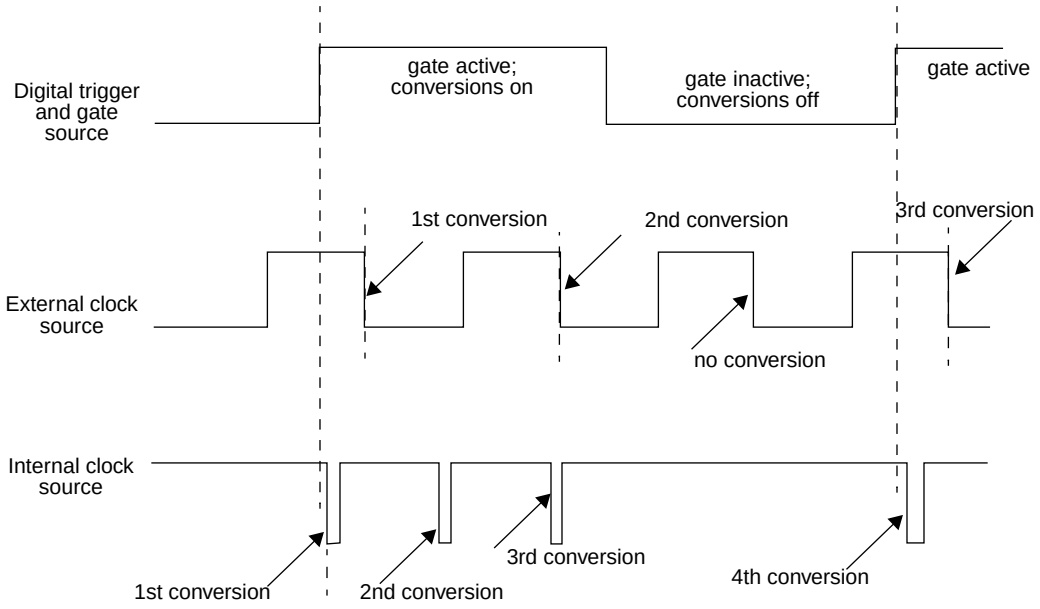


Figure 2-5. Hardware Gate

Data Transfer Modes

You can transfer data from the DAS-1800HC 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 12-bit 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 the interrupt mode. When in the Windows environment, you are advised to use single- or dual-channel DMA instead of an interrupt.

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- **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 family, DMA is directed by one or more 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-1800HC 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 singly 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 software driver automatically uses the FIFO to buffer the samples while the DMA channel is being re-programmed for another address. In most situations, this FIFO buffering capability allows you to acquire and load 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 operation in the Windows Enhanced Mode, you should use dual-channel DMA to acquire data reliably at maximum board speeds.

Analog Output Features

The analog output section of DAS-1800HC Series boards consists of two DACs with 12-bit resolution. Both DACs have a fixed voltage range of ±10V, and they power up to 0V at reset. The two DACs have a capacitive load drive of 100µF and an output current drive of ±5mA.

The analog output can be “paced” with interrupts generated by the onboard pacer clock when the analog inputs are either disabled or timed by an external pacer clock. Single values can be written to the DACs.

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Digital I/O Features

DAS-1800HC Series boards contain four digital inputs (DI0 to DI3) and eight digital outputs (DO0 to DO7). 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 10kΩ pull-up resistors to +5V; therefore, the inputs appear high (logic 1) with no signal connected.

Using Digital Inputs and Outputs

You can use the digital inputs and outputs for any general-purpose task, except as follows:

- If using an external digital trigger and gate, you must use digital input line DI1/TGIN to attach the trigger/gate signal; in this case, you cannot use DI1/TGIN for general-purpose digital input.
- If using an external pacer clock, you must use digital input line DI0/XPCLK to attach the external pacer clock signal; in this case, you cannot use DI0/XPCLK for general-purpose digital input.

When the analog inputs are either disabled or timed by an external pacer clock, the digital I/O can be “paced” with interrupts generated by the onboard pacer clock.

Using Digital Control Signal DOSTB

The DAS-1800HC Series boards provide a strobe signal (DOSTB) for the purpose of strobing data through the digital outputs and latching the data into a register in other equipment. Where DAS-1800HC 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 2-6.

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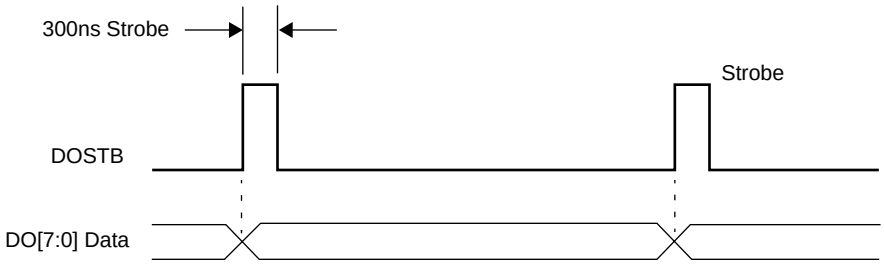


Figure 2-6. Timing Relationship between Data from DO0 to DO7 and Latch Strobe DOSTB

Using Digital Control Signal TGOUT

When using the onboard pacer clock only, you can use the trigger/gate output (TGOUT) signal to synchronize other DAS-1800HC Series boards or to trigger or gate user-specific events as follows:

- When using digital control signal TGIN as a trigger, as shown in Figure 2-7a, note that TGOUT does not retrigger and thus cannot be used with about-trigger acquisitions. Note also, there is a delay of about 200ns between the active edge of TGIN and the starting edge of TGOUT.
- When using digital control signal TGIN as a gate, as shown in Figure 2-7b, 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, shown in Figure 2-7c, note that the delay between the active edge of the internal trigger/gate and the starting edge of TGOUT is less than 1µs.

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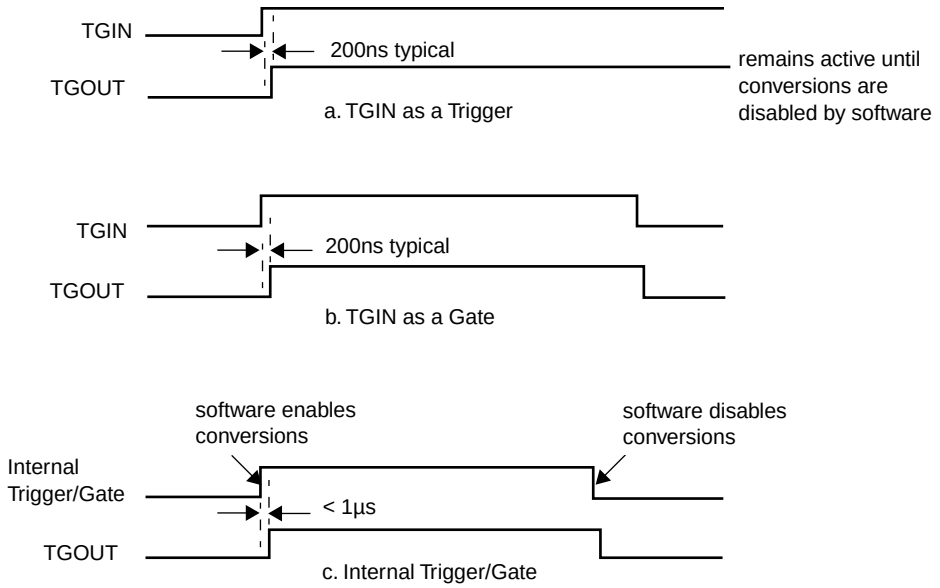


Figure 2-7. Timing for the Generation of TGOUT

Using Digital Control Signal SSHO

The SSHO digital control signal is normally generated by DAS-1800HC Series boards to accommodate an SSH hardware interface. The SSHO signal is generated by either the onboard counter/timer clock or a user-supplied external clock. Characteristics of the SSHO signal when used for SSHO 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 an active edge of the pacer clock and remains there until 200ns after the ADC starts conversion of the last channel in the burst.
- SSHO remains low until another active edge of the pacer clock. To ensure adequate sample time for the SSH hardware, the pacer clock period should be as follows:

  Pacer Clock Period ≥ (Number of Channels + 1) × (Burst Period)

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The Burst Period can be 3.0 to 64µs. A/D conversion begins one burst period after an active edge of the sample clock. Burst mode must be used when SSH hardware is connected to DAS-1800HC Series boards.

When not generating SSHO for SSH hardware control, you can use SSHO as a converter clock output signal. SSHO becomes active only when software enables A/D conversions. The timing for SSHO generation when the DAS-1800HC Series boards are not used for SSH hardware control is shown in Figure 2-8.

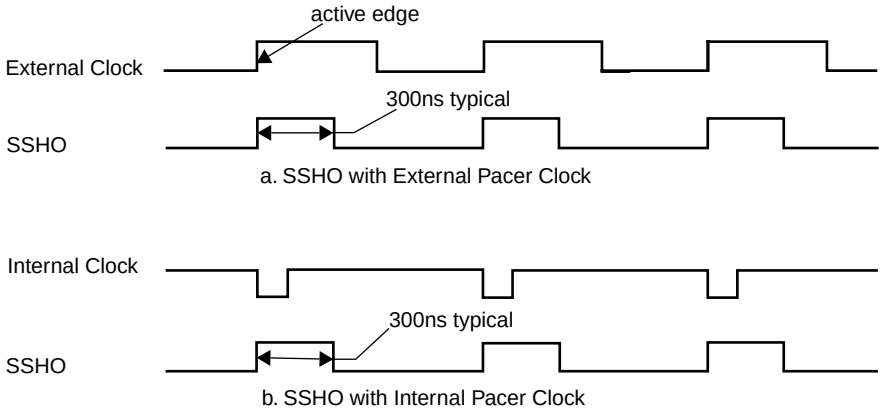


Figure 2-8. Timing for SSHO Generation when not used for SSH Hardware

Assigning an Interrupt

You 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.

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

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

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-1800HC Series boards use the +5V and the +12V provided by your computer. An onboard DC/DC converter develops ±15V at a maximum current draw of 30mA for external use. In addition to the ±15V, the DAS-1800HC Series boards supply the +5V from the computer to a pin on the main I/O connector.

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3

Setup and Installation

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

Unwrapping and Inspecting Your Board

Remove the wrapped board from its outer shipping carton and 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 equipped with a grounded wrist strap, you discharge static electricity as soon as you hold the wrapped board.
   - If 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 satisfied with the inspection, proceed with the software and hardware setup instructions.

Note: DAS-1800HC Series boards are factory calibrated and require no further adjustment prior to installation. If at a later time you decide to re-calibrate 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-1800HC Series Standard Software Package

Important: Before you begin installing any hardware or software for the DAS-1800HC, 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 your DAS-1800HC board's configuration settings.
2. Determine the resources your DAS-1800HC Series board requires.
3. Inventory your computer's resources already allocated to other installed devices.
4. Determine whether your computer has sufficient resources for your DAS-1800HC board.

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5. Determine whether your DAS-1800HC board can use your computer's free resources.
6. Set any jumpers/switches to configure your DAS-1800HC board to use your computer's free resources.
7. Set any other jumpers/switches to configure your DAS-1800HC 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 convenience in installing and uninstalling just the DriverLINX components you need, the DriverLINX CD Browser will assist you in selecting the components to install:

- **Install Drivers** — This required component installs only the files you need for configuring your hardware and running third–party data–acquisition applications that require DriverLINX.
- **Install Interfaces** — This optional component installs the files and example programs you will need to develop custom applications for DriverLINX using C/C++, Visual Basic, Delphi, and LabVIEW.
- **Install LabVIEW** — This component installs the files and programs you will need 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 your DAS-1800HC board into an appropriate free slot in your computer.

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Setting the Base Address

The base address switch is preset at the factory for a hexadecimal value of 300 (768 decimal). If this address appears to conflict with the address of another device in the computer (including other DAS-1800HC Series boards), you must reset the base address switch.

The base address switch is a 7-position DIP switch located as shown in Figure 3-1. 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.

Note: The settings for the base address switch must match the settings shown in DriverLINX.

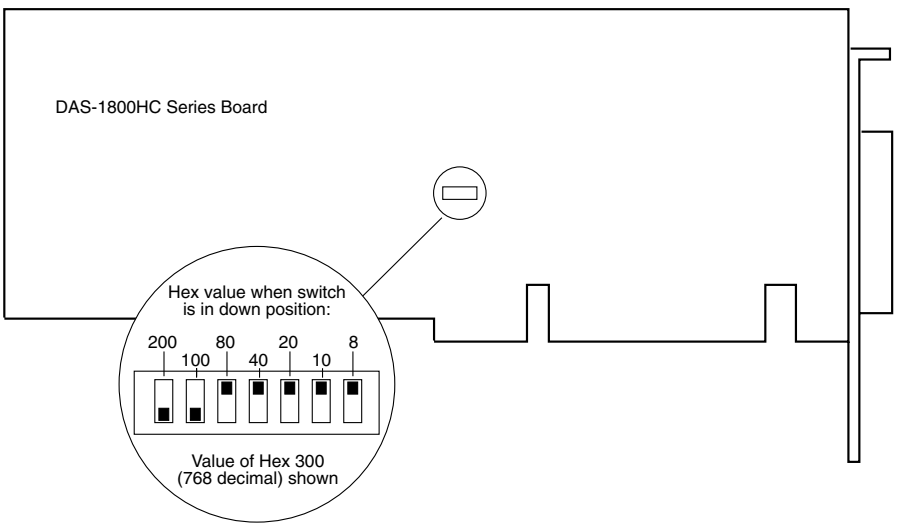


Figure 3-1. Location of Base Address Switch

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Installing the Board

Caution: Installing or removing a board while power is on can damage your computer.

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

1. Turn off power 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 settings of the base address switch match the settings shown in the configuration-utility switch diagram.
5. Insert and secure the board in the selected slot.
6. Replace the computer cover.

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

Configuring the DAS-1800HC Board with DriverLINX

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

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

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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
2B0H to 2DFH	EGA
2E0H to 2EFH	GPIB (AT)

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

Address Range	Use
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-1800HC 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-1800HC Series board and to verify that everything is properly installed and configured.

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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.
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 the 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-1800HC, select *Device*/*Initialize* from the main menu in Learn DriverLINX.
2. The first time the DAS-1800HC 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-1800HC 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-1800HC Series boards.

Caution: To avoid electrical damage, turn off power to the computer and any attached accessories before making connections to DAS-1800HC Series boards.

Attaching an STA-1800HC

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

- A 100-pin female connector for cabling to the main I/O connector of a DAS-1800HC Series board.
- 120 labeled screw terminals for connecting sensor outputs and test equipment to the main I/O connector.
- A CJC (Cold Junction Compensation) temperature circuit for determining correction values for thermocouple inputs.
- Four 37-pin male connectors for cabling to MB01 backplanes and SSH accessories.
- A breadboard area for user-installed circuitry.

Pin assignments for the main I/O connector of a STA-1800HC are a mirror image of those for the 100-pin, main I/O connector of a DAS-1800HC Series board, as shown in Figure 4-1 and Figure 4-2.

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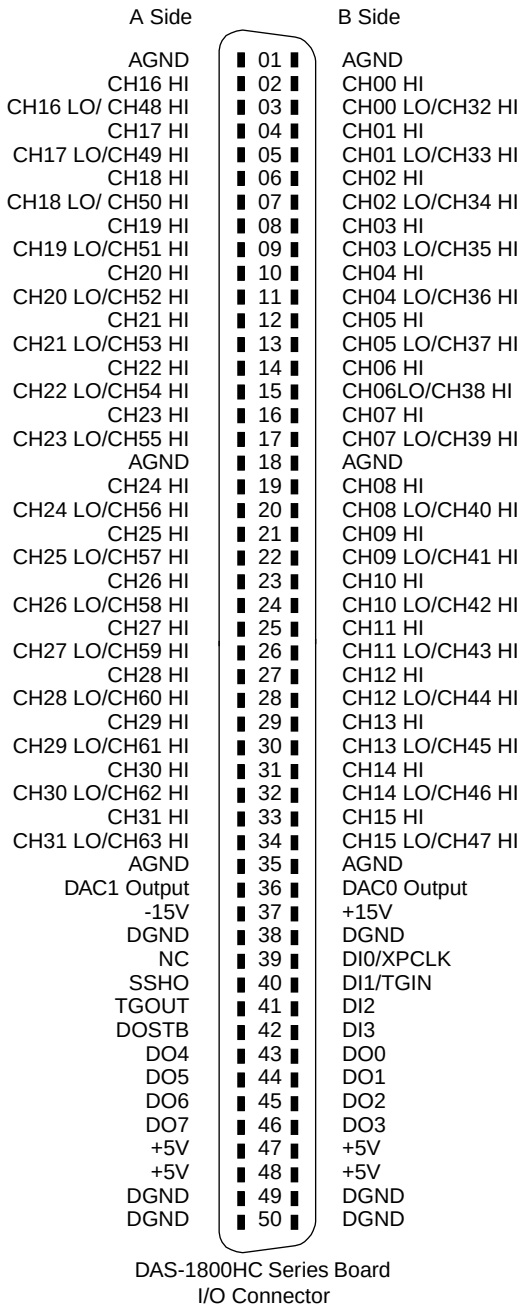


Figure 4-1. Pin Assignments for the Main I/O Connector of the DAS-1800HC Series Boards

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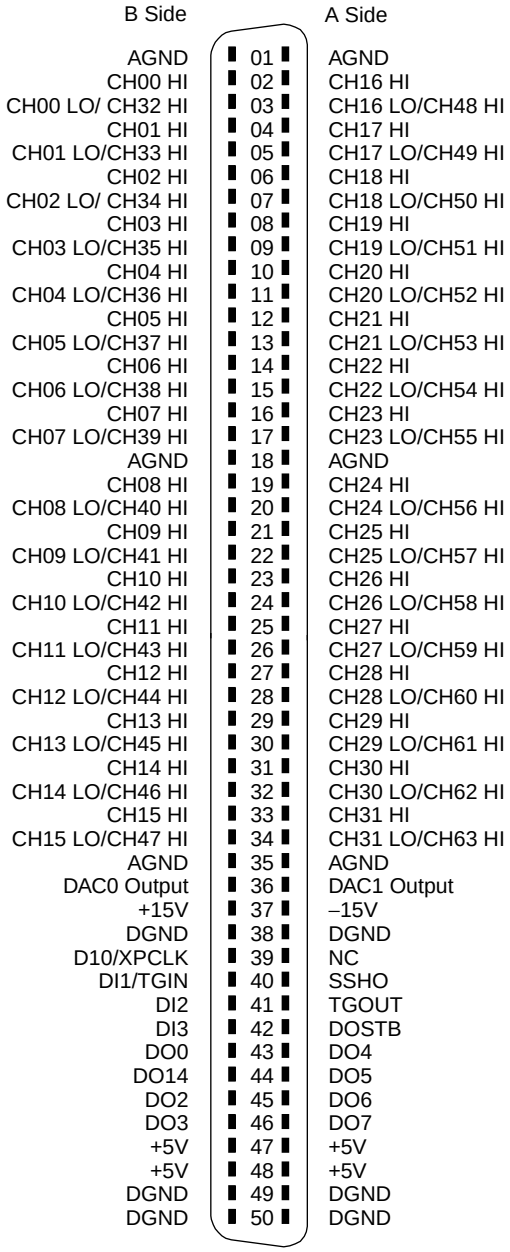


Figure 4-2. Pin Assignments for the Main I/O Connector of the STA-1800HC

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Use a CAB-1800 Series cable to connect an STA-1800HC and DAS-1800HC Series board together as shown in Figure 4-3.

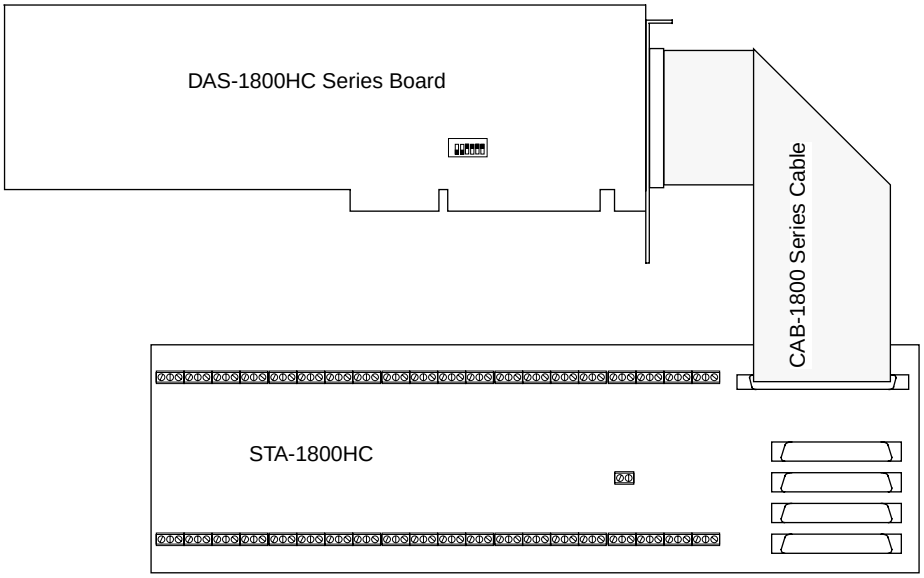


Figure 4-3. Cabling and Connections for Attaching an STA-1800HC

The CAB-1800 Series of cables includes the following models:

- CAB-1800 — an 18-inch, 100-wire ribbon cable.
- CAB-1801 — a 36-inch, 100-wire ribbon cable.
- CAB-1800/S — an 18-inch, 100-wire, shielded, ribbon cable.
- CAB-1801/S — a 36-inch, 100-wire, shielded, ribbon cable.

The red wire on the CAB-1800 Series cables runs between pin 1 of each cable connector. Be sure to mate pin 1 of each cable connector to pin 1 of a board connector.

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Attaching the CJC Circuit of an STA-1800HC

The STA-1800HC contains a CJC circuit that develops a voltage directly proportional to the temperature of the STA-1800HC screw-terminal blocks. At 0˚C, the CJC circuit output is 0V; the output changes at the rate of 10mV per ˚C. The CJC circuit is represented by the schematic in Figure 4-4.

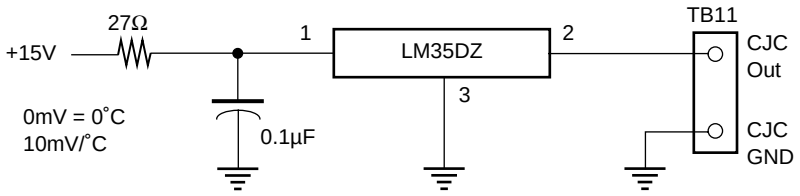


Figure 4-4. CJC Circuit Schematic

As Figure 4-4 shows, the CJC circuit output appears across the TB11 screw terminals. TB11 is located as shown in Figure 4-5.

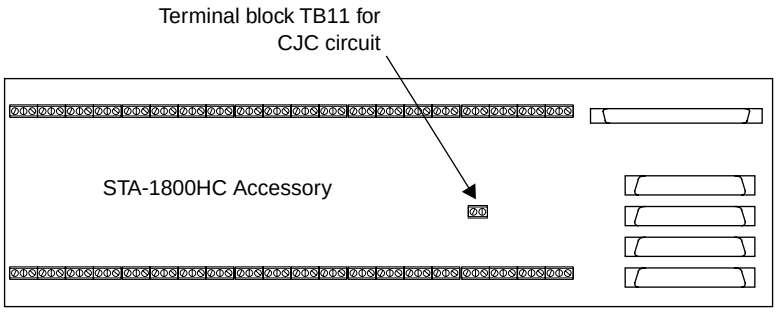


Figure 4-5. Location of CJC Circuit Screw Terminals (TB11)

You can determine the CJC temperature by wiring TB11 to the screw terminals of an unused analog input channel and reading the CJC circuit voltage. Convert this reading to a temperature value you can use to offset thermal error introduced to thermocouple readings at the STA-1800HC screw terminals.

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Attaching a CONN-1800HC

The CONN-1800HC connector panel is an interface for cabling SSH-8s and MB modules to DAS-1800HC Series boards. You can also use the CONN-1800HC for custom hookups. This accessory is essentially an STA-1800HC without screw terminals or CJC circuit. Components are as follows:

- A 100-pin female connector for cabling to the main I/O connector of a DAS-1800HC Series board.
- Four 37-pin male connectors for cabling to MB01 backplanes, SSH accessories, or custom hookups.

Pin assignments for the main I/O connector of a CONN-1800HC are the same as those for the STA-1800HC, as shown in Figure 4-2 on page 4-3. Use a CAB-1800 Series cable (a list of these cables appears on page 4-4) to connect a CONN-1800HC to a DAS-1800HC Series board, as shown in Figure 4-6.

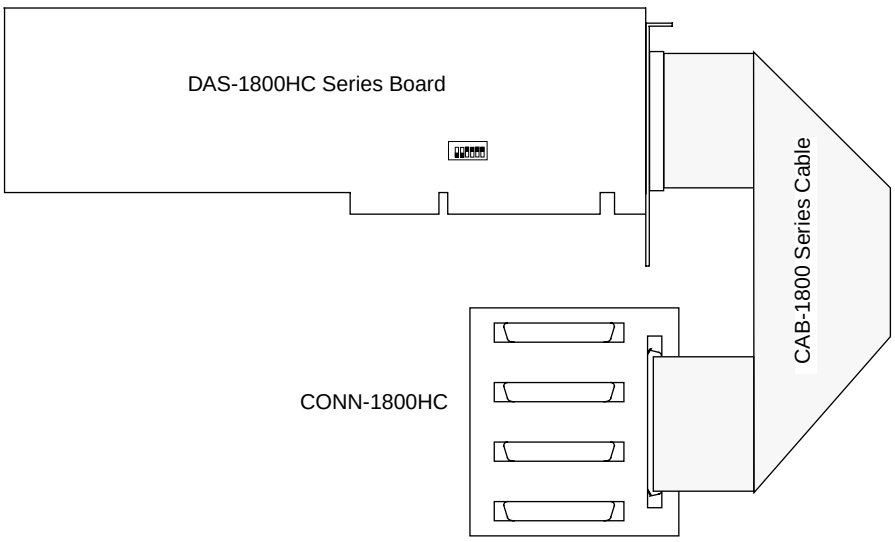


Figure 4-6. Cabling and Connections for Attaching a CONN-1800HC to a DAS-1800HC Series Board

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Attaching an SSH-8

The SSH-8 is a simultaneous-sample-and-hold accessory. This accessory can serve as a front-end analog interface for DAS-1800HC Series boards when connected through an STA-1800HC or a CONN-1800HC. Note that the attached SSH-8 accessories must be set as slaves. Attach the SSH-8 accessories to the STA-1800HC or CONN-1800HC as shown in Figure 4-7. Refer to the *SSH-8 User's Guide* for more information.

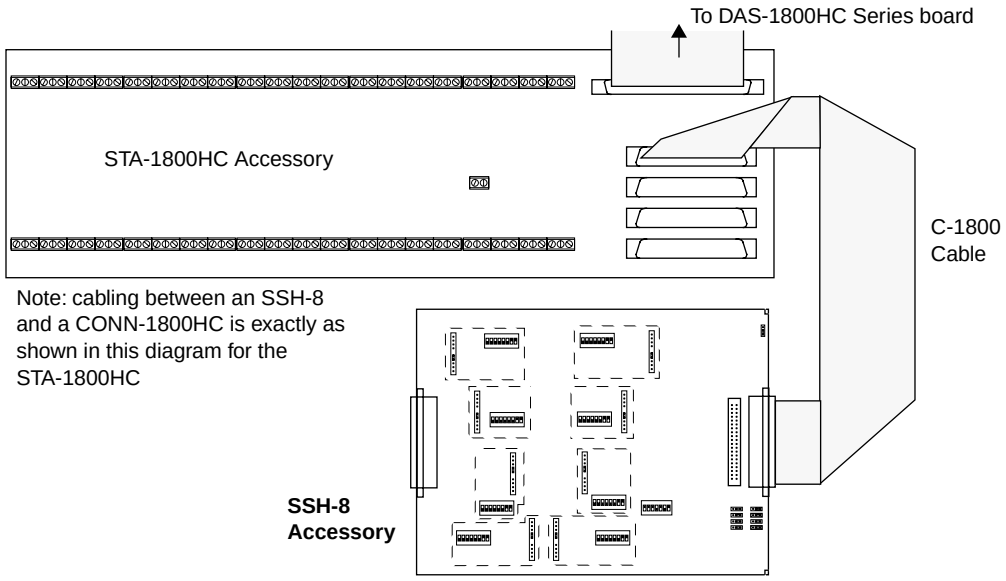


Figure 4-7. Cabling and Connections for Attaching SSH-8 Accessories to a DAS-1800HC Series Board

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Attaching MB01 Backplanes

Use an STA-1800HC or a CONN-1800HC to connect MB01 backplanes to a DAS-1800HC Series board, as shown in Figure 4-8. For details of the MB modules, refer to the *MB Series User's Guide*.

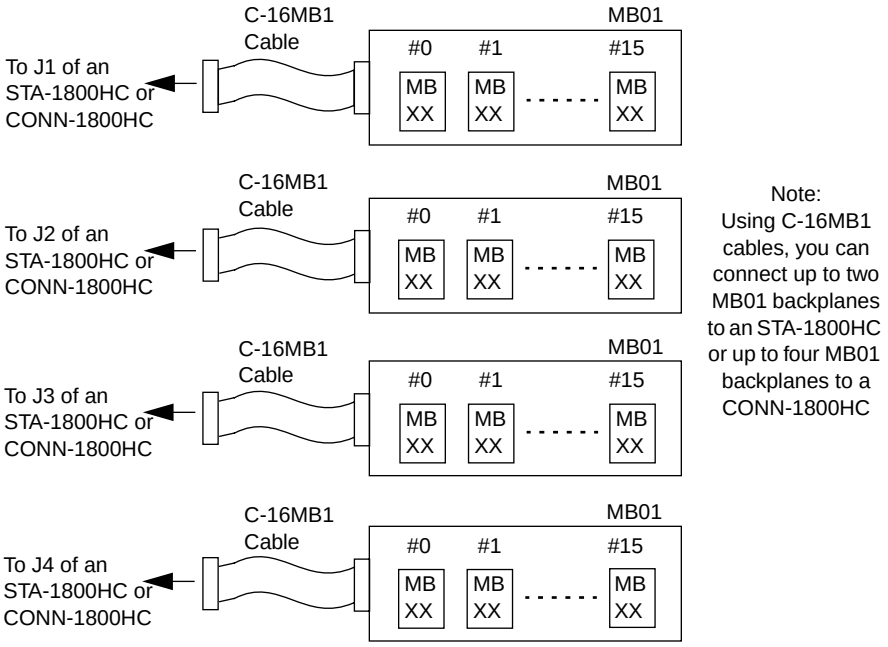


Figure 4-8. Cabling and Connections for Attaching MB01 Backplanes to an STA-1800HC or a CONN-1800HC

Caution: If you are programming an application requiring references to channel numbering on connectors J1 to J4 of an STA-1800HC or CONN-1800HC, you can obtain the correct channel numbering from the pin assignments for these connectors, as shown in Appendix B.

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Attaching an STP-100

The STP-100 screw terminal accessory is an interface for I/O connections to DAS-1800HC Series boards. Use a CAB-1800 Series cable to connect the STP-100 and DAS-1800HC Series boards together as shown in Figure 4-9. Pin assignments for screw terminals of the STP-100 are the same as those for the main I/O connector on the STA-1800HC (see Figure 4-2 on page 4-3).

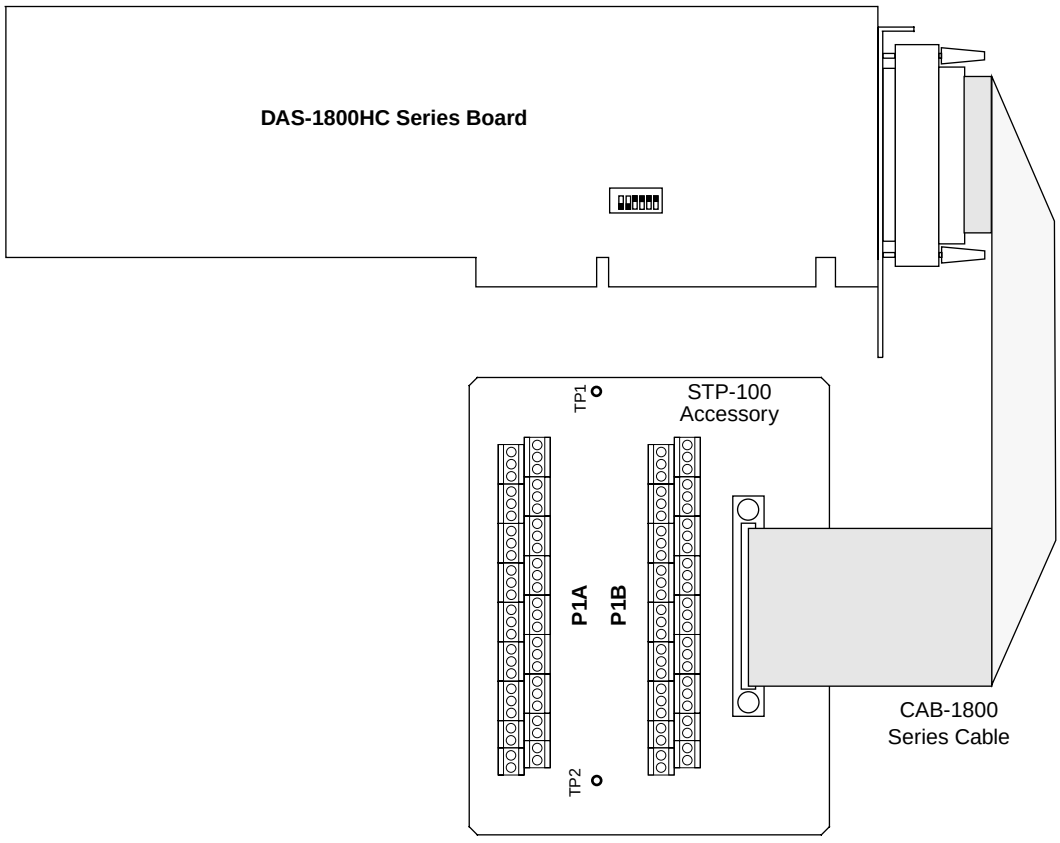


Figure 4-9. Attaching an STP-100

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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-1800HC Series boards.

While the circuit diagrams show direct connections to channel input pins of the main I/O connector, you must make actual connections through corresponding inputs of an STA-1800HC or STP-100. Refer to Appendix B for a list of these inputs and their descriptions.

The circuit diagrams represent a single signal source wired to a single channel (channel *n*). In reality, you can wire 32 separate signal sources to 32 differential inputs or 64 separate signal sources to 64 single-ended inputs.

DAS-1800HC Series boards contain separate grounds for analog and digital signals. An analog ground (AGND) is for analog signals and analog power; a digital ground (DGND) is for digital signals and other power-supply returns.

Precautions

If you expect to use DAS-1801HC boards at high gain, read the precautionary information in the following subsection. Other considerations for I/O connections are offered under “Additional Precautions” on page 4-11.

Precautions for Using DAS-1801HC Boards at High Gain

Operating a DAS-1801HC at a gain of 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-1801HC in 32-channel differential mode. Using the board in 64-channel, single-ended mode at high gains introduces enough ground-loop noise to produce large fluctuations in readings.

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- Minimize noise from crosstalk and induced-voltage pickup in the flat cables and screw-terminal accessories by using shielded cable. Connect the shield to AGND and the inner conductors to Channel LO and HI. Channel LO and AGND 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 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. To prevent this problem, use the following precautions:

- Avoid direct connections to the AC line.
- Make sure all connections are tight and sound so signal wires will not come loose and short to high voltages.
- Use isolation amplifiers and transformers where necessary.

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Connecting a Signal to a Single-Ended Analog Input

Figure 4-10 shows the connections between a signal source and a channel of a DAS-1800HC Series board configured for single-ended input mode.

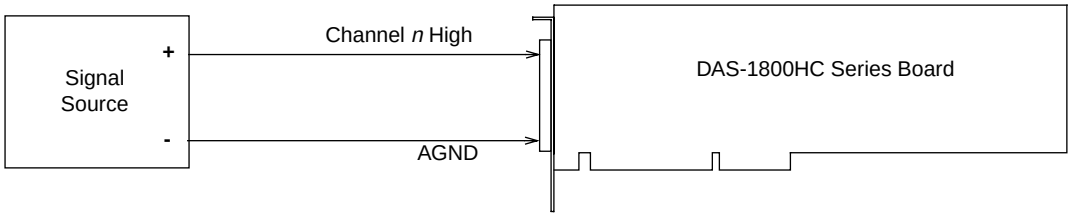


Figure 4-10. Connections for Wiring a Signal Source to a DAS-1800HC Series Board Configured for Single-Ended Inputs

Note: When you wire signals to the analog input channels, you are advised to wire all unused channels to AGND. This action prevents the input amplifiers from saturating, and it ensures the accuracy of your data.

Connecting a Signal to a Differential Analog Input

This section describes common connection schemes for differential inputs. The section also discusses the principles for avoiding ground loops.

Common Connection Schemes for Differential Inputs

Figure 4-11 on page 4-13 shows three connection schemes for wiring a signal source to a channel of a DAS-1800HC Series board configured for differential input mode.

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The upper two circuits of the diagram 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, bias current return is inherently provided by the source. The circuit requires no bias resistors.

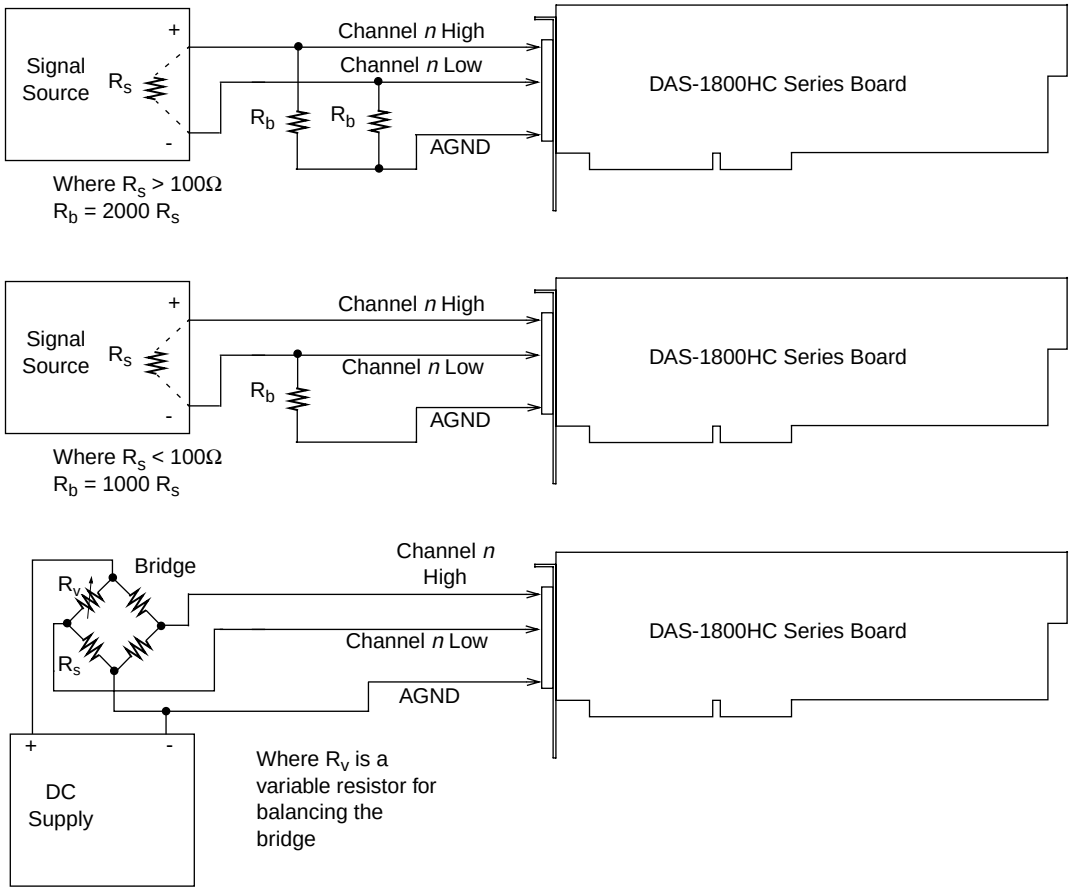


Figure 4-11. Three Types of Connections for Wiring a Signal Source to a DAS-1800HC Series Board Configured for Differential Inputs

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Avoiding Ground Loops with Differential Inputs

Frequently, the signal-source ground and the DAS-1800HC Series board ground are not at the same voltage level because of the distances between equipment wiring and the building wiring. This difference 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). 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 contain a ground loop, your input could see the sum of the signal-source and common-mode voltages. Figure 4-12 shows the proper way to connect a differential input while Figure 4-13 illustrates the effect of a ground loop.

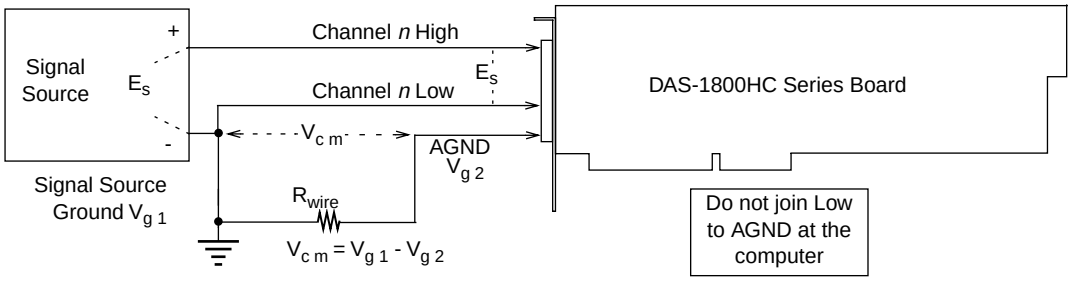


Figure 4-12. A Differential Input Configuration that Avoids a Ground Loop

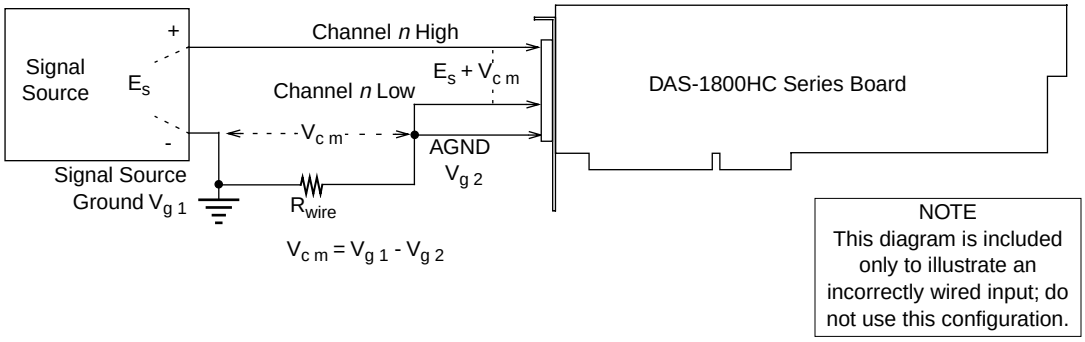


Figure 4-13. Differential Input Configuration with a Ground Loop

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Connecting Analog Output Signals

DAS-1800HC Series boards have outputs for each of the two DACs. Refer to Table A-2 in Appendix A for voltages, current limits, and other loading information. Make your connections to the DAC output terminals through corresponding screw terminals of an STA-1800HC or STP-100. The screw terminals are labeled as follows:

- **DAC0 OUT** — is the screw terminal labeling for the DAC #0 output.
- **DAC1 OUT** — is the screw-terminal labeling for the DAC #1 output.

Connecting Digital I/O Signals

DAS-1800HC Series boards have four digital inputs and eight digital outputs, as described in "Digital I/O Features" on page 2-18. Make your connections to the digital I/O terminals through corresponding screw terminals of an STA-1800HC or STP-100. The terminals are labeled as follows:

- **DI0** to **DI3** — are the screw-terminal labels for the digital input.
- **DO0** to **DO7** — are the screw-terminal labels for the digital output.

Connecting Digital Control Signals

DAS-1800HC Series boards use five digital control signals. Make your connections to the digital control terminals through corresponding screw terminals of an STA-1800HC or STP-100. The terminals are labeled as follows:

- **SSHO** — is the simultaneous-sample-and-hold output terminal. This signal is described in "Using Digital Control Signal SSHO" on page 2-20. Use the SSHO terminal for connecting this signal.
- **TGIN** — is the trigger/gate input, described in the next section and in "Using Digital Control Signal TGOUT" on page 2-19. Refer also to "Triggers" on page 2-12 and to "Gates" on page 2-15. Use the digital-input terminal DI1/TGIN for connecting a TGIN signal.
- **TGOUT** — is the trigger/gate output, described in the next section and in "Using Digital Control Signal TGOUT" on page 2-19. Use the TGOUT terminal for connecting this signal.

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- **XPCLK** — is the external pacer clock input, described in the next section and in “Clock Sources” on page 2-10. Use the digital-input terminal DI0/XPCLK for connecting this signal.
- **DOSTB** — is the digital output strobe, described in “Using Digital Control Signal DOSTB” on page 2-18. Use the DOSTB terminal for connecting this signal.

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 connectors. Each board can run at the same or a different conversion rate as the 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 4-14 shows two connection schemes for synchronizing multiple boards. Both schemes are using the onboard pacer clock to time acquisitions.

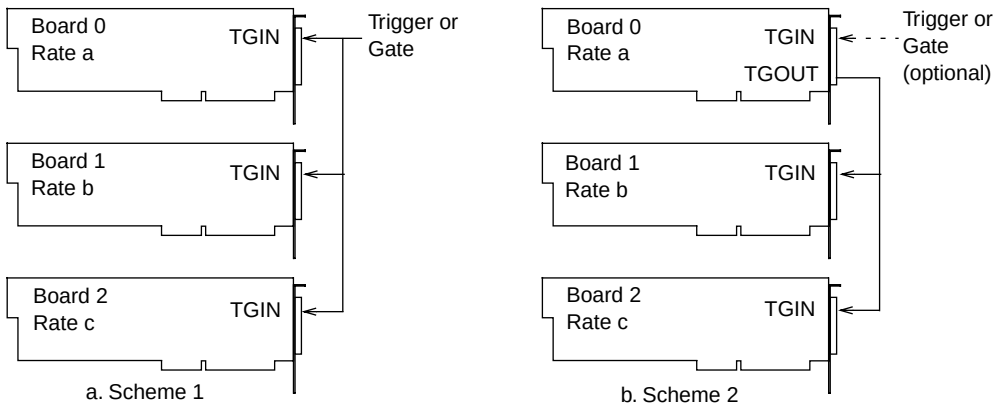


Figure 4-14. Two Connection Schemes for Synchronizing Multiple Boards

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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 pacer clock or an external pacer clock.

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 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-going trigger or gate.

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5

Testing the Board

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

Your DAS-1800 Series board is initially calibrated at the factory. You are advised to check the calibration of a board every six months and to calibrate again when necessary. This section provides the information you need to calibrate a DAS-1800 Series board.

Equipment Requirements

The equipment requirements for calibrating a DAS-1800HC Series board are as follows:

- A digital voltmeter accurate to 6½ digits, such as a Keithley Instruments Model 196 or 2001
- An adjustable ±10V voltage calibrator, such as a Keithley Instruments Model 236
- A CAB-1800 Series cable and a STA-1800HC, STP-100, or CONN-1800HC, or a user-designed interface

Potentiometers and Test Points

Figure 6-1 shows the locations of the potentiometers and test points involved with the calibration of a DAS-1800HC Series board. The potentiometers are labeled R5 to R8, R12 and R13, R15 and R16, and R20. The test points are TP1 to TP5. The calibration utility, described in the next section, directs you to these components and explains what to do with them during the calibration process.

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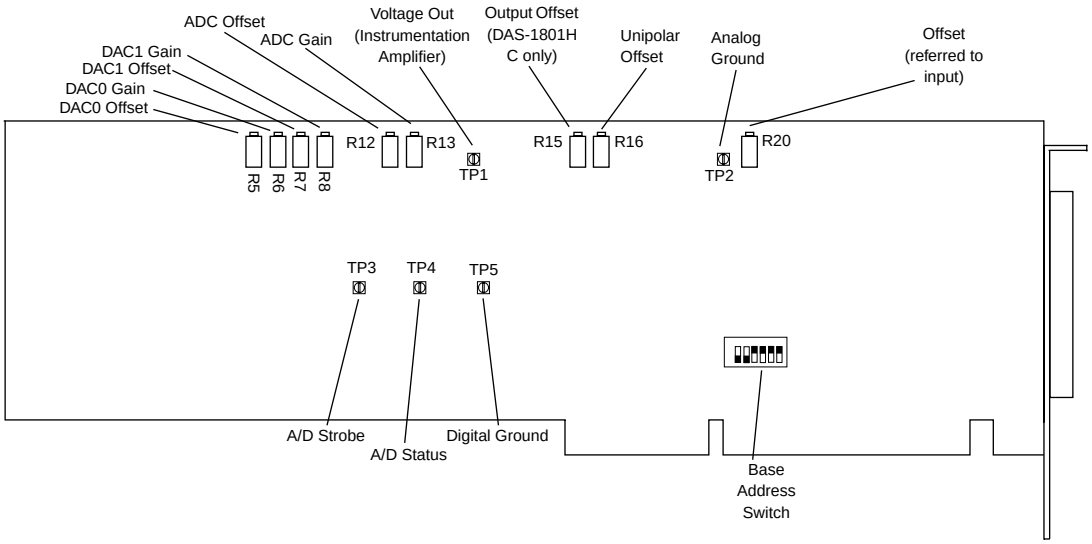


Figure 6-1. Potentiometers and Test Points on the DAS-1800HC Series Boards

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-1800HC Series board is not operating properly, use the information in this section 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-1800HC Series board, use the instructions in this section to isolate the cause of the problem before calling Keithley.

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-1800HC 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.

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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-1800HC Series boards.

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 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 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 seating.
	The board is damaged.	Contact Keithley Technical Support; see page 7-6.

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Table 7-1. Troubleshooting Information (cont.)

Symptom	Possible Cause	Possible Solution
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.
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-1800HC Series board; refer to page 3-5 for more information. Check the I/O assignments of other system resources and reconfigure, if necessary.
System Lockup	A timing error occurred.	Restart your computer.
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.

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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.

Testing the Board and Host Computer

To isolate the problem to the DAS-1800HC 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 accessory board intact, unplug the accessory connector or cable from the DAS-1800HC Series board.
3. Remove the DAS-1800HC Series 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-1800HC 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-1800HC 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 7-1 before calling Keithley 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-1800HC 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-1800HC 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 DAS-1800HC Series 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-1800HC Series board 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-1800HC 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	_____
Computer	Manufacturer	_____
	CPU type	_____
	Clock speed (MHz)	_____
	KB of RAM	_____
	Video system	_____
	BIOS type	_____
Operating System	DOS version	_____
	Windows version	_____
	Windows mode	_____
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-4 list specifications for the DAS-1800HC Series boards.

Table A-1. Analog Input Specifications

Feature	DAS-1801HC	DAS-1802HC
Number of channels	Software-selectable as 32 differential or 64 single-ended	
Input mode	Software-selectable as unipolar or bipolar	
Resolution	12-bit (1 part in 4096)	
Data format	16-bit 2's complement, right-justified	
FIFO size	1024 word	
Channel-gain QRAM size	64 locations	
Range and 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 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 (cont.)

Feature	DAS-1801HC	DAS-1802HC
Temperature coefficient of accuracy (includes ADC) Offset Gain	 • Bipolar: ±20µV/˚C ±(12µV/˚C ÷ gain) maximum • Unipolar: ±20µV/˚C ±(14µV/˚C ÷ gain) maximum • ±20 ppm/˚C for gain < 50 • ±30 ppm/˚C for gain = 50 • ±35 ppm/˚C for gain = 250	
Linearity[1] Integral Differential	 ±½ LSB typical, ±1 LSB maximum ±1 LSB	
Throughput	Refer to “Maximum Achievable Throughput Rates” on page 2-5	
Dynamic parameters Acquisition time Aperture delay Aperture uncertainty Conversion time	 0.3µs 13.0ns 150ps rms 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	

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Table A-1. Analog Input Specifications (cont.)

Feature	DAS-1801HC	DAS-1802HC
Noise[2]		
Bipolar 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 = 2 • p-p = 1, rms = 0.1 for gain = 4 • p-p = 1, rms = 0.1 for gain = 8
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 = 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
DMA levels	5, 6, and 7	
Interrupt levels	3, 5, 7, 10, 11, and 15	
Internal pacer clock rate	Programmable between 0.0012Hz and 333kHz	
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.

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Table A-2. Analog Output Specifications

Attribute	DAS-1800HC Series Boards
Resolution	12-bit (one part in 4096 or 224 ppm)
Data format	Right justified, offset binary
Range	±10.00V
Linearity[1] Integral Differential	 ±¼ LSB typical; ±½ LSB max. ±1 LSB
Output current drive	±5mA max.
Capacitive load drive	100µF
Gain accuracy	Adjustable to 0
Offset accuracy	Adjustable to 0
Glitch energy	300nV * seconds
Power up	DACs power up to 0.0V at reset
Settling time	6µs typical, 30µs maximum to ½ LSB

[1] Monotonicity is guaranteed over the operating range.

Table A-3. Digital I/O Specifications

Attributes	DAS-1800HC Series Boards
Digital output (including SSHO, DOSTB, and TGOUT)	• V_{OH} (min.) = 2.7V @ I_{OH} = –400µA • V_{OL} (max.) = 0.5V @ I_{OL} = 8mA
Digital input	• 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

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Table A-4. Power Supply Specifications

Feature	DAS-1800HC Series Boards
+5VDC input	430mA typical; 870mA maximum
+12VDC input	400mA typical; 550mA maximum
Maximum current available at the ±15V outputs	30mA
Maximum current available at the +5V output	1.0A

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B

Connector Pin Assignments

This appendix contains pin layouts and assignments for I/O connectors of the DAS-1800HC Series boards and the STA-1800HC, STP-100, and CONN-1800HC accessories and for the four 37-pin D connectors of the STA-1800HC accessory.

I/O Connector Pin Assignments

The I/O connectors for the DAS-1800HC Series boards, the STA-1800HC, STP-100, and CONN-1800HC each contain 100 pins arranged in two banks of 50: bank A and bank B. All are female connectors. The STA-1800HC, STP-100 and CONN-1800HC connectors are a mirror image of the DAS-1800HC Series board connector. Figure B-1 shows pin assignments for the main I/O connector of DAS-1800HC Series boards; Figure B-2 shows pin assignments for the main I/O connectors of the STA-1800HC, STP-100, and CONN-1800HC accessories.

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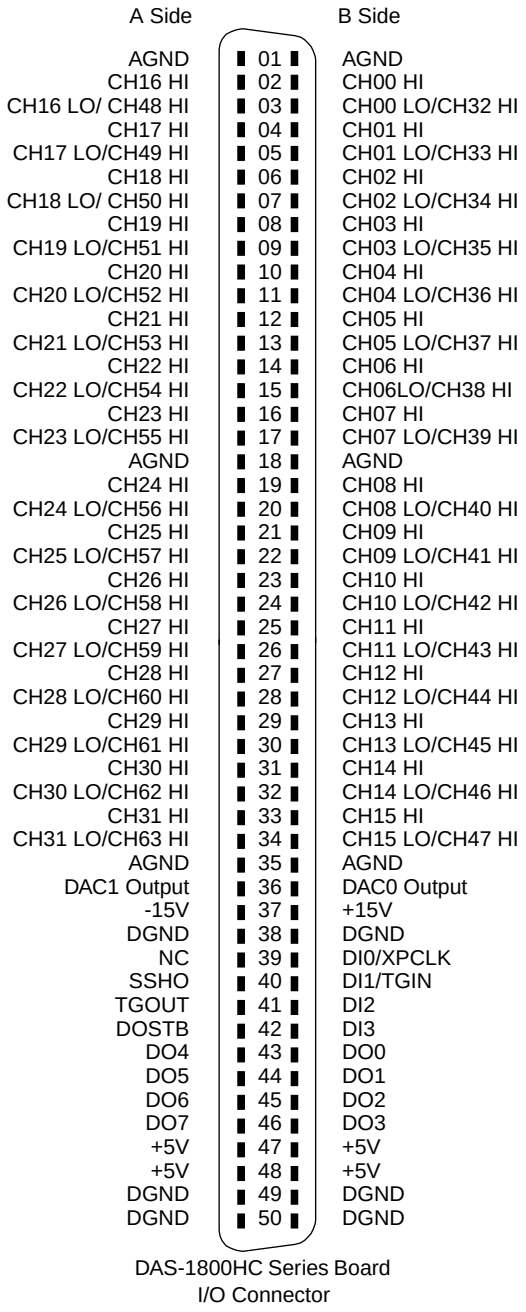


Figure B-1. Pin Assignments for the Main I/O Connector of DAS-1800HC Series Boards

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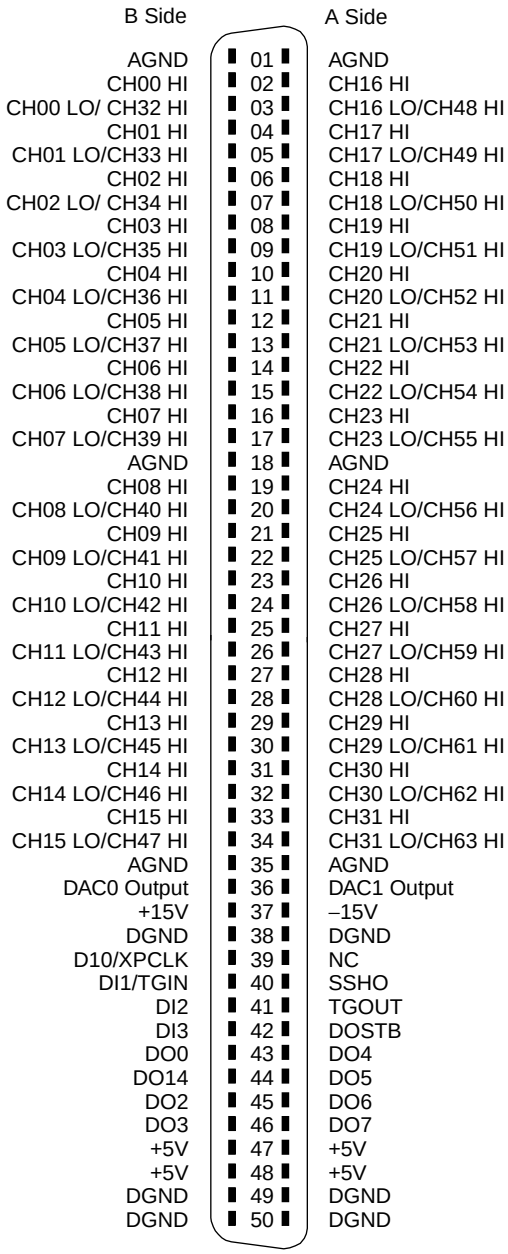


Figure B-2. Pin Assignments for the Main I/O Connectors of the STA-1800HC, STP-100, and CONN-1800HC

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STA-1800HC and CONN-1800HC 37-Pin D Connectors

The STA-1800HC and CONN-1800HC each contain four 37-pin, male, D connectors: J1, J2, J3, and J4. Pin layouts and assignments for these connectors are shown in Figure B-3, Figure B-4, Figure B-5, and Figure B-6.

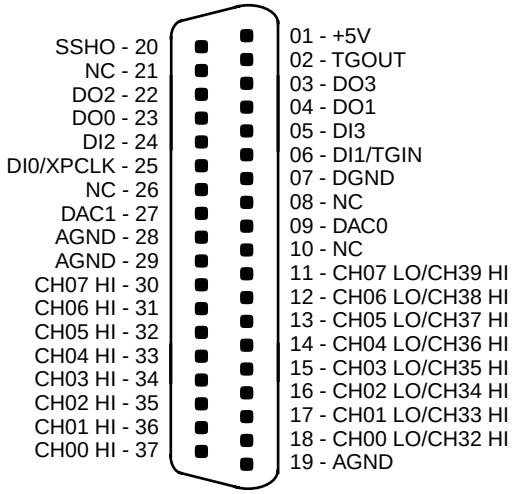


Figure B-3. Connector J1

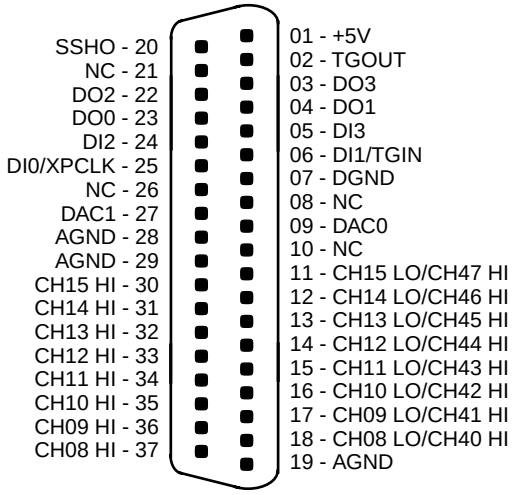


Figure B-4. Connector J2

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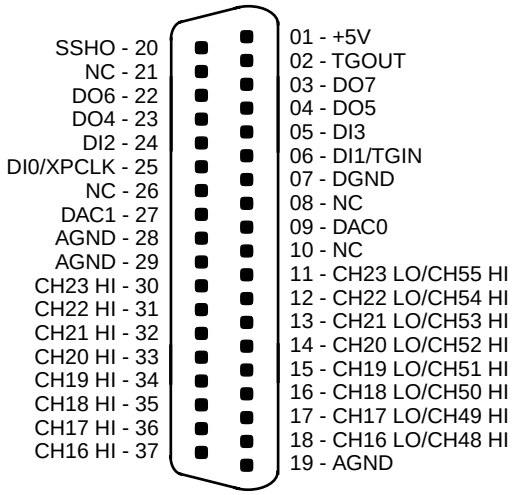


Figure B-5. Connector J3

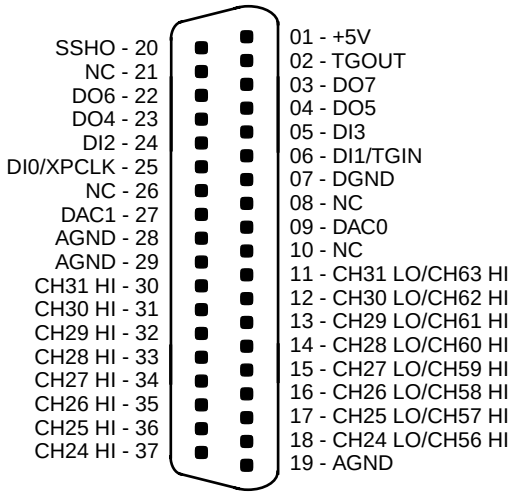


Figure B-6. Accessory Connector J4

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C

DriverLINX Configuration Notes

This appendix contains the following sections:

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

Configuration

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

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Model

Note: In this section, “DAS-1800HC” refers to all models in the DAS-1800HC 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 “HC,” 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 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.

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Address

The default address used by all DAS-1800 boards is 768 decimal or 0×300 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 the DAS-1800HC, A/D channel configuration is software programmable for 64 single-ended or 32 differential analog inputs. On other DAS-1800 boards, A/D channel configuration is software programmable for 16 single-ended or 8 differential analog inputs.

A/D Volts

You must specify the minimum and maximum analog input, full-scale voltages at unity gain. For the DAS-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 HC, AO, and XX-DA boards provide analog output. The output range for the HC and XX-DA boards is bipolar only and is fixed at ±10 volts. For these boards, the minimum voltage is -10V. The maximum voltage is +9.9951V (12-bit DACs) and +9.9997V (16-bit DAS-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.

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AI IRQ

You must select an interrupt request level to support IRQ or DMA mode data transfer. Valid IRQ levels are: 3, 5, 7, 10, 11, or 15. Two devices can share interrupt lines only if not used simultaneously.

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 not used simultaneously.

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, you 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 a 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-15 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-1800AO 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; therefore null Start and null 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 doesn't require an event.

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

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

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

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

Analog Input Subsystem

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.

The other 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.

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 200 ns.

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.

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External Clocking

Specify external clocking using a Rate Timing Event on channel 0 with an external clock source specified. For hardware-independence, you can specify the hardware external clock channel by the symbolic constant, *DI_EXTCLK*. Connect the external clock source to **XPCLK** [44]. The hardware external clocking feature of the DAS-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.

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

Analog Input Multiplexer

The EXP-1800 Input Multiplexers can expand the number of physical channels to 256 single-ended analog input channels. The DAS-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.

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 four 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:

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

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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

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:

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

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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.

Analog Output Subsystem

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-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 converters. The DAS-1800ST and DAS-1802HR models do not provide analog output.

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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.

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.

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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.

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).

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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 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.

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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-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-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-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).

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

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

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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-1800HC 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	

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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 state of these lines during active analog input tasks is not pos0sible 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.

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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.

Counter/Timer Subsystem

The DAS-1800 uses an Intel 8254 Programmable Interval Timer that consists of three 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 three counters, it ties two of them together internally (Counters 1 and 2) and dedicates the third to internal functions. Therefore, DriverLINX implements only one logical counter, Logical counter 0, which corresponds to the internal A/D pacing clock (8254 counters 1 and 2). You can use Logical counter 0 to pace Analog Output or Digital I/O tasks indirectly through hardware interrupts. The DAS-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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Keithley Instruments, Inc. 28775 Aurora Road • Cleveland, Ohio 44139 • 440-248-0400 • Fax: 440-248-6168
1-888-KEITHLEY (534-8453) • www.keithley.com

Sales Offices:

BELGIUM:	Bergensesteenweg 709 • B-1600 Sint-Pieters-Leeuw • 02-363 00 40 • Fax: 02/363 00 64
CHINA:	Yuan Chen Xin Building, Room 705 • 12 Yumin Road, Dewai, Madian • Beijing 100029 • 8610-6202-2886 • Fax: 8610-6202-2892
FINLAND:	Tietäjäntie 2 • 02130 Espoo • Phone: 09-54 75 08 10 • Fax: 09-25 10 51 00
FRANCE:	3, allée des Garays • 91127 Palaiseau Cédex • 01-64 53 20 20 • Fax: 01-60 11 77 26
GERMANY:	Landsberger Strasse 65 • 82110 Germering • 089/84 93 07-40 • Fax: 089/84 93 07-34
GREAT BRITAIN:	Unit 2 Commerce Park, Brunel Road • Theale • Berkshire RG7 4AB • 0118 929 7500 • Fax: 0118 929 7519
INDIA:	Flat 2B, Willocrissa • 14, Rest House Crescent • Bangalore 560 001 • 91-80-509-1320/21 • Fax: 91-80-509-1322
ITALY:	Viale San Gimignano, 38 • 20146 Milano • 02-48 39 16 01 • Fax: 02-48 30 22 74
JAPAN:	New Pier Takeshiba North Tower 13F • 11-1, Kaigan 1-chome • Minato-ku, Tokyo 105-0022 • 81-3-5733-7555 • Fax: 81-3-5733-7556
KOREA:	2FL., URI Building • 2-14 Yangjae-Dong • Seocho-Gu, Seoul 137-888 • 82-2-574-7778 • Fax: 82-2-574-7838
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