DAS-1800HC Series User's Guide

DAS-1800HC Series User's Guide

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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 board 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 control-panel software. There are also chapters on calibration and troubleshooting. To follow the information and instructions contained in this manual, you must be familiar with the operation of an IBM™ PC AT® in the MS-DOS® or Windows™ environments. You must also be familiar with data-acquisition principles and their applications.

The *DAS-1800HC Series User's Guide* is organized as follows:

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

- Chapter 5 briefly describes the Control Panel program and gives instructions for starting up the program.
- Chapter 6 discusses calibration requirements and gives instructions for starting the calibration program.
- Chapter 7 contains information on isolating and determining the source of operating problems. This chapter also contains instructions for obtaining technical support.
- Appendix A contains specifications for the DAS-1800HC Series boards.
- Appendix B contains pin assignments for the DAS-1800HC Series board main I/O connector and of the four 37-pin accessory connectors of the STA-1800HC screw terminal accessory.
- Appendix C discusses the External Driver for the VIEWDAC® and ASYST® programs.
- Appendix D discusses the Keithley Memory Manager and its use.

1

Overview

The DAS-1801HC and DAS-1802HC are high-performance data acquisition boards for IBM PC AT or compatible computers. 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.
- Single- or dual-DMA (Direct Memory Access) operation is software-configurable.
- Interrupt levels are software-configurable.

- Pulsed interrupts allow multiple 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 Chapter 2.

Supporting Software

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

- **DAS-1800 Series standard software package** - This package, which is used for the entire DAS-1800 series of boards, is provided on 3.5-inch and 5.25-inch diskettes and includes function libraries for writing application programs under DOS in high-level languages such as Microsoft® QuickBasic™, Microsoft Professional BASIC, and Microsoft Visual Basic™ for DOS. This package also contains support files, example programs, and the following utility programs:
  - *Control Panel* - The Control Panel (CTL1800.EXE) is a DOS-based stand-alone program. This program provides access to all DAS-1800HC Series board operations without programming. These operations include acquiring analog inputs, controlling analog outputs, and controlling digital I/O. The Control Panel is a means of testing the board and your

application; it is also a means of performing simple applications and saving data to a file. Refer to Chapter 5 for more information about the Control Panel.

- *Configuration Utility* - The configuration utility (D1800CFG.EXE) is a DOS-based program for creating or modifying a DAS-1800 Series configuration file. A configuration file contains the settings used by the DAS-1800 Series Function Call Driver and other driver software for configuring a board. For more information on the configuration utility, refer to "Configuring the Board" on page 3-4.
- *Calibration Utility* - The calibration utility (CAL1800.EXE) is a DOS-based program for calibrating the analog I/O circuitry of DAS-1800HC Series boards. Refer to Chapter 6 for more information about this utility.

Refer to the *DAS-1800 Series Function Call Driver User's Guide* for more information on the DAS-1800 Series standard software package.

- **ASO-1800** - Advanced Software Option. This option is provided in Windows and DOS versions; both versions are supplied on 3.5-inch and 5.25-inch diskettes. The ASO-1800 includes function libraries for application programs you write for MS-DOS and Windows environments in Microsoft C/C++, Borland® C/C++, Borland Turbo Pascal®, Microsoft Visual Basic for Windows, Microsoft QuickC®, and Microsoft Visual C++™. The ASO-1800 also contains miscellaneous support files, example programs, and the following utilities:
  - *Control Panel* - The Control Panel is a stand-alone program supplied in a DOS version (CTL1800.EXE) and a Windows version (CTL1800W.EXE). This program provides access to all DAS-1800HC Series board operations without programming. Control Panel operations include acquiring analog inputs, controlling analog outputs, and controlling digital I/O. The Control Panel is a means of testing the board and your application; it is also a means of performing simple applications and saving data to a file. The Windows version also allows you to transfer acquired data to other Windows applications and to graph eight channels through the Windows DDE (Dynamic Data

Exchange) feature. Refer to Chapter 5 for more information about the Control Panel.

- *Configuration Utility* - The configuration utility (D1800CFG.EXE) is a program for creating or modifying a DAS-1800 Series configuration file. A configuration file contains the settings used by the DAS-1800 Series Function Call Driver and other driver software for configuring a board. For more information on the configuration utility, refer to "Configuring the Board" on page 3-4.

- *Calibration Utility* - The calibration utility (CAL1800.EXE) is a DOS-based program for calibrating the analog I/O circuitry of the DAS-1800HC Series boards. Refer to Chapter 6 for more information about this utility.

Refer to the *DAS-1800 Series Function Call Driver User's Guide* for more information on the ASO-1800.

- **VDAS-1800** - VisualDAS™ Custom Controls for Visual Basic for Windows. Offered as an alternative to the Function Call Driver, VisualDAS helps Visual Basic programmers to develop applications easily. The package includes a comprehensive user's guide, offers extensive online help, and furnishes software on 3.5-inch and 5.25-inch diskettes.

- **Data acquisition and analysis application software** - VIEWDAC is an integrated software packages available for the DAS-1800HC Series boards. Programming tools, such as ASYST scientific and engineering programming language, are also available to help you in writing your application programs.

Note: If you use VIEWDAC or ASYST to program your DAS-1800HC Series board, you must use the DAS-1800 Series External Driver. This driver is included in the DAS-1800 Series standard software package. Refer to Appendix C for information on the external driver.

Accessories

The following accessories are available for use with the DAS-1800HC Series boards:

- **STA-1800HC** - 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 Chapter 4 for connections.
- **STP-100** - screw terminal panel. This accessory provides general-purpose screw-terminal connections in a compact form factor.
- **RMT-04** - rack mount enclosure for the STA-1800HC accessory.
- **SSH-8** - An 8-channel Simultaneous Sample and Hold accessory for the DAS-1800HC Series boards.
- **MB Series modules and backplanes** - plug-in, isolated, signal-conditioning modules and the backplanes that hold them.
- **C-16MB1** - a cable for connecting an STA-1800HC accessory to an MB01 signal-conditioning backplane.
- **CAB-1800** - an 18-inch ribbon cable for connecting a DAS-1800HC Series board to an STA-1800HC or STP-100 accessory.
- **CAB-1801** - a 36-inch ribbon cable for connecting a DAS-1800HC Series board to an STA-1800HC or STP-100 accessory.
- **CAB-1800/S** - an 18-inch shielded, ribbon cable for connecting a DAS-1800HC Series board to an STA-1800HC or STP-100 accessory.

- **CAB-1801/S** - a 36-inch shielded, ribbon cable for connecting a DAS-1800HC Series board to an STA-1800HC or STP-100 accessory.
- **C-1800** - an 18-inch ribbon cable with two 37-pin female type D connectors for connecting an STA-1800HC accessory to an SSH-8 accessory.

2

Functional Description

This chapter describes features of the following DAS-1800HC Series board sections: 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.

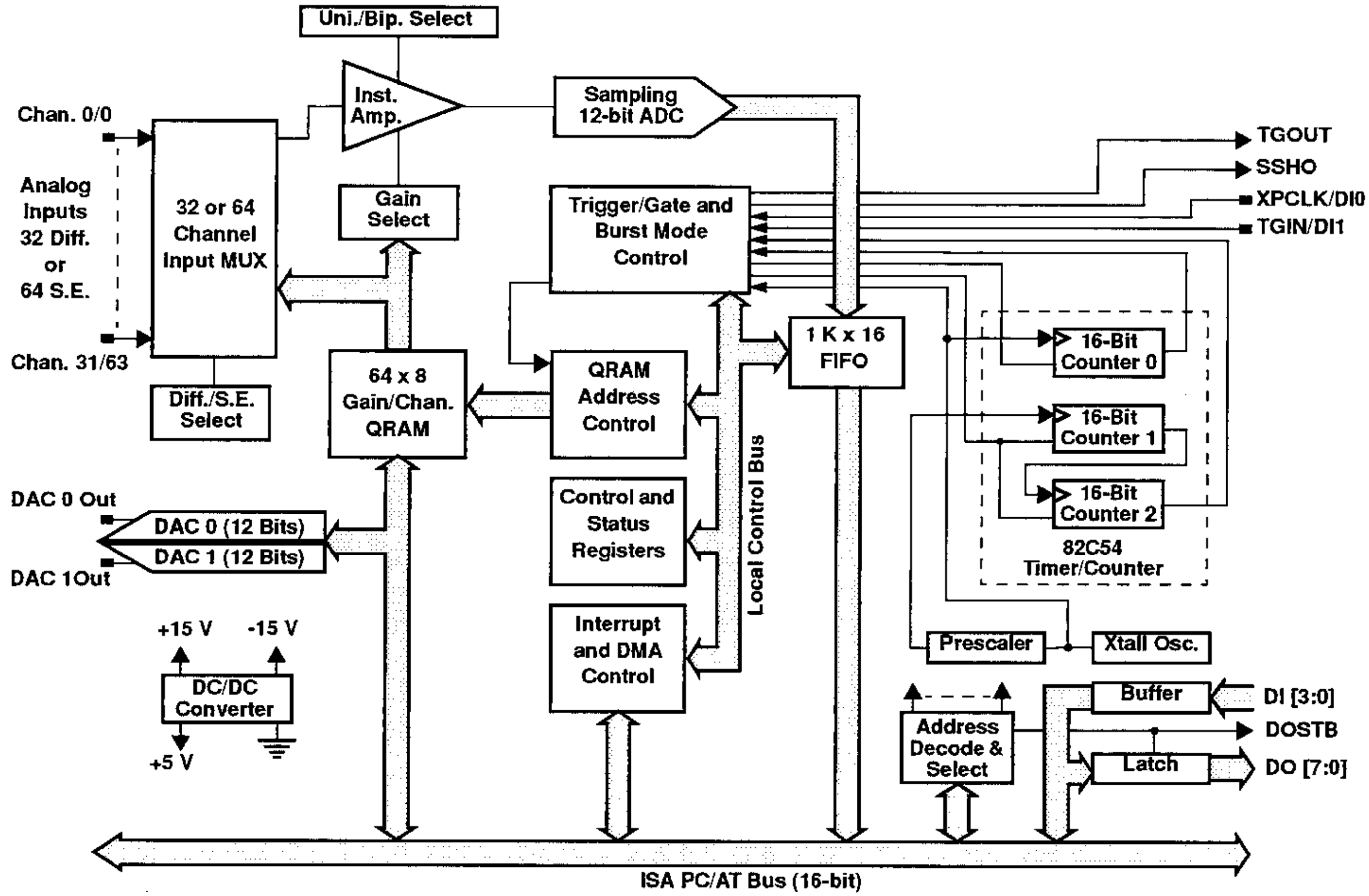

Figure 2-1. Block Diagram of DAS-1800HC Series Boards

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 the configuration software, you can set DAS-1800HC Series boards to operate with either differential or single-ended inputs (see "Configuring the Board" on page 3-4). Differential inputs measure the difference between two signals. Single-ended inputs are referred to a common ground. 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 100 mV and below.

Unipolar/Bipolar Selection

Using the configuration software, you can set the DAS-1800HC Series boards to operate in either the unipolar or bipolar input mode (see "Configuring the Board" on page 3-4). A unipolar signal is always positive (0 to 5 V, for example), while a bipolar signal can swing up and down between positive and negative peak values (±5 V, for example).

The DAS-1800HC Series boards use positive magnitude to represent unipolar signals and twos 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.

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 and 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 5 V	−5.0 to +5.0 V
5	0 to 1 V	−1.0 to +1.0 V
50	0 to 100 mV	−100 to +100 mV
250	0 to 20 mV	−20 to +20 mV

Table 2-2. DAS-1802HC Gains and Ranges for Unipolar and Bipolar Modes

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

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 100 mV or less) are slower than those with high-level inputs and because the channels with low-level inputs must drive out the residual signals left by the high-level inputs. The best way to maximize throughput is to use a combination of sensible channel grouping and to use 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 ±5 V or 0 to 5 V. 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 ±20 mV, 0 to 20 mV, ±100 mV, or 0 to 100 mV ranges, measurement throughput drops for two reasons:

- The amplifier cannot settle quickly enough (particularly the ±20 mV and 0 to 20 mV 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 10 MHz) any noise is amplified and digitized. As a result, you must carry out the measurement of low-level signals carefully to minimize noise effects.

Low-level transducers are best used with signal conditioning. Always use the ±20 mV, 0 to 20 mV, ±100 mV, and 0 to 100 mV 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 -20 mV is measured after a signal at near +5 V. 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 360 Ω (1 kΩ maximum) in series with 90 pF 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
—	±10.0 V	312.5 ksamples/s
±5.00 V	±5.00 V	312.5 ksamples/s
—	±2.50 V	312.5 ksamples/s
—	±1.25 V	312.5 ksamples/s
±1.00 V	—	312.5 ksamples/s
±100 mV	—	312.5 ksamples/s
±20 mV	—	75 ksamples/s

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 10.0 V	312.5 ksamples/s
0 to 5.00 V	0 to 5.00 V	312.5 ksamples/s
—	0 to 2.50 V	312.5 ksamples/s
—	0 to 1.25 V	312.5 ksamples/s
0 to 1.00 V	—	312.5 ksamples/s
0 to 100 mV	—	200 ksamples/s
0 to 20 mV	—	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

	Maximum Throughput			
Range	**To ±5 V**	**To ±1.0 V**	**To ±100 mV**	**To ±20 mV**
From ±5.0 V	312.5 ksamples/s	250 ksamples/s	200 ksamples/s	70 ksamples/s
From ±1.0 V	250 ksamples/s	312.5 ksamples/s	312.5 ksamples/s	70 ksamples/s
From ±100 mV	200 ksamples/s	312.5 ksamples/s	312.5 ksamples/s	70 ksamples/s
From ±20 mV	70 ksamples/s	70 ksamples/s	70 ksamples/s	75 ksamples/s

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 5 V	**To 0 to 1.0 V**	**To 0 to 100 mV**	**To 0 to 20 mV**
From 0 to 5.0 V	312.5 ksamples/s	200 ksamples/s	200 ksamples/s	50 ksamples/s
From 0 to 1.0 V	200 ksamples/s	312.5 ksamples/s	250 ksamples/s	60 ksamples/s
From 0 to 100 mV	200 ksamples/s	250 ksamples/s	250 ksamples/s	60 ksamples/s
From 0 to 20 mV	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 ±10.0 V	**To ±5.0 V**	**To ±2.50 V**	**To ±1.25 V**
From ±10.0 V	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s
From ±5.0 V	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s
From ±2.50 V	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s
From ±1.25 V	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s	312.5 ksamples/s

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 10.0 V	**To 0 to 5.0 V**	**To 0 to 2.5 V**	**To 0 to 1.25 V**
From 0 to 10.0 V	312.5 ksamples/s	312.5 ksamples/s	250 ksamples/s	200 ksamples/s
From 0 to 5.0 V	312.5 ksamples/s	312.5 ksamples/s	250 ksamples/s	200 ksamples/s
From 0 to 2.5 V	250 ksamples/s	250 ksamples/s	312.5 ksamples/s	200 ksamples/s
From 0 to 1.25 V	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 0.0012 Hz to 333 kHz.

- **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.

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 15.625 Hz to 333 kHz.

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

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 2-19.

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

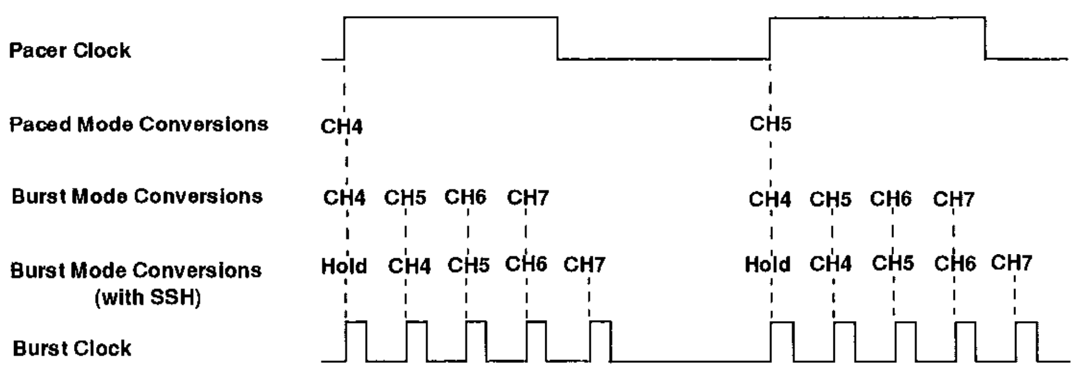

Figure 2-2. Timing Relationships of Conversion Modes for a Queue of Channels 4 to Channel 7

Clock Sources

In paced mode, the pacer clock determines the A/D 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 pacer clock source uses the onboard 82C54 counter/timer and a crystal-controlled 5 MHz time base. The internal pacer clock uses two cascaded counters of the 82C54 and is programmable between a maximum allowable rate of 333 kHz and a minimum available rate of 0.0012 Hz. 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 3.0 µs). If you are using an external clock, make sure that it does not initiate conversions at a faster rate than the ADC can handle.

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

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 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-1800 Series Function Call Driver provides functions for an analog trigger; refer to the *DAS-1800 Series Function Call Driver User's Guide* for more information.
- **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 400 ns, 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 1 µs. Figure 2-4 illustrates the enabling of conversions with a hardware trigger.

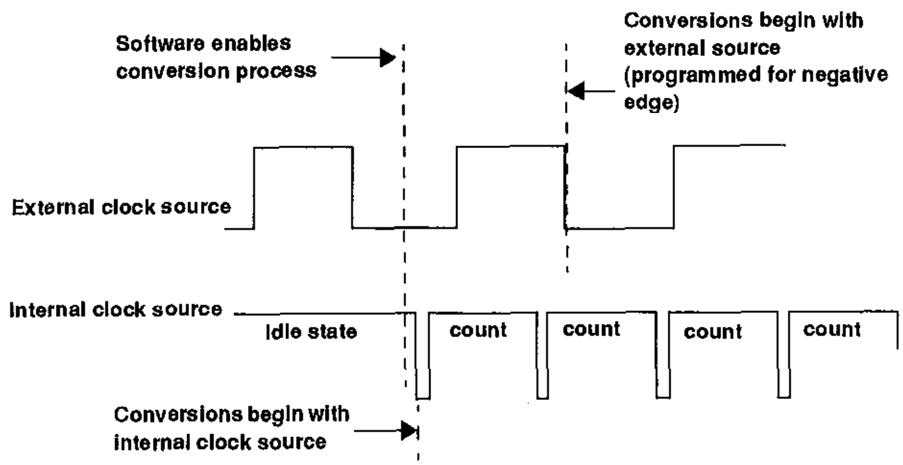

Figure 2-3. Enabling Conversions with Software Triggering/Gating and With Internal and External Clock Sources

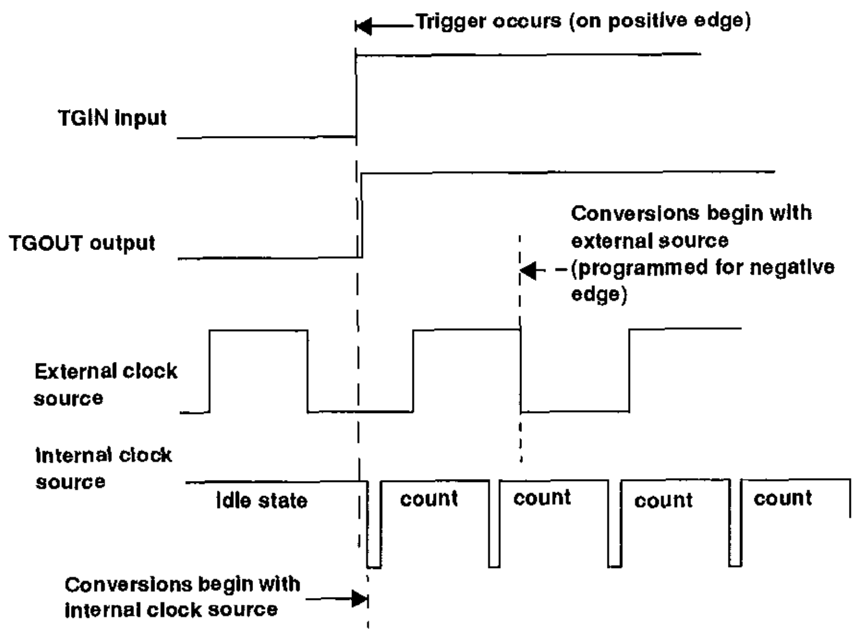

Figure 2-4. Enabling Conversions with a Hardware Trigger

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 avaliable 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 avaliable with DMA-mode operations only.

Post-Trigger Acquisition

In post-trigger acquisition, the data of interest appears after a specific event. Acquisition starts on an internal, 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 2-17.

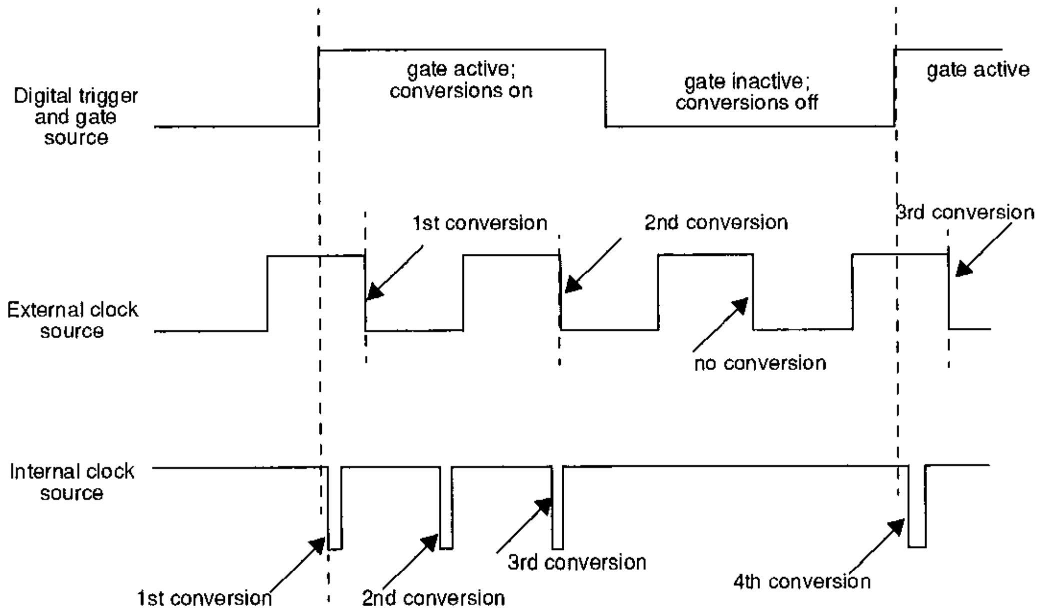

Figure 2-5. Hardware Gate

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.

- **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 (digital-to-analog converters) with 12-bit resolution. Both DACs have a fixed voltage range of ±10 V, and they power up to 0 V at reset.

The two DACs have a capacitive load drive up to 100 µF and an output current drive of up to ±5 mA.

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.

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 2.0 V); logic 0 on an I/O line indicates that the input/output is low (less than 0.8 V). The digital inputs are compatible with TTL-level signals. These inputs are provided with 10 kΩ pull-up resistors to +5 V; 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 you are 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 you are 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 300 ns lag to allow for delays. Data is valid until the next strobe, as shown in Figure 2-6.

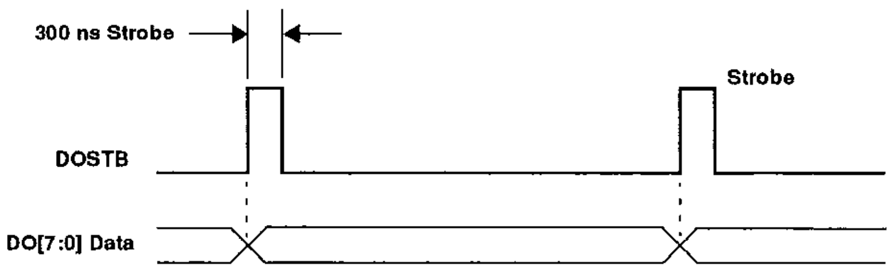

Figure 2-6. Timing Relationship between Data from DO0 to DO7 and Latch Strobe DOSTB

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 the upper diagram of Figure 2-7a. Note that when you use this option, TGOUT does not retrigger and thus cannot be used with about-trigger acquisitions. Note also that there is a delay of about 200 ns between the active edge of TGIN and the starting edge of TGOUT.
- When using digital control signal TGIN as a gate, as shown in the middle diagram of Figure 2-7b. Note that there is a delay of about 200 ns between the active edge of TGIN and the starting edge of TGOUT.
- When using an internal trigger/gate, shown in the lower diagram of 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 1 μs.

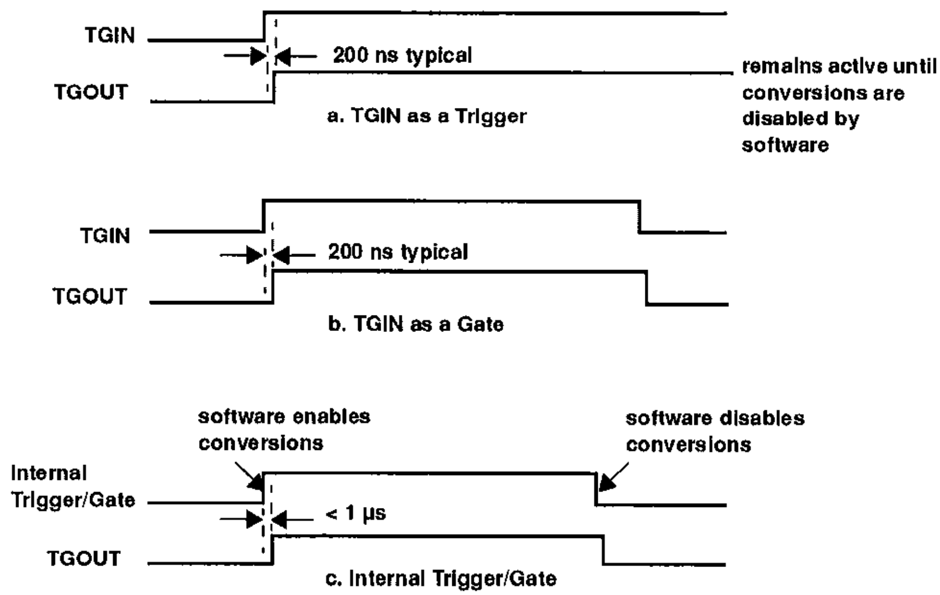

Figure 2-7. Timing for the Generation of TGOUT

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 50 ns after an active edge of the pacer clock and remains there until 200 ns 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)

  The Burst Period can be 3.0 to 64 µs. 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 you are not generating SSHO for SSH hardware control, you can use SSHO as a converter clock output signal. SSHO then 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.

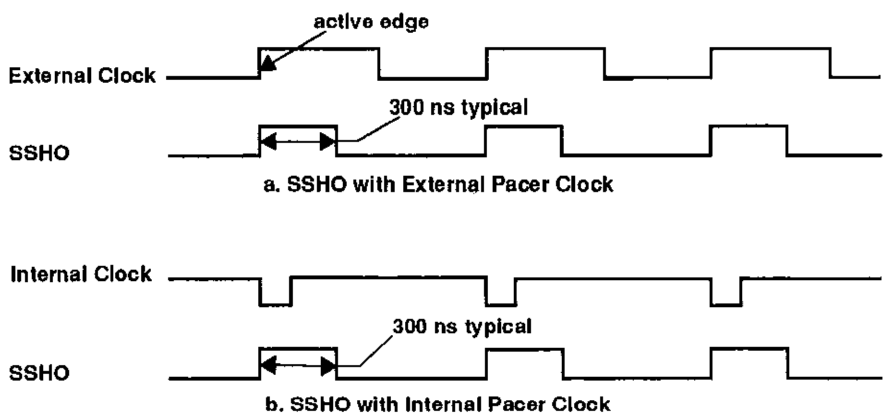

Figure 2-8. Timing for SSHO Generation when not used for SSH Hardware

Power

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

3

Setup and Installation

This chapter describes inspection, software installation, configuration, and hardware installation for the DAS-1800HC Series boards.

Read this chapter before you attempt to install and use your DAS-1800HC Series board.

Inspecting Contents of a DAS-1800HC Series Package

Caution: A discharge of static electricity from your hands can seriously damage certain electrical components on any circuit board. Before handling any board, discharge static electricity from yourself by touching a grounded conductor such as your computer chassis (your computer must be turned off). Whenever you handle a board, hold it by the edges and avoid touching any board components.

Use the following procedure to unwrap and inspect a DAS-1800HC Series board.

1. Factory packaging of the DAS-1800HC Series boards includes a final wrap of protective, anti-static material. Remove the board from its anti-static wrapping material. You may wish to store the wrapping material for possible future use.
2. Inspect the board for signs of damage. If damage is apparent, arrange to return the board to the factory (see “Technical Support” on page 7-5 for instructions on returning material).

3. Check the remaining contents of your package against the packing list to be sure your order is complete. Report any missing items, immediately.

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

Note: DAS-1800HC Series boards are factory calibrated; they require no further adjustment prior to installation. If at a later time you decide to re-calibrate the board, refer to Chapter 6 for instructions.

Installing the Software Package

This section provides the installation procedures for the DAS-1800 Series standard software package and the optional ASO-1800 software package. The DAS-1800 Series standard software package is for the DOS environment only. The ASO-1800 software package has a version for DOS and a version for Windows.

Before you work with the software from any package, make a copy of all diskettes in the package. Use the copies as your working diskettes, and store the originals as backup diskettes.

Installing DOS Software

Use the following procedure to install the DAS-1800 Series standard software package or the DOS version of the optional ASO-1800 software package:

1. Insert diskette #1 of the software package into an appropriate floppy-disk drive of your computer.

2. Change to the drive containing the diskette and enter the following at the DOS prompt:

```
INSTALL
```

3. Respond to the installation-program prompts.

4. When the installation program requests a designation for the drive that is to receive your software, enter a designation of your choosing or accept the default designation of *C*.

5. When the installation program requests a name for the directory that is to receive your software, enter a name of your choosing or accept the default name.

   The installation program automatically creates a directory on the specified drive and then copies all files, expanding any compressed files, to the new directory.

6. Insert any additional disks, as required by the installation program.

The installation program notifies you when it completes the installation. After the installation, you may want to review the following files:

- **FILES.TXT** - An ASCII text file that lists and describes all the files written to the directory created by the installation program.
- **README.TXT** - An ASCII text file containing information available after the publication of this manual.

Installing Windows Software

Use the following procedure to install the Windows portion of the ASO-1800 optional software package:

1. Insert diskette #1 into an appropriate floppy-disk drive of your computer.

2. Run the Windows program.

3. From the Program Manager File menu, select Run.

4. In the Command Line text box, type the letter of the drive containing your Windows diskette and follow with SETUP. For example, if your diskette is in drive A, type the following:

   ```
   A:SETUP
   ```

5. Select OK.

6. Respond to the installation-program prompts.

7. When the installation program requests a designation for the drive that is to receive your software, enter a designation of your choosing or accept the default designation of *C*.

8. When the installation program requests a name for the directory that is to receive the software, enter a name of your choosing or accept the default name.

   The installation program automatically creates a directory on the specified drive and then copies all files, expanding any compressed files, to the new directory.

   The installation program also creates a DAS-1800 program manager group containing icons for all DAS-1800 programs and information files.

9. Insert any additional disks, as required by the installation program.

The installation program notifies you when it completes the installation. After the installation, you may want to review the following files:

- **FILES.TXT** - An ASCII text file that lists and describes all the files written to the directory created by the installation program.
- **README.TXT** - An ASCII text file containing information available too late for publication in this manual.

Configuring the Board

Configuration options for your DAS-1800HC Series board are recorded in a configuration file that is used by software to configure the board. The entry in the configuration file for base address also serves as a reference when you set the base-address switch on the board. The configuration file is described in the following subsection. The base address switch settings are discussed under "Setting the Base Address" on page 3-8.

Using the Configuration File

The configuration file contains a list of the configuration options and a setting for each. When you set up software to operate your DAS-1800HC Series board, you specify the name of the configuration file. The configuration file you specify can be either the default configuration file or a file you create with the configuration utility. This section describes the default configuration file and the configuration utility.

Default Configuration File

The default configuration file, DAS1800.CFG, contains all the board configuration options and their corresponding default settings. This file is furnished in both the DAS-1800 Series standard software package and the optional ASO-1800 software package. The default configuration file contains a list of options for a single board. If your computer contains more than one DAS-1800HC Series board, you can create a configuration file containing lists for all boards. Table 3-1 contains the list of the configuration options and their corresponding default settings, as contained in DAS1800.CFG.

Table 3-1. Default Configuration File Settings

Options	Default Settings
Board Type	DAS1802HC
Base Address	&H300
A/D Mode	Bipolar
A/D Config	Differential
A/D Comm Mode	N/A
DMA Channel	5
IRQ Level	10
# of SSHs	0
SSH Gains	N/A
# of EXPs	N/A

If the default settings meet the needs of your application, refer to "Installing the Board" on page 3-9. If you wish to change the default settings or modify some other DAS-1800HC Series board configuration file, refer to the next subsection.

Configuration Utility

The configuration utility, D1800CFG.EXE, is furnished in both the DAS-1800 Series standard software package and the ASO-1800 optional software package. This utility enables you to modify an existing configuration file or to create a new configuration file. To modify or create a configuration file, use the following procedure:

1. Start the configuration utility from DOS or Windows as follows:

   – *From DOS*, change to the directory containing D1800CFG.EXE and enter the following at the DOS prompt:

     ```
     D1800CFG filename
     ```

     where *filename* is the name of the configuration file you wish to modify or create.

   – *From Windows*, select Run from the Program Manager File menu. Enter the following in the Command Line text box, and select OK.

     ```
     path D1800CFG filename
     ```

     where *path* is the complete path to D1800CFG.EXE, and *filename* is the name of the configuration file you wish to modify or create.

   Whether *filename* is an existing file in the directory containing D1800CFG.EXE or a file to be created, it is the name displayed by the configuration utility's opening screen. However, the settings displayed for *filename* may differ as follows:

   – If *filename* is an existing file in the directory containing D1800CFG.EXE, the configuration utility displays the settings contained in this existing file.

- If *filename* is a file to be created, the configuration utility displays the default configuration settings.
- If no entry was made for *filename*, the configuration utility displays the default configuration file DAS1800.CFG.

Note: If you alter the default configuration file and then wish to recreate it, you must also rename the altered file and then create the new default file by starting the configuration utility with no *filename* and saving the results without change.

---

2. In the opening screen, enter the number of boards you plan to configure (**1** to **3**).

   After you make this entry, the utility program displays the menu box for the first board (board 0, which is shown in the upper-left corner of the menu box). The menu box contains the following configuration options:

   - *Board type* - This option is a choice between DAS-1801HC and DAS-1802HC.
   - *Base address* - This option requires the entry of a 3-digit address.
   - *A/D mode* - This option is a choice between bipolar and unipolar.
   - *A/D configuration* - This option is a choice between differential and single-ended.
   - *A/D common mode ground reference* - This option is not applicable to DAS-1800HC Series boards.
   - *DMA channel* - This option is a choice between available DMA channels or channel pairs.
   - *IRQ level* - This option is a choice between available interrupt levels.
   - *# of SSHs* - This option is the choice of a number to represent the total of attached SSH-8 boards.

- *SSH Gains* - This option is the choice of a gain value for each channel of the attached SSH hardware.
- # of EXPs - This option is not applicable to DAS-1800HC Series boards.

3. To change the setting for a configuration option, use the arrow keys to highlight the option, press `[Enter]` to display a list of settings for that option, use the arrow keys to highlight the desired setting, then press `[Enter]` again to select the setting. These instructions are summarized in the Commands/Status box at the bottom of the screen.

   When setting the A/D Configuration option, note that if you are using MB01 backplanes, you must configure the DAS-1800HC Series board inputs as single-ended.

4. If you are configuring more than one board, press `[N]` when you wish to see the menu box for the next board.
5. When you complete the changes for all boards, press `[Esc]`.
6. The configuration utility asks whether to save the changes. Press `[Y]` for *yes* or `[N]` for *no*.

Setting the Base Address

The base address switch on both the DAS-1801HC and DAS-1802HC 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 6-position DIP switch located as shown in Figure 3-1. To reset this switch for another address, use the "Configuration Utility" on page 3-6 to determine a new address and to see the corresponding switch settings in the menu-box diagram. The settings for the base address switch must match the settings in the menu-box diagram.

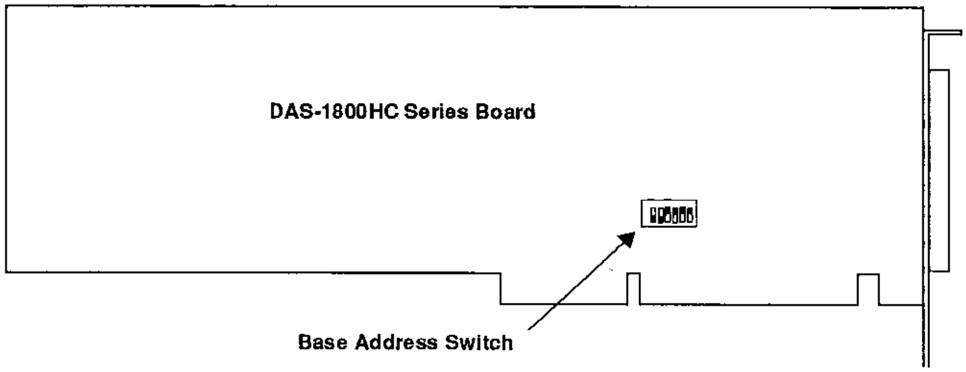

Figure 3-1. Location of Base Address Switch

Note: The settings for the base address switch must match the settings shown by the switch diagram in the menu box of the configuration utility.

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.

7. Turn on power to the computer.

You can use the Control Panel (see Chapter 5) to check board operation.

You are now ready to make I/O connections. Refer to Chapter 4 for descriptions of I/O accessories and connections for DAS-1800HC Series boards.

4

Cabling and Wiring

This chapter 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 sensor 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

Use a CAB-1800 Series cable to connect an STA-1800HC and DAS-1800HC Series board together as shown in Figure 4-1.

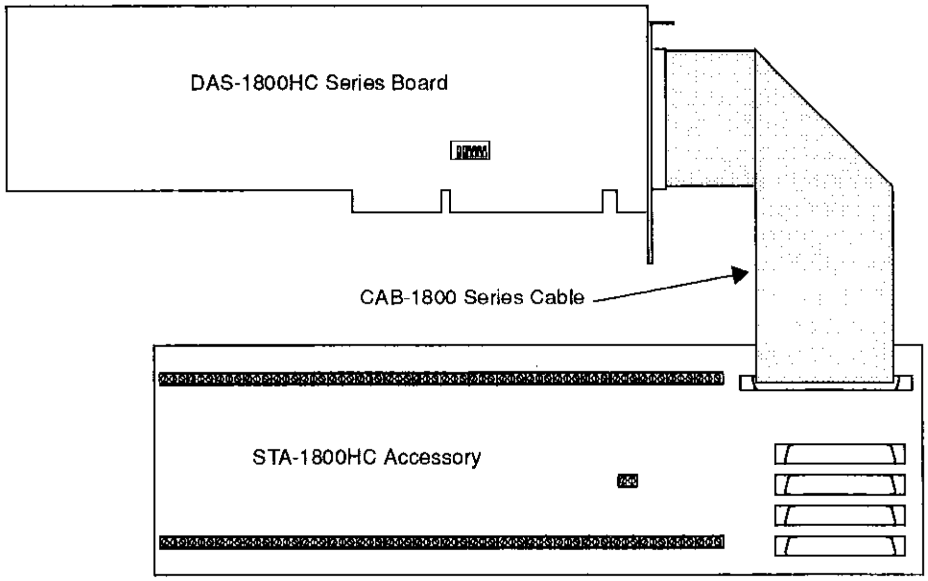

Figure 4-1. Cabling and Connections for Attaching an STA-1800HC Accessory

Cabling options for attaching an STA-1800HC to a DAS-1800HC Series board are as follows:

- 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 attaches to pin 1 of each cable connector. Be sure to mate pin 1 of each cable connector to pin 1 of a board connector. The pin assignments for the main I/O connector of DAS-1800HC Series boards are a mirror image of those for the 100-pin STA-1800HC connector, as shown in Figure 4-2.

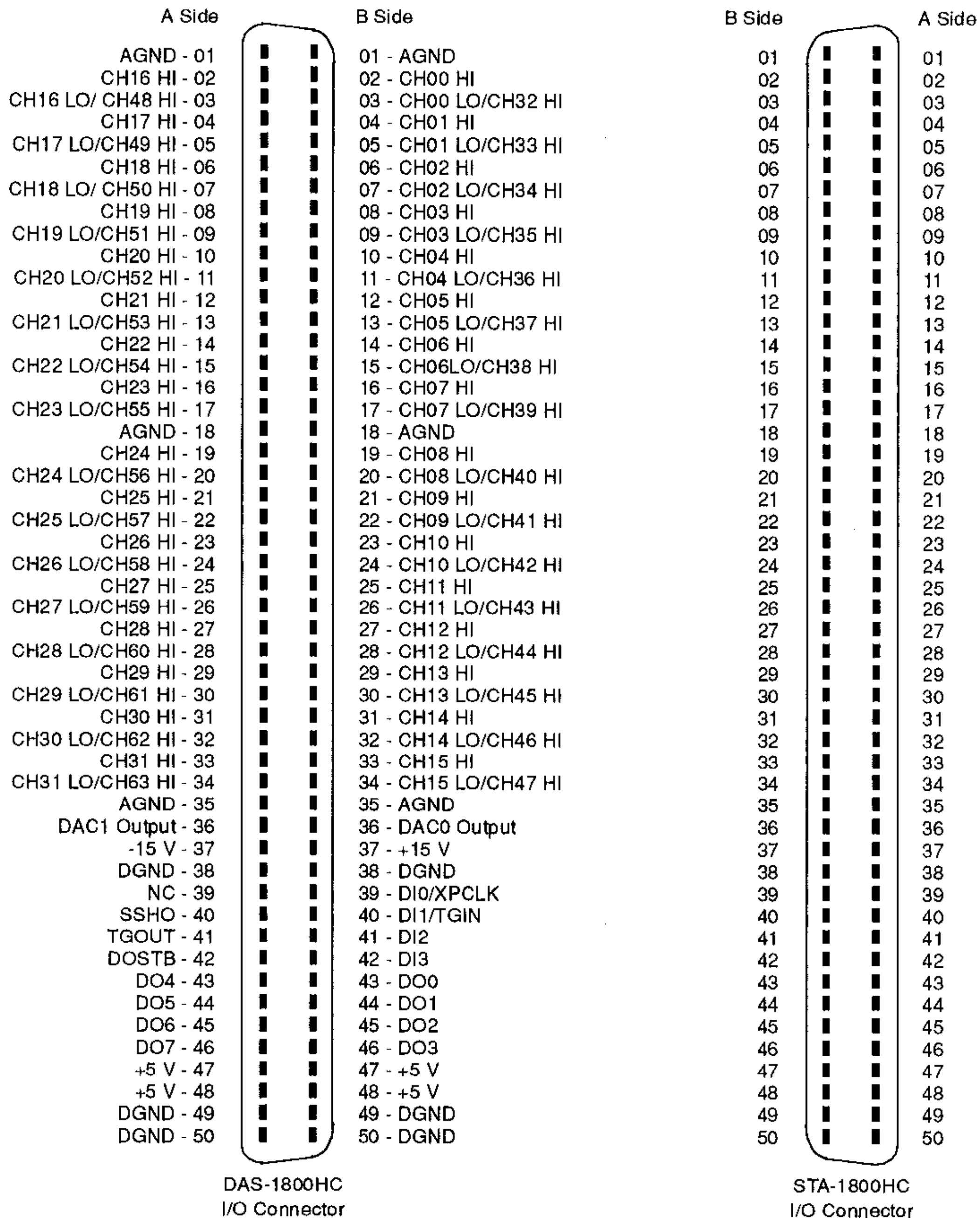

Figure 4-2. Pin Layouts and Assignments for I/O Connectors of the DAS-1800HC Series Boards and the STA-1800HC Board

Connecting to the CJC Sensor of an STA-1800HC

The STA-1800HC contains a CJC sensor that develops a voltage directly proportional to the temperature of the STA-1800HC screw-terminal blocks. At 0 °C, the sensor output is 0 V; it changes at the rate of 10 mV per °C. The CJC sensor circuit is represented by the schematic in Figure 4-3.

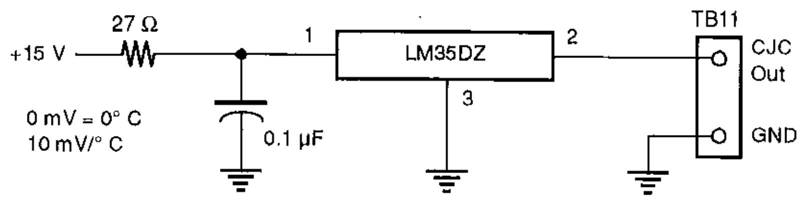

Figure 4-3. CJC Sensor Circuit Schematic

As Figure 4-3 shows, the CJC sensor output appears across the TB11 screw terminals. TB11 is located as shown in Figure 4-4.

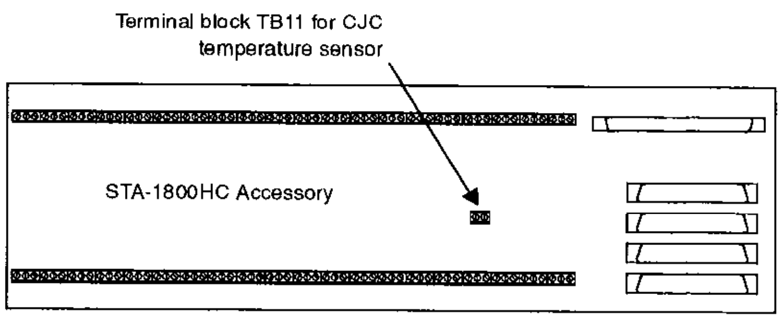

Figure 4-4. Location of CJC Sensor Screw Terminals (TB11)

You can obtain a temperature reading by wiring TB11 to screw terminals for an unused analog input channel. Use this reading to determine the temperature required to compensate for the error introduced to thermocouple readings at the STA-1800HC screw terminals.

Attaching SSH-8 Accessories

The SSH-8 is a simultaneous sample and hold accessory whose functions and capabilities are described in the *SSH-8 User's Guide*. This accessory can serve as a front-end analog interface for DAS-1800HC Series boards when connected through an STA-1800HC. Note that the attached SSH-8 accessories must be set as slaves. Attach the SSH-8 accessories to the STA-1800HC as shown in Figure 4-5. Refer to the *SSH-8 User's Guide* for more information.

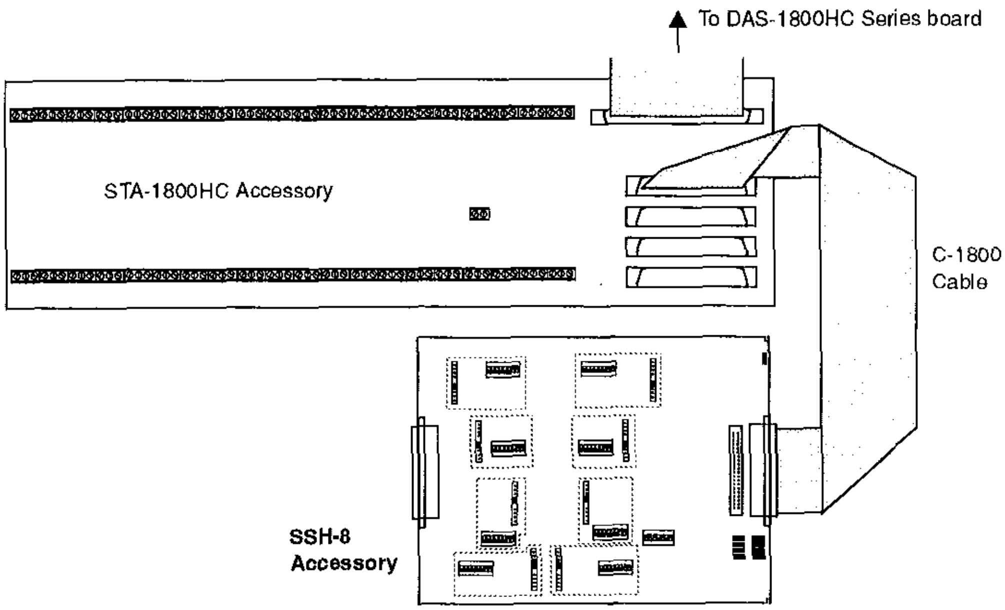

Figure 4-5. Cabling and Connections for Attaching SSH-8 Accessories to a DAS-1800HC Series Board

Attaching MB01 Backplanes

The STA-1800HC can support up to four MB01 backplanes of MB Series signal-conditioning modules connected as shown in Figure 4-6. For details of the MB modules, refer to the *MB Series User's Guide.*

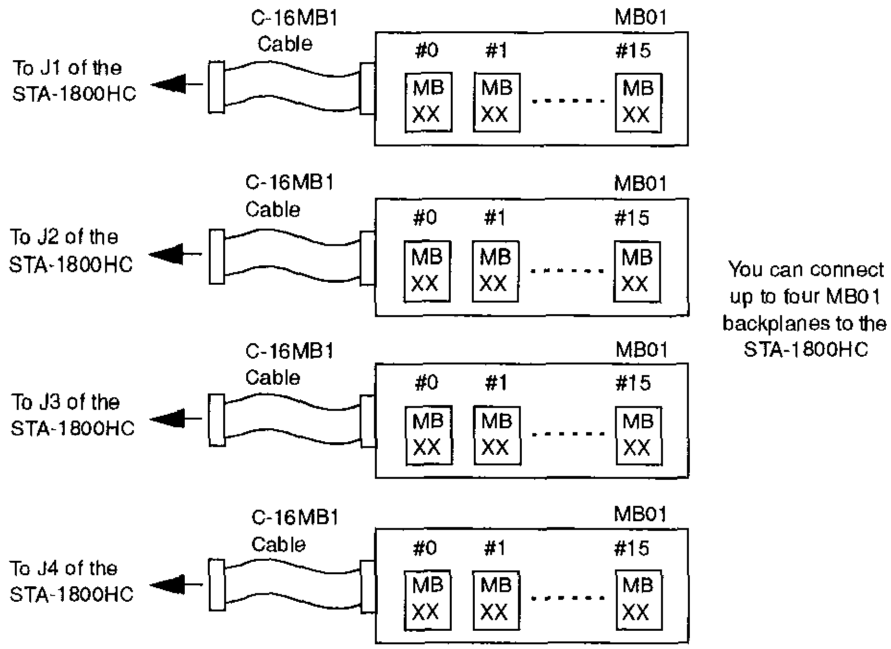

Figure 4-6. Cabling and Connections for Attaching MB01 Backplanes to an STA-1800HC

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 4-7.

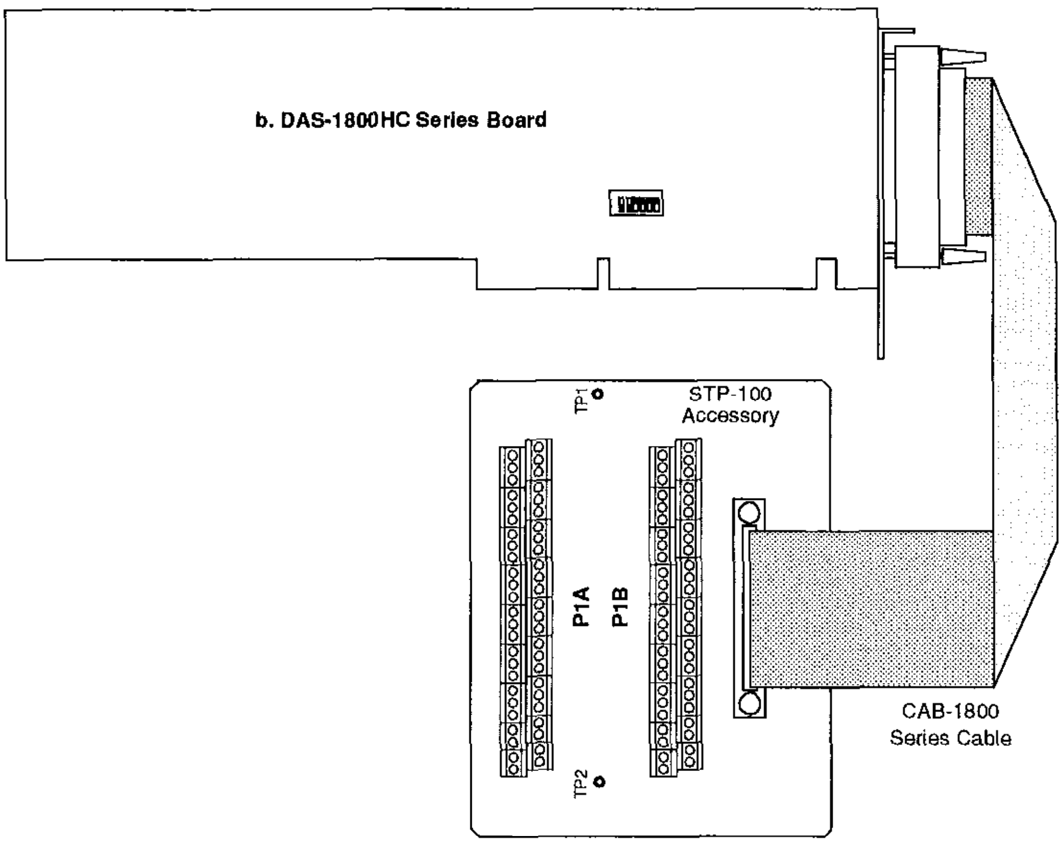

Figure 4-7. Attaching an STP-100

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 4-9.

Precautions for Using DAS-1801HC Boards at High Gain

Operating a DAS-1801HC at a gains 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 10 µV 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.

- 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 40 µV/°C. Thermals can introduce strange random variations caused by air currents, and so on.

- Consider filtering. This approach can use hardware (resistors, capacitors, and so on) but is often accomplished more easily with software. Instead of reading the channel once, read it 10 or more times in quick succession and average the readings. If the noise is random and gaussian, it will be reduced by the square-root of the number of readings.

Additional Precautions

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

- Avoid direct connections to the AC line.

- Make sure all connections are tight and sound so that signal wires are not likely to come loose and short to high voltages.

- Use isolation amplifiers and transformers where necessary.

Connecting a Signal to a Single-Ended Analog Input

Figure 4-8 shows the connections between a signal source and a channel of a DAS-1800HC Series board configured for single-ended input mode.

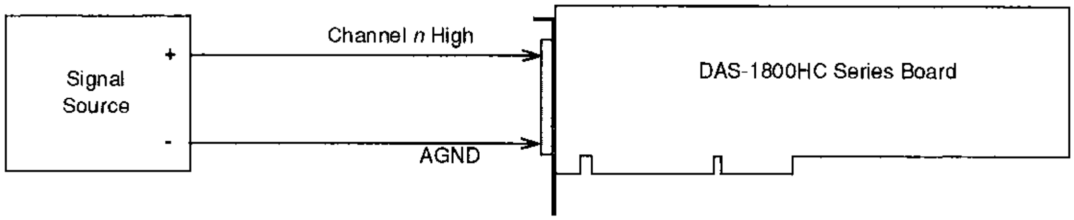

Figure 4-8. Connections for Wiring a Signal Source to a DAS-1800HC Series Board Configured for Single-Ended Inputs

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 4-9 on page 4-11 shows three connection schemes for wiring a signal source to a channel of a DAS-1800HC Series board configured for differential input mode.

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 100 Ω, use the connections in the upper circuit. The resistance of each of the two bias return resistors must equal 2000 R_s.

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

In the lower circuit, bias current return is inherently provided by the source. The circuit requires no bias resistors.

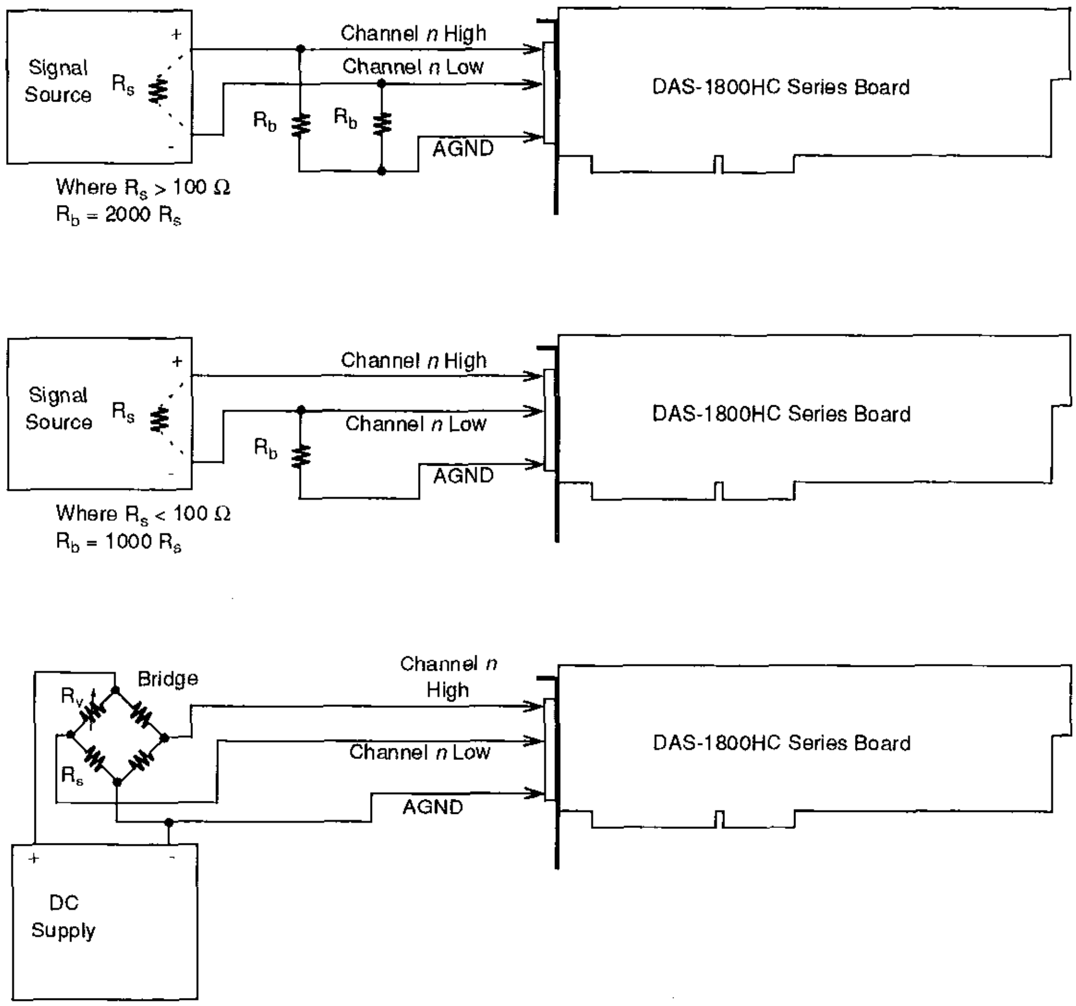

Figure 4-9. Three Types of Connections for Wiring a Signal Source to a DAS-1800HC Series Board Configured for Differential Inputs

Avoiding Ground Loops with Differential Inputs

Very often, 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 4-10 shows the proper way to connect a differential input while Figure 4-11 illustrates the effect of a ground loop.

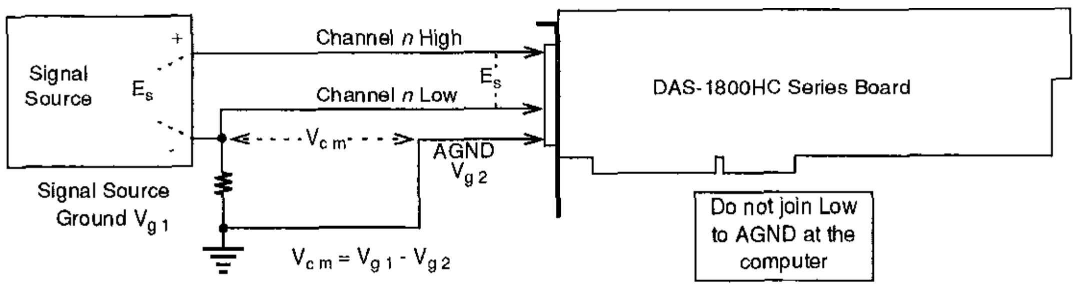

Figure 4-10. A Differential Input Configuration that Avoids a Ground Loop

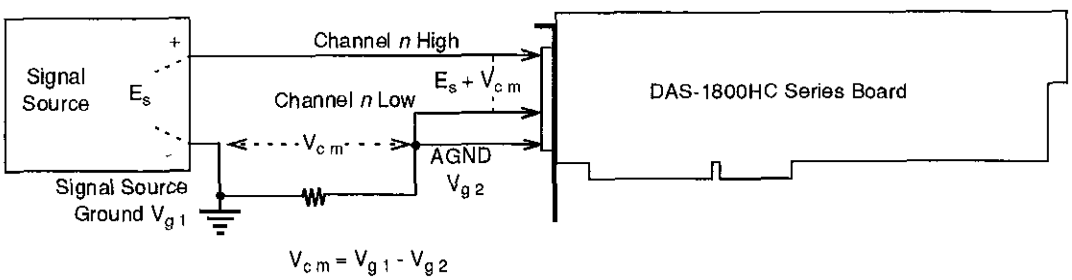

Figure 4-11. Differential Input Configuration with a Ground Loop

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. The screw terminals are labeled as follows:

- **DAC #0 output** - Screw terminals are DAC0 OUT
- **DAC #1 output** - Screw terminals are DAC1 OUT

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 2-17. Make your connections to the digital I/O terminals through corresponding terminals of an STA-1800HC. The terminals are labeled as follows:

- **Digital input** - The digital input terminals are DI0 to DI3.
- **Digital output** - The digital output terminals are DO0 to DO7.

Connecting Digital Control Signals

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

- **SSHO** - The simultaneous sample-and-hold output terminal. This signal is described in "Using Digital Control Signal SSHO" on page 2-19. Use the SSHO terminal for connecting this signal.
- **TGIN** - The trigger/gate input, described in the next section and in "Using Digital Control Signal TGOUT" on page 2-18. Refer also to "Triggers" on page 2-12 and to "Gates" on page 2-14. Use the digital-input terminal DI1/TGIN for connecting a TGIN signal.
- **TGOUT** - The trigger/gate output, described in the next section and in "Using Digital Control Signal TGOUT" on page 2-18. Use the TGOUT terminal for connecting this signal.

- **XPCLK** - The external pacer clock input, described in the next section and in "Clock Sources" on page 2-11. Use the digital-input terminal DI0/XPCLK for connecting this signal.

- **DOSTB** - The digital output strobe, described in "Using Digital Control Signal DOSTB" on page 2-17. Use the DOSTB terminal for connecting this signal.

Connecting and Synchronizing Multiple Boards

You can synchronize up to three DAS-1800HC Series boards using trigger and gate signals from the main I/O connectors. Synchronizing three boards gives you 192 analog input channels. 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 occurs after this time period and subsequent conversions occur at the programmed rate.

Figure 4-12 shows two connection schemes for synchronizing multiple boards. Both schemes are using the onboard pacer clock to time acquisitions.

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 ±100 ns from the active edge of the trigger input. All conversions start within 100 ±100 ns of each other from board to board. When using this scheme, 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 (the master) begins A/D conversions 400 ±100 ns from the active edge of the trigger input or from a software enable. The slave boards begin conversions 300 ±100 ns from the start of conversions in the master. **When using this scheme, you must use only the onboard pacer clock.**

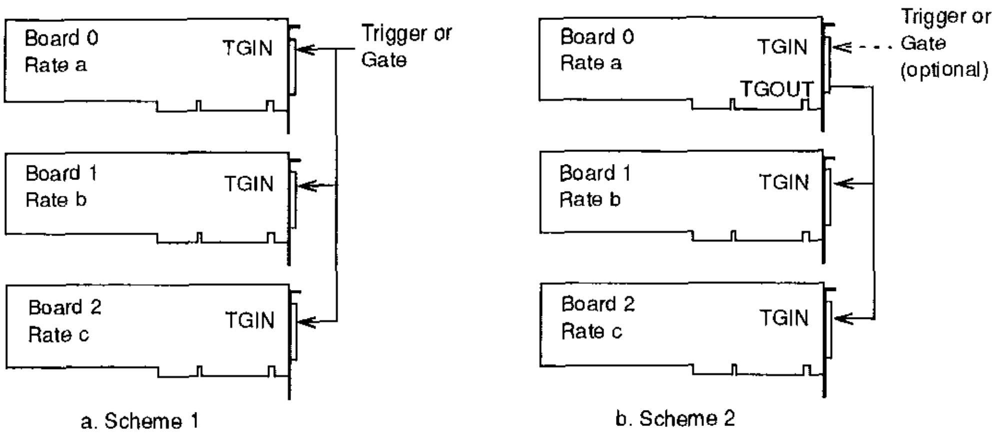

Figure 4-12. Two Connection Schemes for Synchronizing Multiple Boards

Note that TGOUT is an active, high-going signal. Therefore, you should program the slave-board TGIN inputs for a positive-going trigger or gate.

5

The Control Panel

The Control Panel is a utility program for testing the functions of your DAS-1800 Series boards; it is available in a DOS version (CTL1800.EXE) and a Windows version (CTL1800W.EXE). The DOS version is a part of both the DAS-1800 Series standard software package and the ASO-1800 software package. The Windows version is a part of the ASO-1800 software package only.

Note: Before using the Windows version of the Control Panel, you are advised to install the Keithley Memory Manager (VDMAD.386) to ensure the allocation of a memory buffer large enough for Control Panel needs. Refer to Appendix D for details of the Keithley Memory Manager.

To use the Control Panel, perform the following steps:

1. Start the Control Panel from the DOS or Windows environments as follows:

   – *If you are in the DOS environment,* change to the directory containing the CTL1800.EXE program and enter the following at the DOS prompt:

   ```
   CTL1800
   ```

   – *If you are in the Windows environment,* double click on the Control Panel icon in the DAS-1800 Group window, which is within the Program Manager window.

   After the Control Panel starts, it asks you for the name of a configuration file.

2. To use the settings from the default configuration file, select OK. If you prefer to use the settings from another configuration file, enter the name of that file and select OK.

   After the Control Panel accepts the name of a configuration file, it displays the DAS-1800 TEST & CONTROL panel. This panel contains the controls that allow you to acquire, read, and transfer data and to set up and display parameters.

3. To set up and perform an operation, select the appropriate buttons. To obtain information on the setup and performance of an operation, use the Help option in the Control Panel menu. To obtain information on DAS-1800HC Series board functions and parameters, refer to Chapter 2.

4. To set up and perform a digital I/O operation, select Digital I/O from the Control Panel menu; to set up and perform a D/A operation, select D/A from the Control Panel menu. When the Control Panel displays the DIGITAL I/O & D/A panel, you can select appropriate buttons to proceed with your operation.

5. *If you are working in the Windows environment*, you can use the Control Panel's Dynamic Data Exchange (DDE) to transfer data to another Windows program and to graph eight channels by selecting DDE from the Control Panel menu.

6. Use the File menu to open, close, or save a file.

7. When you finish using the Control Panel, select the Exit option from the File menu to terminate the program.

6

Calibration

Your DAS-1800HC 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 chapter provides the information you need to calibrate a DAS-1800HC Series board.

Equipment Requirements

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

- A digital voltmeter accurate to 6 1/2 digits
- An adjustable ±10 V voltage calibrator
- An STA-1800HC accessory with CAB-1800 cable, an STP-100 accessory, 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.

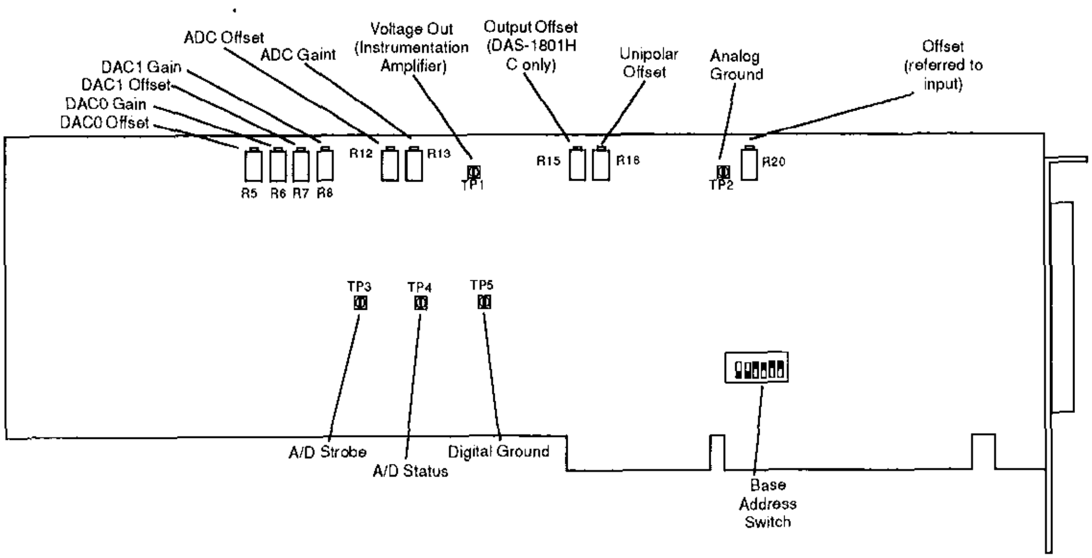

Figure 6-1. Potentiometers and Test Points on the DAS-1800HC Series Boards

Calibration Utility

To calibrate a DAS-1800HC Series board, use the DOS-based CAL1800.EXE calibration utility. This utility is included in both the DAS-1800 Series standard software package and the ASO-1800 software package.

Start the calibration utility by changing to its directory and entering the following at the DOS prompt:

```
CAL1800
```

Follow the utility-program prompts as they appear; the program guides you through the calibration process.

7

Troubleshooting

If your DAS-1800HC Series board is not operating properly, use the information in this chapter to isolate the problem.

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 the factory.

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 3-8 for instructions on setting the base address.
	The interrupt level is incorrect or not consistent with what the program is addressing.	Make sure no other computer device is using the interrupt level specified in your program. If necessary, reset the interrupt level.
	The board configuration is incorrect.	Check the remaining settings in the configuration file.
	The board is incorrectly aligned in the accessory slot.	Check the board for proper seating.
	The board is damaged.	Contact the factory; see page 7-5.
Intermittent operation	The most common cause of this problem is that the I/O bus speed is in excess of 8 MHz.	Reduce I/O bus speed to a maximum of 8 MHz (to change the I/O bus speed, run BIOS setup). See your computer documentation for instructions on running BIOS setup.
	Vibrations or loose connections exist.	Cushion source of vibration and tighten connections.
	The board is overheating.	Check environmental and ambient temperature. See the documentation for your computer.

Table 7-1. Troubleshooting Information (cont.)

Symptom	Possible Cause	Possible Solution
Data appears to be invalid	The most common cause of this problem is that the I/O bus speed is in excess of 8 MHz.	Reduce I/O bus speed to a maximum of 8 MHz (to change the I/O bus speed, run BIOS setup). See the documentation for your computer for instructions on running BIOS setup.
	An open connection exists.	Check wiring to screw terminal.
	Another system resource is using the specified base address.	Reconfigure the base address of the DAS-1800HC Series board; refer to page 3-8 for more information. Check the I/O assignments of other system resources and reconfigure, if necessary.
	A timing error occurred.	Press `[Ctrl]` + `[Break]`

If your board is not operating properly after using the information in Table 7-1, continue with the next two sections to further isolate the problem.

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:

1. Turn the power to the host computer OFF, and remove power connections to the computer.

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

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 7-5 before calling the factory.

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

Call the factory before returning any equipment for repair. Please make sure you have the folowing 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	________

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 twos complement, right-justified	
FIFO size	1024 word	
Channel-gain QRAM size	64 locations	
Gain (range)	1 (0.0 to +5.0 V for unipolar) 1 (±5.0 V for bipolar)	1 (0.0 to +10 V for unipolar) 1 (±10 V for bipolar)
	5 (0.0 to +1.0 V for unipolar) 5 (±1.0 V for bipolar)	2 (0.0 to +5.0 V for unipolar) 2 (±5.0 V for bipolar)
	50 (0 to 100 mV for unipolar) 50 (±100 mV for bipolar)	4 (0.0 to +2.5 V for unipolar) 4 (±2.5 V for bipolar)
	250 (0 to +20 mV for unipolar) 250 (±20 mV for bipolar)	8 (0.0 to 1.25 V for unipolar) 8 (±1.25 V for bipolar)
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	

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

Feature	DAS-1801HC	DAS-1802HC
Temperature coefficient of accuracy (includes ADC)	Offset: • Bipolar: ±20 µV/ °C ±(12 µV/° C ÷ gain) max • Unipolar: ±20 µV/ °C ±(14 µV/° C ÷ gain) max	
	Gain: • ±20 ppm/ °C for gain < 50 • ±30 ppm/° C for gain = 50 • ±35 ppm/° C for gain = 250	
Linearity[1]	Integral: ±½ LSB typical, ±1 LSB max.	
	Differential: ±1 LSB	
Throughput	Refer to "Maximum Achievable Throughput Rates" on page 2-5	
Dynamic parameters	Acquisition time: 0.3 µs	
	Aperture delay: 13.0 ns	
	Aperture uncertainty: 150 ps rms	
	Conversion time: 3.0 µs max. (includes acquisition time)	
Input bias current	±40 nA max. @ 25° C	
	±60 nA max. over operating range	
Common mode rejection ratio	74 dB for gain = 1	74 dB for gain = 1
	80 dB for gain = 5	80 dB for gain = 2
	100 dB for gain = 50	80 dB for gain = 4
	100 dB for gain = 250	86 dB for gain = 8
Input overvoltage	±15 V continuous powered	
	±15 V continuous unpowered	

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	Bipolar electrical noise (in counts) • 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	Unipolar electrical noise (in counts): • 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 0.0012 Hz and 333 kHz	
Minimum external pacer clock pulse width	10 ns	
Maximum external pacer clock rate	333 kHz	
Minimum hardware trigger pulse width	10 ns	

Notes

[1] Monotonicity is guaranteed over the operating range.

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

Table A-2. Analog Output Specifications

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

Notes

[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.) = 2.7 V @ I_{OH} = −400 µA
	V_{OL} (max.) = 0.5 V @ I_{OL} = 8 mA
Digital input	V_{IH} (min.) = 2.0 V; I_{IH} (max.) = 20 µA
	V_{IL} (max.) = 0.8 V; I_{IL} (max.) = −0.2 mA
Digital output strobe pulse width	300 ns typical; data is latched on the rising edge of DOSTB

Table A-4. Power Supply Requirements

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

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 accessories and for the four 37-pin D connectors of the STA-1800HC accessory.

I/O Connector for the DAS-1800HC Series Boards and the STA-1800HC

The I/O connectors for the DAS-1800HC Series boards and the STA-1800HC each contain 100 pins arranged in two banks of 50: bank A and bank B. Both are female connectors. The STA-1800HC connector is a mirror image of the DAS-1800HC Series board connector, as shown in Figure B-1.

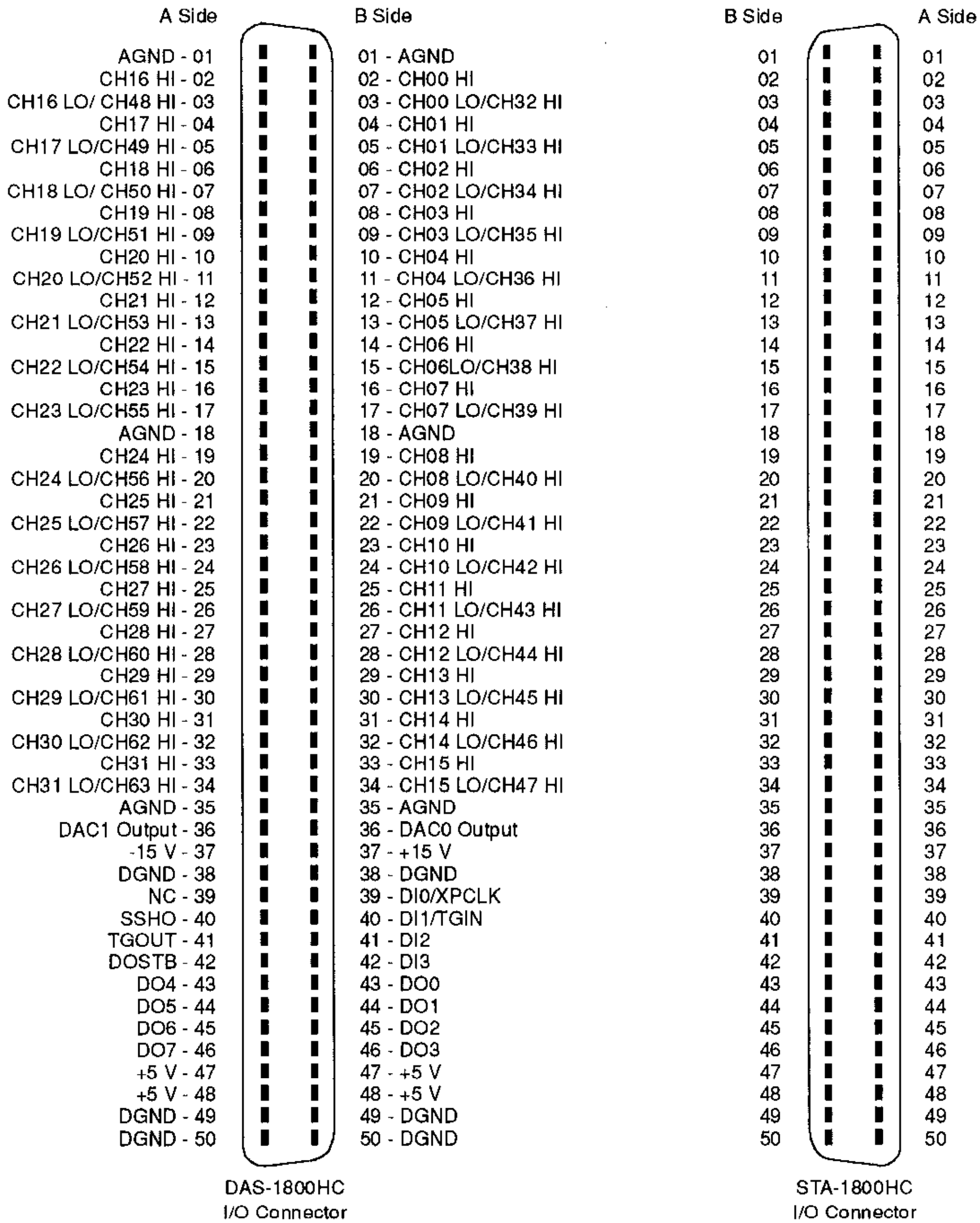

Figure B-1. Pin Layouts and Assignments of the I/O Connectors of DAS-1800HC Series Boards and the STA-1800HC

STA-1800HC 37-Pin D Connectors

The STA-1800HC screw terminal accessory contains four 37-pin, male, D connectors: J1, J2, J3, and J4. Pin layouts and assignments for these connectors are shown in Figures B-2, B-3, B-3, and B-4.

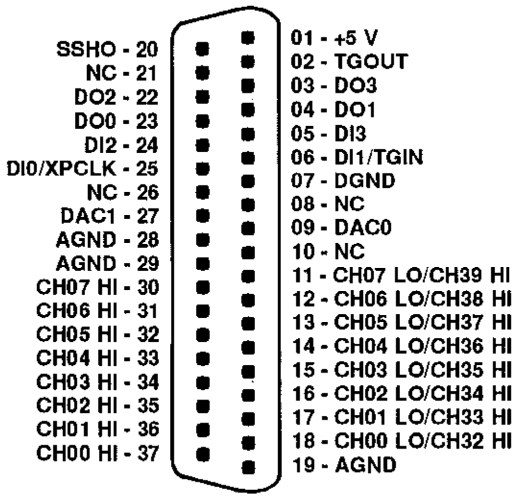

Figure B-2. STA-1800HC Connector J1

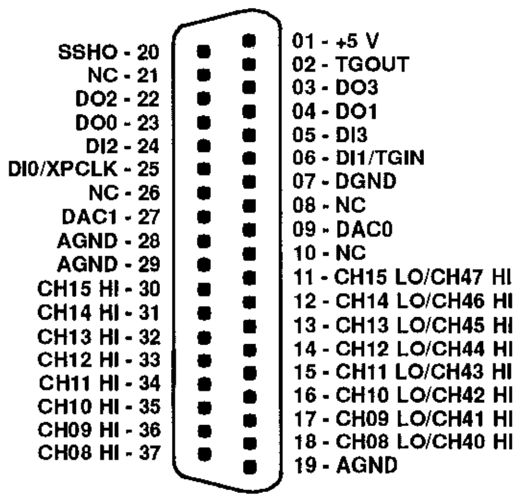

Figure B-3. STA-1800HC Accessory Connector J2

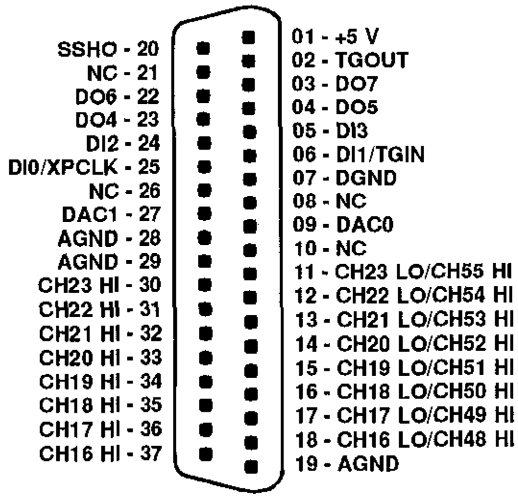

Figure B-4. STA-1800HC Accessory Connector J3

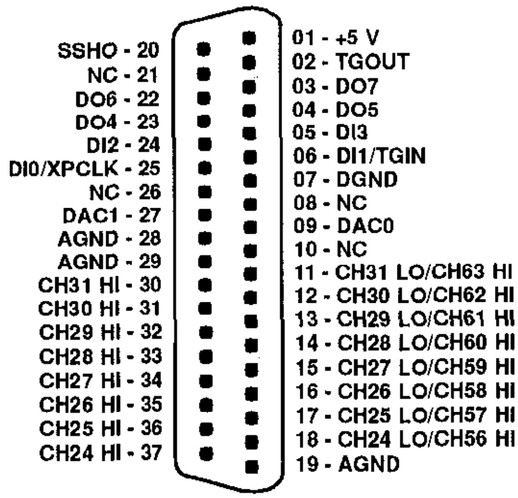

Figure B-5. STA-1800HC Accessory Connector J4

C

DAS-1800 Series External Driver

The DAS-1800 Series External Driver (DAS1800.EXE) allows the use of a DAS-1800HC Series board with the following data acquisition and analysis software:

- VIEWDAC
- ASYST

DAS1800.EXE is a part of the DAS-1800 Series standard software package and is a terminate-and- stay-resident (TSR) program. As a TSR, DAS1800.EXE occupies a small amount of memory in the computer.

Before you can use the DAS-1800 Series External Driver, you must have a configuration file for the DAS-1800HC Series board you are using. If you need to create a configuration file, refer to "Configuration Utility" in Chapter 3.

Note: The base address switches on the board must match the settings in the configuration utility.

Running the DAS-1800 Series External Driver

Because DAS1800.EXE is a TSR, you must load the program into memory before running your application program. The DAS-1800 Series External Driver remains in memory until you turn off your computer.

To load the DAS-1800 Series External Driver, change to the directory containing DAS1800.EXE and enter the following at the DOS prompt:

```
das1800 configuration_filename
```

where *configuration_filename* is the name of the configuration file you are using. If you do not specify a configuration file, the driver searches for the default configuration file, DAS1800.CFG, in the current directory.

Note: You can load the DAS-1800 Series External Driver automatically whenever you start the computer by adding the appropriate lines to your AUTOEXEC.BAT file.

Accessing the DAS-1800 Series External Driver

VIEWDAC application programs access the DAS-1800 Series External Driver automatically. If you are using ASYST, perform the following steps to access the DAS-1800 Series External Driver:

1. After loading the DAS-1800 Series External Driver, start up ASYST version 2.10 or greater and permanently load the Data Acq Master and the Ext DAS Driver Support system overlays from the Data Acquisition menu. ASYST automatically searches for and creates a DAS device called *DAS1800*.

2. Enter the following at the OK prompt to make DAS-1800 the current device.

   ```
   DAS1800
   ```

Special Characteristics

Normally, the DAS-1800 Series External Driver works transparently and is used automatically by VIEWDAC and ASYST. This section points out considerations to keep in mind when using these software packages with DAS-1800HC Series boards.

Note: The DAS-1800HC Series board supports multiple-point acquisitions in interrupt and DMA modes. The board supports only one acquisition at a time in synchronous mode.

Pseudo-Digital Input/Output: Extended Functions

VIEWDAC and ASYST do not have normal access to the non-standard features of DAS-1800HC Series boards such as burst mode, burst mode conversion rate, and so on. The DAS-1800 Series External Driver resolves this problem by providing a series of *pseudo-digital input/output channels* through which such software can access these non-standard features.

Note: Do not confuse the pseudo-digital input/output channels of the External Driver with the digital input channel and the digital output channel of DAS-1800HC Series boards. The former are a software means of access to certain features of the board; the latter are a hardware means for handling digital I/O of the board.

Table C-1 describes the pseudo-digital input channel available in the DAS-1800 Series External Driver and the functions it performs.

Table C-1. Pseudo-Digital Input Channel

Channel	Function	Description
32	About-trigger index	Gets the index, in the acquisition array, of the point at which the trigger occurs for about-trigger mode. Refer to "Analog Triggering" on page C-6 for more information on the about-trigger mode.

Table C-2 lists the pseudo-digital output channels available in the DAS-1800 Series External Driver and the functions they perform.

Table C-2. Pseudo-Digital Output Channels

Channel	Function	Description
32	Trigger channel	The channel on which the trigger event occurs. For an analog trigger, the value written to this channel can range from 0 to 63. For a hardware digital trigger, the DAS-1800 Series External Driver assumes digital input channel 0 and the value written to this channel is ignored. Refer to "Analog Triggering" on page C-6 for more information about analog triggers; refer to Chapter 2 for more information about hardware digital triggers.
33	Trigger type	The type of trigger you want to use to begin conversions. 0 = a hardware digital trigger. A hardware digital trigger occurs when the board detects a rising or falling edge on the signal connected to the digital input DI1/ TGIN (pin B40). 1 = an analog trigger. An analog trigger occurs when the conditions specified by pseudo-digital output channels 35, 38, and 39 are met by the analog input signal on the channel specified by digital output channel 32. Refer to "Analog Triggering" on page C-6 for more information about analog triggers; refer to Chapter 2 for more information about hardware digital triggers.

Table C-2. Pseudo-Digital Output Channels (cont.)

Channel	Function	Description
35	Trigger polarity and sense	The conditions that must be met before an analog or a digital trigger can occur. 0 = positive-edge trigger. For an analog trigger, the signal must rise above the voltage level specified by digital output channel 38 (using the hysteresis value specified by digital output channel 39, if applicable). For a digital trigger, the signal must rise from low to high. 1 = negative-edge trigger. For an analog trigger, the signal must fall below the voltage level specified by digital output channel 38 (using the hysteresis value specified by digital output channel 39, if applicable). For a digital trigger, the signal must fall from high to low. Refer to "Analog Triggering" on page C-6 for more information about analog triggers; refer to Chapter 2 for more information about hardware digital triggers.
38	Analog voltage level	The voltage level at which an analog trigger event occurs. The value written to this channel is a count value in the range of • 0 to 4095 for unipolar mode • -2048 to 2047 for bipolar mode. Refer to "Analog Triggering" on page C-6 for more information about analog triggers. Refer to "Analog Trigger Parameters" on page C-9 for more information about converting voltage to a count value.
39	Hysteresis value	The amount of hysteresis applied to an analog trigger signal. The value written to this channel is a count value between 0 and 4095. A 0 hysteresis value disables the option. Refer to "Analog Triggering" on page C-6 for more information about analog triggers. Refer to "Analog Trigger Parameters" on page C-9 for more information about converting voltage to a count value.
41	Conversion mode	0 = Paced (normal) mode 1 = SSH mode (requires SSH-8) Refer to Chapter 2 for information on conversion mode.

Table C-2. Pseudo-Digital Output Channels (cont.)

Channel	Function	Description
42	Enable/disable burst mode	0 = Burst mode Off (disabled) 1 = Burst mode On (enabled) Refer to Chapter 2 for information on conversion mode.
43	Burst mode conversion rate	Sets the burst mode conversion rate for the next analog input operation. Specify a value of 3 to 255 as a divisor for the onboard 1 MHz time base. Refer to "Maximum Achievable Throughput Rates" in Chapter 2 for the maximum allowable burst mode conversion rates at a given gain.
47	Gating	Enables or disables the hardware gate. The value written to this channel can be one of the following: **0** = the hardware gate is disabled. **1** = the hardware gate is enabled. Refer to Chapter 2 for more information about hardware gates.
48	About-trigger acquisition	Enables/disables the about-trigger mode, as follows: **0** = disabled. **1** to ***n*** = enabled, where *n* is the number of samples-per-channel to be acquired after the trigger in the about-trigger mode. The value for *n* cannot be greater than 65535 ÷ number-of-channels.
49	External clock edge	Sets the external conversion clock edge, as follows: 0 = positive 1 = negative

Analog Triggering

An analog trigger event occurs when one of the following conditions is met by the analog input signal on a specified analog trigger channel:

- The analog input signal rises above a specified voltage level (positive-edge trigger).

- The analog input signal falls below a specified voltage level (negative-edge trigger).

You specify the voltage level as a count value in the range of 0 to 4095 for unipolar mode or -2048 to 2047 for bipolar mode. Refer to "Analog Trigger Parameters" on page C-9 for information on how to convert a voltage value to a count value.

Figure C-1 illustrates these analog trigger conditions, where the specified voltage level is +5 V.

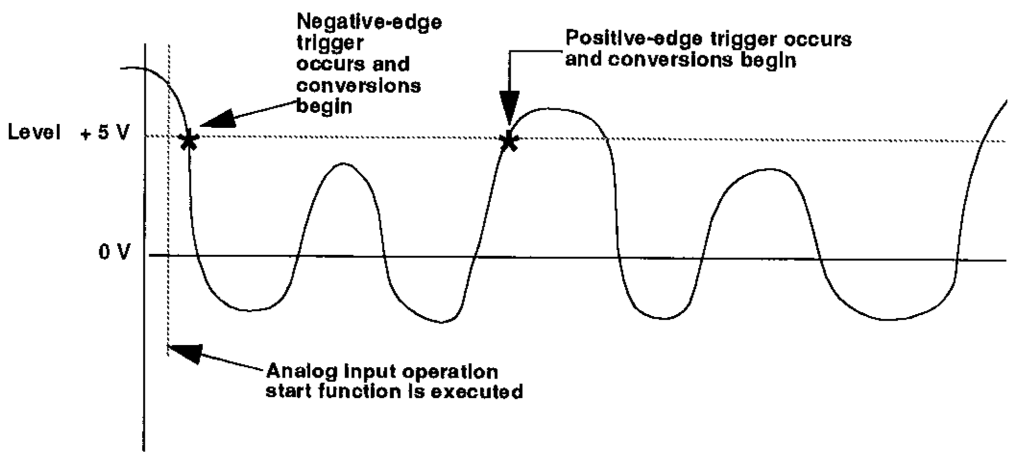

Figure C-1. Analog Trigger Conditions

You can specify a hysteresis value to prevent noise from triggering an operation. For a positive-edge trigger, the analog signal must fall below the specified voltage level by at least the amount of the hysteresis value before the trigger event can occur; for a negative-edge trigger, the analog signal must rise above the specified voltage level by at least the amount of the hysteresis value before the trigger event can occur.

The hysteresis value is an absolute number, which you specify as a count value between 0 and 4095. When you add the hysteresis value to the voltage level (for a negative-edge trigger) or subtract the hysteresis value from the voltage level (for a positive-edge trigger), the resulting value must also be between 0 and 4095. For example, assume that you are using a negative-edge trigger on a channel configured for a bipolar input range type. If the voltage level is +4.8 V (1966 counts), you can specify a hysteresis value of 0.1 V (41 counts), but you cannot specify a hysteresis value of 0.3 V (123 counts). Refer to "Analog Trigger Parameters" on page C-9 for information on how to convert a voltage value to a count value.

In Figure C-2, the specified voltage level is +5 V and the hysteresis value is 0.1 V. The analog signal must fall below +4.9 V and then rise above +5 V before a positive-edge trigger occurs; the analog signal must rise above +5.1 V and then fall below +5 V before a negative-edge trigger occurs.

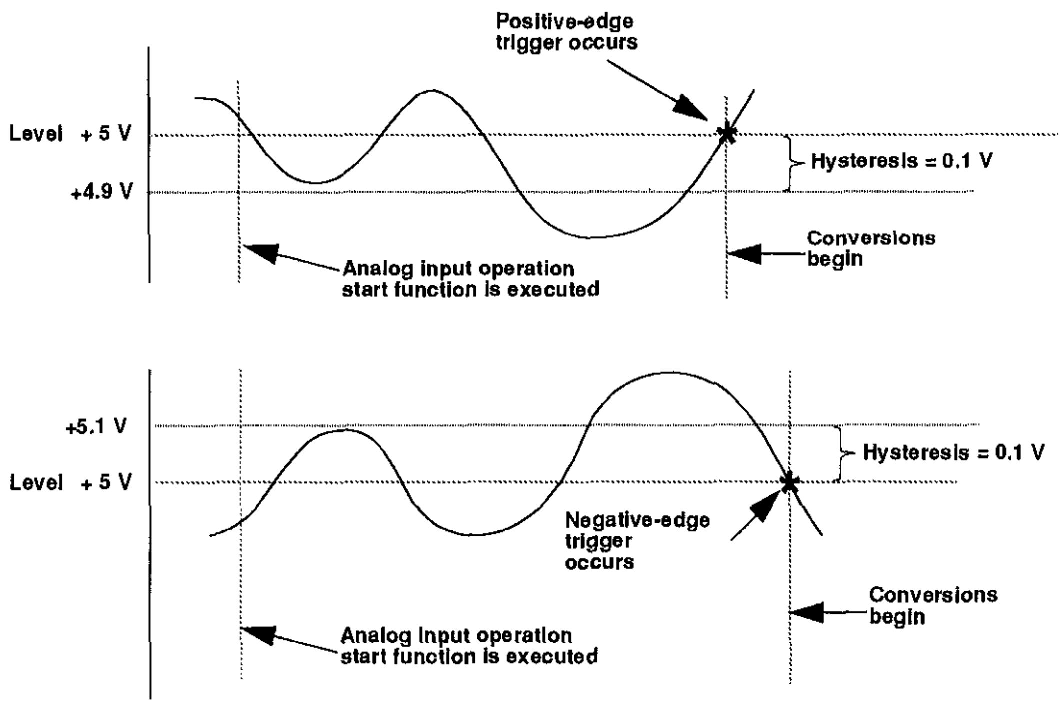

Figure C-2. Using a Hysteresis Value

When using an analog trigger, the software samples the specified analog trigger channel to determine whether the trigger condition has been met. Therefore, a slight time delay may occur between the time the trigger condition is actually met and the time the software realizes that the trigger condition has been met and initiates conversions. In addition, the actual point at which conversions begin depends on whether you are using an internal or external clock source. These considerations are described as follows:

- **Internal clock source** - The 82C54 counter/timer circuitry remains idle until the trigger occurs. When the trigger occurs, the board initiates conversions immediately.
- **External clock source** - Conversions are armed when the trigger occurs. At the next falling edge of the external clock source, the board initiates conversions.

Analog Trigger Parameters

Each time the ADC samples the voltage at an input channel, the ADC sends a corresponding digital signal in the form of a 16-bit binary number to the A/D FIFO. The data portion of the 16-bit binary number is actually 12 bits long.

If the input channel is configured for unipolar signals, the 12-bit data portion of the binary number is positive magnitude; the remaining four bits are zero to indicate positive polarity. If the input channel is configured for bipolar signals, the 12-bit data portion is twos complement, in which bit 12 indicates polarity; the remaining four bits are sign extenders representing bit 12.

When you use the DAS-1800 External Driver, you can set up an analog trigger for the purpose of starting an interrupt- or DMA-based data acquisition. To set up the analog trigger, you must specify the trigger channel, the trigger slope, the trigger level, and an optional hysteresis value to apply to the trigger level. Of these four parameters, the trigger channel and slope are a matter of selection. Trigger level and hysteresis value, however, are parameters you must calculate. The following subsections discuss the requirements for these calculations.

Trigger Level Calculation

You specify the trigger level as a decimal equivalent of the 12-bit data portion of the binary number in the A/D FIFO. This equivalent is an integer in the range of 0 to 4095 for unipolar mode or -2048 to 2047 for bipolar mode; the equivalent is referred to as the *count*. Since the count is based on a 12-bit binary number, it is always within the ranges shown in Table C-3.

Table C-3. Decimal Range of Count

Analog Input Mode	Count Range
Unipolar	0 to 4095
Bipolar	-2048 to 2047

To determine the count for an analog trigger level, use the following relationship:

$$Count = \frac{Volts}{BitValue}$$

In this equation, which is based on a gain of 1, *Volts* is the desired trigger level in volts and *BitValue* is the current analog input range divided by 4096. BitValue is as shown in Table C-4.

Table C-4. BitValue for Analog Trigger Level

Board	Input Mode	Gain	Range	BitValue
DAS-1801HC	Unipolar	1	0 to 5	0.001221
	Bipolar	1	-5 to 5	0.0024414
DAS-1802HC	Unipolar	1	0 to 10	0.0024414
	Bipolar	1	-10 to 10	0.004883

For example, if you are using a DAS-1801HC board in bipolar mode and you want a trigger level of +2.5 V, you calculate the count for the external driver as follows:

$$Count = \frac{2.5}{0.0024414} = 1024$$

Trigger Hysteresis Calculation

The count for a desired level of hysteresis is based on the following relationship at a gain of 1:

$$Count = \frac{Volts}{BitValue}$$

In these equations, Volts is the desired hysteresis (magnitude) value in volts, and BitValue is the current analog input range divided by 4096, as shown in Table C-4.

Table C-5. BitValue for Trigger Hysteresis

Board	Input Mode	Gain	Range	BitValue
DAS-1801HC	Unipolar	1	0 to 5	0.001221
	Bipolar	1	-5 to 5	0.0024414
DAS-1802HC	Unipolar	1	0 to 10	0.0024414
	Bipolar	1	-10 to 10	0.004883

For example, if you are using a DAS-1802HC board in bipolar mode and you want a count for a hysteresis value of +0.1 V, you calculate the count as follows:

$$Count = \frac{0.1}{0.0024414} = 41$$

About Triggering

An about-trigger acquisition is described under "Triggers" in Chapter 2. In the about-trigger acquisitions, the software or an external trigger starts an acquisition. An about-trigger event can stop an acquisition or force the acquisition of a specified number of additional samples. The about-trigger event is digital and is introduced by way of pin 40 (DI1/TGIN) of the main I/O connector.

You set up an about-trigger acquisition by specifying the number of samples-per-channel (*n*) following the about-trigger event.

Triggering is available in non-cyclic DMA mode only. With VIEWDAC, this availability limits the total number of samples to 64 KB.

After an about-trigger acquisition begins, it normally continues until one of the following events occur:

- The total number of samples is acquired, even if an about-trigger event has not occurred. In this situation, the trigger index is 0.
- The about-trigger event occurs and *n* samples are acquired. In this situation, the point at which the about-trigger event occurs is the index into the buffer.
- The about-trigger event occurs but only some number of samples less than *n* can be acquired before the total acquisition is complete. In this situation, the point at which the about-trigger event occurs is the index into the buffer.
- You stop the acquisition manually, or an error occurs.

Software Interrupt Vectors

The DAS-1800 Series External Driver uses two of the software interrupt vectors (interrupts 60h to 67h) set aside by DOS. To insure against conflicts with other devices, hardware, or programs, you can set each of the interrupt vectors to use an interrupt number that is different from the default.

Change the interrupt vector numbers by using the SET command from DOS. This command saves a string in the DOS environment that the

DAS-1800 Series External Driver searches for on loading. These strings are specified in Table C-6.

Table C-6. Interrupt Vectors

Interrupt	Default Interrupt Number	Environment String[1]
Device linking vector	66h	'DAS DS=xx'
Critical error vector	65h	'DAS CE=xx'

Notes

[1] Where xx ranges from 60h to 67h.

Note: Do not confuse these software interrupt vectors with the hardware interrupt levels used by DAS-1800HC boards.

Error Messages

Table C-7 lists the error/status codes returned by the DAS-1800 Series External Driver, possible causes for error conditions, and possible solutions for resolving error conditions. The error/status codes are returned in decimal format. If you cannot resolve an error condition, contact the factory.

Table C-7. Error/Status Codes

Error Code (in Decimal)	Cause	Solution
0	No error has been detected.	Status only; no action is necessary.
24576	**Error In Configuration File**: The configuration file you specified in the driver initialization function is corrupt, does not exist, or contains one or more undefined keywords.	Check that the file exists at the specified path. Check for illegal keywords in file; you can avoid illegal keywords by using the D1800CFG.EXE utility to create and modify configuration files.
24577	**Illegal Base Address in Configuration File**: The base address specified in the configuration file is invalid.	Use the D1800CFG.EXE utility to change the base address in the configuration file. The address must be on a 16-byte boundary between 200h and 3F0h.
24581	**Illegal Channel Number**: The specified channel is out of range.	Specify a legal channel number: Analog input: 0 to 63 Analog output: 0, 1, 2 (both 0 and 1) Digital input: 0 Digital output: 0
24582	**Illegal Gain**: The gain code specified for an analog input operation is out of range.	Specify a legal gain code: 0 to 3.
24584	**Bad Number in Configuration File**: The configuration file contains a numeric value that is not in the correct format.	Check all numeric entries in the configuration file; make sure that &H precedes hexadecimal numbers. Use the D1800CFG.EXE utility to modify the configuration file.
28674	**Bad Board Number**: The driver initialization function found an illegal board number in the specified configuration file.	Specify a legal board number: 0, 1, or 2
28686	**Resource Busy**: The application program attempted to start an operation while a similar operation was in progress.	There should be no interrupt or DMA acquisition in process before another acquisition begins.

Table C-7. Error/Status Codes (cont.)

Error Code (in Decimal)	Cause	Solution
28693	**About Count Illegal**: Specified number of about-trigger sample is greater than buffer size.	Limit the number of about-trigger samples to the buffer size.
32773	**Board Not Found at Configured Address**: The board initialization function does not detect the presence of a board.	Make sure that the base address setting of the switches on the board matches the base address setting in the configuration file.
32779	**Conversion Overrun**: Data was overwritten before it was transferred to the computer's memory.	Adjust the clock source to slow down the rate at which the board acquires data. Remove other application programs that are running and using computer resources.
32790	**Interrupt Ooverrun**: During an interrupt-mode analog output or digital I/O operation, an interrupt was detected from a DAS-1800 Series board while the software was servicing a previous interrupt from the same board.	Reduce the acquisition rate. Analog output and digital I/O operations are limited to 5 kHz in DOS.
32794	**Interrupts Already Active**: You have attempted to start an operation whose interrupt level is being used by another system resource.	Stop the first operation before starting the second operation.
32795	**DMA Already Active**: You attempted to start an DMA-mode analog input operation while another was already in process.	Stop the first operation before starting the second operation.
32800	**FIFO Overflow**: During a DMA-mode or interrupt-mode input operation, the onboard data FIFO overflowed; the hardware automatically stopped the acquisition.	The conversion rate you are using is too fast for the operating environment you are in. Reduce your conversion rate and/or reconfigure your board to use dual-DMA if using DMA mode (run D1800CFG.EXE and restart your program).

D

Keithley Memory Manager

The process that Windows uses to allocate memory can limit the amount of memory available to Keithley DAS boards operating in Windows Enhanced mode. To reserve a memory heap large enough for the needs of your application, use the Keithley Memory Manager (KMM), included in the ASO software package.

The reserved memory heap is part of the total physical memory available in your system. When you start up Windows, the KMM reserves the memory heap. Then, whenever your application program requests memory, the memory buffer is allocated from the reserved memory heap instead of from the Windows global heap. The KMM is DAS board independent and can be used by multiple Windows programs simultaneously.

Note: The memory allocated with the KMM can be used by a DMA controller, if applicable.

The following are supplied with the KMM:

- **VDMAD.386** - Customized version of Microsoft's Virtual DMA Driver. This file consists of a copy of Microsoft's Virtual DMA Driver and a group of functions that is added to perform the KMM functions. When you use the KMM to reserve a memory heap, Microsoft's Virtual DMA Driver is replaced by the VDMAD.386 file.

  Note: If you have multiple versions of VDMAD.386, it is recommended that you install the latest version; to determine which version is the latest version, refer to the time stamp of the file.

- **KMMSETUP.EXE** - Windows program that helps you set up the VDMAD.386 parameters and then modifies your SYSTEM.INI file accordingly.

Installing and Setting Up the KMM

To install and set up the KMM whenever you start up Windows, you must modify the SYSTEM.INI file. You can modify the SYSTEM.INI file using either the KMMSETUP.EXE program or a text editor.

Using KMMSETUP.EXE

Using the KMMSETUP.EXE program, you can modify your Windows SYSTEM.INI file as follows:

1. Invoke KMMSETUP.EXE in one of the following ways:
   - From the Program Manager menu, choose File and then Run, and then type the complete path and program name for KMMSETUP.
   - Select the KMMSETUP icon, if installed.
2. In the New VDMAD.386 box, enter the path and name of the VDMAD.386 file, as follows:

   ```
   C:\WINDOWS\VDMAD.386
   ```

   The string you enter replaces `*vdmad` in the `device=*vdmad` line in your SYSTEM.INI file.

   Note: Normally, the VDMAD.386 file is stored in the WINDOWS directory. If it is stored elsewhere, enter the correct path and name or use the Browse button to find the file.

   ---

3. Notice the Current Setting box. The value specified reflects the current size of the reserved memory heap in KBytes.

4. In the Desired Setting box, enter the desired size of the reserved memory heap in KBytes.

   The value you enter replaces the `KEIDMAHEAPSIZE=` line in the [386Enh] section of your SYSTEM.INI file.

   Notes: The memory size you specify is no longer available to Windows. For example, if your computer has 8 MBytes of memory installed and you specify `KEIDMAHEAPSIZE=1000` (1 MByte), Windows can only see and use 7 MBytes.

   If you specify a value less than 128, a 128 KByte minimum heap size is assumed. The maximum heap size is limited only by the physical memory installed in your system and by Windows itself.

   ---

5. Select the Update button to update the SYSTEM.INI file with the changes you have made.

6. Restart Windows to ensure that the system changes take effect.

Using a Text Editor

Using a text editor, you can modify your Windows SYSTEM.INI file in the [386Enh] section, as follows:

1. Replace the line `device=*vdmad` with the following:

   ```
   device=c:\windows\vdmad.386
   ```

   Note: Normally, the VDMAD.386 file is stored in the WINDOWS directory. If it is stored elsewhere, enter the correct path and name.

   ---

2. Add the following line:

   ```
   KEIDMAHEAPSIZE=<size>
   ```

   where *size* indicates the desired size of the reserved memory heap in KBytes.

Notes: The memory size you specify is no longer available to Windows. For example, if your computer has 8 MBytes of memory installed and you specify `KEIDMAHEAPSIZE=1000` (1 MByte), Windows can only see and use 7 MBytes.

If you do not add the `KEIDMAHEAPSIZE` keyword or if the size you specify is less than 128, a 128 KByte minimum heap size is assumed. The maximum heap size is limited only by the physical memory installed in your system and by Windows itself.

---

3. Restart Windows to ensure that the system changes take effect.

Removing the KMM

If you make changes to the SYSTEM.INI file, you can always remove the updated information from the SYSTEM.INI file and return all previously reserved memory to Windows.

If you are using KMMSETUP.EXE, select the Remove button to remove the updated information. If you are using a text editor, modify and/or delete the appropriate lines in SYSTEM.INI. In both cases, make sure that you restart Windows to ensure that the system changes take effect.

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