DAS-4100 Series

USER'S GUIDE

DAS-4100 Series
User's Guide

Revision A - October 1995
Part Number: 94540

New Contact Information

Keithley Instruments, Inc.
28775 Aurora Road
Cleveland, OH 44139

Technical Support: 1-888-KEITHLEY
Monday – Friday 8:00 a.m. to 5:00 p.m (EST)
Fax: (440) 248-6168

Visit our website at http://www.keithley.com

Keithley MetraByte Division

Keithley Instruments, Inc.

440 Myles Standish Blvd. Taunton, MA 02780

Telephone: (508) 880-3000 • FAX: (508) 880-0179

Preface

The *DAS-4100 Series User's Guide* provides the information needed to install and use DAS-4101 Series and DAS-4102 Series 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-4101 and DAS-4102 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-4100 Series boards apply to all DAS-4101 and DAS-4102 boards. When a feature applies to a particular board, that board's name is used.

The *DAS-4100 Series User's Guide* is organized as follows:

- Chapter 1 provides an overview of the features of DAS-4100 Series boards, including a description of supported software and accessories.
- Chapter 2 provides a detailed technical description of the features of DAS-4100 Series boards.
- Chapter 3 describes how to unpack, install, set up, and connect applications to DAS-4100 Series boards.
- Chapter 4 describes how to use the scope and test program to test the functions of DAS-4100 Series boards.
- Chapter 5 provides troubleshooting information.
- Appendix A lists the specifications for DAS-4100 Series boards.
- Appendix B describes the Keithley Memory Manager.
- Appendix C presents bandwidth charts for the supported input ranges.

An index completes this manual.

Note: Not all features of DAS-4100 Series boards are currently supported by all software packages. Refer to the documentation provided with your software package to determine which features are supported.

Table of Contents

List of Figures

List of Tables

1

Overview

DAS-4100 Series boards are analog input boards for IBM® PC AT® or compatible computers. This chapter describes the features of the DAS-4100 Series boards, the software that supports them, and available accessories.

Note: Not all features of DAS-4100 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-4100 Series boards are as follows:

- The boards support high-speed data acquisition on one or two analog input channels; two-channel operation is simultaneous.
- The analog-to-digital converter (ADC) can digitize an analog input signal at a rate of 64 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 can support, as an option, Equivalent Time Sampling (ETS) for repetitive waveforms; ETS provides conversion rates of up to 2.048 Gsamples/second.

- 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
  - Video digitization
  - Acquisition of optical and laser signals

Supporting Software

The following software is available for operating DAS-4100 Series boards:

- **DAS-4100 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-4100 Series boards.
- **ASO-4100 software package** - The optional Advanced Software Option for DAS-4100 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++, or Microsoft Visual Basic™ for Windows. The package also includes support files, utility programs, and language-specific example programs. Refer to the *DAS-4100 Series Function Call Driver User's Guide* for more information.

- **DAS-4100 Series configuration utility** - The configuration utility (CFG4100.EXE), provided as part of both the DAS-4100 Series standard software package and the ASO-4100 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-4100 Series Function Call Driver and other software packages to perform the board's operations. Refer to page 3-6 for more information.
- **DAS-4100 Series scope and test program** - The scope and test program (D4100.EXE), provided as part of both the DAS-4100 Series standard software package and the ASO-4100 software package, runs under DOS and allows you to test the hardware features of a DAS-4100 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-4100 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 following accessories are available for use with the DAS-4100 Series boards:

- **SDC-5600 Digital Signal Processing board** - Uses the optional DSP port on the DAS-4100 Series board to transfer data for digital signal processing; available from Sonix Inc., 8700 Morrissette Drive, Springfield, VA 22152 (703-440-0222).
- **Memory expansion accessories**- Provide up to 128M bytes of additional buffer memory for storing data; refer to the Keithley MetraByte catalog or contact your local sales office for information on obtaining these accessories.

2

Technical Reference

A functional block diagram of the DAS-4100 Series board is shown in Figure 2-1.

Figure 2-1. DAS-4100 Series Functional Block Diagram

The analog signal is applied to one of the two input connectors (Channel A or Channel B). You can use software-selectable AC or DC coupling, and 50Ω or 1MΩ input impedances. The input signal is buffered and then fed into a programmable attenuator stage, followed by a programmable gain stage, which 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 are 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 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.

An analog signal in the range of –16 to +16 V may be applied to the Analog Trigger In connector. Operating under software control, the board can be programmed to respond to either the rising or falling edge of the trigger signal.

The remainder of this chapter describes the analog input features of DAS-4100 Series boards in more detail.

Analog-to-Digital Converter (ADC)

The ADC on DAS-4100 Series boards is a 64 Msamples/second, 8-bit flash converter. This section describes the data format, reference voltage range and vernier gain, static conversion errors, noise gain, and dynamic conversion errors of the ADC.

Data Format

The ADC outputs data in a twos complement data format (–128 to +127) where –128 corresponds to negative full scale and +127 corresponds to positive full scale.

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 –2.1 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-4100 Series boards, the resolution is eight bits and the ADC full-scale input voltage range is ±4 V; therefore, the resulting step width is 31.25 mV. Figure 2-2 illustrates a 3-bit ADC example.

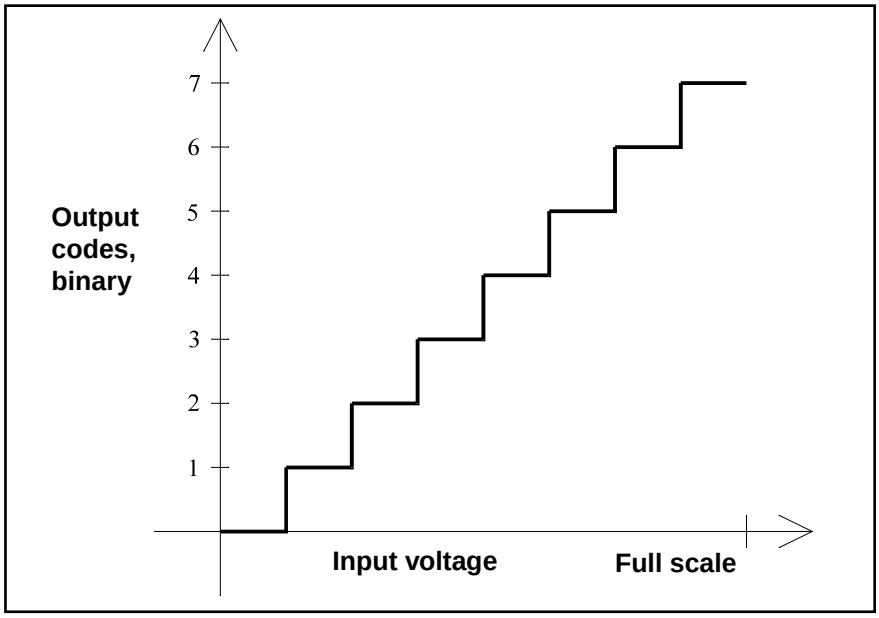

Figure 2-2. Ideal Transfer Function of a 3-Bit ADC

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-4100 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.

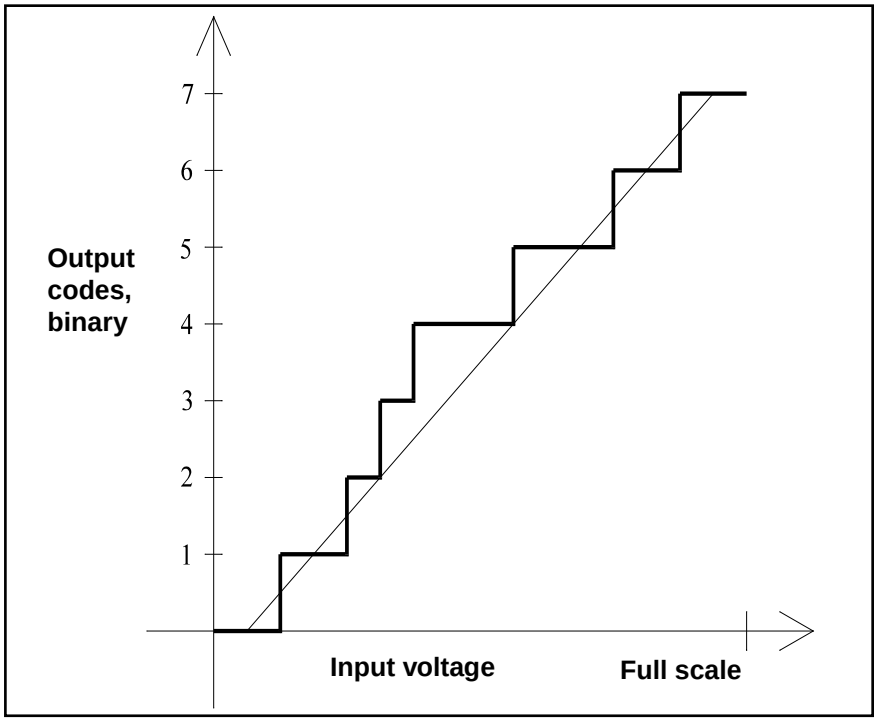

Figure 2-3. Non-Ideal Transfer Function of a 3-Bit ADC

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-4100 Series boards is specified with an integral and differential nonlinearity of ±0.6 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 0.4 LSBs wide and all odd steps 1.6 LSBs wide), the SNR is reduced to approximately 46.3 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 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 1.23 MHz, DAS-4100 Series boards have an ENOB of 7.5 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-4101 Series boards have a single analog input. DAS-4102 Series boards can acquire data from either analog input (Channel A or B), or from both channels simultaneously. The software is used to specify the channel(s).

The analog input channels are terminated with a 50 Ω socketed resistor. You can use the configuration file to disconnect this resistor by operating a relay; in this case, the input resistance is 1MΩ . You can also replace the resistor to select any input impedance between 50 Ω and 1 MΩ. Refer to page 3-12 for more information.

Note: To use a 10:1 oscilloscope probe, you must select the 1 MΩ input resistance under software control.

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 11.3 V peak-to-peak.

Input Ranges

DAS-4100 Series boards currently support 16 bipolar factory-calibrated analog input ranges. Through software, you specify the analog input range and the gain of the analog input channel.

Table 2-1 lists the analog input ranges supported by DAS-4100 Series boards and their corresponding gain codes. The gain code is used in software to determine the range. The choice of gain code affects the bandwidth; refer to Appendix C for more information.

Table 2-1. Analog Input Ranges

Input Range	Gain Code	Bandwidth (–3dB) DC to:
±100 mV	12	100 MHz
±125 mV	8	110 MHz
±250 mV	4	100 MHz
±400 mV	13	140 MHz
±0.5 V	0	100 MHz
±0.5 V	9	160 MHz
±0.5 V	14	150 MHz
±0.625 V	10	160 MHz
±0.8 V	15	160 MHz
±1 V	5	210 MHz
±1 V	11	170 MHz
±1.25 V	6	220 MHz
±2 V	1	250 MHz
±2 V	7	230 MHz
±2.5 V	2	250 MHz
±4 V	3	280 MHz

Memory

This section describes memory on the DAS-4100 Series board and memory on the host computer.

Onboard Memory

DAS-4100 Series boards contain buffer memory for storing data and nonvolatile memory for storing calibration values.

Buffer Memory

Since the conversion rate of DAS-4100 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 two samples from the ADC are packed together and written to the memory buffer as one block.

The DAS-4101 contains 64K, 256K, 1M, or 2Mbytes of onboard memory; the DAS-4102 contains 64K, 256K, or 1Mbytes. If you require larger memory sizes, you can use up to eight memory expansion accessories with up to 16M bytes of memory each to provide a maximum of 128M bytes of memory. Since only one expansion accessory can be active at any given time, the maximum length of a single data acquisition is 16,777,216 samples. Intervention by the host computer is necessary to switch between expansion accessories. You must specify that you are using a memory expansion accessory by setting a jumper on the board; jumper information is supplied with the memory expansion accessory.

Whenever a DAS-4100 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-4100 Series boards contains 128 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 four 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-4100 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-4100 Series boards require sixteen bytes in the I/O address space of the host computer.

You select the base address for the I/O address space by setting jumpers on the board; refer to page 3-9 for information.

Memory Address Space

The memory address space of the host computer is used for reading the acquired data from the DAS-4100 Series onboard buffer memory or expansion accessory memory and for loading the counters. The host computer accesses the onboard memory using the decoding logic on the DAS-4100; onboard buffer memory is mapped to the host computer upper memory. The host computer accesses the memory of an expansion accessory using the bus interface of the memory expansion accessory; refer to the documentation provided with the expansion accessory for more information.

Figure 2-4 illustrates the memory address space of a host computer.

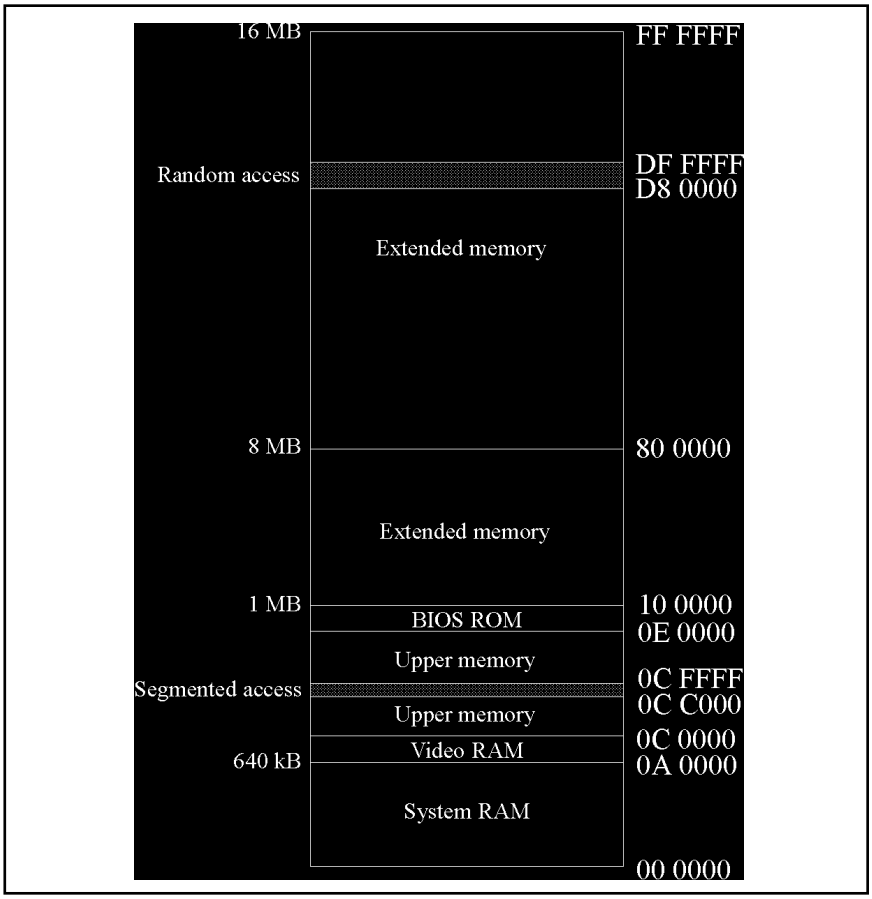

Figure 2-4. Host Computer Memory Address Space

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-4100 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 3-11 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: a 16 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 3-12 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-4100 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 0 to 16,777,216 samples in 2-byte increments.

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 64 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, or 128, as shown in Table 2-2.

Table 2-2. Available Conversion Rates Using Internal Clock

Divider	Conversion Rate	Sample Period
256	64.0 Msamples/second	15.625 ns
512	32.0 Msamples/second	31.25 ns
1,024	16.0 Msamples/second	62.5 ns
2,048	8.0 Msamples/second	125 ns
4,096	4.0 Msamples/second	250 ns
8,192	2.0 Msamples/second	500 ns
16,384	1.0 Msamples/second	1000 ns
32,768	0.5 Msamples/second	2000 ns

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 5 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 64 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 J700; refer to page 3-16 for information.

Triggers

A trigger is an event that determines when a DAS-4100 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-4100 Series boards.

Trigger Sources

DAS-4100 Series boards support software triggers, analog triggers, and digital triggers. These trigger sources are described in the following sections.

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 changes from a voltage that is less than the trigger level (threshold) to a voltage that is greater than the trigger level (positive-edge trigger).
- The analog input signal changes from a voltage that is greater than the trigger level (threshold) to a voltage that is less than the trigger level (negative-edge trigger).
- The analog input signal is already above the trigger level at the time the board becomes ready to accept a trigger (positive-level trigger).
- The analog input signal is already below the trigger level at the time the board becomes ready to accept a trigger (negative-level trigger).

DAS-4100 Series boards can be triggered by the analog input signal on Channel A, on Channel B (DAS-4102 Series boards), or by a signal applied to the Analog Trigger Input. To trigger on Channel A (or B), you can use software to program the threshold in 256 steps covering the software-selected input range. To trigger using the Analog Trigger Input, you can program the threshold in 256 steps from –16 to +15.875 V.

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.

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.

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.

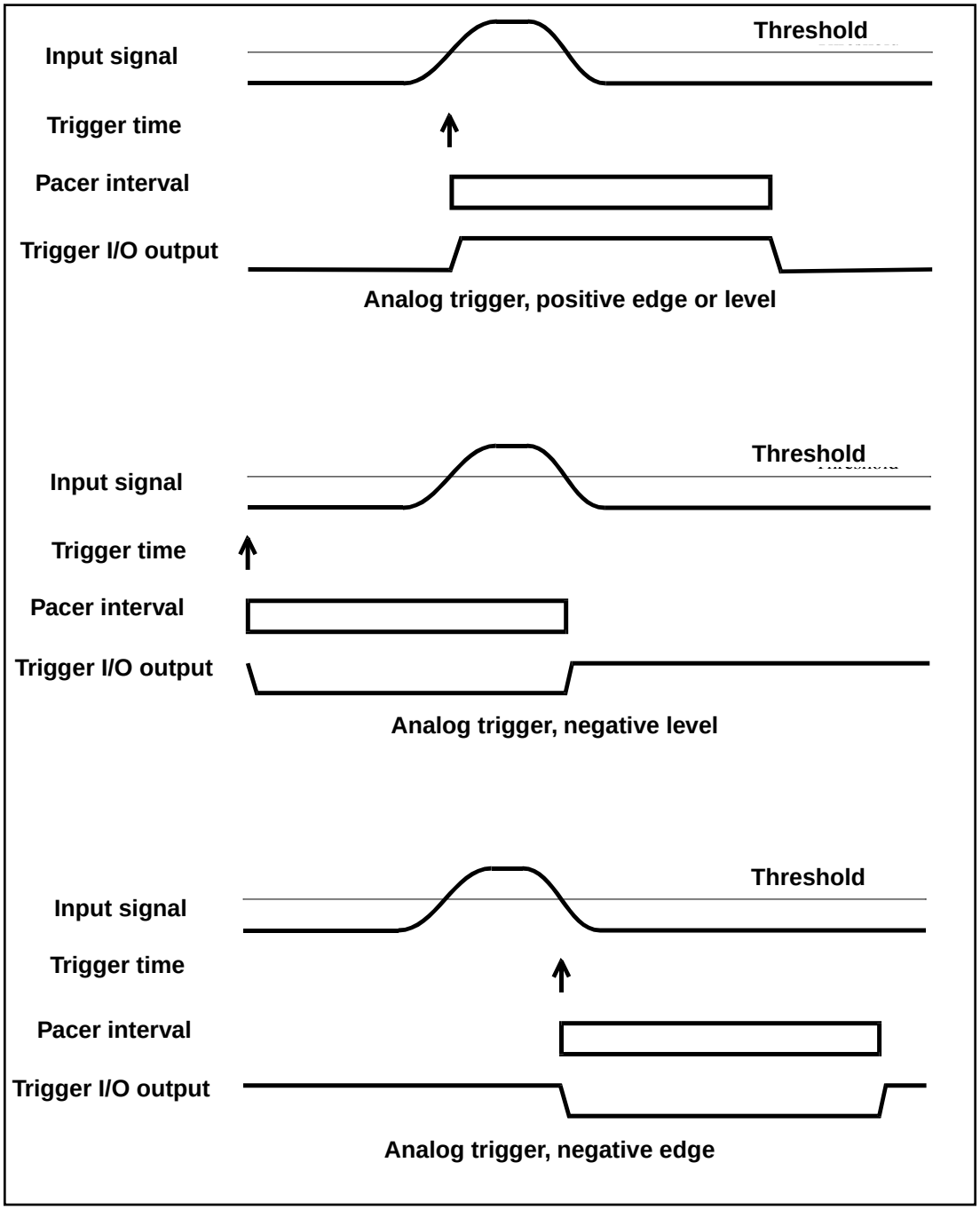

Figure 2-5. Analog Trigger Modes

Figure 2-6 illustrates post-trigger acquisition.

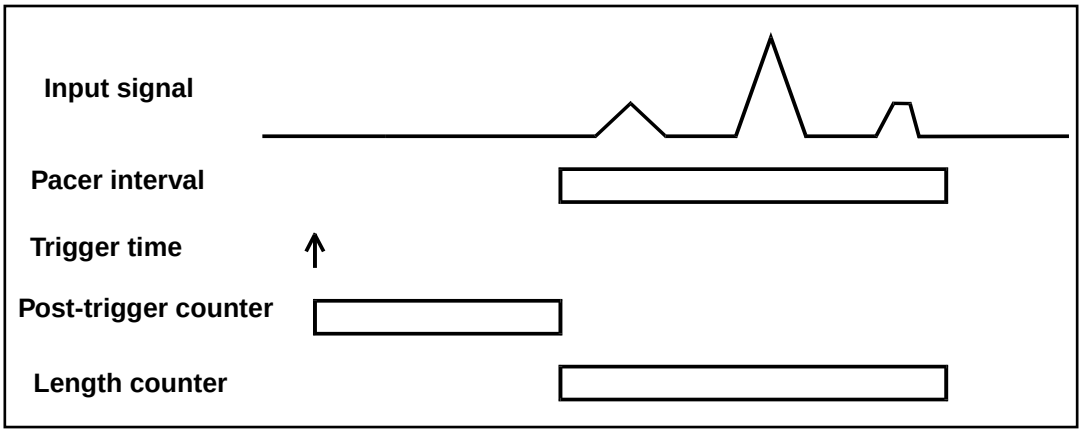

Figure 2-6. Post-Trigger Acquisition

Figure 2-7 illustrates the effect of the start and length counter values on the onboard buffer memory.

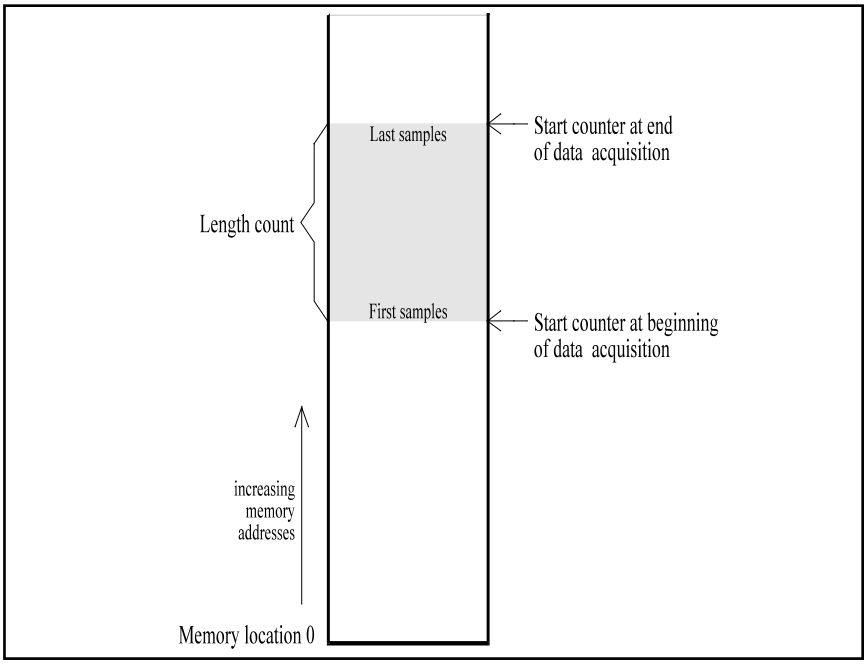

Figure 2-7. Memory Usage in Post-Trigger Acquisition

The counters are programmable in increments of two 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 two. 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. Two 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 two extra samples. If the start counter is not reloaded, the next acquisition overwrites these samples with the first two 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.

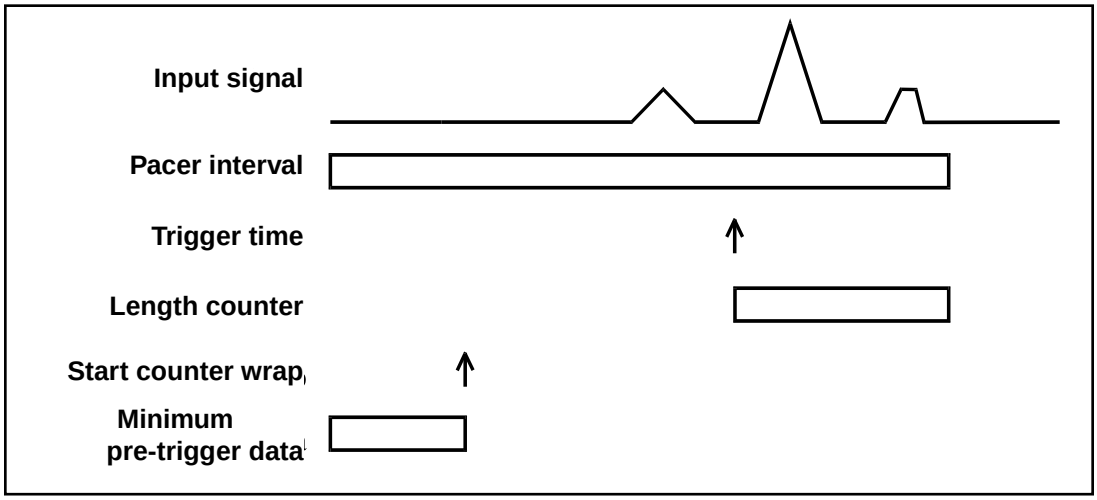

Figure 2-8. About-Trigger Acquisition

The counters are programmable in increments of two 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 two. 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.

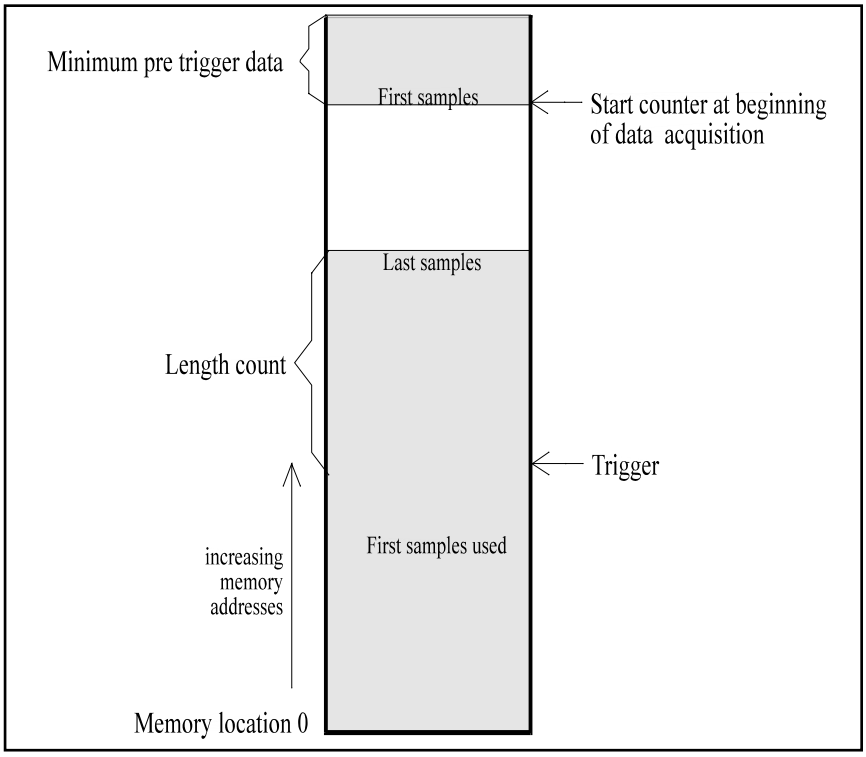

Figure 2-9. Memory Usage in About-Trigger Acquisition

Note: 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-4100 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-4100 Series Function Call Driver User's Guide* for information. The DAS-4100 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-4100 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.

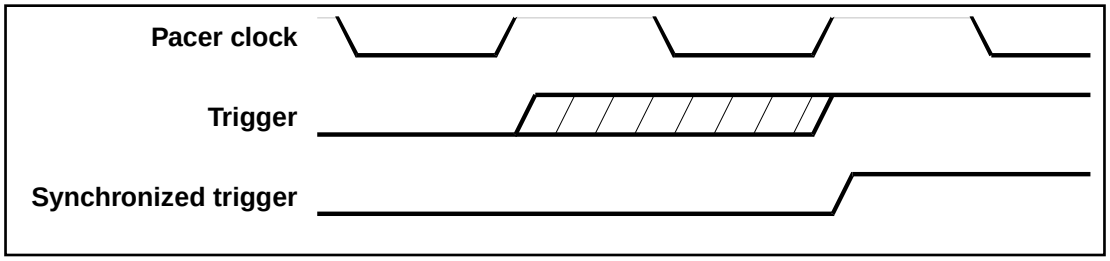

Figure 2-10. Possible Trigger Position

The clock divider of the DAS-4100 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 (15.6 ns with the 64 MHz clock) rather than one period of the divided clock. If a clock divide factor of 1 (clock rate of 64 MHz) is selected, both methods yield identical results. Figure 2-11 illustrates this trigger jitter.

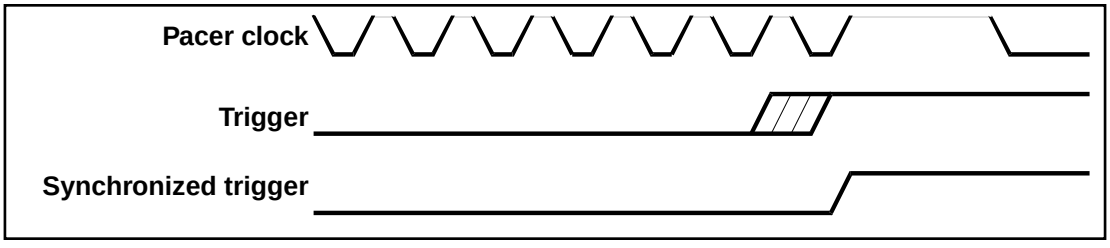

Figure 2-11. Trigger Jitter with Synchronized Divider

The trigger synchronization function also operates with an external pacer clock.

Equivalent Time Sampling (ETS) Option

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 64 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 16.4 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 (2.05 Gsamples/second). Figure 2-12 illustrates an ETS factor of two.

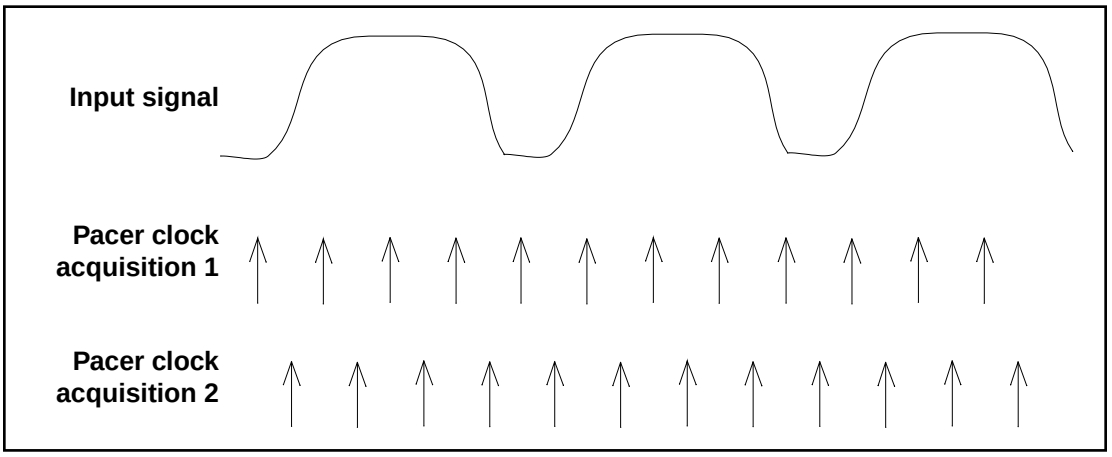

Figure 2-12. Equivalent Time Sampling (ETS)

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.

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-4100 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-4100 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.

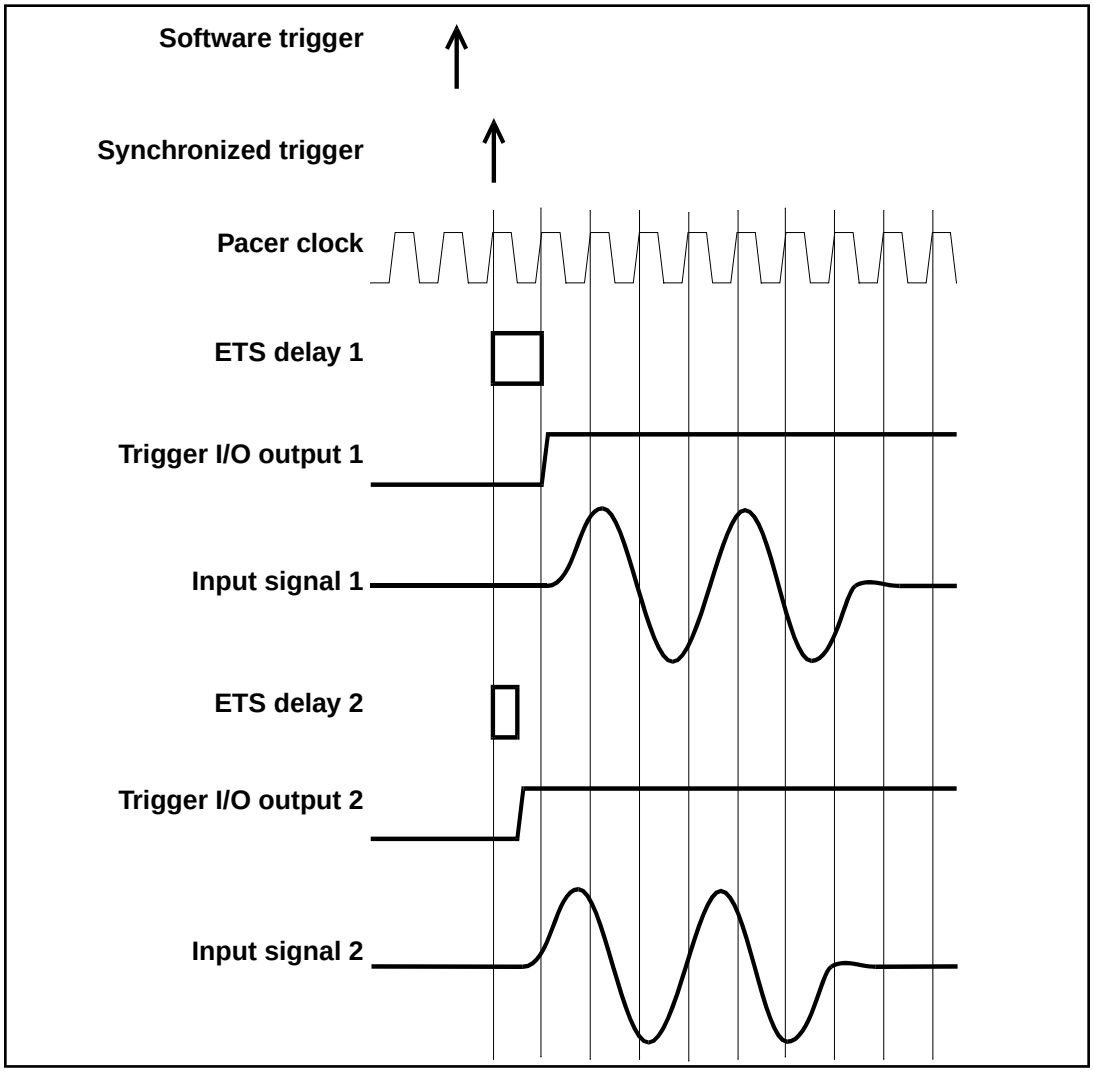

Figure 2-13. ETS Delay

Peak Detector Option

DAS-4100 Series boards can be equipped with an optional 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 96 Msamples/second and reads the data from memory using the start counter for address generation.

3

Setup and Installation

This chapter contains the information you need to install and use your DAS-4100 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-4100 Series board, perform the following steps when unpacking the board:

1. Remove the wrapped DAS-4100 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-4100 Series standard software package and how to install the ASO-4100 software package from both DOS and Windows. To install other software packages, refer to the documentation supplied with the software package.

Installing the DAS-4100 Series Standard Software Package

To install the DAS-4100 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-4100 Software Package

The ASO-4100 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-4100 software package.

DOS Installation

To install the DOS version of the ASO-4100 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-4100 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. From the Program Manager menu, choose File and then choose Run.
5. Assuming that you are using disk drive A, type the following at the command line in the Run dialog box, and then select 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.

The installation program also creates a DAS-4100 family group; this group includes example Windows programs and help files.

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-4100 Series boards by setting jumpers on the board and/or by specifying the configuration in a configuration file:

- Base I/O address
- Memory address
- Memory x 2 option (for DAS-4101/2M)
- Interrupt level
- DC/AC coupling
- Zero wait state
- Input impedance for analog input channels
- Input impedance for Clock I/O connector
- Input impedance for Trigger I/O connector
- Input impedance for Analog Trigger In connector
- Ground connection

Table 3-1 lists the items that are configurable for DAS-4100 Series boards, the available options, the default settings in the configuration file, and the default jumper setting.

Table 3-1. Configuring DAS-4100 Series Boards

Attribute	Options	Where Option is Set		Default in Configuration File	Default on Board
		File	Board		
Base I/O address[1]	&H200 to &H3F0	✔	✔	&H250	&H250
Memory address[1]	A 0000 to D C000	✔	✔	C C000	C C000
Interrupt level[1]	2, 5, 7, 10, 11, 12, 15	✔	✔	7	7
DC/AC coupling	DC, AC	✔		DC	Not applicable
Zero wait state[2]	Enabled, Disabled	✔		Enabled	Not applicable
Input impedance	50 Ω to 1 MΩ	✔		50 Ω	49.9 Ω
Ground connection	None, Case-to-analog		✔	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.

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-4100 Series Function Call Driver and other software packages to perform DAS-4100 Series board operations. A default configuration file called DAS4100.CFG is provided in both the DAS-4100 Series standard software package and the AS0-4100 software package. The factory-default settings in DAS4100.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 CFG4100.EXE configuration utility, shipped with both the DAS-4100 Series standard software package and the ASO-4100 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 configuration utility from DOS or Windows, as follows:
   - *If you are running under DOS*, from the directory containing the CFG4100.EXE configuration utility, enter the following at the DOS prompt:

     `CFG4100` *filename*

     where *filename* is the name of the configuration file you wish to create or modify.
   - *If you are running under Windows*, choose Run from the Program Manager File menu, enter the following in the box, and select OK:

     `CFG4100` *filename*

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

     Make sure that you enter the correct path to CFG4100.EXE, or use the Browse button to find this file.

   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 DAS4100.CFG.

Note: The example programs, provided with the ASO-4100 software package, use the default configuration file DAS4100.CFG. If you intend to use the example programs, make sure that DAS4100.CFG exists and that the settings in DAS4100.CFG match the jumper settings of your board.

2. On the opening menu screen, enter the number of DAS-4100 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.

Note: If you modify the port (base I/O) address or the memory address, you can press **S** to display the corresponding jumper settings. Information on setting these jumpers is also provided in the following section.

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-4100 Series boards are shown in Figure 3-1.

Figure 3-1. Jumper Locations

Setting the Base I/O Address

DAS-4100 Series boards require sixteen bytes in the I/O address space of the host computer. DAS-4100 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 (J600) to set the base I/O address. Table 3-2 lists the settings of J600 for base I/O addresses in the range of 200h to 2F0h. 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

	IO Map	J600-1	J600-2	J600-3	J600-4	J600-5	J600-6
1	200-20F	OUT	IN	IN	IN	IN	IN
2	210-21F	OUT	IN	IN	IN	IN	OUT
3	220-22F	OUT	IN	IN	IN	OUT	OUT
4	230-23F	OUT	IN	IN	IN	OUT	OUT
5	240-24F	OUT	IN	IN	OUT	IN	IN
6	250-25F[1]	OUT	IN	IN	OUT	IN	OUT
7	260-26F	OUT	IN	IN	OUT	OUT	IN
8	270-27F	OUT	IN	IN	OUT	OUT	OUT
9	280-28F	OUT	IN	OUT	IN	IN	IN
10	290-29F	OUT	IN	OUT	IN	IN	OUT
11	2AO-2AF	OUT	IN	OUT	IN	OUT	IN
12	2BO-2BF	OUT	IN	OUT	IN	OUT	OUT
13	2CO-2CF	OUT	IN	OUT	OUT	IN	IN
14	2DO-2DF	OUT	IN	OUT	OUT	IN	OUT
15	2EO-2EF	OUT	IN	OUT	OUT	OUT	IN
16	2FO-2FF	OUT	IN	OUT	OUT	OUT	OUT
	Address bits	A9	A8	A7	A6	A5	A4

Notes
[1] Default setting.

Setting the Memory Address

Onboard memory on DAS-4100 Series boards consists of banks of 16K bytes in upper memory. DAS-4100 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

	Map	J601-1	J601-2	J601-3	J601-4	J601-5	J601-6
1	C000	IN	IN	OUT	OUT	OUT	OUT
2	C400	IN	IN	OUT	OUT	OUT	IN
3	C800	IN	IN	OUT	OUT	IN	OUT
4	CC00[1]	IN	IN	OUT	OUT	IN	IN
5	D000	IN	IN	OUT	IN	OUT	OUT
6	D400	IN	IN	OUT	IN	OUT	IN
7	D800	IN	IN	OUT	IN	IN	OUT
8	DC00	IN	IN	OUT	IN	IN	IN
	Address bits	A19	A18	A17	A16	A15	A14

Notes
[1] Default setting.

The host computer must leave room for the onboard memory of the DAS-4100 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-4100 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

J603	Interrupt	Bus Pin
J603-1	IRQ 15	D6
J603-2	IRQ 12	D5
J603-3	IRQ 11	D4
J603-4	IRQ 10	D3
J603-5[1]	IRQ 7	B21
J603-6	IRQ 5	B23
J603-7	IRQ 2	B4

Notes
[1] Default setting.

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-4100 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.

The input voltage range and resistance is determined by two plug-in resistors per channel. Channel A has a series resistor, R100, followed by a relay controlled termination resistor to ground, R101. Channel B has two resistors serving the same purpose: R116 and R117. The resistors are plugged into small component jacks on the board making changes easy and eliminating the need to solder. This voltage divider is followed by another relay which allows AC or DC coupling. This is followed by a 1.0 MΩ resistor to ground and a very high input resistance buffer. The resistance of the FET input buffer can be ignored.

Figure 3-2 illustrates the analog input circuitry.

Figure 3-2. Analog Input Circuitry

The DAS-4100 is shipped with 50 Ω input resistance and an 8 V maximum range. If a higher range is desired, the voltage divider must be changed. The tap on the voltage divider that goes to the buffer should not go higher than a ±8 V range to avoid clipping, assuming zero volts offset. For example, to maintain 50 Ω, but accommodate a 16 V signal, the two resistors should be 25 Ω.

For an input resistance of less than 10,000 Ω, the 1 MΩ resistor to ground can be ignored. The values for the resistors are shown in Table 3-5. Note that *R* represents the desired input resistance and *V* represents the desired input voltage range.

Table 3-5. Input Impedance for Analog Input Channels

Impedance	Channel A	Channel B
Less than 10,000 Ω	$R101 = \frac{8R}{V}$	$R117 = \frac{8R}{V}$
	$R100 = R - R101$	$R116 = R - R117$
Greater than 10,000 Ω	$R100 = \frac{R \times (V - 8)}{V}$	$R116 = \frac{R \times (V - 8)}{V}$
	$R101 = \frac{1,000,000 \times (R - R100)}{1,000,000 + R100 - R}$	$R117 = \frac{1,000,000 \times (R - R116)}{1,000,000 + R116 - R}$

Table 3-6 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. 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.

Table 3-6. Input Resistor Selection Chart

Input Resistor (in Ω)	Input Range (in V)	R100/R116 (in Ω)	R100/R116 (in W)	R101/R117 (in Ω)	R101/R107 (in W)
50	8	0.0	0.0	49.9	1.28
	10	10.0	0.40	40.2	1.60
	16	24.9	2.56	24.9	2.56
	20	30.1	4.8	20.0	3.20
75	8	0.0	0.0	75.0	0.84
	10	15.0	0.28	60.4	1.08
	16	37.4	1.72	37.4	1.72
	20	45.3	3.2	30.1	2.12
93	8	0.0	0.0	93.1	0.68
	10	18.7	0.20	75.0	0.88
	16	46.4	1.36	46.4	1.36
	20	56.2	2.6	37.4	1.72
100	8	0.0	0.0	100.0	0.64
	10	20.0	0.20	80.6	0.80
	16	49.9	1.28	49.9	1.28
	20	60.4	2.40	40.2	1.60
1,000	8	0	0.0	1,000	0.08
	10	200	0.04	806	0.08
	16	499	0.12	499	0.12
	20	604	0.24	402	0.16
10,000	8	0	0.0	10,200	0.0
	10	2,000	0.0	8060	0.0
	16	4,990	0.0	4,990	0.0
	20	6,040	0.01	4,020	0.0

Table 3-6. Input Resistor Selection Chart (cont.)

Input Resistor (in Ω)	Input Range (in V)	R100/R116 (in Ω)	R100/R116 (in W)	R101/R117 (in Ω)	R101/R107 (in W)
100,000	8	0	0.0	11,000	0.0
	10	20,000	0.0	86,600	0.0
	16	49,900	0.0	52,300	0.0
	20	60,400	0.0	41,200	0.0
1,000,000	8	0	0.0	OPEN	0.0
	10	200,000	0.0	3,900,000[1]	0.0
	16	499,000	0.0	1,000,000	0.0
	20	604,000	0.0	665,000	0.0

Notes
[1] Default setting.

Trigger and Clock Input Termination

The Clock I/O connector has a 2000 Ω pull-up resistor to +5 V and a jumper selectable 50 Ω termination resistor to ground. The Trigger I/O connector has jumper selectable 100 Ω pull-up resistor to +5 V to obtain a higher drive level than standard TTL levels. They are both followed by a plug in 20 Ω series protection resistor. The 20 Ω resistor, combined with the output resistance of the driver ICs, makes the output appear as approximately 50 Ω.

J700 is associated with the Clock I/O connector and allows a 50 Ω termination resistor to ground. It is intended to be used to terminate 50 Ω lines that are driving the inputs. Signals driving long lines or lines that are driving many devices, where the DAS-4100 is at the end of the line, will be less distorted when properly terminated with 50 Ω.

The 50 Ω termination should not be used when the board is providing the Clock Out signal because it will load down the signal too much.

The 20, 50, and 100 Ω resistors are inserted into solderless component jacks to change configurations or for easy replacement in case of damage.

For example, to increase drive current but reduce protection, you may lower or short out R701 and R706. Figure 3-3 illustrates the Clock I/O connector circuitry; the Clock I/O configuration is shown in Table 3-7. Figure 3-4 illustrates the Trigger I/O connector circuitry; the Trigger I/O configuration is shown in Table 3-8.

Figure 3-3. Clock I/O Connector Circuitry

Table 3-7. TTL Clock I/O Settings, J710

Component	Clock Input Termination	
J700	OUT[1]	2 kΩ pull-up
	IN	R702
R702	50 Ω	
R701	20 Ω Series Protection	

Notes
[1] Default setting.

Figure 3-4. Trigger I/O Connector Circuitry

Table 3-8. TTL Trigger I/O Settings, J711

Component	Trigger Termination Pull-Up	
J701	IN	R707
	OUT[1]	2 kΩ
R707	100 Ω	
R706[2]	20 Ω Series Protection	

Notes
[1] Default setting.
[2] Replace R706 with a shunt if J701 is IN.

Analog Trigger Input

The Analog Trigger In connector is used for external trigger mode. This connector accommodates input of an analog signal in the range of –16 to +16 V. Operating under software control, the board will respond to either the rising or falling edge of the trigger signal. The input presents a 4.8 kΩ resistor load terminated to –1.0 V. The input may be terminated to 50 Ω to ground via one jumper block. When terminating with 50 Ω, the input presents 50 Ω resistor terminated to –0.01 V. If the 50 Ω termination is not installed, the input is diode protected to 60 V_{rms}. Input voltage should be limited to 5 V_{rms} with the 50 Ω termination. Figure 3-5 illustrates the Analog Trigger In connector circuitry; the Analog Trigger In configuration is shown in Table 3-9.

Figure 3-5. Analog Trigger In Connector Circuitry

Table 3-9. Analog Trigger Input

Component	Input Termination	
J201	OUT[1]	4.8 kΩ
	IN	R213
R213	50 Ω	

Notes
[1] Default setting.

Factory-Set Jumpers

The additional jumpers that appear on the DAS-4100 are set for proper board operation and should not be changed. Factory-set jumper settings are listed in Table 3-10 in case of accidental alteration.

Table 3-10. Factory-Set Jumper Locations

Jumper	Setting	Jumper	Setting	Jumper	Setting	Jumper	Setting
J102	IN	J503	LEFT	J704.2	IN	J708	IN
J103	IN	J504	UP	J704.3	IN	J709.1	IN
J104	IN	J505	UP	J706.1	OUT	J709.2	OUT
J105	IN	J602	IN	J706.2	OUT	J709.3	OUT
J202	IN	J605	UP	J706.3	OUT	J709.4	IN
J400	OUT	J606	IN	J706.4	IN	J709.5	IN
J402	NONE	J703	IN	J706.5	OUT	J712	OUT
J403	NONE	J704.1	OUT	J707	IN		

Memory Size

The DAS-4100 Series boards are equipped with different types of memory chips, depending on the memory size (64K through 2M). Jumpers J304, J305, J306, J307, J308 and J401 are set at the factory to correspond to the memory size and type, and should not be changed. The information in Table 3-11 is provided for reference only.

Table 3-11. Factory-Set Memory Jumpers

Board	J304	J305	J306	J307	J308	J401[1]
DAS-4101/64K	All right	OUT	OUT	IN	OUT	1 up, 2 down, 5 up, 9 up
DAS-4101/256K	All right	OUT	OUT	IN	OUT	1 up, 3 down, 5 up, 9 up
DAS-4101/1M	All right	IN	IN	IN	OUT	1 up, 5 up, 9 up, 10 down
DAS-4101/2M	All left	IN	IN	IN	IN	4 up, 5 up, 8 down, 9 up
DAS-4102/64K	All right	OUT	OUT	IN	IN	1 up, 2 down, 5 up, 9 up
DAS-4102/256K	All right	OUT	OUT	IN	IN	1 up, 3 down, 5 up, 9 up
DAS-4102/1M	All right	IN	IN	IN	IN	1 up, 5 up, 9 up, 10 down

Notes
[1] Positions not shown are OUT.

Adding a Ground Connection

To prevent the switching noise generated by the digital high-speed logic of the DAS-4100 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, insert a jumper into jumper block J607 to add a ground connection between case ground and analog ground. To access jumper block J607, take off the shield by removing the screw at the top of the shield.

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

Installing the Board

Before installing a DAS-4100 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-4100 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-4100 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 SMB 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-4100 Series board; refer to Appendix A for information.

After you install the DAS-4100 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-4100 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

You connect signal sources to a DAS-4100 Series board using the five standard SMB coaxial connectors on the back of the board. Refer to Figure 3-1 on page 3-9 for the location of these connectors, which are used as follows:

- **Channel A** - Attach an analog input signal to Channel A of the DAS-4100 Series board.
- **Analog Trigger In**- Attach an analog signal to the trigger source multiplexer.
- **Channel B** - Attach an analog input signal to Channel B of the DAS-4102 Series board.
- **Trigger I/O** - Attach an external digital trigger to the DAS-4100 Series board; source of output signal.
- **Clock I/O** - Attach an external pacer clock to the DAS-4100 Series board; source of output signal.

The signals on the five connectors are terminated with resistors. The resistors provided with the DAS-4100 Series board have a value of 49.9 Ω, but you can replace these resistors with a different value, if necessary. Refer to page 3-12 for information on replacing resistors for the Channel A and Channel B connector; refer to page 3-16 for information on replacing resistors for the Clock I/O and Trigger I/O connectors.

You can reduce noise interference created by instruments connected to the connectors by adding a ground connection; refer to page 3-21 for information.

4

Scope and Test Program

The DAS-4100 Series scope and test program (D4100.EXE) is a utility program that allows you to test the hardware features available on DAS-4100 Series boards, to recalibrate the analog input section of the board, and to perform basic oscilloscope functions.

D4100 is a menu-based, keyboard-controlled DOS program that requires a VGA compatible display. It has one support file, D4100.PAR, which is shipped with both the DAS-4100 Series standard software package and the ASO-4100 software package.

To run the scope and test program, go to the directory containing the D4100.EXE file and enter the following at the DOS prompt:

```
D4100
```

From the initial screen, press any key to continue. Any errors that are found with the EEPROM configuration data CRC or with the D4100.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 D4100.EXE

Table 4-1 lists the keys that control the D4100.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 D4100.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 4-10 for more information about parameter files.
P	Prints the currently displayed screen. The printer type is controlled through the HP_Print.DRV file.
Q	Quits the program.
R	Redraws the screen. This is useful for clearing the scope display after accumulating waveforms.
S	Saves a parameter file. Refer to page 4-10 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.
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	Toggles the highlight cursor between the bottom and top menus. If a prompt is currently on the screen, the prompt is removed and the highlight location does not toggle.

Table 4-1. Control Keys (cont.)

Key	Description
+	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.

The suffix ’h’ (hexadecimal) can be used on any entered number.

Scope and Test Program Menus

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

A/D Menu

Table 4-2 lists the parameters on the A/D menu. You can access the A/D menu at any time by pressing the **A** key. The A/D menu has two pages; you may toggle between them using the page up and page down keys.

Table 4-2. A/D Menu

Parameter	Description
Sampling Rate	Changes the conversion rate for the board. The conversion rate can range from 0.500 Msamples/second to 16384 Msamples/second, which is an ETS rate.
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 2-24.
Channel select	Determines which channels will be displayed. Choices are Channel A only, Channel B only, both channels, A updating B, frozen, A frozen B updating, or both frozen.
Buffer post	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 two. Changing the post-trigger delay affects the waveform location pointed to by buffer start.
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.
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 8,388,608. If the buffer length specified is longer than memory available, then the collection will wrap around.
Voltage level	Sets the voltage input level of the board. This can range from 0.20 V to 8.0 V peak-to-peak. This parameter is duplicated for Channel B.

Table 4-2. A/D Menu (cont.)

Parameter	Description
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. This parameter is duplicated for Channel B.
Vernier gain	Sets the vernier gain. This information is initially taken from the EEPROM, or from the most recently loaded parameter file. This parameter is duplicated for Channel B.
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 turned 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 and common (board is triggered through software control), Thresh A, Thresh B, and Eanalog (board is triggered by the input signal crossing a set threshold level), or Edigital (board is triggered through a TTL signal on the Trigger I/O connector).
Trigger threshold	Specifies the trigger threshold level used by an analog trigger. A Tr_ icon is displayed in Thresh A and Thresh B modes on the left side of the display to indicate the set threshold level.
Trigger in polarity	Only meaningful in external trigger modes. If this is '+' then the waveform will be triggered by a rising edge, otherwise it will trigger on a falling edge.
Trigger out polarity	Controls the polarity of the Trigger I/O connector on the back of the board. If this is '+' then the Trigger I/O connector is high while the board is digitizing and low otherwise; this is reversed for a negative trigger out polarity.
Parallel trigger	Overrides the trigger out polarity switch if this switch is on. Parallel trigger is used to trigger multiple boards simultaneously when all the boards are in external trigger modes.

Table 4-2. A/D Menu (cont.)

Parameter	Description
Interrupts	Used to toggle interrupt generation. Note that D4100 will not actually count interrupts. This switch was provided only for testing the board circuitry with an external device, such as an oscilloscope.
ETS wait	Provides a delay between shots to allow a slow device (such as a pulser/receiver) time to recover between shots. This delay is only used in ETS modes; it has no effect in transient sampling rates.
Clock	Switches between an internal and an external pacer clock. An internal pacer clock is the onboard 64 MHz clock. The external pacer clock is an externally generated clock signal of any frequency up to 64 MHz applied to the Clock I/O connector.
Termination coupling A/B	This parameter is duplicated for Channel B and is used to select the input state of the board. The signal can be either AC or DC coupled, and can be either 50 Ω or 1 MΩ terminated.
A/D board number	Only meaningful in multiple board setups. When switching between boards, all the current parameters are kept.
A/D Base Port	Displays the current base address of the board. This is not a switch; it is displayed for informational purposes only.

Display Menu

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

Table 4-3. Display Menu

Parameter	Description
Scale Factor A/B	Multiplies or divides the waveform by the specified amount. This is useful for splitting the scope display by putting channel A in one half and channel B in the other. Markers on the right side of the scope show the current bounds of the waveform.
Vertical Offset A/B	Allows scrolling of the waveform in the vertical plane. Note that this is purely a display offset; it is not actually affecting the data coming off the DAS-4100 board.
Display start	Allows scrolling through the collected data. If you attempt to scroll past the digitized data you will see random noise; this is merely the data that was in A/D memory upon computer power up.
Accumulate A/B	Turns waveform accumulation on or off. If this is ON, waveforms will not be erased. To clear the display of accumulated waveforms, press the **R** key.
Lookup tables A/B	Controls data coming from the A/D board. The choices are: OFF, twos complement, and absolute value. If lookup tables are OFF, the data comes off in binary format. Note that there are no display differences between binary and twos complement format.
Num. to average	Specifies the number of waveforms to average before displaying. This can range from 1 (averaging off) to 128, by powers of two.
Zero wait	Turns the synchronous ready bus signal ON or OFF. If synchronous ready is ON and the DAS-4100 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-4100 Series board and the motherboard are not synchronized correctly, errors appear in the waveform in the form of large spikes.
Time/points	Specifies whether the time-based entries (buffer start, buffer post, buffer length, display start A/B, gate start A/B, and gate length A/B) are displayed in raw data points or as a time calculated from the current conversion rate.

Gates Menu

Table 4-4 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 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 4-4. Gates Menu

Parameter	Description
Peak detect A/B	Turns the peak detector ON or OFF. Peak detector results are displayed beneath the volts/division display for the appropriate channel.
> / <	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).

Calibrating the DAS-4100 Series Board

When a DAS-4100 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. Input a one-cycle, software-triggered, calibrated triangle waveform into the board. The signal generator must be able to output exact 0.20 V, 0.25 V, 0.50 V, 0.80 V, 1.00 V, 1.25 V, 1.60 V, 2.00 V, 2.50 V, 4.00 V, 5.00 V and 8.00 V amplitude waveforms.
2. For each of the sixteen 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.
3. With the analog input connector off, adjust the offset voltage until the input signal rests exactly in the center of the scope display. This must be done for all 16 input ranges.

The board is now calibrated. Save the current calibration information in a parameter file, or, if you prefer, resave this information to the EEPROM. To save the information to EEPROM, go to the EEPROM menu from the A/D menu. Press the **Page Down** key and select the EEPROM option.

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

Using Parameter Files

The D4100 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:

- **D4100.ADC** - 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 D4100 is exited. This allows you to automatically restore D4100 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.

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; press **Enter** when the highlight is on the correct file.

5

Troubleshooting

If your DAS-4100 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-4100 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 3-9 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 3-12 for instructions.

Table 5-1. Troubleshooting Information (cont.)

Symptom	Possible Cause	Possible Solution
Board does not respond (cont.)	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.
	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-4100 Series board.

Testing Board and Host Computer

To determine whether the problem is in the host computer or in the DAS-4100 Series board, perform the following steps:

1. Remove power connections to the host computer.
2. Unplug any cables from the DAS-4100 Series board.
3. Remove the DAS-4100 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-4100 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-4100 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-4100 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-4100 Series board in place. This test checks the computer accessory slot. If you are using more than one DAS-4100 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-4100 Series board originally in the computer. Try the DAS-4100 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-4100 Series board	Model	DAS-4101/64K DAS-4101/256K DAS-4101/512K DAS-4101/1024K DAS-4102/64K DAS-4102/256K DAS-4102/512K DAS-4102/1024K
	Serial #	_____
	Revision code	_____
Computer	Manufacturer	_____
	CPU type	286 386 486 Pentium
	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 _____
	Windows mode	Standard Enhanced
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
Telex 503989
FAX 508/880-0179

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-4100 Series boards.

Table A-1. DAS-4100 Series Specifications

Feature	Attribute	Specifications
Channels	Number	One (4101 Series) or two (4102 Series) If 4102, both can be used simultaneously
	Channel-to-channel isolation (DC to 50 MHz)	50 dB with channels at same sensitivity 46 dB with 4 V signal on Channel A and Channel B set to 260 mV sensitivity
	Input coupling	DC (default; input range of –8.0 V to +8.0 V without distortion) AC (8 V p-p, maximum input)
	Input impedance	50 Ω (DC coupled) shunted by approximately 20 pF[1]
	Maximum safe input voltage at 50 Ω	5 Vrms continuous, ±250 V transients lasting less than 100 µs
	Input capacitance	20 pF, approximately
ADC	Output Coding	Twos complement (–128 to +127)
	Type	64 Msamples/second, 8-bit flash
	Input reference voltage	0 V to –2.5 V, –2.0 V typical
	Integral and differential linearity	±0.6 LSB

Table A-1. DAS-4100 Series Specifications (cont.)

Feature	Attribute	Specifications
ADC (cont.)	Integral and differential nonlinearity	±0.94 LSB with no missing codes
	Large-signal bandwidth	160 MHz @ Vin = full scale
	Aperture jitter	15 ps rms
	Input slew rate	440 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% @ 64 MHz)
	Equivalent-time sampling period	Time base accuracy (±1 ps) + ADC aperture jitter (±17 ps) + trigger delay jitter (±44 ps) = ±62 ps total (0.787 @ 128 MHz)
Attenuator	Attenuation factor	1, 4, 5, 8
Gain stage	Gain levels	2, 4, 8,10
Offset DAC (DAC1)	Setting	Programmable in 4096 steps; increasing the setting shifts the ADC input voltage to a more negative value[2]
Vernier gain DAC (DAC2)	Reference voltage	Programmable in 4096 steps from 0 V to –2.1 V; increasing setting increases the ADC input voltage range and reduces sensitivity[3]
Input ranges (factory-calibrated)	±100 mV range (gain code 12)	Bandwidth (–3dB)[4] = 100 MHz DC offset range = –1.00 to 2.00 V Offset step size = 0.8791 mV
	±125 mV range (gain code 8)	Bandwidth (–3 dB)[6] = 110 MHz DC offset range = –1.00 to 2.00 V Offset step size = 0.8547 mV
	±250 mV range (gain code 4)	Bandwidth (–3 dB)[6] = 100 MHz DC offset range =–1.00 to 2.00 V Offset step size = 0.7326 mV

Table A-1. DAS-4100 Series Specifications (cont.)

Feature	Attribute	Specifications
Input ranges (factory-calibrated) (cont.)	±400 mV range (gain code 13)	Bandwidth (–3 dB)[6] = 140 MHz DC offset range = –4.00 to 4.00 V Offset step size = 3.516 mV
	±0.5 V range (gain code 0)	Bandwidth (–3 dB)[6] = 100 MHz DC offset range = –1.00 to 1.00 V Offset step size = 0.4884 mV
	±0.5 V range (gain code 9)	Bandwidth (–3 dB)[6] = 160 MHz DC offset range = –4.00 to 4.00 V Offset step size = 0.3419 mV
	±0.5 V range (gain code 14)	Bandwidth (–3 dB)[6] = 150 MHz DC offset range = –4.00 to 4.00 V Offset step size = 4.396 mV
	±0.625 V range (gain code 10)	Bandwidth (–3 dB)[6] = 160 MHz DC offset range = –4.00 to 4.00 V Offset step size = 4.274 mV
	±0.8 V range (gain code 15)	Bandwidth (–3 dB)[6] = 160 MHz DC offset range = –4.00 to 4.00 V Offset step size = 7.033 mV
	±1 V range (gain code 5)	Bandwidth (–3 dB)[6] = 210 MHz DC offset range = –4.00 to 5.00 V Offset step size = 2.930 mV
	±1 V range (gain code 11)	Bandwidth (–3 dB)[6] = 170 MHz DC offset range = –4.00 to 5.00 V Offset step size = 6.838mV
	±1.25 V range (gain code 6)	Bandwidth (–3 dB)[6] = 220 MHz DC offset range = –4.00 to 5.00 V Offset step size = 3.663 mV
	±2 V range (gain code 1)	Bandwidth (–3 dB)[6] = 250 MHz DC offset range = –4.00 to 4.40 V Offset step size = 1.954 mV
	±2 V range (gain code 7)	Bandwidth (–3 dB)[6] = 230 MHz DC offset range = –4.00 to 4.40 V Offset step size = 5.861 mV

Table A-1. DAS-4100 Series Specifications (cont.)

Feature	Attribute	Specifications
Input ranges (factory-calibrated) (cont.)	±2.5 V range (gain code 2)	Bandwidth (–3 dB)[6] = 250 MHz DC offset range = –3.00 to 4.00 V Offset step size = 2.442mV
	±4 V range (gain code 3)	Bandwidth (–3 dB)[6] = 280 MHz DC offset range = –2.00 to 3.00 V Offset step size = 3.907 mV
Counters	Start	Used for data acquisition: Length: 16,777,216 Resolution: 2 Used for peak detection: Length: 16,777,216 Resolution: 1
	Length	Used for data acquisition: Length: 16,777,216 Resolution: 2 Used for peak detection: Length: 8,388,608 Resolution: 1
	Post-trigger[5]	Used for data acquisition: Length: 16,777,216 Resolution: 2
Onboard buffer memory	Size	DAS-4101/64K: 64K bytes DAS-4101/256K: 256K bytes DAS-4101/1M: 1M bytes DAS-4101/2M: 2M bytes DAS-4102/64K: 64K bytes DAS-4102/256K: 256K bytes DAS-4102/1M: 1M bytes

Table A-1. DAS-4100 Series Specifications (cont.)

Feature	Attribute	Specifications
Pacer clock	Internal	Divisors: 1, 2, 4, 8, 16, 32, 64, 128 Internal 64 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 64 MHz Minimum pulse width: 4 ns (high or low) Input load: 2 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	5 ns (high or low)
	External digital trigger input load	1 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)	2 samples to memory size
	Post-trigger delay	0 to memory size in 2-byte increments (31.25ns@ 64MHz)
	Minimum pre-trigger data	0 to memory size in 2-byte increments
	Trigger jitter	One period of the undivided pacer clock (15.6 ns)
Equivalent time sampling (ETS)[6]	Delay range	10 ns to 22 ns
	Delay resolution	39 ps (256 steps to 10 ns)
	Delay accuracy	140 ps
	Maximum rate	2.05 Gsamples/second

Table A-1. DAS-4100 Series Specifications (cont.)

Feature	Attribute	Specifications
Peak detector[6]	Start address	1 sample increments
	Detection length	1 to 4 memory size
	Data formats	Binary Twos complement Absolute value
	Speed	Conversion rate / 4 (for 64 MHz internal pacer clock: 16 Msamples/second, maximum
	Results	Peak value (8 bits) Peak address (22 bits)
DSP port[6]	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 / 2 (32 Msamples/second)
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 or 8 bits (programmable)
	Data formats	Binary Twos complement Absolute value
	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

Table A-1. DAS-4100 Series Specifications (cont.)

Feature	Attribute	Specifications
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 3-12.
[2] The step size of the offset setting depends on the vernier gain.
[3] The nominal setting should be near –2.0 V for best ADC performance.
[4] The input bandwidth is measured including digitization (50 W input impedance). If AC input coupling is selected, the lower cutoff frequency is 4 Hz.
[5] 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.
[6] Optional feature.

B

Keithley Memory Manager

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

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

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

The following are supplied with the KMM:

- **VDMAD.386** - Customized version of Microsoft's Virtual DMA Driver for Windows Version 3.1.
- **VDMAD.VXD** - Customized version of Microsoft's Virtual DMA Driver for Windows 95.

  Both VDMAD.386 and VDMAD.VXD consist of a copy of Microsoft's Virtual DMA Driver and a group of functions that is added to perform the KMM functions. When you use the KMM to reserve a memory heap, Microsoft's Virtual DMA Driver is replaced by the appropriate file.

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

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

Installing and Setting Up the KMM

To install and set up the KMM whenever you start up Windows, you must modify the SYSTEM.INI file. For Windows Version 3.1, you can modify the SYSTEM.INI file using either the KMMSETUP.EXE program or a text editor. For Windows 95, you modify the SYSTEM.INI file using the KMMSETUP.EXE program.

Using KMMSETUP.EXE

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

1. Invoke KMMSETUP.EXE.

   For Windows 3.1, you can select the KMMSETUP icon, or you can choose File\Run and then choose Browse to locate KMMSETUP.EXE.

   For Windows 95, you can access the appropriate folder and then double-click the KMMSETUP icon, or you can choose Start\Run and then choose Browse to locate KMMSETUP.EXE.

   The software displays the Keithley memory Manager - Setup panel.

2. Specify the appropriate options. For more information, choose the Help button.
3. Select the Update button to update the SYSTEM.INI file with the changes you have made.
4. Restart Windows to ensure that the system changes take effect.

Using a Text Editor

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

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

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

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

   ---

2. Add the following line:

   `KEIDMAHEAPSIZE=<`*`size`*`>`

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

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

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

   ---

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

Removing the KMM

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

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

C

Bandwidth Charts for Input Voltage Ranges

The following figures show the effect of input voltage ranges on the bandwidth of DAS-4100 Series board. These figures are useful in determining the best input voltage range for a particular application. Note that the number in parentheses indicates the gain code used.

Figure C-1. ±0.5 V Input Range (Gain Code 0)

Figure C-2. ±2 V Input Range (Gain Code 1)

Figure C-3. ±2.5 V Input Range (Gain Code 2)

Figure C-4. ±4 V Input Range (Gain Code 3)

Figure C-5. ±0.25 V Input Range (Gain Code 4)

Figure C-6. ±1 V Input Range (Gain Code 5)

Figure C-7. ±1.25 V Input Range (Gain Code 6)

Figure C-8. ±2 V Input Range (Gain Code 7)

Figure C-9. ±0.125 V Input Range (Gain Code 8)

Figure C-10. ±0.5 V Input Range (Gain Code 9)

Figure C-11. ±0.625 V Input Range (Gain Code 10)

Figure C-12. ±1 V Input Range (Gain Code 11)

Figure C-13. ±0.1 V Input Range (Gain Code 12)

Figure C-14. ±0.4 V Input Range (Gain Code 13)

Figure C-15. ±0.5 V Input Range (Gain Code 14)

Figure C-16. ±0.8 V Input Range (Gain Code 15)

Index

Symbols

A

B

C

D

E

G

H

I

J

K

L

M

N

O

P

R

S

T

U

V

W

Z