DAS-4200 Series

DAS-4200 Series

User's Guide

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Preface

The *DAS-4200 Series User's Guide* provides the information needed to install and use DAS-4201/128K and DAS-4201/512K high-speed analog input boards.

The manual is intended for data acquisition system designers, engineers, technicians, scientists, and other users responsible for installing, setting up, and connecting applications to DAS-4201/128K and DAS-4201/512K boards. It is assumed that users are familiar with data acquisition principles, with their computer, and with their particular application.

Throughout the manual, references to DAS-4200 Series boards apply to both DAS-4201/128K and DAS-4201/512K boards. When a feature applies to a particular board, that board's name is used.

The *DAS-4200 Series User's Guide* is organized as follows:

- Chapter 1 provides an overview of the features of DAS-4200 Series boards, including a description of supported software and accessories.

- Chapter 2 provides a detailed technical description of the features of DAS-4200 Series boards.

- Chapter 3 describes how to unpack, install, set up, and connect applications to DAS-4200 Series boards.

- Chapter 4 describes how to use the scope and test program to test the functions of DAS-4200 Series boards.

- Chapter 5 provides troubleshooting information.

- Appendix A lists the specifications for DAS-4200 Series boards.

An index completes this manual.

Note: Not all features of DAS-4200 Series boards are currently supported by all software packages. Refer to the documentation provided with your software package to determine which features are supported.

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Overview

DAS-4200 Series boards are analog input boards for IBM® PC AT® or compatible computers. This chapter describes the features of the DAS-4200 Series boards, the software that supports them, and available accessories.

Note: Not all features of DAS-4200 Series boards are currently supported by all software packages. Refer to the documentation provided with your software package to determine which features are supported.

Features

The major features of DAS-4200 Series boards are as follows:

- The boards support high-speed data acquisition on one of two analog input channels.

- The analog-to-digital converter (ADC) can digitize an analog input signal at a rate of 100 Msamples/second with a resolution of 8 bits.

- Digitized data is stored in an onboard, high-speed memory buffer to ensure continuous acquisition of data. The host computer can download data for further processing, display, and storage.

- A wide variety of trigger options allows you to tailor operation of the board to the specific requirements of your application.

- The boards support Equivalent Time Sampling (ETS) for repetitive waveforms; ETS provides conversion rates of up to 3.2 Gsamples/second.

- An onboard hardware peak detector can find features in the data.

- The boards are suitable for the following applications:

    – Digital oscilloscopes

    – Spectrum analysis

    – Automated Test Equipment (ATE)

    – Capturing transient data

    – Ultrasonic inspection systems

    – Measuring acoustic emissions

    – Nondestructive testing

    – Mass spectrometry

    – Radar systems

    – Time-domain reflectometry

    – Pattern recognition

    – Acquisition of optical and laser signals

Supporting Software

The following software is available for operating DAS-4200 Series boards:

- **DAS-4200 Series standard software package** - This package, which comes with the board, is provided on 3.5-inch high-density disks. The package includes utility programs that allow you to configure, test, and calibrate DAS-4200 Series boards.

- **ASO-4200 software package** - The optional Advanced Software Option for DAS-4200 Series boards is provided on 3.5-inch high-density disks. The package includes function libraries for writing application programs using Microsoft C/C++, Borland$^{®}$ C/C++, Microsoft Visual C++, or Microsoft Visual Basic$^{®}$ for Windows. The package also includes support files, utility programs, and language-specific example programs. Refer to the *DAS-4200 Series Function Call Driver User's Guide* for more information.

- **DAS-4200 Series configuration utility** - The configuration utility (CFG4200.EXE), provided as part of both the DAS-4200 Series standard software package and the ASO-4200 software package, runs under DOS and allows you to create or modify a configuration file. The configuration file provides information about the board; this information is used by the DAS-4200 Series Function Call Driver and other software packages to perform the board's operations. Refer to page 3-7 for more information.

- **DAS-4200 Series scope and test program** - The scope and test program (D4200.EXE), provided as part of both the DAS-4200 Series standard software package and the ASO-4200 software package, runs under DOS and allows you to test the hardware features of a DAS-4200 Series board, calibrate the analog input circuitry of the board, and perform basic oscilloscope functions on the board. Refer to Chapter 4 for more information.

- **Visual Test Extensions™ (VTX™)** - These optional custom controls for Visual Basic for Windows help you write application programs for DAS-4200 Series boards. Refer to the *Visual Test Extensions™ User's Guide* and the VTX online help for more information.

- **VisualSCOPE** - This optional software package runs under Windows and emulates a stand-alone oscilloscope on your host computer. Refer to the VisualSCOPE documentation for more information.

Accessories

The SDC-5600 Digital Signal Processing board is the only accessory available for use with the DAS-4200 Series boards. The SDC-5600 DSP board uses the optional DSP port on the DAS-4200 Series board to transfer data for digital signal processing. This accessory is available from Sonix Inc., 8700 Morrissette Drive, Springfield, VA 22152 (703-440-0222).

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Technical Reference

A functional block diagram of the DAS-4200 Series board is shown in Figure 2-1.

Figure 2-1. DAS-4200 Series Functional Block Diagram

The analog input signal is applied to one of the two input connectors (Channel A or Channel B). A programmable multiplexer (MUX) selects one of the two channels and either AC or DC coupling.

The output of the multiplexer is buffered and then fed into a programmable attenuator (Att.) followed by the first gain stage (Gain1) with programmable gain. A second programmable multiplexer (MUX) selects the radio frequency path (bipolar mode). The second gain stage (Gain2) again amplifies the signal by a programmable factor and drives the input of the analog-to-digital (A/D) converter.

A programmable offset supplied by a digital-to-analog converter (DAC1) is added to the signal to shift it into the correct input voltage range of the ADC. The overall gain and attenuation of the analog signal path is programmable in coarse, discrete steps. To provide a final input sensitivity programmable in very small increments, a second DAC (DAC2) feeds a finely programmable voltage into the ADC as a reference signal. The ADC compares the analog signal at its input to the applied reference voltage and generates an 8-bit number proportional to the ratio of these two voltages at the rate of the input clock.

The two DACs used together provide an accurate compensation for all device tolerances in the analog input circuitry. The settings of these DACs are stored as calibration data for various input voltage ranges in nonvolatile memory.

The clock signal at the Clock I/O connector can be generated either externally or internally. The internal clock signal is routed through a programmable divider (1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, 4096) to the ADC and the counter logic.

The trigger signal at the Trigger I/O connector is an input signal when an externally generated digital trigger signal is applied or an output signal when a software or analog trigger event occurs.

The remainder of this chapter describes the analog input features of DAS-4200 Series boards in more detail.

Analog-to-Digital Converter (ADC)

The ADC on DAS-4200 Series boards is a 100 Msamples/second, 8-bit flash converter. The ADC uses a twos complement data format (-128 to +127). This section describes the reference voltage range and vernier gain, static conversion errors, noise gain, and dynamic conversion errors of the ADC.

Reference Voltage Range and Vernier Gain

The reference voltage range of the ADC is typically –2.0 V to 0 V with a nominal value of –2.0 V. The reference voltage determines the full-scale input voltage range of the ADC. You specify a reference voltage from 0 V to –2.5 V by programming the gain DAC (DAC2). Decreasing the magnitude of the reference voltage increases the overall gain, since the full-scale input voltage range of the ADC becomes smaller. This allows you to moderately increase the overall gain without any degradation in input bandwidth; however, note that the existing nonlinearities of the ADC have more impact on the accuracy of the digitized waveform.

Static Conversion Errors

The ADC produces one of 256 discrete output codes for an analog input voltage, resulting in a stair-step shaped transfer function. Ideally, all steps of this transfer function have the same width (the full-scale input voltage V_{fs} divided by the number of steps $2^N - 1$, where N is the resolution of the ADC in bits). For DAS-4200 Series boards, the resolution is eight bits and the ADC full-scale input voltage range is set to 2.0 V; therefore, the resulting step width is 7.84 mV. Figure 2-2 illustrates a 3-bit ADC example.
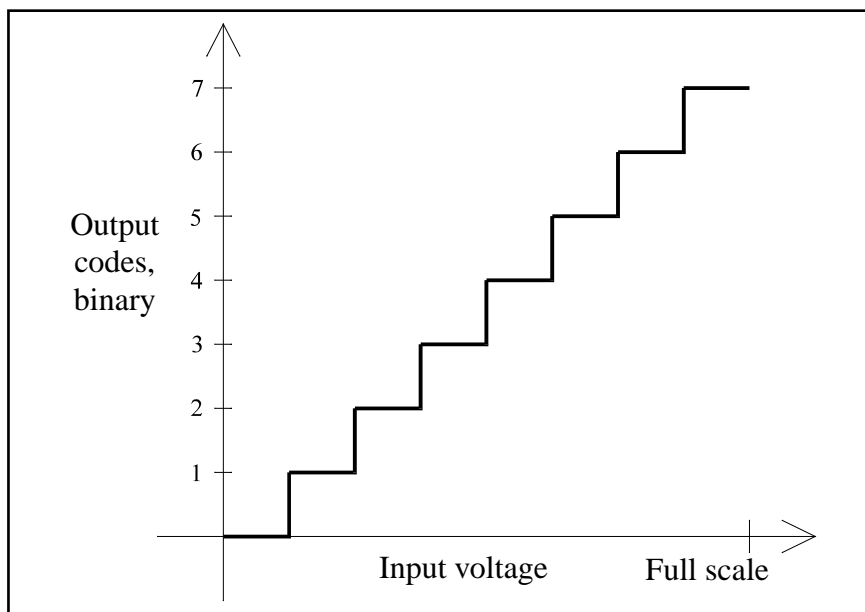
Figure 2-2. Ideal Transfer Function of a 3-Bit ADC

The transfer curve of a device with no conversion error at all would be a straight line. Since the ADC transforms a continuous input voltage into discrete codes, as expressed by the stair-step function, it has an inherent conversion error. The magnitude of this error depends on the size of the steps and on the number of bits of the ADC. The theoretical signal-to-noise ratio (SNR) in dB of an ideal ADC with a full-scale input signal is equal to $(6.02 * N + 1.76)$ dB, where N is the resolution of the ADC in bits. For DAS-4200 Series boards (8-bit ADC), the SNR is 49.92 dB. If a smaller input signal V_{in} is applied to the ADC, the theoretical SNR is decreased by $20 * log(V_{fs}/V_{in})$ dB.

The transfer function of a real ADC deviates somewhat from the ideal curve in Figure 2-2. The deviation of a transfer function from the ideal curve is specified by integral nonlinearity and differential nonlinearity, as shown in Figure 2-3.
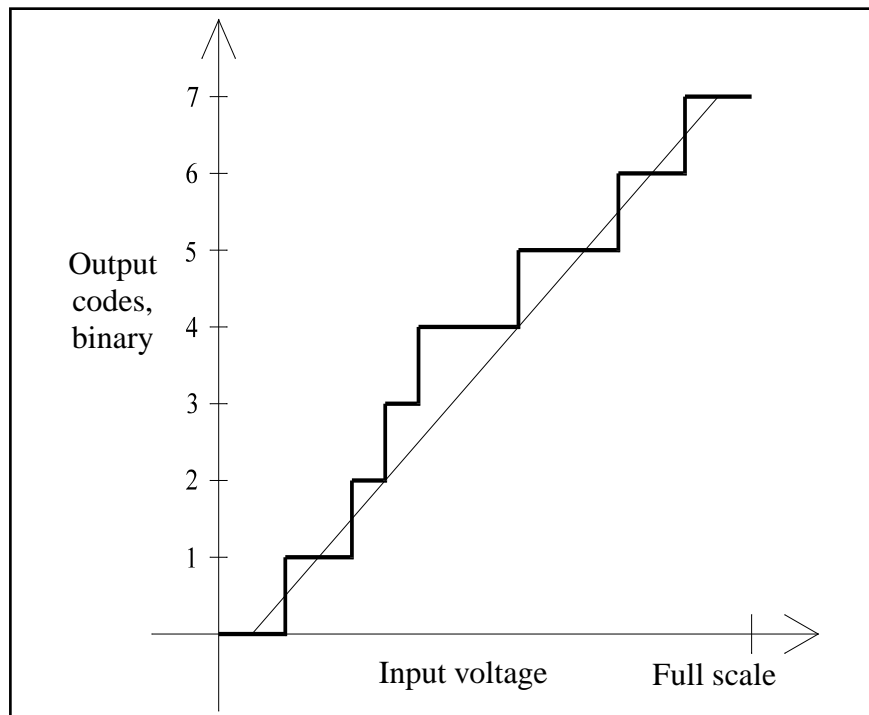
Figure 2-3. Non-Ideal Transfer Function of a 3-Bit ADC

The width of the two steps producing output codes 2 and 3 is one-half the ideal value, and the width of the next two steps is 1.5 times the ideal width. In this case, the differential nonlinearity is ±0.5 LSB and the maximum deviation from the ideal straight line (integral nonlinearity) is ±1.5 LSB. By shifting the straight reference line (adjusting the input offset), the "best fit" integral nonlinearity would be ±0.75 LSB.

The ADC of DAS-4200 Series boards is specified with an integral and differential nonlinearity of ±0.95 LSB (no missing codes). This is a guaranteed worst-case value; the actual nonlinearity is lower. Assuming the worst distribution of step widths still satisfying the guaranteed nonlinearity (all even steps 0.05 LSBs wide and all odd steps 1.95 LSBs wide), the SNR is reduced to approximately 44.2 dB. The actual value is closer to the theoretical 49.9 dB, typically 48 dB. This value is relative to a full-scale input signal. The noise voltage due to the conversion into discrete amplitude values has a constant rms amplitude of 0.29 LSB.

Noise Gain

The small-signal gain of the ADC can be directly derived from its transfer curve: the steeper the slope, the higher the gain. Since the transfer function is a stair-step function, most of the input voltage range has a small-signal gain of zero (horizontal section of the curve) interspersed with small parts of very high small-signal gain at the transition between two output codes. This leads to an offset-dependent amplification or attenuation of very small input signals like noise.

The offset voltage at the ADC input can be programmed in very fine steps; in most ranges, each step can be less than one LSB. The input noise is less than one LSB in the less sensitive input voltage ranges, but can be made to appear with a full one LSB amplitude or to completely disappear by finely shifting the offset voltage. This phenomenon directly results from the noise voltage, which in this case is comparable to the actual input noise voltage.

Dynamic Conversion Errors

The input circuitry of the ADC is an analog circuit, with a defined analog bandwidth. The small-signal bandwidth of the ADC is typically 335 MHz; therefore, it does not contribute significantly to the overall analog bandwidth limit of the board. The large-signal bandwidth is 210 MHz, playing a role only in the 2 V input range with an overall bandwidth of 140 MHz.

The ADC samples the analog input voltage at regular intervals, converting the time-continuous input signal into a time-discrete output signal. This introduces errors in the conversion process if the input signal varies over time. The pacer clock causes the ADC to sample its input signal at regular intervals; however, small deviations from this regular schedule introduce an amplitude error if the input signal changes between the correct time and the actual time the sample is taken. This timing uncertainty is called aperture jitter.

Other sources of dynamic distortion are unequal frequency responses and delay times of the individual comparators inside the flash converter. Noise on the clock lines also contributes to the dynamic errors.

The error introduced by these types of distortion depends on the slew rate of the input signal at the ADC input. The effective number of bits of resolution (ENOB) specifies the resolution of an ideal converter producing the observed output signal with the same input signal. With a full-scale input signal of 3.58 MHz, DAS-4200 Series boards have an ENOB of 7.6 bits; with a full-scale input signal of 50 MHz, DAS-4200 Series boards have an ENOB of 6.6 bits.

The slew rate dependency of the sampling accuracy has the effect that the peak of a high-frequency input signal is sampled much more accurately than the regions with the largest slew rates. This makes over-sampling with very high effective sampling rates a useful tool for accurate peak amplitude measurement. For these types of applications, the specification of dynamic performance in ENOBs is not applicable.

Channels

DAS-4200 Series boards can acquire data from one of two analog input channels (Channel A or Channel B) at a time. You use software to specify the channel.

The time required to switch between channels depends on the settling time of offset and vernier gain but is typically between 5 μs and 15 ms.

The analog input channels are terminated with a 50 Ω socketed resistor. By replacing this resistor, you can select any input impedance between 50 Ω and 1 MΩ. Refer to page 3-15 for more information.

Note: To use a 10:1 oscilloscope probe, you must replace the socketed resistor with a 1 MΩ resistor.

Exceeding the maximum input voltage causes distortion of the sampled waveform. If you select an input impedance of 50 Ω, the input voltage should not exceed 5 V_{rms}.

Input Ranges

DAS-4200 Series boards currently support eight bipolar factory-calibrated analog input ranges. Through software, you specify the gain of the analog input channel.

Table 2-1 lists the gains and analog input ranges supported by DAS-4200 Series boards.

Table 2-1. Analog Input Ranges

Analog Input Range	Gain
±2 V	1
±1 V	2
±500 mV	4
±250 mV	8
±125 mV	16
±62.5 mV	32
±31.25 mV	64
±15.625 mV	128

Memory

This section describes memory on the DAS-4200 Series board and memory on the host computer.

Onboard Memory

DAS-4200 Series boards contain buffer memory for storing data and nonvolatile memory for storing calibration values.

Buffer Memory

The DAS-4201/128K contains 128K bytes of onboard memory; the DAS-4201/512K contains 512K bytes.

Since the conversion rate of DAS-4200 Series boards is too high to be directly processed by the host computer, the digitized data is stored in an onboard memory buffer. Groups of four samples from the ADC are packed together and written to the memory buffer as one block.

Whenever a DAS-4200 Series board is idle, the host computer can access the buffer memory. The computer reads the data to download it into its own main memory and process it. For diagnostic purposes, the host computer can also write to the buffer memory; this allows testing of the hardware and easier debugging of application algorithms.

Nonvolatile Memory (EEPROM)

DAS-4200 Series boards contains 64 16-bit registers of Electrically Erasable and Programmable Read-Only Memory (EEPROM). Unlike the onboard buffer memory, the EEPROM does not lose its contents when power to the board is removed. Most of the EEPROM holds calibration settings for the two DACs used for fine control of analog offset and gain.

The EEPROM also holds a linearization table for the ETS delay, a copy of the board's serial number, a CRC check code, and some housekeeping information.

Host Computer Memory

DAS-4200 Series boards require part of both the host computer I/O address space and the host computer memory address space.

I/O Address Space

DAS-4200 Series boards require two groups of eight bytes in the I/O address space of the host computer. One group (ports 0 to 7) is used for setup and basic control functions. The other group (ports 8 to 15) is used for all additional functions. Ports 8 to 15 use the same I/O base address with an offset of 1024 (400h).

You select the base address for the I/O address space by setting jumpers on the board; refer to page 3-11 for information.

Memory Address Space

The memory address space of the host computer is used for reading the acquired data from the DAS-4200 Series onboard buffer memory and for loading the counters. The host computer accesses the onboard memory using the decoding logic on the DAS-4200; onboard buffer memory is mapped to the host computer upper memory.

Figure 2-4 illustrates the memory address space of a host computer.
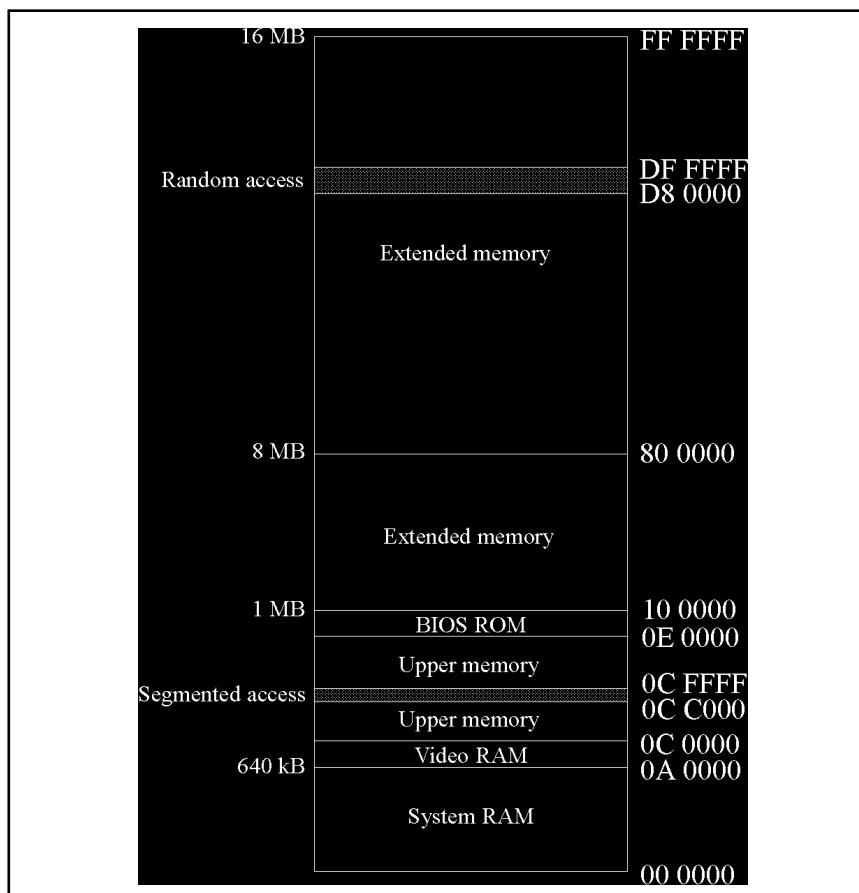
Figure 2-4. Host Computer Memory Address Space

The host computer reads from or writes to the onboard memory by using banks of 16K bytes. The 16K byte area acts as a window through which part of the memory on the DAS-4200 Series board is accessed. One of these banks at a time is selected to appear in this window.

You select the base address for the memory address space by setting jumpers on the board; refer to page 3-12 for information.

Bus Interface

The bus interface allows the host computer to initialize all onboard parameters, read from and write to onboard memory, set the counters, trigger the board, and obtain status information.

The bus interface uses two distinct address spaces of the host computer: an 8 byte segment in the I/O address space for control information and a 16K byte segment in the memory address space for data exchange. Refer to page 2-10 for more information.

An interrupt can be generated to signal the host computer at the end of a data acquisition or peak detection. You select the interrupt level by setting jumpers on the board. Refer to page 3-14 for more information.

During power-up and whenever the RESET button is pressed, the host computer activates its RESET signal, and the internal logic of the board is forced into a known, inactive state. Since the settings of the DACs are unknown, all reference voltages in the analog input circuitry are held at a value close to 0 V. The first write to the board in the I/O address space releases these voltages to their normal levels.

Counters

DAS-4200 Series boards use the following counters:

- **Start counter** - Determines the location in buffer memory where the currently sampled data is stored; it is preset by the host computer with the starting address of the next data acquisition.

- **Length counter** - Determines the total number of samples acquired. When the length counter counts down to zero, the data acquisition ends.

- **Post-trigger counter** - Determines the number of samples to delay the start of a data acquisition after a valid trigger has been accepted. The post-trigger delay is programmable from 4 to 16,777,216 samples.

The host computer loads the counters before the start of a data acquisition operation or the start of the peak detector.

Pacer Clocks

Through software, you select either an internal or an external pacer clock to determine when each A/D conversion is initiated.

Internal Pacer Clock

The internal pacer clock is the onboard 100 MHz crystal oscillator. The clock signal is fed through a driver to the Clock I/O connector.

You can divide the frequency of the internal pacer clock by 1, 2, 4, 8, 16, 32, 64, 128, 256, 512, 1024, 2048, or 4096 as shown in Table 2-2.

Table 2-2. Available Conversion Rates Using Internal Clock

Divider	Conversion Rate	Sample Period
1	3.2 Gsamples/second	ETS[1]
2	1.6 Gsamples/second	ETS[1]
4	800.0 Msamples/second	ETS[1]
8	400.0 Msamples/second	ETS[1]
16	200.0 Msamples/second	ETS[1]
32	100.0 Msamples/second	10 ns
64	50.0 Msamples/second	20 ns
128	25.0 Msamples/second	40 ns
256	12.5 Msamples/second	80 ns
512	6.25 Msamples/second	160 ns
1024	3.125 Msamples/second	320 ns

Table 2-2. Available Conversion Rates Using Internal Clock (cont.)

Divider	Conversion Rate	Sample Period
2048	1.563 Msamples/second	640 ns
4096	0.781 Msamples/second	1280 ns

Notes
[1] ETS is not supported by the Function Call Driver.

You can also use the Clock I/O connector as an output. When used as an output, the Clock I/O connector can provide a TTL-level output signal (0 to 2 V) of the undivided clock frequency to a doubly terminated (25 Ω) load.

External Pacer Clock

An external pacer clock is an externally generated clock signal of any frequency up to 100 MHz applied to the Clock I/O connector. When you start an analog input operation, the board is armed. At the next rising edge (and at every subsequent rising edge of the external pacer clock), a conversion is initiated.

Note: To avoid reflections on the connecting cable, you can terminate the Clock I/O connector input by inserting a jumper into jumper block J502; refer to page 3-17 for information.

Adjusting the Duty Cycle

The input clock of the ADC and the control logic must satisfy certain timing restrictions which depend on the duty cycle of the supplied pacer clock. The duty cycle adjustment stage uses a software-controlled potentiometer to set the duty cycle to an optimum value. This value is set at the factory for the internal 100 MHz pacer clock and stored on the DAS-4200 Series board. By calling AUTO4200.EXE when you start up the host computer, the duty cycle adjustment potentiometer is set to this value.

Triggers

A trigger is an event that determines when a DAS-4200 Series board can respond to either an internal or an external pacer clock. Depending on the type of acquisition and setup parameters, the trigger event can occur before, during, or after the actual sampling of data. The trigger signal can originate from a variety of sources.

This section describes trigger sources, types of trigger acquisition, and trigger synchronization on DAS-4200 Series boards.

Trigger Sources

DAS-4200 Series boards support software triggers, hardware analog triggers, and hardware digital triggers.

Software Trigger

A software trigger event occurs when a particular instruction is executed by the host computer.

When you use a software trigger, the Trigger I/O connector acts as an output. When the trigger event occurs, either a rising or a falling edge is output on the Trigger I/O connector. The edge polarity depends on the internal pacer clock and can be used to start an external process, such as pulsing an ultrasonic transducer. At the end of the data acquisition, the signal on the Trigger I/O connector returns to its inactive state.

Analog Trigger

An analog trigger (or threshold trigger) event occurs when one of the following conditions is met by an analog input signal:

● The analog input signal rises above a programmable threshold (positive-edge trigger).

● The analog input signal falls below a programmable threshold (negative-edge trigger).

● The analog input signal is already above a programmable threshold at the time the board becomes ready to accept a trigger (positive-level trigger).

● The analog input signal is already below a programmable threshold at the time the board becomes ready to accept a trigger (negative-level trigger).

DAS-4200 Series boards use the ADC input on the currently selected analog input channel as the analog input signal. You can use software to program the threshold in 256 steps from -8.0 V to $+8.0$ V with a step width of 16/256 (62.5 mV). The threshold values can range from -128 to $+127$.

When you use an analog trigger, the Trigger I/O connector acts as an output. When the trigger event occurs, either a rising or a falling edge is output on the Trigger I/O connector. A rising edge signal is output if the trigger polarity is positive; a falling edge signal is output if the trigger polarity is negative. At the end of the data acquisition, the signal on the Trigger I/O connector returns to its inactive state.

Figure 2-5 illustrates the analog trigger conditions. Note that level triggers and edge triggers have identical results if the analog input signal does not exceed the threshold in the specified direction at the time the board is set up.
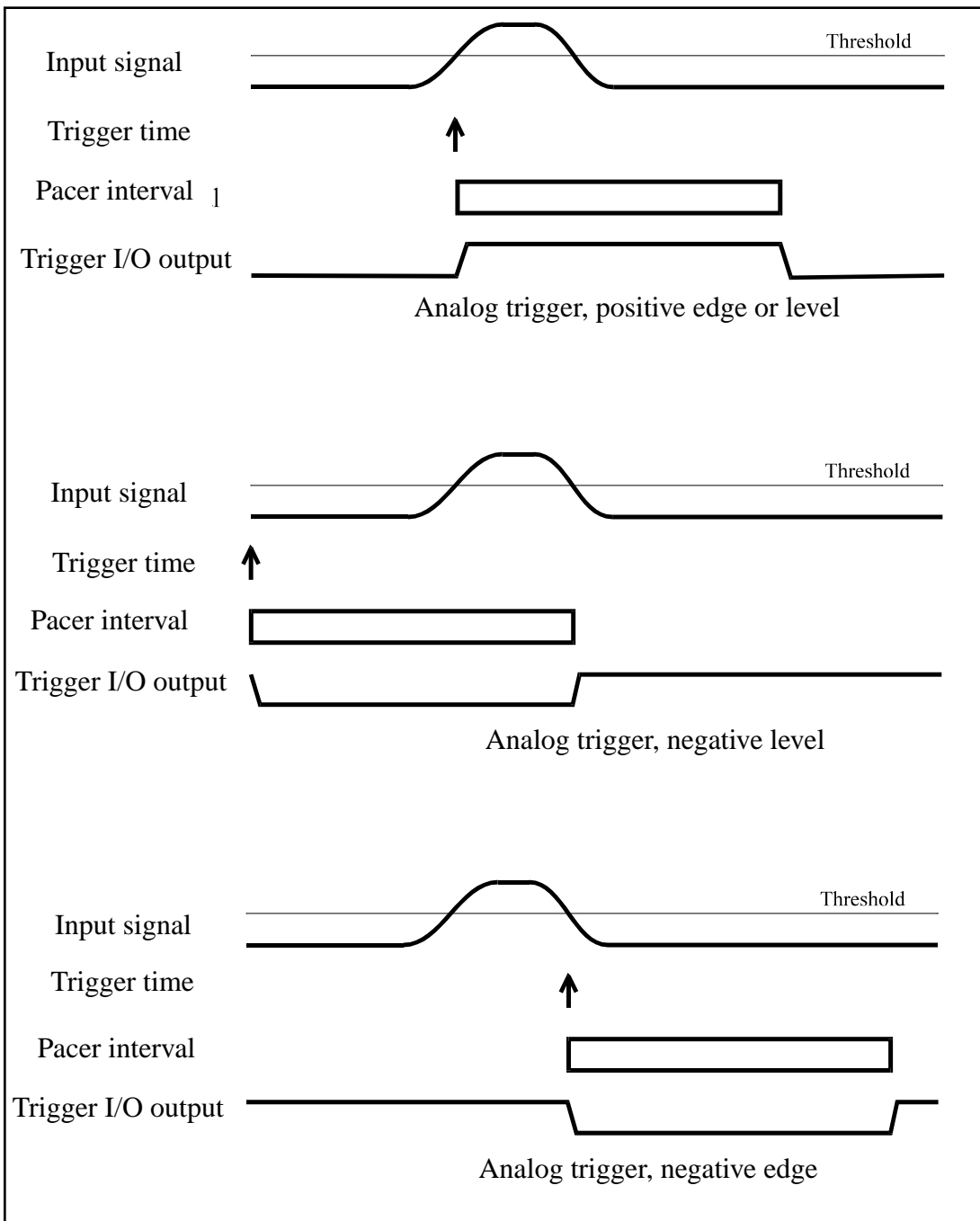
Figure 2-5. Analog Trigger Modes

Digital Trigger

A digital trigger event occurs when an externally generated digital signal of programmable polarity (positive edge or negative edge) is detected as an input on the Trigger I/O connector.

Note: To avoid reflections on the connecting cable, you can terminate the Trigger I/O connector input by inserting a jumper into jumper block J501; refer to page 3-19 for information.

Trigger Acquisition

Depending on your application, you can sample data before and/or after a trigger event occurs. If you want to collect data after a specific trigger event, use post-trigger acquisition. If you want to collect data before a specific trigger event or before and after a specific trigger event, use about-trigger acquisition.

Post-Trigger Acquisition

Use post-trigger acquisition to store data samples after a trigger event occurs. You can also use a programmable post-trigger delay to shift the sampling out in time a specified interval after the trigger event occurs.

You initialize the board by setting all control bits and counter values, and then you arm the board. In the armed state, most of the internal logic enters a low-power idle mode while waiting for a trigger event to occur. A trigger event starts the post-trigger counter, which is loaded with the length of the delay from the trigger event to the beginning of the sampling interval.

After the post-trigger counter reaches its programmed count, both start and length counters are released. The start counter determines the address of the first sample written into the buffer memory; the length counter determines the number of samples to be acquired. The data acquisition ceases when the length counter arrives at its programmed count.

Figure 2-6 illustrates post-trigger acquisition.
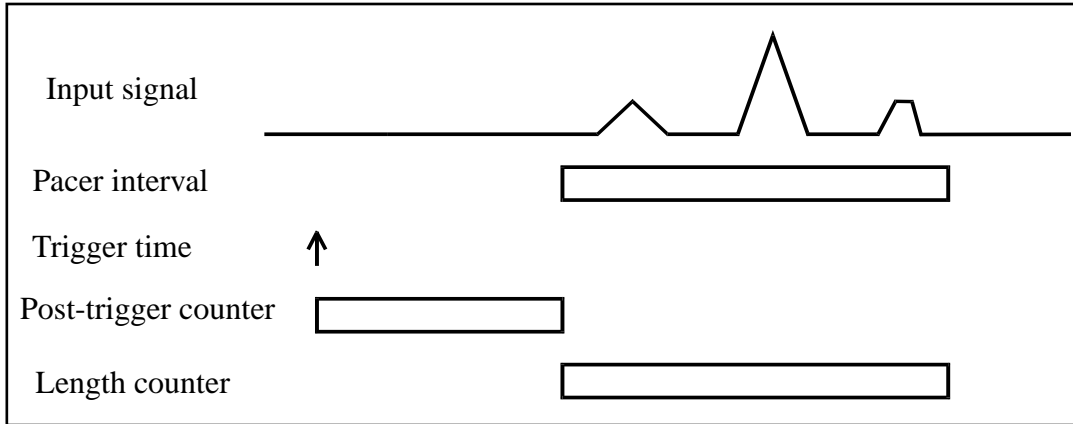
Figure 2-6. Post-Trigger Acquisition

Figure 2-7 illustrates the effect of the start and length counter values on the onboard buffer memory.
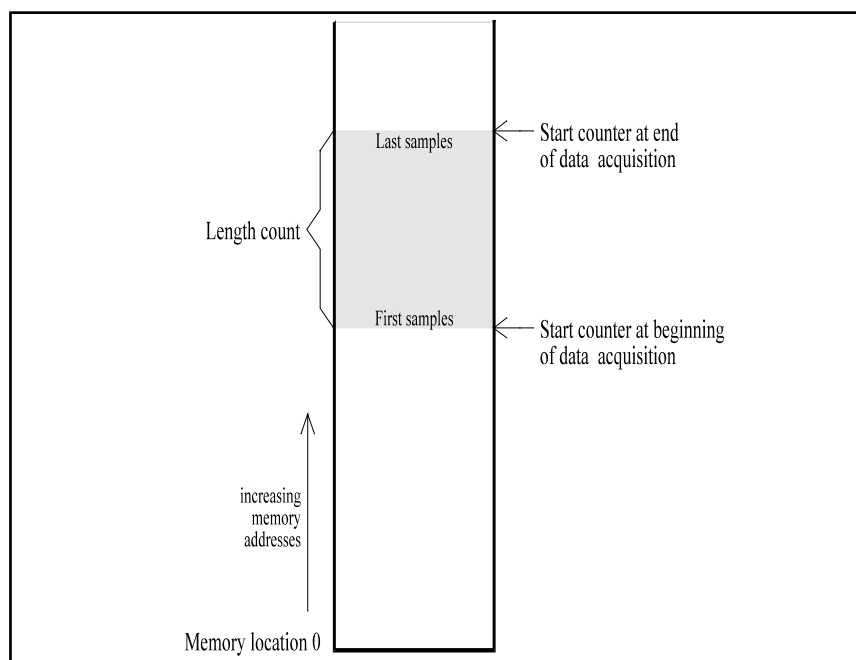
Figure 2-7. Memory Usage in Post-Trigger Acquisition

The counters are programmable in increments of four samples. The start counter is loaded with the true start address in memory (the two least significant bits are internally set to zero); the length counter is loaded with the number of samples to be acquired divided by four. If used, the post-trigger counter is loaded with the post-trigger delay (in samples) divided by four and inverted. Loading the post-trigger counter is always the last step of the setup, since this immediately arms the board, preparing it to accept a trigger.

If the start counter is not reloaded between subsequent post-trigger data acquisitions, consecutive memory areas are used. Four more samples than programmed in the length counter are actually written to memory. At the end of the acquisition, the start counter points to the memory location containing these four extra samples. If the start counter is not reloaded, the next acquisition overwrites these samples with the first four new samples.

About-Trigger Acquisition

Use about-trigger acquisition to store data samples before a trigger event occurs or before and after a trigger event occurs.

You initialize the board by setting all control bits and counter values, and then you arm the board. After arming, the board starts to acquire data immediately. The start counter determines the address of the first sample written into the buffer memory and the minimum number of samples that must be collected before a trigger can be accepted. (In about-trigger acquisition, the start counter is normally loaded with the last address of the buffer memory minus the minimum number of pre-trigger samples.)

The start counter counts up during the entire acquisition. When the start counter reaches its maximum value, it wraps around to zero, continuing to fill the entire buffer memory with data. If no trigger event occurs, the entire buffer memory is filled repeatedly.

After the start counter wraps around to zero for the first time, a trigger can be accepted. If the trigger event occurs during the time between arming the board and the first start counter wrap to zero, it is ignored. This ensures that a minimum amount of data is acquired before the trigger event occurs.

When a trigger event occurs and is accepted, the current content of the start counter is saved and the length counter starts counting. The length counter determines the number of samples to be acquired. The acquisition again ends when the length count is reached.

Figure 2-8 illustrates an about-trigger acquisition.
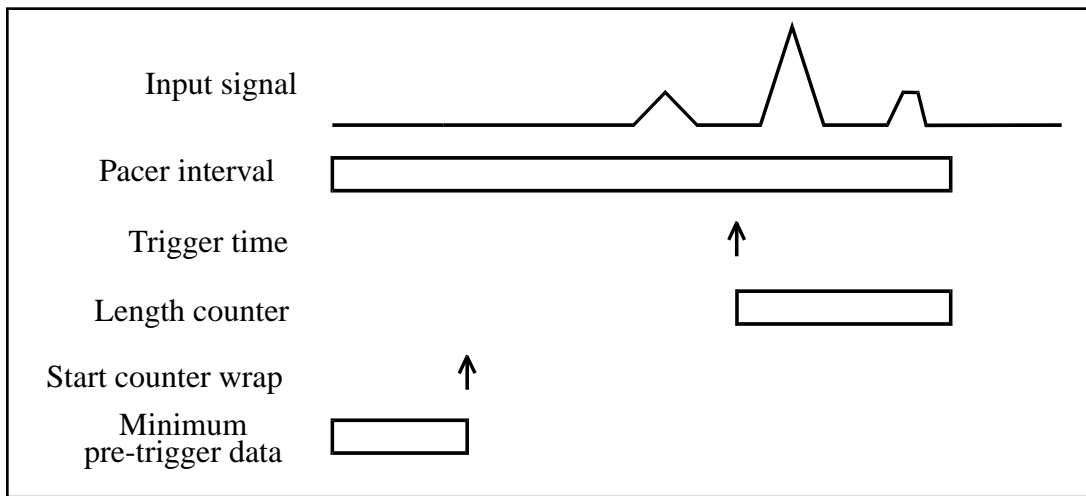
Figure 2-8. About-Trigger Acquisition

The counters are programmable in increments of four samples. The start counter is loaded with the last address in memory minus the minimum number of pre-trigger samples; the length counter is loaded with the number of samples to be acquired divided by four. The post-trigger counter is loaded last; although the value written is ignored, the post-trigger counter must be loaded to arm the board.

You can use the memory address saved at trigger time to determine the correlation between memory address and sample time with respect to the trigger.

Figure 2-9 illustrates the effect of start and length counter values on the onboard buffer memory.

Minimum pre trigger data

First samples — Start counter at beginning
of data acquisition

Last samples

Length count

Trigger

First samples used

increasing
memory
addresses

Memory location 0
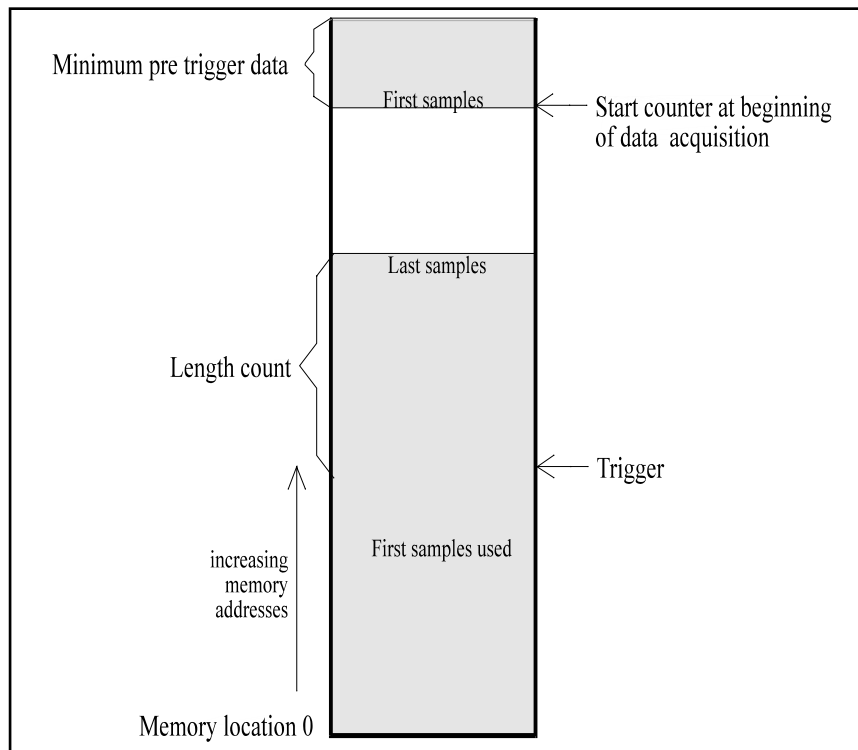
Figure 2-9. Memory Usage in About-Trigger Acquisition

Notes: An about-trigger acquisition may use the entire buffer memory. In contrast, during a post-trigger data acquisition, only the samples that are actually used are written into buffer memory, leaving all other areas of the buffer memory unaffected.

The term pre-trigger acquisition is often used for an about-trigger acquisition when only the pre-trigger samples are significant. The DAS-4200 Series Function Call Driver differentiates between pre-trigger acquisition (where the number of post-trigger samples is zero) and about-trigger acquisition (where you specify the number of post-trigger samples); refer to the *DAS-4200 Series Function Call Driver User's Guide* for information. The DAS-4200 scope and test program uses the term pre-trigger mode for both pre-trigger acquisition and about-trigger acquisition.

Trigger Synchronization

At the start of a data acquisition, the DAS-4200 Series board receives a trigger signal, which is synchronized to the pacer clock and then used by the control logic. Since the trigger occurs asynchronously with respect to the pacer clock, there is an uncertainty of one pacer clock period in measuring the trigger position. Figure 2-10 illustrates this uncertainty.
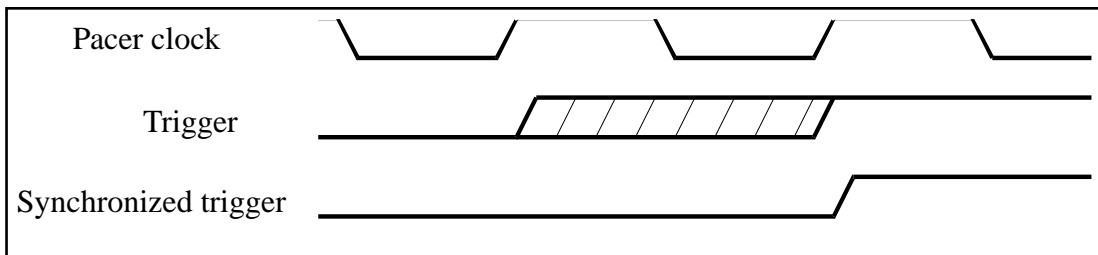
Figure 2-10. Possible Trigger Position

The clock divider of the DAS-4200 Series board uses the undivided clock to synchronize the trigger signal in post-trigger data acquisitions. Then, the board starts dividing the clock down. This results in a trigger uncertainty (trigger jitter) of one period of the undivided clock (10 ns with the 100 MHz clock) rather than one period of the divided clock. If a clock divide factor of 32 (clock rate of 100 MHz) is selected, both methods yield identical results. Figure 2-11 illustrates this trigger jitter.
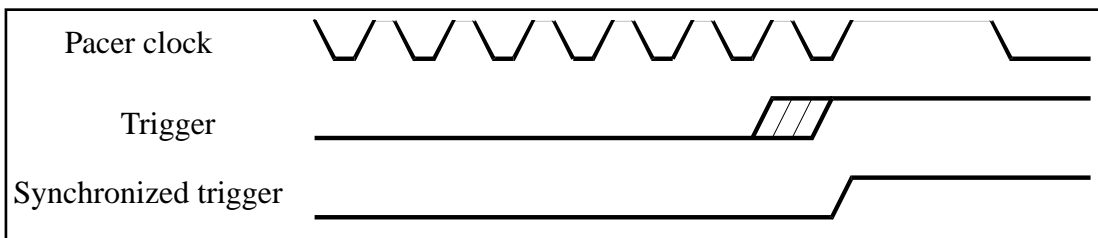
Figure 2-11. Trigger Jitter with Synchronized Divider

You can enable or disable trigger synchronization by inserting or removing a jumper on the board; refer to page 3-15 for information. If you require a conversion rate that is less than 50 MHz and cannot be provided by the supported pacer clock dividers (refer to Table 2-2 on page 2-13), it is recommended that you use an external pacer clock in the range of 50 MHz to 100 MHz.

Equivalent Time Sampling (ETS)

If an analog input signal is repetitive, you can sample the signal several times with the pacer clock shifted relative to the input signal by a fraction of the sample period. This method is called equivalent time sampling (ETS) and allows you to achieve an effective conversion rate higher than 100 Msamples/second.

With N acquisitions and a pacer clock shifted by the fraction of the sample period $1/(N * f_{clock})$ between the acquisitions, the effective conversion rate is $N * f_{clock}$. N is called the ETS factor. The maximum ETS factor is 256, corresponding to an effective conversion rate of 25.6 Gsamples/second; however, jitter of the internal pacer clock and logic delays limit the useful range of ETS factors to an upper limit of 32 (3.2 Gsamples/second). Figure 2-12 illustrates an ETS factor of two.

Input signal

Pacer clock
acquisition 1

Pacer clock
acquisition 2
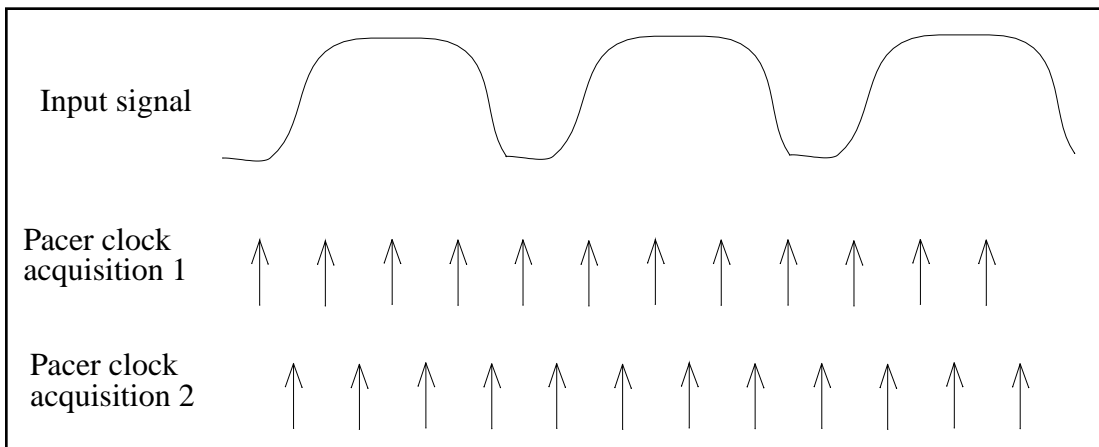
Figure 2-12. Equivalent Time Sampling (ETS)

The individual samples are stored in adjacent sections of the buffer memory. To reconstruct the correct sequence of samples, the host computer interleaves the data of the individual waveforms. For ETS factors of 2, 4, or 8 (corresponding to effective conversion rates of 200, 400, or 800 Msamples/second respectively), this interleaving is partially done in hardware.

To control the fine timing shift of either the trigger signal or the resynchronized pacer clock, the trigger control section uses a programmable high-resolution delay, the ETS delay.

The process generating the input signal is started by a software trigger generated by the data acquisition board. Note that when using ETS, the DAS-4200 Series board waits for a software trigger only; analog triggers and digital triggers cannot be used.

When the trigger event occurs, an internal trigger signal is generated synchronously to the internal pacer clock. This synchronous trigger signal is then delayed in the ETS delay by a programmable fraction of the pacer clock and output on the Trigger I/O connector. This starts the process generating the input signal.

As shown in Figure 2-13, the delayed start of the input signal causes the DAS-4200 Series board to sample the signal at different points in the two acquisitions described previously. During acquisition 1 with a larger ETS delay shift, the pacer clock occurs earlier with respect to the input signal; therefore, the data from this acquisition is sorted into the even-numbered samples of the combined data set: 0, 2, 4, and so on. The data from acquisition 2 is sorted into the odd-numbered samples: 1, 3, 5, and so on.
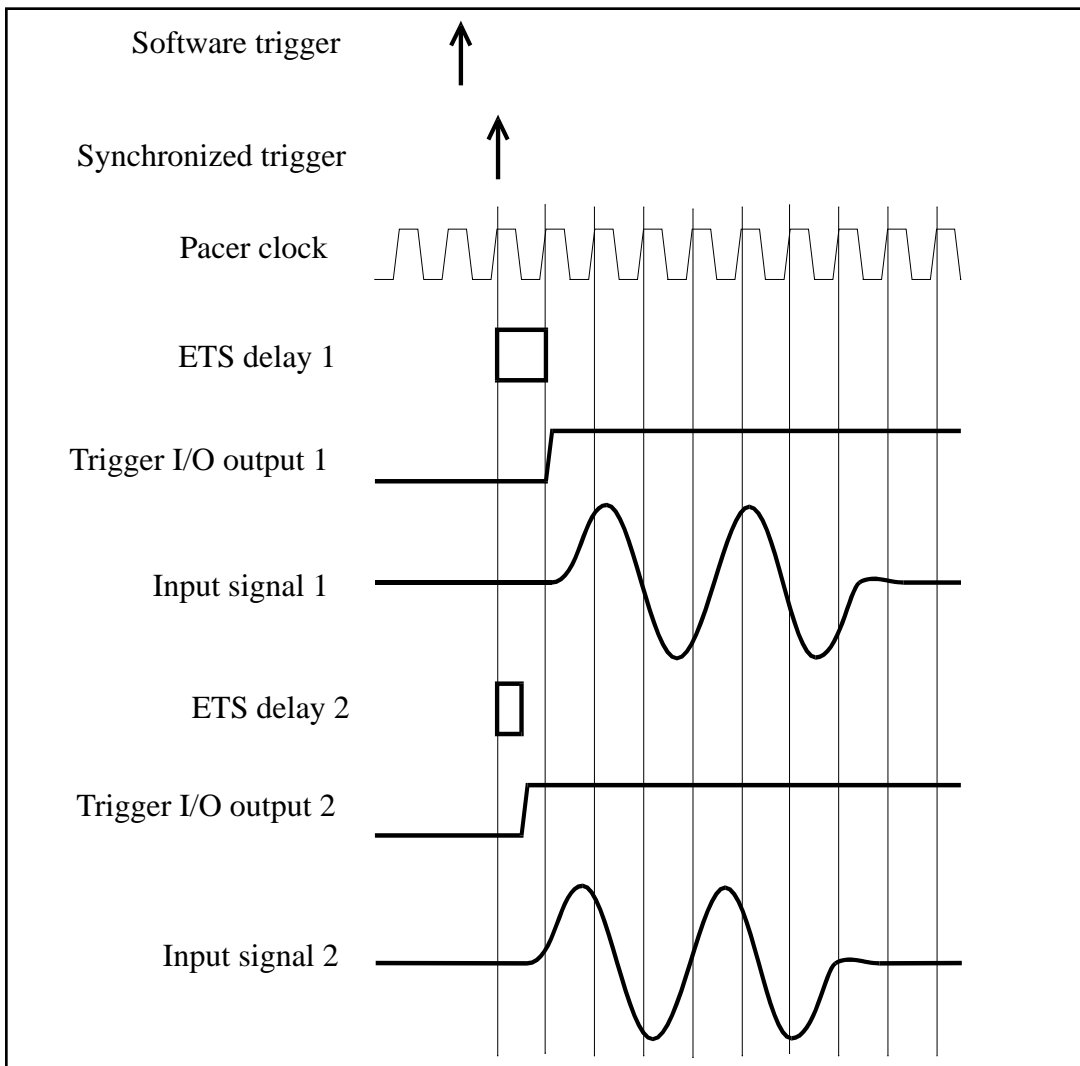
Figure 2-13. ETS Delay

Peak Detector

DAS-4200 Series boards contain a hardware peak detector to speed up applications, such as ultrasonic signal processing, that make extensive use of peak information from the sampled waveform. The peak detector operates at a speed of 25 Msamples/second and reads the data from memory using the start counter for address generation.

The peak detector operates in an automatic peak detection mode. It finds all peaks (changes of slope direction) in the acquired waveform. The peak detector stops whenever it finds a peak and signals this to the host computer. The host computer then reads the memory address of the peak found. This in turn restarts the peak detector to find the next peak. The host computer retrieves the amplitude values of the peaks from the buffer memory at the end of the peak detection.

Notes: The total time needed to find all peaks depends on the number of peaks in the data and the speed at which the host computer can read the address information. In a noisy waveform, the peak detection can be rather time-consuming.

The peak detector is not supported by the current DAS-4200 Function Call Driver.

Figure 2-14 illustrates a sample waveform and the peaks detected.
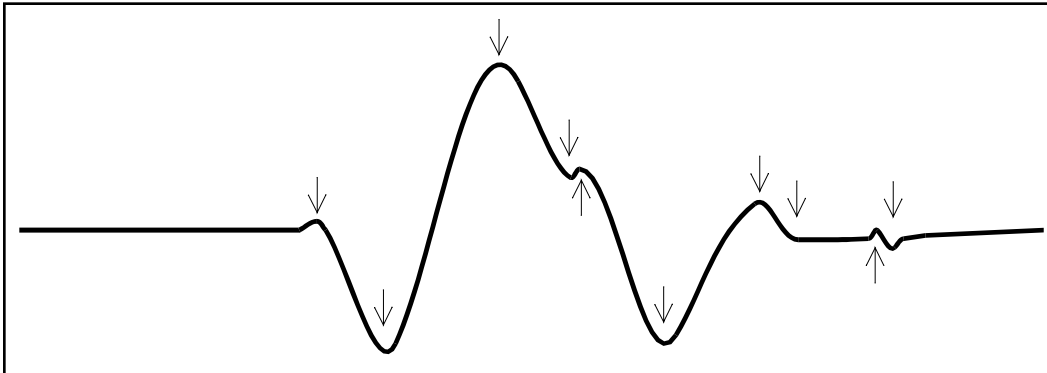
Figure 2-14. Peak Detection

The falling slope of the highest peak in Figure 2-14 is not monotonic; in this case, the peak detector reports two additional peaks. Minima and maxima are found in alternating sequence. If a peak consists of a sequence of samples with identical values, the first sample of this sequence is reported, as the third last marked peak of Figure 2-14 shows. If the very end of the waveform contains a peak, this peak may not be found unless at least one more sample establishing a change in slope is included in the data set for the peak detection.

If you use the peak detector on a noisy signal, most of the reported peaks are probably caused by the noise and must be removed with subsequent processing by the host computer. If you are using the twos complement or absolute value data format, you can prevent the peak detector from reporting these peaks of little or no significance by using the peak detector with zero band suppression. Zero band suppression prevents the peak detector from reporting peaks with an amplitude value falling into a band around 0 V. You should adjust the offset of the ADC so that the baseline of the waveform corresponds to a sample value of 0 with twos complement data. The magnitude of this zero band suppression threshold is programmable.

If zero band suppression is enabled, two adjacent peaks can both be maxima if the interleaving minimum falls into the suppression band and is not reported. To locate this peak, you can use the CPU of host computer itself.

3

Setup and Installation

This chapter contains the information you need to install and use your
DAS-4200 Series board.

Unpacking the Board

Caution: A discharge of static electricity from your hands can seriously
damage certain electrical components on any circuit board. It is
recommended that you use wrist strap grounds when handling a board. If
wrist strap grounds are not available, make sure that you 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.

To prevent any damage to your DAS-4200 Series board, perform the
following steps when unpacking the board:

1. Remove the wrapped DAS-4200 Series board from its outer shipping
   carton.

2. Carefully remove the board from its antistatic wrapping material.
   (You may wish to store the wrapping material for future use.)

Note: Do not remove the pink foam pad. Leave the board on the pink
foam pad until you are ready to install the board in the computer.

3. Inspect the board for signs of damage. If any damage is apparent, arrange to return the board to the factory; refer to page 5-4 for more information.

4. Check the remaining contents of your package against the packing list to ensure that your order is complete. Report any missing items immediately.

5. Once you have determined that the board is acceptable, install the software and configure the board. Refer to the following sections for information.

Installing the Software

This section describes how to install the DAS-4200 Series standard software package and how to install the ASO-4200 software package from both DOS and Windows. To install other software packages, refer to the documentation supplied with the software package.

Installing the DAS-4200 Series Standard Software Package

To install the DAS-4200 Series standard software package, perform the following steps:

1. Make a backup copy of the supplied disks. Use the copies as your working disks and store the originals as backup disks.

2. Insert disk #1 into the disk drive.

3. Assuming that you are using disk drive A, enter the following at the DOS prompt:

    ```
    A:install
    ```

    The installation program prompts you for your installation preferences, including the drive and directory you want to copy the software to. It also prompts you to insert additional disks, as necessary.

4. Continue to insert disks and respond to prompts, as appropriate.

    When the installation program prompts you for a drive designation, enter a designation of your choosing or accept the default drive C.

When the installation program prompts you for a directory name, enter a name of your choosing or accept the default name.

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

5. When the installation program notifies you that the installation is complete, review the following files:

   – FILES.TXT lists and describes all the files copied to the hard disk by the installation program.

   – README.TXT contains information that was not available when this manual was printed.

Installing the ASO-4200 Software Package

The ASO-4200 software package contains software for both the DOS and Windows environments. This section describes how to install both the DOS version and the Windows version of the ASO-4200 software package.

DOS Installation

To install the DOS version of the ASO-4200 software package, perform the following steps:

1. Make a backup copy of the supplied disks. Use the copies as your working disks and store the originals as backup disks.

2. Insert disk #1 into the disk drive.

3. Assuming that you are using disk drive A, enter the following at the DOS prompt:

   ```
   A:install
   ```

   The installation program prompts you for your installation preferences, including the drive and directory you want to copy the software to. It also prompts you to insert additional disks, as necessary.

4. Continue to insert disks and respond to prompts, as appropriate.

   When the installation program prompts you for a drive designation, enter a designation of your choosing or accept the default drive C.

When the installation program prompts you for a directory name, enter a name of your choosing or accept the default name.

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

5. When the installation program notifies you that the installation is complete, review the following files:

    – FILES.TXT lists and describes all the files copied to the hard disk by the installation program.

    – README.TXT contains information that was not available when this manual was printed.

Windows Installation

To install the Windows version of the ASO-4200 software package, perform the following steps:

1. Make a backup copy of the ASO-Windows disk. Use the copies as your working disks and store the originals as backup disks.

2. Insert the ASO-Windows disk into the disk drive.

3. Start Windows.

4. Use the appropriate command in your Windows environment to display the Run dialog box:

    – **Windows 3.x** - On the File menu of the Windows Program Manager, click **Run**.

    – **Windows 95** - From the task bar, click **Start**. On the Start menu, click **Run**.

5. Assuming that you are using disk drive A, type the following at the command line in the Run dialog box, and then click **OK**:

    ```
    A:SETUP
    ```

    The installation program prompts you for your installation preferences, including the drive and directory you want to copy the software to. It also prompts you to insert additional disks, as necessary.

6. Continue to insert disks and respond to prompts, as appropriate.

    When the installation program prompts you for a drive designation, enter a designation of your choosing or accept the default drive C.

When the installation program prompts you for a directory name, enter a name of your choosing or accept the default name.

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

Under Windows 3.x and Windows 95, the installation program creates a program group called Keithley DAS-4200; this group provides access to the DOS-based configuration utility, to the Keithley Memory Manager utility, and to the DAS-4200 scope and test program.

Under Windows 95, the installation program also creates a program menu called Keithley DAS-4200 (accessible by clicking Start and then pointing to Programs). The program menu also provides access to the DOS-based configuration utility, to the Keithley Memory Manager utility, and to the DAS-4200 scope and test program.

7. When the installation program notifies you that the installation is complete, review the following files:

   – FILES.TXT lists and describes all the files copied to the hard disk by the installation program.

   – README.TXT contains information that was not available when this manual was printed.

Configuring the Board

You configure the following items for DAS-4200 Series boards by setting jumpers on the board and/or by specifying the configuration in a configuration file:

- Base I/O address
- Memory address
- Interrupt level
- Zero wait state
- Trigger synchronization
- Input impedance for analog input channels
- Input impedance for Clock I/O connector

- Input impedance for Trigger I/O connector
- Ground connection

Table 3-1 lists the items that are configurable for DAS-4200 Series boards, the available options, the default settings in the configuration file, and the default jumper setting.

Table 3-1. Configuring DAS-4200 Series Boards

Attribute	Options	Where Option is Set		Default in Configuration File	Default on Board
		File	Board		
Base I/O address[1]	&H240 to &H2F8	✔	✔	&H250	&H250
Memory address[1]	A 0000 to D C000	✔	✔	C C000	C C000
Interrupt level[1]	5, 7, 9, 10, 11, 12, 15	✔	✔	7	7
DC/AC coupling	DC, AC	✔		DC	Not applicable
Zero wait state[2]	Enabled, Disabled	✔		Enabled	Not applicable
A/D channels[3]	2	✔		2	Not applicable
Trigger synchronization	Enabled, Disabled		✔	Not applicable	Disabled
Input impedance	50 Ω to 1 MΩ		✔	Not applicable	49.9 Ω
Ground connection	None, Case-to-analog, Case-to-digital, Analog-to-digital		✔	Not applicable	None

Notes
[1] The setting in the configuration file must match the settings of the jumpers on the board.
[2] The default setting is appropriate for most computers. If you are using an older computer, you may want to try changing the setting.
[3] This is required by some software packages, such as Keithley MetraByte's VTX.

Refer to page 3-9 for information on setting the jumpers. Refer to the next section for information on creating a configuration file.

Creating a Configuration File

A configuration file is required by the DAS-4200 Series Function Call Driver and other software packages to perform DAS-4200 Series board operations. A default configuration file called DAS4200.CFG is provided in both the DAS-4200 Series standard software package and the AS0-4200 software package. The factory-default settings in DAS4200.CFG are shown in Table 3-1.

If the default settings in the configuration file are appropriate for your application, refer to the following section to ensure that the jumper settings on the board match the settings in the configuration file.

If the default settings are not appropriate for your application, you must create a new configuration file or modify an existing configuration file to specify the correct configuration options. The CFG4200.EXE configuration utility, shipped with both the DAS-4200 Series standard software package and the ASO-4200 software package, is provided for this purpose.

To create a new configuration file or modify an existing configuration file, perform the following steps:

1. Invoke the DOS-based configuration utility from DOS or Windows, as follows:

    – **DOS** - From the directory containing the CFG4200.EXE configuration utility, enter the following at the DOS prompt:

        CFG4200 filename

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

    – **Windows 3.x** - On the File menu of Program Manager, click **Run**. In the Run dialog box, type the following and then click **OK**:

        CFG4200 filename

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

– **Windows 95** - From the task bar, click **Start**. On the Start menu, click **Run**. In the Run dialog box, type the following and then click **OK**:

```
CFG4200 filename
```

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

If the utility finds a configuration file named *filename*, it displays the opening menu screen with *filename* shown; this file contains the configuration options found in *filename*. If the utility does not find a configuration file named *filename*, it displays the opening menu screen with *filename* shown; this file contains the default configuration options. If you do not enter a file name, the utility displays the opening menu screen of the default configuration file DAS4200.CFG.

Note: The example programs, provided with the ASO-4200 software package, use the default configuration file DAS4200.CFG. If you intend to use the example programs, make sure that DAS4200.CFG exists and that the settings in DAS4200.CFG match the jumper settings of your board.

---

2. On the opening menu screen, enter the number of DAS-4200 Series boards you plan to configure (1 or 2).

   The utility displays the configuration options for the first board (board 0). The number of the board is shown in the upper-left corner of the top menu box.

3. To modify any of the configuration options, use the arrow keys to highlight the option you want to change, press **Enter** to display a list of available settings, use the arrow keys to highlight the appropriate setting, and press **Enter**. These instructions are summarized in the Commands/Status box at the bottom of the screen.

   When the configuration options for this board are correct, press **N** to display the configuration options for the next board.

4. After you modify the appropriate configuration options for all boards, press **Esc**. The utility asks if you want to save the new settings to the specified configuration file.

5. Press **Y** to save the new settings and exit. Press **N** to exit without saving the new settings.

When you finish creating or modifying the configuration file, refer to the following section to ensure that the jumper settings on the board match the settings in the configuration file.

Setting Jumpers on the Board

The locations of the jumpers required for configuring DAS-4200 Series boards are shown in Figure 3-1.
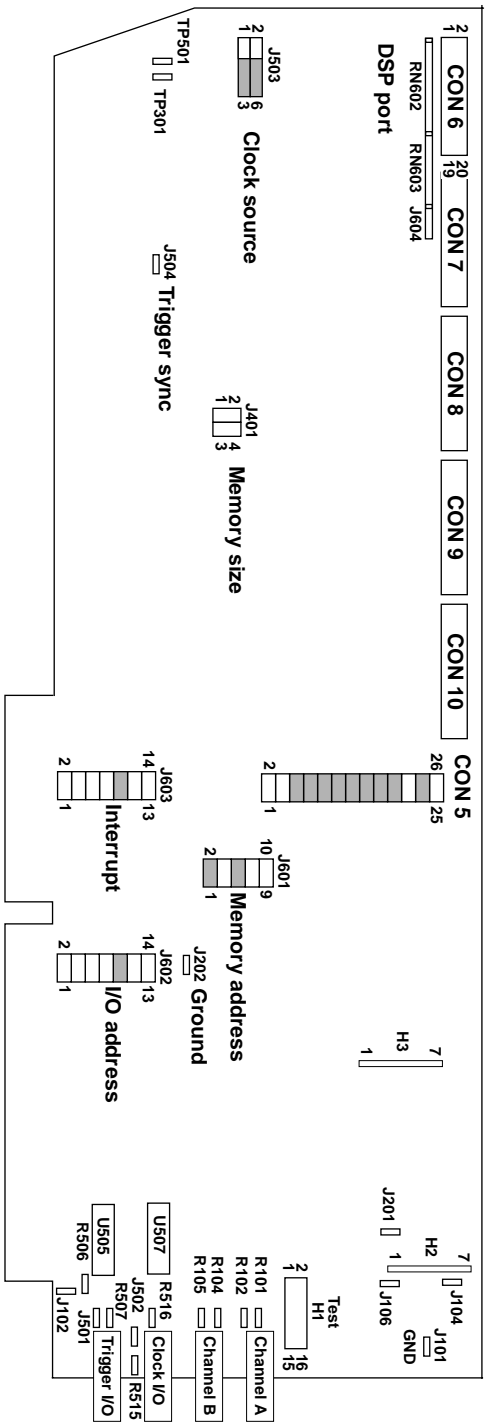
Figure 3-1. Jumper Locations

Setting the Base I/O Address

DAS-4200 Series boards require two groups of eight bytes in the I/O address space of the host computer. Address line A10 selects one of these groups. Since A10 is not included in the I/O address decoding of compatible computers, only eight bytes of the host's I/O space are used.

DAS-4200 Series boards are shipped with a base I/O address of 250h. If your application requires a different setting, use the I/O address jumper block (J602) to set the base I/O address. Table 3-2 lists the settings of J602 for base I/O addresses in the range of 240h to 2F8h. Note that OUT indicates that a jumper is not inserted in the specified jumper position and IN indicates that a jumper is inserted in the specified jumper position.

Table 3-2. Base I/O Address

Base I/O Address	Jumper J602						
	13-14	11-12	9-10	7-8	5-6	3-4	1-2
240	OUT	IN	IN	OUT	IN	IN	IN
248	OUT	IN	IN	OUT	IN	IN	OUT
250[1]	OUT	IN	IN	OUT	IN	OUT	IN
258	OUT	IN	IN	OUT	IN	OUT	OUT
260	OUT	IN	IN	OUT	OUT	IN	IN
268	OUT	IN	IN	OUT	OUT	IN	OUT
270	OUT	IN	IN	OUT	OUT	OUT	IN
278	OUT	IN	IN	OUT	OUT	OUT	OUT
280	OUT	IN	OUT	IN	IN	IN	IN
288	OUT	IN	OUT	IN	IN	IN	OUT
290	OUT	IN	OUT	IN	IN	OUT	IN
298	OUT	IN	OUT	IN	IN	OUT	OUT
2AO	OUT	IN	OUT	IN	OUT	IN	IN
2A8	OUT	IN	OUT	IN	OUT	IN	OUT

Table 3-2. Base I/O Address (cont.)

Base I/O Address	Jumper J602						
	13-14	**11-12**	**9-10**	**7-8**	**5-6**	**3-4**	**1-2**
2BO	OUT	IN	OUT	IN	OUT	OUT	IN
2B8	OUT	IN	OUT	IN	OUT	OUT	OUT
2CO	OUT	IN	OUT	OUT	IN	IN	IN
2C8	OUT	IN	OUT	OUT	IN	IN	OUT
2DO	OUT	IN	OUT	OUT	IN	OUT	IN
2D8	OUT	IN	OUT	OUT	IN	OUT	OUT
2EO	OUT	IN	OUT	OUT	OUT	IN	IN
2E8	OUT	IN	OUT	OUT	OUT	IN	OUT
2FO	OUT	IN	OUT	OUT	OUT	OUT	IN
2F8	OUT	IN	OUT	OUT	OUT	OUT	OUT

Notes
[1] Default factory setting.

Setting the Memory Address

Onboard memory on DAS-4200 Series boards consists of banks of 16K bytes in upper memory. DAS-4200 Series boards are shipped with a memory address of CC00:0000. If your application requires a different setting, use the memory address jumper block (J601) to set the memory address, as shown in Table 3-3. Note that OUT indicates that a jumper is not inserted in the specified jumper position and IN indicates that a jumper is inserted in the specified jumper position.

Table 3-3. Memory Address

Full Memory Address	Jumper J601				
	1-2	3-4	5-6	7-8	9-10
A 0000	IN	IN	IN	IN	IN
A 4000	IN	IN	IN	IN	OUT
A 8000	IN	IN	IN	OUT	IN
A C000	IN	IN	IN	OUT	OUT
B 0000	IN	IN	OUT	IN	IN
B 4000	IN	IN	OUT	IN	OUT
B 8000	IN	IN	OUT	OUT	IN
B C000	IN	IN	OUT	OUT	OUT
C 0000	IN	OUT	IN	IN	IN
C 4000	IN	OUT	IN	IN	OUT
C 8000	IN	OUT	IN	OUT	IN
C C000[1]	IN	OUT	IN	OUT	OUT
D 0000	IN	OUT	OUT	IN	IN
D 4000	IN	OUT	OUT	IN	OUT
D 8000	IN	OUT	OUT	OUT	IN
D C000	IN	OUT	OUT	OUT	OUT

Notes
[1] Default factory setting.

Excluding the Memory Area

The host computer must leave room for the onboard memory of the
DAS-4200 Series board in its memory address map. To ensure that the
host computer is configured to leave room in its memory address map,
you must exclude the memory area of 16K bytes (CC00:0000 to
CFFF:000F or your memory address setting) from the memory available
for the EMS manager of your system (for example, QEMM or EMM386).

For QEMM, your C:\CONFIG.SYS file should contain a line similar to the following:

```
DEVICE = C:\QEMM\QEMM386.EXE X=CC00-CFFF
```

For EMM386, your C:\CONFIG.SYS file should contain a line similar to the following:

```
DEVICE = C:\DOS\EMM386.EXE X=CC00-CFFF
```

The memory address range is expressed as a segment address; omitting the trailing zero from the full memory address listed in Table 3-3 yields the equivalent segment address. Note that the examples assume a certain directory structure on the disk; you may have to modify these commands.

Setting the Interrupt Level

An interrupt can be generated to signal the host computer at the end of a data acquisition or peak detection. DAS-4200 Series boards are shipped with an interrupt level of 7. If your application requires a different setting, set the interrupt level by inserting a jumper into one of the positions of the interrupt jumper block (J603). Make sure that you insert a jumper into only one of the positions of J603; refer to Table 3-4. Note that OUT indicates that a jumper is not inserted in the specified jumper position and IN indicates that a jumper is inserted in the specified jumper position.

Table 3-4. Interrupt Level Selection

Interrupt Level	Jumper J603						
	13-14	11-12	9-10	7-8	5-6	3-4	1-2
15	OUT	OUT	OUT	OUT	OUT	OUT	IN
12	OUT	OUT	OUT	OUT	OUT	IN	OUT
11	OUT	OUT	OUT	OUT	IN	OUT	OUT
10	OUT	OUT	OUT	IN	OUT	OUT	OUT
7[1]	OUT	OUT	IN	OUT	OUT	OUT	OUT
5	OUT	IN	OUT	OUT	OUT	OUT	OUT
9	IN	OUT	OUT	OUT	OUT	OUT	OUT

Notes
[1] Default factory setting.

Interrupts are enabled and disabled under software control; however, leaving all positions of jumper J603 open prevents the DAS-4200 Series board from interrupting the host computer.

Setting Trigger Synchronization

If you want to synchronize the pacer clock to a trigger event, you must enable trigger synchronization by inserting a jumper in the trigger synchronization jumper block (J504). To disable trigger synchronization, remove the jumper from J504.

Setting the Input Impedance for Analog Input Channels

The coaxial connectors for Channel A and Channel B are terminated with a socketed resistor. The resistors provided with the DAS-4200 Series board have a value of 49.9 Ω to match the 50 Ω impedance of the connectors; for a different termination, you can replace these resistors with 1% metal film resistors of a different value.

Use resistor sockets R101 and R102 to adjust the input impedance and sensitivity of Channel A; use resistor sockets R104 and R105 to adjust the input impedance and sensitivity of Channel B. Figure 3-2 illustrates the analog input circuitry.
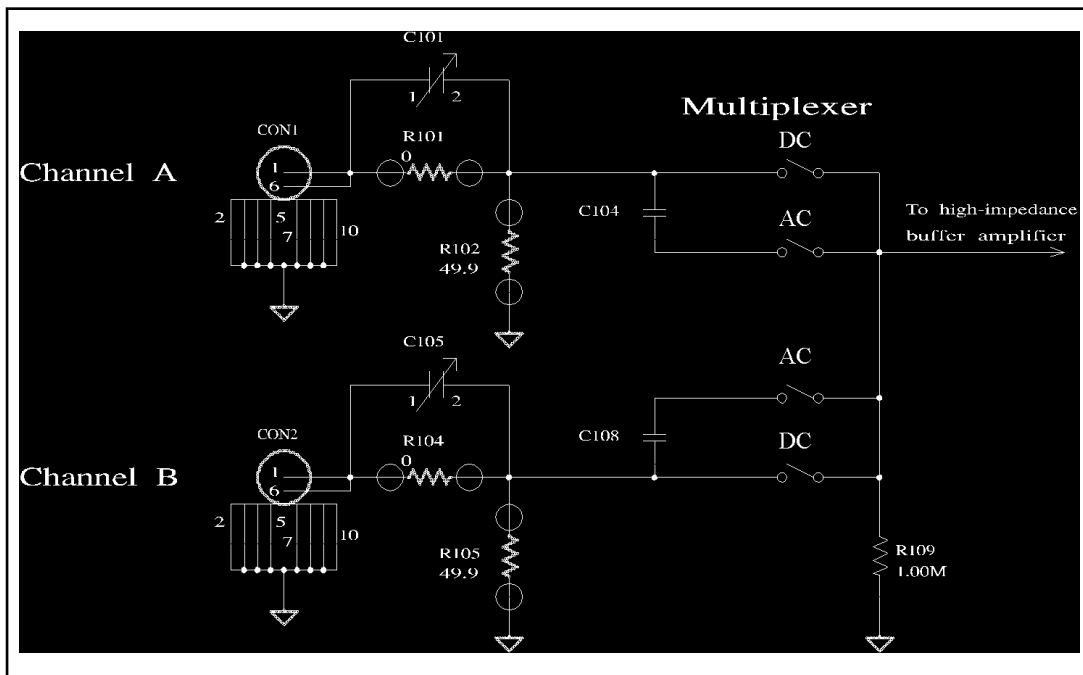
Figure 3-2. Analog Input Circuitry

Table 3-5 lists the values and power ratings of the resistors you can use to increase the maximum full-scale input voltage and change the input impedance.

Table 3-5. Changing the Input Impedance

Input Impedance	R101 (R104)	R102 (R105)
50 Ω	0	49.9 / 0.33W[1]
75 Ω[2]	0	75.0 / 0.21W
93 Ω[2]	0	93.1 / 0.17W
100 Ω	0	100 / 0.16W
1 kΩ	0	1000
10 kΩ	0	10.2k
100 kΩ	0	110k
1 MΩ	0	open

Notes
[1] Default factory setting.
[2] Due to the short connections to the connector, you can use this value without significant degradation in signal quality, as long as the impedance of the connected cable is met.

The power dissipated by the input resistors at input impedances of 1 kΩ and above is insignificant; any resistor with a power rating of 1/10 W or more is acceptable.

Setting the Input Impedance for the Clock I/O Connector

The Clock I/O connector is terminated with a socketed resistor with a value of 49.9 Ω to match the 50 Ω impedance of the connector; for a different termination, you can replace this resistor with a 1% metal film resistor of a different value.

Use resistor socket R515 to adjust the input impedance of the Clock I/O connector. To terminate the input with the resistor value of R515, insert a jumper into jumper block J502.

Figure 3-3 illustrates the Clock I/O connector circuitry.
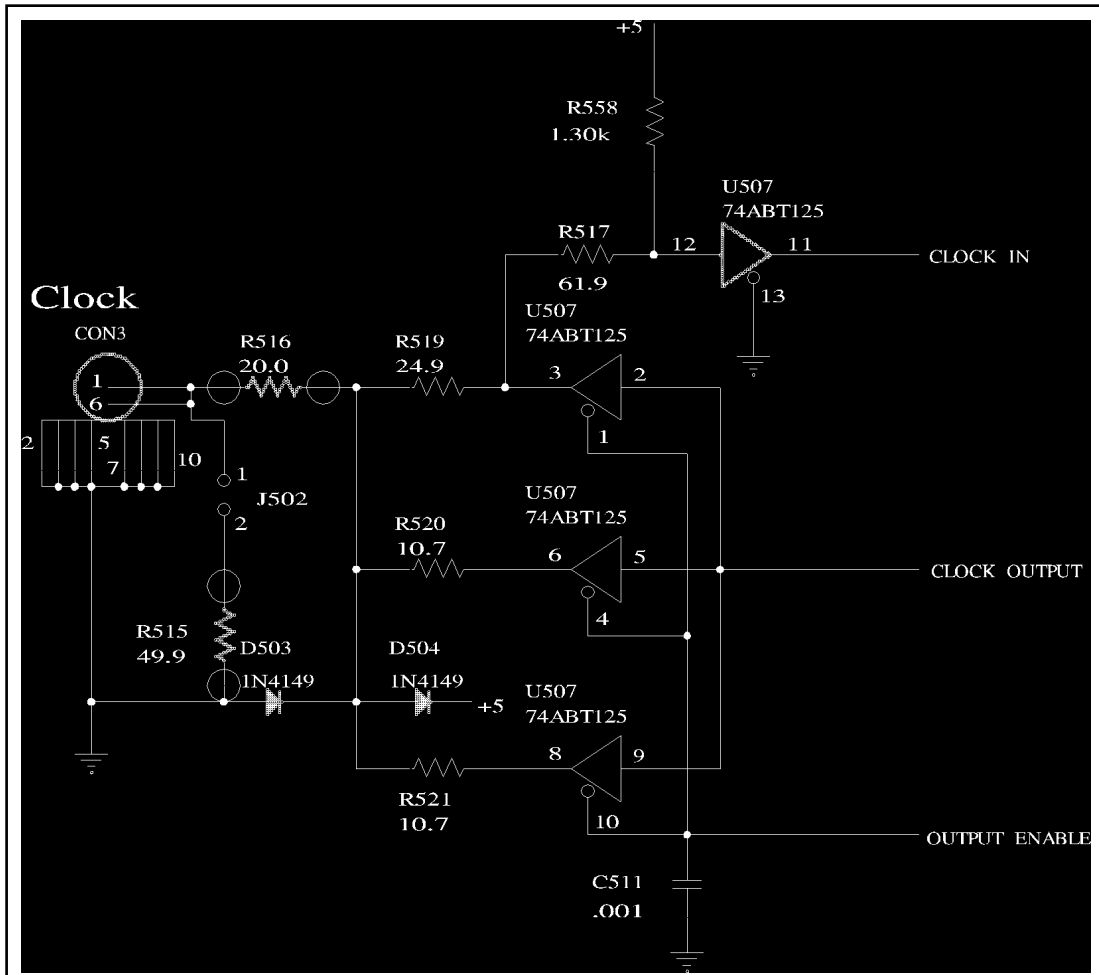
Figure 3-3. Clock I/O Connector Circuitry

Refer to Table 3-5 on page 3-17 for a list of the values and power ratings
of the resistors you can use.

Note: If you short the Clock I/O connector to ground or supply a signal
to the Clock I/O connector with the board in internal clock mode, the
DAS-4200 Series board will not operate properly.

Setting the Input Impedance for the Trigger I/O Connector

The Trigger I/O connector is terminated with a socketed resistor with a value of 49.9 Ω to match the 50 Ω impedance of the connector. If you are using an external digital trigger and want a different termination, you can replace this resistor with a 1% metal film resistor of a different value.

Use resistor socket R506 to adjust the input impedance of the Trigger I/O connector. To terminate the input with the resistor value of R506, insert a jumper into jumper block J501.

Figure 3-4 illustrates the Trigger I/O connector circuitry.
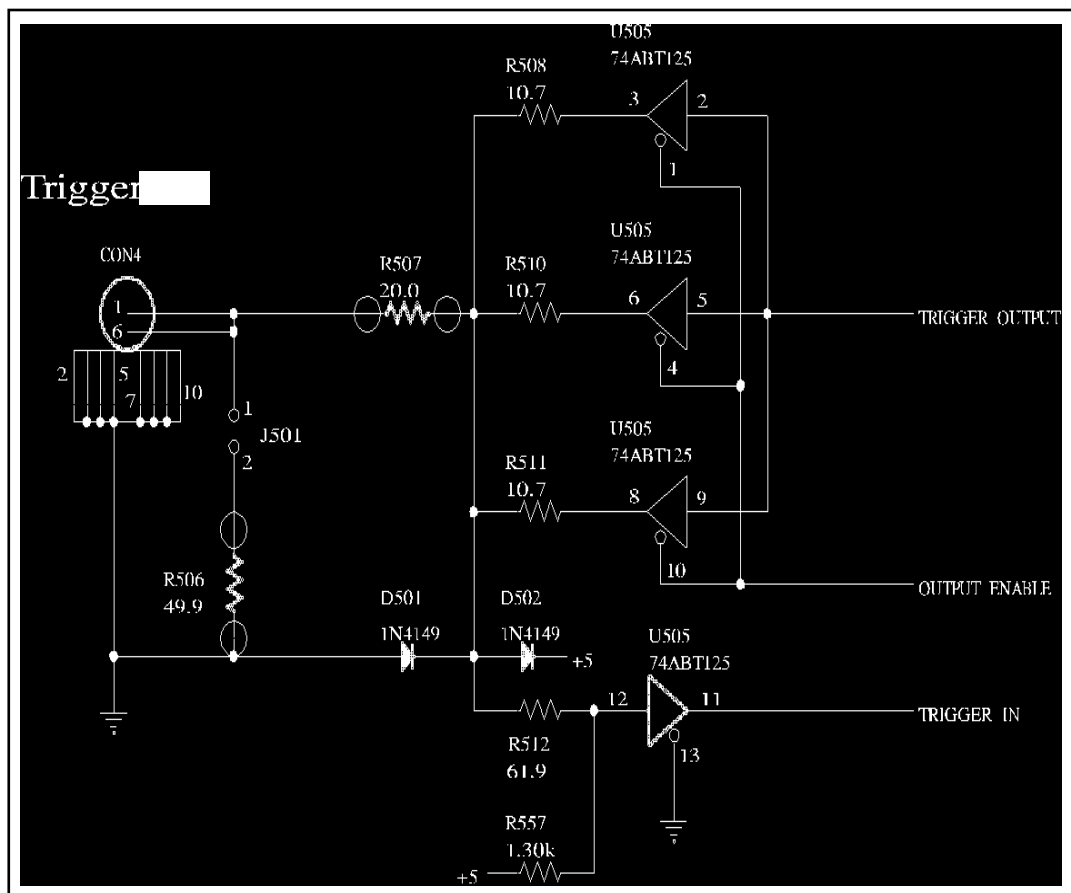
Figure 3-4. Trigger I/O Connector Circuitry

Refer to Table 3-5 on page 3-17 for a list of the values and power ratings of the resistors you can use.

If you must reduce the signal level on the connector, setting jumper J501 results in a lower level on the trigger signal. You can increase the signal level by replacing R507 with a shorting wire; however, overvoltage protection will be reduced.

Adding a Ground Connection

To prevent the switching noise generated by the digital high-speed logic of the DAS-4200 Series board from interfering with the analog input signal, the analog section is shielded and has a separate ground. Digital and analog ground are connected on the board at one point.

In addition, the case of the host computer is connected to earth ground through the power cord. An instrument connected to one of the BNC connectors on the board may create a ground loop through its earth ground connection. Depending on the actual configuration of your system, you can reduce noise interference by external sources by adding a direct connection between the bracket (case ground) and either digital or analog ground of the board.

To add a ground connection, you can use one of the following jumpers:

● Insert a jumper into jumper block J101 to add a ground connection between case ground and analog ground. To access jumper block J101, take off the shield by removing the screw at the top of the shield and leaving the bottom shield in place.

● Insert a jumper into jumper block J102 to add a ground connection between case ground and digital ground.

● Insert a jumper into jumper block J202 to add a ground connection between analog and digital ground.

Experiment until you find the grounding arrangement that works best in your system.

Installing the Board

Before installing a DAS-4200 Series board in your computer, make sure that the jumpers on the board are set appropriately and that the jumper settings match the settings in the configuration file, where appropriate. Refer to page 3-5 for more information.

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

To install the board, perform the following steps:

1. Turn power to the computer and all attached equipment OFF.

2. Remove the computer chassis cover.

3. Select an available slot. A DAS-4200 Series board requires a single, full-size slot.

    For adequate cooling, select a slot with good air flow, particularly across the hot components: the two ICs with the black heat sinks next to the shield and the DC/DC converter in the corner of the board with the bevel. If you are concerned about insufficient cooling, consider adding an inexpensive fan board into the expansion slot adjacent to the component side of the DAS-4200 Series board.

4. Loosen and remove the screw at the top of the blank adapter plate, and then slide the plate up and out to remove.

5. Holding the board by its edges or by the pink foam pad with one hand, touch an uninsulated metal part of the computer case with your other hand.

6. Take off the pink foam pad, angle the BNC connectors into the slot in the back of your computer, and insert the board into the selected 16-bit expansion connector on the motherboard.

7. Replace the computer chassis cover.

8. Plug in all cables and cords.

9. Turn power to the computer ON. Make sure that the power supply of your computer can handle the current requirements of the DAS-4200 Series board; refer to Appendix A for information.

After you install the DAS-4200 Series board in the computer, you can attach your application to the board; refer to the next section for information. Before writing your application program, you can test the functions of the DAS-4200 Series board using the scope and test program under DOS; refer to Chapter 4 for information.

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

Attaching Applications

To attach applications to a DAS-4200 Series board, use the four standard BNC coaxial connectors on the back of the board. Refer to Figure 3-1 on page 3-10 for the location of these connectors, which are used as follows:

- **Channel A** - Attaches an analog input signal to Channel A of the DAS-4200 Series board.

- **Channel B** - Attaches an analog input signal to Channel B of the DAS-4200 Series board.

- **Clock I/O** - Attaches an external pacer clock to the DAS-4200 Series board.

- **Trigger I/O** - Attaches an external digital trigger to the DAS-4200 Series board.

The signals on the four connectors are terminated with resistors. The resistors provided with DAS-4200 Series boards have a value of 49.9 Ω, but you can replace these resistors with a different value, if necessary. Refer to page 3-15 for information on replacing resistors for the Channel A and Channel B connector; refer to page 3-17 for information on replacing resistors for the Clock I/O connector; refer to page 3-19 for information on replacing resistors for the Trigger I/O connector.

You can reduce noise interference created by instruments connected to the connectors by adding a ground connection; refer to page 3-20 for information.

Note: To achieve compliance with the European EMC directive 39/336 EEC (CE Mark certification), spring gaskets have been installed over the BNC connectors. When a cable is attached, these gaskets are compressed between the cable connector and the bracket.

4

Scope and Test Program

The DAS-4200 Series scope and test program (D4200.EXE) is a utility program that allows you to test the hardware features available on DAS-4200 Series boards, to recalibrate the analog input section of the board, and to perform basic oscilloscope functions, such as saving and recalling waveforms to disk.

D4200 is a menu-based, keyboard-controlled DOS program that requires a VGA compatible display. It has one support file, D4200.PAR, which is shipped with both the DAS-4200 Series standard software package and the ASO-4200 software package.

To run the scope and test program, enter the following at the DOS prompt:

```
D4200
```

From the initial screen, press any key to continue. Any errors that are found with the EEPROM configuration data CRC or with the D4200.PAR file are shown on the second screen. From the second screen, press any key to continue to the main program menu.

Control Keys for D4200.EXE

Table 4-1 lists the keys that control the D4200.EXE scope and test program. In addition, several function group menus are listed at the top of the oscilloscope screen; press the first letter in the title of a menu to change to the menu. Note that D4200.EXE is case-insensitive.

Table 4-1. Control Keys

Key	Description
A	Switches the menu and the current highlight to the A/D menu. From the A/D menu, you can modify most of the hardware features of the board.
C	Restores the calibration settings to the original values stored in the EEPROM.
D	Switches the menu and the current highlight to the Display menu. The Display menu controls operations such as waveform accumulation and averaging.
G	Switches the menu and the current highlight to the Gates menu. The Gates menu controls the parameters on which the onboard peak detector runs.
H	Displays a help screen, which lists these control keys.
L	Loads a parameter file. Refer to page 4-15 for more information about parameter files.
M	Toggles measurement cursors on or off. If the measurement cursors are currently on, they are turned off. Otherwise, you are prompted to select measurement of voltage or time. See also the descriptions of the 1, 2, 3, <, and > keys.
O	Displays the Options menu. The Options menu controls the printer type and allows writing of the calibration values to the EEPROM.
P	Prints the currently displayed screen. The printer type is controlled through the options menu.
Q	Quits the program, unless a waveform recall is currently active. If recalling a waveform, Q returns D4200 to normal real-time acquisition.
R	Redraws the screen. This is useful for clearing the scope display after accumulating waveforms.
S	Saves a parameter file. Refer to page 4-15 for more information about parameter files.
T	Takes a single shot. This key is valid only if the single-shot switch on the A/D menu is turned on.

Table 4-1. Control Keys (cont.)

Key	Description
W	Displays a prompt asking whether to save or recall waveforms. If saving, you are prompted for the number of waveforms to save and a file name to save them in. If recalling, you are prompted for a D4200 generated waveform file. You can scroll through the waveforms saved in this file with the page up and page down keys.
RET	Selects the currently highlighted option if the highlight cursor is on the top menu.
SPACE	Toggles between setting and unsetting the move factor. The move factor controls the rate at which the + and - keys increment the current selection.
ESC	Returns the highlight cursor to the top menu. If a prompt is currently on the screen, the prompt is removed and the highlight location does not toggle.
+	Increments the current selection by the amount specified by the move factor. If the move factor is highlighted, then the next highest move factor is chosen. The move factor wraps around; all other entries do not.
-	Decrements the current selection by the amount specified by the move factor. If the move factor is highlighted, then the next lowest move factor is chosen. The move factor wraps around; all other entries do not.
E	Allows direct entry of a number. This is only valid for certain entries. The entered number is automatically changed, if necessary, to fit the parameters of that selection. For example, the buffer start must be in increments of 4; if you enter a 6, it is automatically changed to 8.
>	Moves the current measure cursor to the right (for time cursors) or up (for voltage cursors). The **.** key also works; the key need not be shifted.
<	Moves the current measure cursor left (for time cursors) or down (for voltage cursors). The **,** key also works; the key need not be shifted.
1	Selects the first measure cursor. The **<** and **>** keys change the position of the first cursor.

Table 4-1. Control Keys (cont.)

Key	Description
2	Selects the second measure cursor. The < and > keys change the position of the second cursor.
3	Selects both measure cursors simultaneously. The < and > keys move both cursors in tandem.

Table 4-2 lists the suffixes that you can use on any entered number.

Table 4-2. Suffixes

Suffix	Description
h	Hexadecimal
p	Picoseconds
u	Microseconds
m	Milliseconds
s	Seconds
v	Voltage

Scope and Test Program Menus

The following sections describe the parameters on the scope and test program menus.

A/D Menu

Table 4-3 lists the parameters on the A/D menu. You can access the A/D menu at any time by pressing the **A** key.

Table 4-3. A/D Menu

Parameter	Description
Sampling Rate	Changes the conversion rate for the board. The conversion rate can range from 0.781 Msamples/second to 800 Msamples/second, which is an ETS rate.
Signal type	Changes the analog signal path to RF (radio frequency), Video, LogAmp, or User.[1]
Single shot	Turns single-shot mode on or off. If single-shot mode is off, the waveforms are updated in real time. If single-shot mode is on, waveform collection is suspended until the **T** key is pressed; this causes one waveform to be taken. If ETS mode or averaging is on, then enough waveforms for one complete ETS shot are taken. For example, if you are averaging four 200 MHz waveforms, then eight shots are taken. For more information on ETS, refer to page 2-25.
Buffer start	Specifies the starting location in onboard memory at which waveforms are collected. If pre-trigger mode (about-trigger mode) is on, this parameter controls the minimum amount of pre-trigger data that is saved. For example, if pre-trigger mode is on, and the buffer start is set to 400, then 400 points of pre-trigger data are saved before a trigger pulse is accepted.
Post-trigger delay	Specifies the number of samples to wait after the trigger event occurs before starting to collect data. You cannot change this parameter if pre-trigger mode (about-trigger mode) is on; it is automatically set to zero. Changing the post-trigger delay affects the waveform location pointed to by buffer start.
Buffer length	Specifies the amount of data that is saved after the trigger pulse is accepted. The post-trigger delay setting does not affect the buffer length. The maximum allowable value of buffer length is determined by the size of memory installed on the DAS-4200 Series board.
Voltage level	Sets the voltage input level of the board. This can range from 0.015625 V to 2.0 V.
Voltage offset	Sets the offset voltage of the offset DAC (DAC1). This information is initially taken from the EEPROM or from the most recently loaded parameter file.

Table 4-3. A/D Menu (cont.)

Parameter	Description
Vernier gain	Sets the vernier gain. This information is initially taken from the EEPROM, or from the most recently loaded parameter file.
Pre-trigger	Turns pre-trigger mode (about-trigger mode) on or off. If pre-trigger mode is on, the buffer start parameter specifies the minimum amount of pre-trigger data to collect; if the display start parameter on the Display menu is negative, you can view the pre-trigger data. If pre-trigger mode is off and the display start parameter is negative, the display start is automatically changed to 0.
Trigger type	Selects the trigger source. The options are software (board is triggered through software control), external (board is triggered through a TTL signal on the Trigger I/O connector), or analog (board is triggered by the input signal crossing a set threshold level).
Level / Edge	Specifies the sensitivity of a trigger. For an analog trigger, specifies whether the trigger occurs when the input signal rises above/falls below a set level (edge sensitivity) or if the input signal is above/below the set level (level sensitivity). For a digital trigger, specifies whether the trigger occurs when a rising/falling edge (edge sensitivity) occurs or if the signal is high or low (level sensitivity).
Trigger threshold	Specifies the trigger threshold level used by an analog trigger. A Tr_ icon is displayed on the left side of the display to indicate the set threshold level.
Clock	Switches between an internal and an external pacer clock. An internal pacer clock is the onboard 100 MHz clock. The external pacer clock is an externally generated clock signal of any frequency up to 100 MHz applied to the Clock I/O connector.
A/D Base Port	Displays the current base address of the board. This is not a switch; it is displayed for informational purposes only.
Expd. on / off [2]	Turns the use of a memory expansion accessory on or off.

Table 4-3. A/D Menu (cont.)

Parameter	Description
Expd. board #[2]	Specifies the number of the memory expansion accessories used.
Channel type	Specifies the analog input channels used. The options are None, Channel A - DC coupling, Channel A - AC coupling, Channel B - DC coupling, and Channel B - AC coupling. You cannot use both channels simultaneously.

Notes

[1] At the current time, only the RF analog input signal path is supported. For information about the other options, contact the Keithley MetraByte Applications Engineering Department; refer to page 5-4.

[2] The memory expansion accessory is not supported at this time.

Display Menu

Table 4-4 lists the parameters on the Display menu. You can access this menu at any time by pressing the **D** key.

Table 4-4. Display Menu

Parameter	Description
Display start	Selects the area of memory that is currently displayed. If pre-trigger mode (about-trigger mode) is off, the display start is an absolute address in onboard memory. If pre-trigger mode is on, the display start is relative to the trigger point (a display start of 0 would start the waveform display at the trigger point). A floating T is displayed above the waveform to show exactly where the trigger point is. If pre-trigger mode is on, you can enter a negative number for the display start to display pre-trigger data.
Time / points	Specifies whether the time-based entries (buffer start, post-trigger delay, buffer length, gate start, gate length, and display start) are displayed in raw data points or as a time calculated from the current conversion rate.

Table 4-4. Display Menu (cont.)

Parameter	Description
Oscope width	Specifies the number of data points displayed across the scope. This can range from 31 points to 8000 points, changing by powers of two. A one-to-one pixel-to-point ratio is achieved with a scope width of 500. If the scope width is less than 500, pixels are interpolated between the true data points. If the scope width is greater than 500 points, only the maximum value within a group is displayed.
Accumulate	Turns waveform accumulation on or off. To clear the display of accumulated waveforms, press the **R** key.
Num. to average	Specifies the number of waveforms to average before displaying. This can range from 1 (averaging off) to 128.
Transfer width[1]	Specifies the transfer width between the DAS-4200 Series board and the host computer as either 16 bits or 8 bits. Some computers do not support 16-bit transfers. If the waveform display is incorrect, try switching to 8-bit transfer.
Data type[2]	Specifies the data format as either twos complement or binary. This setting does not affect the display; however, it does change the format of the data saved in waveform save mode.
Zero wait	Turns the synchronous ready bus signal on or off. If synchronous ready is on and the DAS-4200 Series board and the host computer motherboard are synchronized correctly, data transfer takes place at a faster rate. However, if synchronous ready is on and the DAS-4200 Series board and the motherboard are not synchronized correctly, errors will appear in the waveform.

Table 4-4. Display Menu (cont.)

Parameter	Description
Video filter[3]	Specifies the recharge rate of onboard capacitors in the video signal path. This can range from 0 to 7. A low value passes the waveform through without modification. A high value removes all data except the most extreme peaks. This parameter is only meaningful if the signal type is set to video mode.
Trigger delay	Specifies the software delay that is applied between each trigger. This delay is not specified in microseconds; it is the time the computer takes to count from 0 to the specified number. This is useful when using a software trigger mode with low repetition rate signal sources, such as some ultrasonic analog pulsers/receivers.

Notes
[1] At the current time, only the16-bit transfer width is supported.
[2] At the current time, only the twos complement data type is supported.
[3] At the current time, the video signal path is not supported.

For information about the other options, contact the Keithley MetraByte
Applications Engineering Department; refer to page 5-4

Gates Menu

Table 4-5 lists the parameters of the Gates menu, which controls the
operation of the peak detector. You can access the Gates menu at any time
by pressing the **G** key. The peak detector cannot be run on recalled
waveforms. The time-of-flight (TOF) and peak amplitude (PA) readings
are displayed above the scope display. The TOF is displayed relative to
the trigger point; the PA is always displayed as a voltage.

Table 4-5. Gates Menu

Parameter	Description
Gate on / off	Specifies the gate setting. This can be Off, Normal (peak detector displays only the PA and TOF), or Auto (peak detector displays all local minimum and maximum peaks). With normal peak detection, the PA and TOF are displayed on a status line above the scope; the gate need not be in the visible portion of the scope. With automatic peak detection, a vertical line is displayed at all the local minima and maxima; automatic peak detector peaks cannot be recorded. Peaks are only shown in the visible portion of the gate during automatic peak detection.
Zero band	Specifies a region around zero volts to remove from automatic peak detector consideration. The display is in terms of data points. Points that fall within the zero band region are not passed to the automatic peak detector. This is useful for removing extraneous peaks resulting from background noise of the input signal.
Gate start	Specifies the starting location for the peak detector. If pre-trigger mode (about-trigger mode) is on, the starting location is relative to the trigger point; if pre-trigger mode is off, the start is an absolute reference into onboard memory.
Gate length	Specifies the length of the region under consideration to the peak detector.
Gate threshold	Specifies the threshold level of the gate. If the peak detector is in Level / > mode, only peaks above the threshold level are valid. If the peak detector is in Level / < mode, only peaks below the threshold level are valid.
Absolute peaks	Causes the peak detector to view all data through an absolute value function. This is most useful in the Level / > mode where either the most positive or most negative peak is returned. This does not alter the displayed waveform, but affects the operation of the peak detector.
> / <	Specifies whether the peak detector looks for rising (>) or falling (<) edges in edge mode, or at valleys (<) or peaks (>) in level mode.
Level / Edge	Specifies whether the peak detector looks for the first crossing of the threshold (edge mode) or for the maximum peak or valley (level mode).

Options Menu

Table 4-6 lists the miscellaneous parameters of the Options menu. You can access the Options menu at any time by pressing the **O** key.

Table 4-6. Options Menu

Parameter	Description
Make D4200.PAR	Creates a special parameter file called D4200.PAR with the current settings in the program. At program startup, D4200.EXE automatically loads D4200.PAR with the initial values for all the menu entries.
Write calib	Creates a special file that contains only the current calibration information. This file cannot be recalled later in the program.
Printer type/ resolution/port	Specifies the type of printer that is used if the **P** key is pressed. The printer type can be HP PaintJet, LaserJet, or DeskJet550. The port can be LPT1, LPT2, or LPT3. Printing can be done over a network.

Configuration Menu

The Configuration menu specifies calibration values that are stored in the EEPROM on the board. You can access the Configuration menu at any time by pressing **I**.

Use the **Write EEPROM** parameter to permanently change the calibration values stored in EEPROM. A double confirmation is required. The first is yes / no; the second asks for a password, which is hardcoded at Keithley (case insensitive). If you are changing the factory settings for the first time, a parameter file called FACTORY.PAR is created. Do not overwrite the EEPROM unless you are certain that the board is correctly calibrated.

The remaining functions in this menu are not enabled; they are for internal use only.

Saving Waveforms

Only the section of a waveform that is covered by the peak detection gate is saved. To save a waveform, perform the following steps:

1. Position the gate over the desired portion of the waveform. Note that the gate need not be visible, and the peak detector need not be on; however, it is recommended that you turn the peak detector off so that more memory is available for waveform saving.

2. Press **W** and then **S** to save the waveform.

   The program prompts you for the number of waveforms to save and a file name to save them in.

3. Enter the required information. The program displays a warning if the specified file name already exists. A maximum of 64K of data can be saved at once; if you specify more then 64K, the maximum number of waveforms of the specified length are saved instead.

Two files are created during this process. One has a .WAP extension and the other has a .WAV extension. These extensions cannot be changed. The .WAV file contains the raw waveform data in series of columns, separated by spaces, in an ASCII format. You can examine a .WAV file using any text editor; a typical file might look something like this:

```
a1  b1  c1  d1  e1
a2  b2  c2  d2  e2
a3  b3  c3  d3  e3
a4  b4  c4  d4  e4
a5  b5  c5  d5  e5
```

The 'a' column is the data from the first waveform; the 'b' column is the data from the second waveform, and so on.

You can also examine a .WAP file using any text editor; the .WAP file contains the following information about certain parameters at the time the waveforms were created:

- **4200** - Header information; this will never change.

- **Number of waveforms saved** - Number of columns in .WAV file.

- **Data type** - 0 = binary; 1 = twos complement. (Note that at the current time, only twos complement data type is supported.)

- **Sampling rate** - 0 = 0.78125 Msamples/second, 1 = 1.5625 Msamples/second, ... 7 = 100 Msamples/second.

- **Gate start** - In samples.

- **Gate length** - In samples.

- **Signal type** - 0 = RF, 1 = Video, 2 = LogAmp, 3 = User. (Note that at the current time, only the RF signal type is supported.)

- **Voltage level** - 0 = 0.0315V, 1 = 0.0625V, 2 = 0.125V...

The waveform is not updated during the saving process in order to increase the overall speed of the process. If your signal source is a relatively slow device, it is recommended that you increment the trigger delay parameter in the Display menu to allow the source device time to recover between shots.

Recalling Waveforms

You can recall saved waveforms for future display. You can recall waveform files only if the appropriate .WAV and .WAP files both reside in the same directory. To recall waveforms, perform the following steps:

1. Press **W** and then **R**.

   The program prompts you for a file name.

2. Enter any standard DOS file name expression (wildcards are permitted). If you enter a wildcard expression, the program displays a list of all subdirectories and file names with a .WAV extension.

In the waveform recall mode, you can modify only the display start, accumulate, and scope width parameters. The page up and page down keys scroll between waveforms. Press **Q** to return to normal real-time waveform updating.

Calibrating the DAS-4200 Series Board

When a DAS-4200 Series board is shipped, it has already been calibrated; however, over time, the analog section of the board can drift, slightly distorting the calibration. To recalibrate your board, if necessary, perform the following steps:

1. From the Display menu, select 500 points for the oscilloscope width.

2. Input a one-cycle, software-triggered, calibrated triangle waveform into the board. The signal generator must be able to output exact 4.0 V, 2.0 V, 1.0 V, 0.5 V, 0.25 V, 0.125 V, 0.0625 V, 0.03125 V, and 0.0 V amplitude waveforms.

3. For each of the eight voltage ranges, change the vernier gain and voltage offset on the A/D menu until the peak and valley of the input waveform just touch (but do not cross) the top and bottom of the scope display. Make sure that the input setting of the board exactly matches the output setting of the signal generator before calibrating a set range.

4. With the analog input connector off, adjust the offset voltage until the input signal rests exactly in the center of the scope display.

The board is now calibrated. Save the current calibration information in a parameter file, or, if you prefer, resave this information to the EEPROM from the Configuration menu.

Note: If you overwrite the factory calibration in EEPROM memory, subsequent recalibration is not covered under warranty.

Using Parameter Files

The D4200 program creates parameter files that contain both the current calibration information and the current settings of all the menu entries. You can examine these parameter files using any text editor. The parameter files are described as follows:

- **D4200.PAR** - This file is read in when the program starts. The calibration information in this file is ignored; the EEPROM has precedence. If this file does not exist, then hardcoded defaults are used instead.

- **PROG_END.PAR** - This file is automatically created when D4200 is exited. This allows you to automatically restore D4200 to its operating state just before program termination.

To save a parameter file, enter **S**; the program prompts you for a file name. The extension of the file name is forced to .PAR; this cannot be changed. If a file already exists with the given name, a confirmation is required before the old file is overwritten.

To load a parameter file, enter **L** and specify the file name (wildcards are permitted); if you enter a wildcard, the program displays a file selection menu containing all .PAR files and all subdirectories; press **Enter** when the highlight is on the correct file.

5

Troubleshooting

If your DAS-4200 Series board is not operating properly, use the information in this chapter to isolate the problem. If the problem appears serious enough to warrant technical support, refer to page 5-4 for information on how to contact an applications engineer.

Identifying Symptoms and Possible Causes

Table 5-1 lists general symptoms and possible solutions for problems with DAS-4200 Series boards.

Table 5-1. Troubleshooting Information

Symptom	Possible Cause	Possible Solution
Board does not respond	Base I/O address is unacceptable.	Make sure that no other system resource is using the base I/O address specified by the I/O address jumper. Reconfigure the base I/O address, if necessary. Refer to page 3-11 for instructions.
	Interrupt level is unacceptable.	Make sure that no other system resource is using the interrupt level specified by the interrupt jumper. Reconfigure the interrupt level, if necessary. Refer to page 3-14 for instructions.

Table 5-1. Troubleshooting Information (cont.)

Symptom	Possible Cause	Possible Solution
Board does not respond (cont.)	Memory address is unacceptable.	Make sure that no other system resource is using the memory address and the next 16K. Refer to "Setting the Memory Address" on page 3-12. OR The memory is not excluded from the memory manager. Refer to "Excluding the Memory Area" on page 3-13.
	The board configuration is unacceptable.	Check the settings in the configuration file. Make sure that they match the settings of the jumpers on the board, where appropriate.
	The board is incorrectly aligned in the accessory slot.	Check installation.
	The board is damaged.	Contact the Keithley MetraByte Applications Engineering Department; refer to page 5-4.
	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; refer to your computer documentation for instructions on running BIOS setup.
Intermittent operation	Vibrations or loose connections exist.	Cushion source of vibration and tighten connections.
	The board is overheating.	Check environmental and ambient temperature.
	Electrical noise exists.	Provide better shielding or reroute wiring.

Table 5-1. Troubleshooting Information (cont.)

Symptom	Possible Cause	Possible Solution
Intermittent operation (cont.)	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; refer to your computer documentation for instructions on running BIOS setup.
System lockup	A timing error occurred.	Press **Ctrl** + **Break**.

If you cannot identify the problem using the information in Table 5-1, refer to the next section to determine whether the problem is in the host computer or in the DAS-4200 Series board.

Testing Board and Host Computer

To determine whether the problem is in the host computer or in the DAS-4200 Series board, perform the following steps:

1. Remove power connections to the host computer.

2. Unplug any cables from the DAS-4200 Series board.

3. Remove the DAS-4200 Series board from the computer and visually check for damage. If a board is obviously damaged, refer to page 5-4 for information on returning the board.

4. With the DAS-4200 Series board out of the computer, check the computer for proper operation. Power up the computer and perform any necessary diagnostics.

If you have another DAS-4200 Series board that you know is functional, refer to the next section to determine whether the problem is in the accessory slot or in the I/O connections. If you do not have another board, refer to page 5-4 for information on how to contact an applications engineer.

Testing Accessory Slot and I/O Connections

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

1. When you are sure that the computer is operating properly, remove computer power again, and install a DAS-4200 Series board that you know is functional. Do not make any I/O connections.

2. Apply computer power and check operation with the functional DAS-4200 Series board in place. This test checks the computer accessory slot. If you are using more than one DAS-4200 Series board, check the other slots you are using.

3. If the accessory slots are functional, check the I/O connections. Connect any devices, one at a time, and check operation.

4. If operation is normal, the problem is in the DAS-4200 Series board originally in the computer. Try the DAS-4200 Series boards one at a time in the computer to determine which is faulty.

5. If you cannot isolate the problem, refer to the next section for instructions on getting technical support.

Technical Support

Before returning any equipment for repair, call the Keithley MetraByte Applications Engineering Department at:

(508) 880-3000
Monday - Friday, 8:00 A.M. - 6:00 P.M., Eastern Time

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

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

DAS-4200 Series board	Model	DAS-4201/128K
		DAS-4201/512K
	Serial #	_____
	Revision code	_____
Computer	Manufacturer	_____
	CPU type	286 386 486 Pentium
		Pentium Pro
	Clock speed (MHz)	20 25 33 66 100 ____
	Math coprocessor	Yes No
	Amount of RAM	_____
	Video system	VGA SVGA
	BIOS type	_____
	Memory manager	_____
Operating system	DOS version	_____
	Windows version	3.0 3.1 95 _____
Software package	Name	_____
	Serial #	_____
	Version	_____
	Invoice/order #	_____
Compiler (if applicable)	Language	_____
	Manufacturer	_____
	Version	_____

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

When returning equipment for repair, include the following information:

- Your name, address, and telephone number.

- The invoice or order number and date of equipment purchase.

- A description of the problem or its symptoms.

- The RMA number on the outside of the package.

Repackage the equipment, using the original antistatic wrapping, if possible, and handling it with ground protection. Ship the equipment to:

ATTN: RMA #_____
Repair Department
Keithley MetraByte
440 Myles Standish Boulevard
Taunton, Massachusetts 02780

Telephone (508) 880-3000
FAX 508/824-5517

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

A

Specifications

Table A-1 lists the analog input specifications for DAS-4200 Series boards.

Table A-1. DAS-4200 Series Specifications

Feature	Attribute	Specifications
Channels	Number	Two (only one can be used at a time)
	Channel-to-channel isolation (DC to 50 MHz)	40 dB with channels at same sensitivity 30 dB with 4 V signal on Channel A and Channel B set to 31 mV sensitivity
	Channel-to-channel switching time	30 µs with both channels set for DC coupling and identical level 15 ms with both channels set at opposite extremes for worst-case switching
	Input coupling	DC (default; input range of −8.0 V to +8.0 V without distortion) AC (16 V p-p, maximum input)
	Input impedance	50 Ω (DC coupled) shunted by approximately 45 pF[1]
	Maximum safe input voltage at 50 Ω	5 Vrms continuous, ±250 V transients lasting less than 100 µs
	Input capacitance	30 pF, approximately
ADC	Type	100 Msamples/second, 8-bit flash
	Input reference voltage	0 V to −2.5 V, −2.0 V typical
	Output coding[2]	Twos complement (−127 to +127)

Table A-1. DAS-4200 Series Specifications (cont.)

Feature	Attribute	Specifications
ADC (cont.)	Integral and differential linearity	±0.5 LSB
	Integral and differential nonlinearity	±0.95 LSB with no missing codes
	Large-signal bandwidth	100 MHz @ Vin = full scale
	Small-signal bandwidth	175 MHz @ Vin = 1/4 scale
	Aperture jitter	12 ps rms
	Input slew rate	800 V/μs
	Step width	7.84 mV
	Signal-to-noise ratio	48 dB, typical
Accuracy	Gain	±5% of full scale using calibration file
	DC offset	±5% of offset using calibration file
	Real-time sampling period	Time base accuracy (±1 ps) + ADC aperture jitter (±17 ps) = ±18 ps total (±0.18% @ 100 MHz)
	Equivalent-time sampling period	Time base accuracy (±1 ps) + ADC aperture jitter (±17 ps) + trigger delay jitter (±44 ps) = ±62 ps total (±5% @ 800 MHz, ±2.5% @ 400 MHz, ±1.25% @ 200 MHz)
Attenuator	Output signal	±3 V maximum without distortion
First gain stage	Gain levels	2, 4, 6, 8[3]
Second gain stage	Gain levels	2, 4, 6, 8[3]
Offset DAC (DAC1)	Setting	Programmable in 4096 steps; increasing the setting shifts the ADC input voltage to a more negative value[4]
Vernier gain DAC (DAC2)	Reference voltage	Programmable in 4096 steps from 0 V to −2.5 V; increasing setting increases the ADC input voltage range and reduces sensitivity[5]

Table A-1. DAS-4200 Series Specifications (cont.)

Feature	Attribute	Specifications
Input ranges (factory-calibrated)	±15.625 mV range	Bandwidth (+1.5/−3 dB)[6] = 90 MHz DC offset range = −125 to +312 mV Offset step size = 0.107 mV
	±31.25 mV range	Bandwidth (+1.5/−3 dB)[6] = 110 MHz DC offset range = −125 to +250 mV Offset step size = 0.092 mV
	±62.5 mV range	Bandwidth (+1.5/−3 dB)[6] = 130 MHz DC offset range = −250 to +500 mV Offset step size = 0.183 mV
	±125 mV range	Bandwidth (+1.5/−3 dB)[6] = 130 MHz DC offset range = −500 to +1000 mV Offset step size = 0.366 mV
	±250 mV range	Bandwidth (+1.5/−3 dB)[6] = 140 MHz DC offset range = −500 to +500 mV Offset step size = 0.244 mV
	±500 mV range	Bandwidth (+1.5/−3 dB)[6] = 140 MHz DC offset range = −1 to +1 V Offset step size = 0.488 mV
	±1 V range	Bandwidth (+1.5/−3 dB)[6] = 140 MHz DC offset range = −2 to +2 V Offset step size = 0.977 mV
	±2 V range	Bandwidth (+1.5/−3 dB)[6] = 180 MHz DC offset range = −4 to +4 mV Offset step size = 1.954 mV

Counters	Start	Used for data acquisition:
		    Length: 16,777,216
		    Resolution: 4
		Used for peak detection:
		    Length: 16,777,216
		    Resolution: 1

	Length	Used for data acquisition:
		    Length: 16,777,216
		    Resolution: 4
		Used for peak detection:
		    Length: 4,194,304
		    Resolution: 1

Table A-1. DAS-4200 Series Specifications (cont.)

Feature	Attribute	Specifications

Counters (cont.)	Post-trigger[7]	Used for data acquisition:
		   Length: 16,777,216
		   Resolution: 4

Onboard buffer memory	Size	DAS-4201/128K: 128K bytes DAS-4201/512K: 512K bytes
Pacer clock	Internal	Divisors: 1, 2, 4, 8, 16, 32, 64, 128. (For corresponding conversion rates and sampling periods, refer to Table 2-2 on page 2-13.) Internal 100 MHz oscillator: stability 100 ppm (0.01%) over temperature and aging (1 year) Sampling interval accuracy: 0.1%
	External	TTL-level signal of up to 100 MHz Minimum pulse width: 4 ns (high or low) Input load: 1.3 kΩ pull-up resistor to +5 V (can be terminated with 50 Ω by setting a jumper) Maximum input voltage: -4 to +9 V (±4 V with 50 Ω termination), transients of ±250 V (100 μs) can be tolerated
Trigger	Sources	Software Analog (threshold): positive or negative threshold crossing; threshold programmable in 256 steps over the full-scale input range; edge or level trigger External digital: positive or negative TTL input signal on Trigger I/O connector
	External digital trigger minimum pulse width	15 ns (high or low)
	External digital trigger input load	1.3 kΩ pull-up resistor to +5 V (can be terminated with 50 Ω by setting a jumper)
	External digital trigger maximum input voltage	-4 to +9 V (±4 V with 50 Ω termination), transients of ±250 V (100 μs) can be tolerated
	Number of samples per trigger (length)	4 samples to memory size, but not to exceed 16, 777,216 samples
	Post-trigger delay	0 to 4,194,304 samples (40 ns to 2.62 ms at 100 MHz)
	Minimum pre-trigger data	4 to 4,194,304 samples
	Trigger jitter	One period of the undivided pacer clock (10 ns)

Table A-1. DAS-4200 Series Specifications (cont.)

Feature	Attribute	Specifications
Equivalent time sampling (ETS)	Delay range	10 ns to 22 ns
	Delay resolution	39 ps (256 steps to 10 ns)
	Delay accuracy	140 ps
	Maximum rate	3.2 Gsamples/second
Peak detector	Start address	1 sample increments
	Detection length	1 to 4,194,304 samples
	Data formats	Binary Twos complement Absolute value
	Speed	Conversion rate / 4 (for 100 MHz internal pacer clock: 25 Msamples/second, maximum; 195.3 ksamples/second, minimum)[8]
	Results	Peak value (8 bits) Peak address (22 bits)
DSP port	Start address	1 sample increments
	Transfer length	1 sample increments to 4,194,304
	Data formats	Binary Twos complement Absolute value
	Transfer speed	Conversion rate / 4 (25 Msamples/second)
Nonvolatile memory (EEPROM)	Size	1K bits
	Organization	64 x 16 bits
	User registers	2 x 16 bits
	Checksum	16-bit CRC (CCITT - reverse)
	Number of write cycles	10,000
	Data retention	20 years

Table A-1. DAS-4200 Series Specifications (cont.)

Feature	Attribute	Specifications
Bus interface	Bus	PC ISA bus (8.0 or 8.33 MHz)
	I/O map address size	16 bytes in two blocks of 8 bytes
	I/O data transfer size	8 bits
	Memory map address size	16K bytes in upper memory
	Memory data transfer size	16 bits
	Data formats	Twos complement
	Access speed	3 Msamples/second to 7 Msamples/second (16-bit mode) 1 Msamples/second (8-bit mode)
	Zero wait state	Programmable
	Memory segmentation	Entire memory or 16K byte segments
	Acquisition length	4-sample increments to memory size
General	Size	Full-size AT extension board
	Power consumption	2.7 A at +5.0 V, typical 0.3 A at +12.0 V, typical 0.2 A at −12.0 V, typical
	Operating temperature	0 to + 55°C (ambient)
	Storage temperature	−20 to +70°C

Notes

[1] You can change the input impedance using two plug-in resistors per channel; refer to page 3-15.

[2] For conversion into absolute value data, use twos complement coding. The absolute value data should be interpreted as twos complement data. The conversion into absolute value data takes place when data is read from buffer memory by the host computer or the peak detector; the contents of buffer memory are not converted into absolute value format.

[3] Higher gains provide a slightly reduced bandwidth.

[4] The step size of the offset setting depends on the vernier gain.

[5] The nominal setting should be near −2.0 V for best ADC performance.

[6] The input bandwidth is measured including digitization (50 Ω input impedance). If AC input coupling is selected, the lower cutoff frequency is 4 Hz.

[7] The post-trigger counter is loaded with the start counter value for peak detection; it is not used during an about-trigger acquisition or during a peak detection.

[8] If used with ETS, the maximum speed is 12.5 Msamples/second.

B

Keithley Memory Manager

The Keithley Memory Manager (KMM) is included in your ASO software package as a utility you can use to avoid the memory limitations that Windows can impose on your application. The KMM reserves a memory heap that is part of the total physical memory available in your system. When your application program requests memory, the KMM takes the memory from the reserved memory heap rather than the Windows global heap. The KMM is DAS-board-independent and can be used by multiple Windows programs simultaneously. Also, the memory allocated by the KMM can be used by a DMA controller.

The KMM includes the following files:

- **VDMAD.386** is a customized version of Microsoft's Virtual DMA Driver for use in the Windows 3.x environment. When you use the KMM to reserve a memory heap, Microsoft's Virtual DMA Driver is replaced by the VDMAD.386 file.

- **VDMAD.VXD** is a customized version of Microsoft's Virtual DMA Driver for use in the Windows 95 environment. When you use the KMM to reserve a memory heap, Microsoft's Virtual DMA Driver is replaced by the VDMAD.VXD file.

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

- **KMMSETUP.EXE** is a utility you can use with Windows 3.x or Windows 95 to set up the KMM parameters and modify your Windows configuration files accordingly.

Installing and Setting Up the KMM in Windows 3.x

To install and set up the KMM whenever you start up Windows, you must modify the SYSTEM.INI file. The following subsections describe how you can modify the SYSTEM.INI file using either the KMMSETUP.EXE utility or a text editor.

Using KMMSETUP.EXE

Use KMMSETUP.EXE to modify your Windows SYSTEM.INI file. When you install the ASO software, the installation utility creates a program group called Keithley DAS-4200 Series under the Windows 3.x Program Manager. Follow these steps to start the KMM Setup utility:

1. Locate the Keithley DAS-4200 Series program group. If necessary, use the Window menu of Program Manager to locate the program group.

2. To start the KMM Setup utility, double-click the icon labelled Memory Manager Setup in the Keithley DAS-4200 Series program group.

3. When the KMM Setup window appears, click **Help** for instructions on using the utility.

Note: By default, the ASO installation utility copies the VDMAD.386 file to the C:\WINDOWS directory. If you have moved the file to another directory, type the correct path and file name or click **Browse** under **New VDMAD.386** in the KMM Setup window to locate the file.

Using a Text Editor

In Windows 3.x, you can use a text editor to modify the [386Enh] section of your SYSTEM.INI file, as follows:

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

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

   Note: By default, the software installation utility copies the VDMAD.386 file to the C:\WINDOWS directory. If you have moved the file to another directory, type the correct path and file 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 MB of memory installed and you specify `KEIDMAHEAPSIZE=1000` (1 MB), Windows can only see and use 7 MB.

   If you do not add the `KEIDMAHEAPSIZE` keyword or if the size you specify is less than 128, a 128-KB 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.

Installing and Setting Up the KMM in Windows 95

When you install the ASO software on a Windows 95 system, the installation utility creates a menu (as well as a program group) called Keithley DAS-4200 Series. Follow these steps to start the KMM Setup utility:

1. From the task bar, click **Start**.

2. On the Start menu, point to **Programs**.

3. On the Programs menu, point to **Keithley DAS-4200 Series**.

4. On the DAS-4200 Series menu, click **Memory Manager Setup**.

5. When the KMM Setup window appears, click **Help** for instructions on using the program.

Note: By default, the software installation utility copies the VDMAD.VXD file to the C:\WINDOWS directory. If you have moved the file to another directory, type the correct path and file name or click **Browse** under **New VDMAD.VXD** in the KMM Setup window to locate the file.

Removing the KMM

You can always remove the updated information from the Windows configuration files and return all previously reserved memory to Windows. Follow the appropriate step:

- From the KMM Setup window, click **Remove** to remove the updated information.

- From a text editor (for Windows 3.x only), modify and/or delete the appropriate lines in SYSTEM.INI.

In either case, you must restart Windows to make the system changes take effect.

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