DAS-1600 External Driver
User's Guide

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Preface

The *DAS-1600 External Driver User's Guide* provides the information
you need to use the DAS-1600 External Driver (somtimes referred to as
the External DAS Driver). The DAS-1600 External Driver allows you to
use Keithley's DAS-1600, DAS-1400, and DAS-1200 Series boards with
the following Keithley data acquisition and analysis software:

- VIEWDAC®

- EASYEST LX®

- EASYEST AG™

- ASYST®

This manual is intended for application programmers. It should be used in
conjunction with the DAS board user's guide and with the documentation
for the data acquisition software you are using.

Note: The DAS-1600 External Driver may support options your software
does not; likewise, your software may support options this external driver
does not.

If you need help, contact your local sales office or Keithley's Applications Engineering Department between 8 am and 7 pm (EST), Monday through Friday:

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An applications engineer will help diagnose and resolve your problem by telephone.

Using the DAS-1600 External Driver

The DAS-1600 External Driver allows your VIEWDAC, EASYEST LX, EASYEST AG, or ASYST application program to exchange data with DAS-1600, DAS-1400, and DAS-1200 Series boards.

Supported Hardware

The DAS-1600 External Driver supports the following Keithley data acquisition (DAS) boards.

- DAS-1601

- DAS-1602

- DAS-1401

- DAS-1402

- DAS-1201

- DAS-1202

Options Supported

The DAS-1600 External Driver supports the following options:

- Analog input operations, including interrupt and Direct Memory Access (DMA)

    - 16 single-ended or eight differential 12-bit analog input channels

– Up to 136 channels through EXP-16 and EXP-GP support

● Two 12-bit analog output channels (on the DAS-1601 and DAS-1602 only)

● 32 digital I/O bits on the DAS-1601, DAS-1602, DAS-1201, and DAS-1202; eight digital I/O bits on the DAS-1401 and DAS-1402

● Event counting

● Pulse output

● Analog triggering

● Simultaneous sample-and-hold through the SSH-4A

Files on Disk

The following files are included on the DAS-1600 External Driver disk:

● **DAS1600.EXE** - This file is the external DAS driver for DAS-1600, DAS-1400, and DAS-1200 Series boards. It controls the boards and allows communication between an application program and the board. DAS1600.EXE executes as a terminate-and-stay-resident (TSR) program that occupies a small amount of memory in the host.

● **D1600CFG.EXE** - This is the configuration program for the DAS-1600, DAS-1400, and DAS-1200 Series boards. It creates configuration files that the DAS-1600 External Driver (DAS1600.EXE) can read.

● **DAS1600.CFG** - This is the default configuration file used by DAS1600.EXE when no file name is specified. When first used, this file contains the default configuration settings for DAS-1600 Series boards.

● **DAS1400.CFG** - When first used, this file contains the default configuration settings for DAS-1400 Series boards.

● **DAS1200.CFG** - When first used, this file contains the default configuration settings for DAS-1200 Series boards.

Quick Start

This section describes how to configure, install, and access the DAS-1600 External Driver.

Setting Up the Board

Referring to the appropriate DAS user's guide, set the switches on the board to select the board's base address, input configuration (single-ended or differential), analog-to-digital (A/D) and digital-to-analog (D/A) range type (unipolar or bipolar), D/A reference voltages, DMA channel, clock rate select, wait state enable, and A/D gain. Remember these settings; you will need them when you run the configuration program, D1600CFG.EXE, described in the next section.

The following are a few DAS-1600/1400/1200 Series connections that you may want to keep in mind:

- **External digital trigger** - Connect the external digital trigger signal to the IP1 pin on the main I/O connector.

- **External clock** - Connect the external clock signal to the IP0 pin on the main I/O connector.

- **Event counting** - Connect the event signal to the CTR 0 IN pin on the main I/O connector.

- **Pulse output** - Connect the pulse output signal to the CTR 2 OUT pin on the main I/O connector.

Refer to your DAS board user's guide for other connections.

Running the Configuration Program

The DAS-1600 External Driver is shipped with default configuration files that reflect the factory settings of DAS-1600/1400/1200 Series boards. Whenever you change any of these settings, you must run the DAS-1600 configuration program, D1600CFG.EXE, in order for the external driver to function properly.

When you load the external driver, as described in the following section, the external driver looks in the current directory for the default configuration file, DAS1600.CFG. You can also specify the name of an existing configuration file, such as DAS1400.CFG for a DAS-1400 Series board or DAS1200.CFG for a DAS-1200 Series board, or the name of a new configuration file that you want to define.

To run the menu-driven configuration program, perform the following steps:

1. Create a DAS1600 directory on your hard disk. For example, at the DOS prompt, enter the following:

   ```
   mkdir das1600
   ```

2. Copy the following files from the DAS-1600 External Driver disk to the DAS1600 directory: DAS1600.EXE, D1600CFG.EXE, DAS1600.CFG, DAS1400.CFG, and DAS1200.CFG.

3. Enter the following at the DOS prompt:

   ```
   cd \das1600
   D1600CFG configuration_filename
   ```

   where *configuration_filename* represents the DOS path and name of your configuration file. For example, you could name the configuration file DAS1602.CFG and specify the path as c:\das1600\das1602.cfg. If you do not specify a configuration file, the current directory and the default filename, DAS1600.CFG, are used.

4. Configure the board parameters using the configuration program, as described in "Using the Configuration Program" on page 6.

Loading the DAS-1600 External Driver

You must load the DAS-1600 External Driver, DAS1600.EXE, each time you start up your computer in order for your application program to recognize it. The DAS-1600 External Driver remains in memory until you turn off or reboot your computer.

To load the DAS-1600 External Driver, access the directory containing DAS1600.EXE and enter the following at the DOS prompt:

```
das1600 configuration_filename
```

where *configuration_filename* is the name of the configuration file you are using. If you do not specify a configuration file, the driver searches for the default configuration file, DAS1600.CFG, in the current directory.

Note: You can also load the DAS-1600 External Driver automatically whenever you start the computer by modifying your AUTOEXEC.BAT file.

Accessing the DAS-1600 External Driver

This section describes how to access the DAS-1600 External Driver when using VIEWDAC, EASYEST LX, EASYEST AG, and ASYST. For additional information, refer to your VIEWDAC, EASYEST LX / AG, or ASYST documentation.

VIEWDAC

If the DAS-1600 External Driver is the only driver installed in your system, your VIEWDAC application programs access the DAS-1600 External Driver automatically. If more than one driver is installed, you must select the external driver (board name) from within a VIEWDAC DAS Task.

EASYEST LX / AG

If the DAS-1600 External Driver is the only driver installed in your system, your EASYEST LX / AG application programs access the DAS-1600 External Driver automatically.

If more than one driver is installed, you must perform the following steps to access the DAS-1600 External Driver:

1. Select *Devices* from the EASYEST LX / AG menu bar.

2. From the *DAS Configuration* screen, select option 1, *DAS Board Selection.*

3. Select the appropriate external driver (board name) from the displayed list.

ASYST

If you are using ASYST, always perform the following steps to access the DAS-1600 External Driver:

1. After loading the DAS-1600 External Driver, start up ASYST version 2.10 or greater and permanently load the *Data Acq Master* and the *Ext DAS Driver Support* system overlays from the Data Acquisition menu. ASYST automatically searches for and creates a DAS device called DAS1600.

2. Enter the following at the OK prompt to make DAS-1600 the current device:

        DAS1600

Using the Configuration Program

The configuration program begins by prompting you to specify the number of DAS-1600/1400/1200 Series boards you want to configure. You can configure up to two boards in each configuration file. The program then displays the configuration menus. The menu options are described in the following subsection.

Menu Items

The D1600CFG.EXE configuration program menu items are described in Table 1.

Table 1. Configuration Program Menu Items

Menu Item	Choices	Default Value
Board Type[1]	DAS-1601 DAS-1602 DAS-1401 DAS-1402 DAS-1201 DAS-1202	DAS-1601
Base Address[1]	200h to 3F0h in increments of 10h If you are using more than one board in your system, the base address must be different for each board.	300h
Clock Rate Select[1]	1 MHz or 10 MHz	10 MHz
Wait State[1]	Yes (enabled) or No (disabled)	No (disabled)
A/D Input Mode[1]	Bipolar or Unipolar This option is available only on the DAS-1601/1602 and DAS-1401/1402.	Bipolar
A/D Configuration[1]	Differential or Single-ended This option is available only when no EXP boards are present.	Differential
D/A Channel 0/1 Output Mode[1]	Bipolar or Unipolar This option is available only on the DAS-1601/1602.	Bipolar
D/A Channel 0/1 Output Range[1]	−10 V (for a board setting of 10) −5 V (for a board setting of 5) U (if the board setting is user) This option is available only on the DAS-1601/1602.	−10V

Table 1. Configuration Program Menu Items (cont.)

Menu Item	Choices	Default Value
DMA Channel[1]	1 or 3 If you are using more than one board in your system, the DMA channel must be different for each board.	3
IRQ Channel	2 through 7 Used for DMA and interrupt operations only. If you are using more than one board in your system, the interrupt channel must be different for each board. Verify the interrupt assignment of other boards in your system to ensure there is no conflict.	7
Digital I/O Configuration	Input or Output (for each of the four configurable ports) This option is available only on the DAS-1601/1602 and the DAS-1201/1202.	Output (for all ports)
Number of EXP-16 Modules[1]	0 through 8 No more than eight EXP-16s and/or EXP-GPs are supported in a system. For example, you could have four EXP-16s and four EXP-GPs; similarly, you could have eight EXP-16s and no EXP-GPs.	0
Set EXP-16 Gains[1]	0.5 through 2000 (for each EXP-16) This option is available only if an EXP-16 is present. Selecting this item switches control to the EXP-16 gain window, which allows you to select the gain of each EXP-16 channel. Press [Esc] to return to the main menu when all gains are set.	1 (for all EXP-16s)

Table 1. Configuration Program Menu Items (cont.)

Menu Item	Choices	Default Value
Number of EXP-GP Modules[1]	0 through 8 No more than eight EXP-16s and/or EXP-GPs are supported in a system. For example, you could have four EXP-16s and four EXP-GPs; similarly, you could have eight EXP-16s and no EXP-GPs.	0
EXP-GP Gains[1]	1 or 2.5 (for each EXP-GP) 1, 10, 100, or 1000 (for each EXP-GP channel if a gain of 1 is selected) 2.5, 25, 250, or 2500 (for each EXP-GP channel if a gain of 2.5 is selected) This option is available only if an EXP-GP is present. Selecting this item displays all EXP-GP boards that are present. Select a board; then select its global gain. Then select a EXP-GP channel, and the channel's gain. Press [Esc] to return to the previous menu and then to the main menu.	1 (for all EXP-GP boards and channels)
CJR Channel[1]	Depends on the number of EXP-16s and EXP-GPs selected. This option is available only if an EXP-16 or EXP-GP is present.	–1 (no CJR channels)
Number of SSH-4As[1]	0 through 4 The maximum number of SSH-4As allowed depends on the number of EXP-16s and EXP-GPs present.	0
SSH-4A Gains[1]	1, 10, 100, 200, 300, 500, 600, 700, or 800 (for each channel on each SSH-4A) This option is only available if an SSH-4A is present.	1 (for all channels)

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Table 1. Configuration Program Menu Items (cont.)

Menu Item	Choices	Default Value
SSH-4A Mode[1]	Master or Slave This option is only available if an SSH-4A is present. It should match the mode switch of the first SSH-4A.	Master
SSH-4A Timing[1]	Internal or External This option is only available if an SSH-4A is present. It should match the timing jumper of the first SSH-4A.	Internal
A/D Gain[1]	1, 2, 4, or 8 (for DAS-1202) 1, 10, 100, or 500 (for DAS-1201) This option is available only on the DAS-1201 and DAS-1202.	1

Notes

[1] This setting is hardware dependent; it must match the hardware (board) setting.

You can use the keys listed in Table 2 for special purposes within the configuration menus.

Table 2. Configuration Menu Special Keys

Special Keys	Description
[Esc]	Exit the configuration program with the option of saving the current settings to a file.
[n]	Toggle between boards when two boards are being configured.
[s]	Display a diagram of the DAS-1600/1400/1200 Series hardware switch settings that match the current driver configuration, followed by (if EXPs or SSH-4As are configured) an EXP and SSH-4A logical-to-physical-channel mapping table.

Exiting the DAS-1600 Configuration Program

To exit the D1600CFG.EXE configuration program, press [Esc].The configuration file displays the following prompt:

```
Update configuration_filename? (Yes and exit/No and
    exit or [Esc] to cancel)
```

where *configuration_filename* represents the name of your configuration file.

Enter [Y] to save the configuration and return to DOS. Enter [N] to exit to DOS without saving the configuration. Enter [Esc] to return to the configuration program.

Loading the External Driver in Multiple Board Configurations

The number of DAS-1600/1400/1200 Series boards that you can install in your system is limited by the available slots in your computer. Each memory-resident external driver can support two DAS-1600/1400/1200 Series boards. The number of external drivers that you can load is limited only by the amount of available memory in your computer.

Note: Some operations may not be available when using multiple DAS boards depending on the system resources that the operations require and how system resources are allocated. For example, DAS-1600 Series boards support two DMA channels; therefore, if you are using both DMA channels on one board, you cannot perform a DMA operation on the second board.

To access more than two boards, load the DAS-1600 External Driver as many times as you have configuration files. For example, to access three boards, you can create two configuration files called D1600-1.CFG and D1600-2.CFG, where D1600-1.CFG contains the configuration data for two boards at addresses 300h and 310h and D1600-2.CFG contains the

configuration data for a single board at address 340h. To load the DAS-1600 External Drivers, use the following syntax:

```
DAS1600 D1600-1.CFG
DAS1600 D1600-2.CFG
```

DAS-1600 External Driver Characteristics

The following sections describe special attributes and operating characteristics of the DAS-1600 External Driver.

Channels and Gains

DAS-1600 and DAS-1400 Series boards support channel-gain queues of 128 channels. Channel-gain queues are not supported by DAS-1200 Series boards. Table 3 lists the gains and corresponding gain codes supported by DAS-1600/1400/1200 Series boards.

Table 3. Supported Gains and Gain Codes

Board	Gain	Gain Code
DAS-1601 DAS-1401 DAS-1201[1]	1	0
	10	1
	100	2
	500	3
DAS-1602 DAS-1402 DAS-1202[1]	1	0
	2	1
	4	2
	8	3

Notes

[1] Gains on DAS-1200 Series boards are not software programmable. They are displayed here for use in altering the burst mode conversion rate only.

EXP-16s and EXP-GPs

You can use the following expansion boards with DAS-1600/1400/1200 Series boards:

- **EXP-16** - Each EXP-16 board multiplexes 16 differential inputs into one output signal. Use Output Channel jumper J4 on the EXP-16 to assign the output signal to one of the analog input channels on the DAS-1600/1400/1200 Series board.

  If you are using more than one EXP-16, you must assign each EXP-16 to a different analog input channel on the DAS-1600/1400/1200 Series board. Assign input channel 0 to the first EXP-16, channel 1 to the second EXP-16, and so on.

- **EXP-GP** - Each EXP-GP board multiplexes eight inputs into one output signal. Use Output Channel jumper J4 on the EXP-GP to assign the output signal to one of the analog input channels on the DAS-1600/1400/1200 Series board.

  If you are using more than one EXP-GP, you must assign each EXP-GP to a different analog input channel on the DAS-1600/1400/1200 Series board. Assign input channel 0 to the first EXP-GP, channel 1 to the second EXP-GP, and so on.

Note: The DAS-1600/1400/1200 Series board must be set up for single-ended operation when it is used with a EXP-16 or EXP-GP.

Cascading Multiple EXP Boards

A physical channel is the analog input channel on the DAS-1600/1400/1200 Series board to which the EXP board is assigned. The logical channel is the channel that the application software uses to access channels on the DAS-1600/1400/1200 Series board and any EXP boards. The logical and physical channel assignments are displayed in the D1600CFG.EXE configuration program when you select *Show Switches*.

You can cascade multiple EXP-16 and EXP-GP boards by assigning each EXP board to a distinct analog input channel on a DAS-1600/1400/1200 Series board as discussed previously. You can also connect an STA-16 to

the system to use the remaining analog input channels on the
DAS-1600/1400/1200 Series board.

Note: If you are using an STA-16 with EXP boards, the channels used by
the EXP-GPs and EXP-16s are still accessible on the STA-16. However,
make sure that you do not connect any signals to these inputs.

Digital output bits OP0 to OP3 are used to select the current channel on
the EXP boards. The DAS-1600 External Driver does not allow you to
use these output bits if any EXP boards are configured.

Table 4 shows the relationship between the logical and physical channels
on a DAS-1602 when using two EXP-GPs and two EXP-16s.

Table 4. Logical and Physical Channels

Logical Channels	Physical Channel	EXP-GP / EXP-16 Jumper J4
0 to 15	EXP-16: 0	0
16 to 31	EXP-16: 1	1
32 to 39	EXP-GP: 2	2
40 to 47	EXP-GP: 3	3
48 to 59	DAS-1602: 4 to 15	Not applicable

Specifying Gains

VIEWDAC uses the EXP-16 and EXP-GP gains specified in the
configuration file. For EASYEST LX and AG, you must set the gain of
channel 0 only (channel 0 is on the first EXP-16 or on the first EXP-GP if
no EXP-16s are configured); choose *Show Switches* to display the EXP
logical-to-physical-channel mapping table). In this case, the gain of all
channels is relative to the setting of the A/D range type (unipolar or
bipolar) and the gain of channel 0. You must compensate for gains other
than the gain of channel 0 if the gain for other channels differs.

> **Note:** When using a gain of 0.5 on the EXP-16, the maximum input range is ±12 V, not ±20 V.

Digital I/O

Since the extended digital ports (32 to 46) require 12 output bits, the software always shows a minimum of 12 available bits, no matter how a digital output port is configured. If a digital output port is configured for 8, 4, or 0 output bits, you can disregard the extra bits. The following subsections describe the digital I/O support on the various DAS boards.

DAS-1600/1200 Series

The DAS-1600/1200 Series boards have four fixed digital input bits and four fixed digital output bits. In addition, an Intel 8255 integrated circuit is included on the board to provide 24 additional digital bits. These 24 bits are organized into four ports (ports A, B, CL, and CH); you can configure each port for either input or output.

> **Note:** When an EXP board is configured, the four fixed digital output bits are dedicated to EXP board control and are not available for digital output.

The DAS-1600 External Driver supports one digital input channel and one digital output channel on each board (if any bits are available). The number of bits used in each channel depends on the port configuration and whether an EXP board is configured.

Starting from the least significant bit, Port A uses the first eight bits available, Port B uses the next eight bits available, Port CL uses the next four bits available, Port CH uses the next four bits available, and the fixed bits use the next four bits available. If a particular port is configured for input, it does not use any bits in the output channel; if a particular port is configured for output, it does not use any bits in the input channel.

Note: The digital channel requires DP.INTEGER output if more than 16 bits are configured.

For example, a DAS-1600/1200 Series board is configured with no EXPs and with Port A, Port B, Port CL, and Port CH all configured for output. Table 5 illustrates how the bits in the digital I/O channels are used.

**Table 5. Digital I/O Channel Usage
(No EXPs, All Ports Output)**

Bits	Output Channel Use	Input Channel Use
0 to 3	Port A	4 fixed input bits
4 to 7		
8 to 11	Port B	
12 to 15		
16 to 19	Port CL	
20 to 23	Port CH	
24 to 27	4 fixed output bits	

As another example, a DAS-1600/1200 Series board is configured with one or more EXPs and with Port A, Port B, Port CL, and Port CH configured for output. Table 6 illustrates how the bits in the digital I/O channels are used. Note that the four fixed output bits are dedicated to EXP board control and are not available.

**Table 6. Digital I/O Channel Usage
(EXPs Used, All Ports Output)**

Bits	Output Channel Use	Input Channel Use
0 to 3	Port A	4 fixed input bits
4 to 7		
8 to 11	Port B	
12 to 15		
16 to 19	Port CL	
20 to 23	Port CH	
24 to 27		

As another example, a DAS-1600/1200 Series board is configured with no EXPs, with Port A and Port B configured for output, and with Port CL and Port CH configured for input. Table 7 illustrates how the bits in the digital I/O channels are used.

**Table 7. Digital I/O Channel Usage
(No EXPs, A and B Output, CL and CH Input)**

Bits	Output Channel Use	Input Channel Use
0 to 3	Port A	Port CL
4 to 7		Port CH
8 to 11	Port B	4 fixed input bits
12 to 15		
16 to 19	4 fixed output bits	
20 to 23		
24 to 27		

As a final example, a DAS-1600/1200 Series board is configured with no EXPs, with Port B and Port CH configured for output, and with Port A and Port CL configured for input. Table 8 illustrates how the bits in the digital I/O channels are used.

**Table 8. Digital I/O Channel Usage
(No EXPs, B and CH Output, A and CL Input)**

Bits	Output Channel Use	Input Channel Use
0 to 3	Port B	Port A
4 to 7		
8 to 11	Port CH	Port CL
12 to 15	4 fixed output bits	4 fixed input bits
16 to 19		
20 to 23		
24 to 27		

DAS-1400 Series

DAS-1400 Series boards have four fixed digital input bits and four fixed digital output bits.

Note: When an EXP board is configured, the four fixed digital output bits are dedicated to EXP board control and are not available for digital output.

Table 9 illustrates how the bits in the digital I/O channels are used if a DAS-1400 Series board is configured with no EXPs.

Table 9. Digital I/O Channel Usage (No EXPs)

Bits	Output Channel Use	Input Channel Use
0 to 3	4 fixed output bits	4 fixed input bits

Using the DAS-1600 External Driver

Table 10 illustrates how the bits in the digital I/O channels are used if a DAS-1400 Series board is configured with one or more EXPs. Note that the four fixed output bits are dedicated to EXP board control and are not available.

Table 10. Digital I/O Channel Usage (EXPs Used)

Bits	Output Channel Use	Input Channel Use
0 to 3		4 fixed input bits

Internal Clocking

When using an internal clock source, a conversion begins without waiting for an external clock signal and proceeds at the specified rate until finished. With the jumper in the 1 MHz position, the clock resolution is 1 μs. With the jumper in the 10 MHz position, the clock resolution is 0.1 μs.

External Clocking

When using an external clock source, the software waits for a rising edge at the IP 0 input pin before starting each conversion. Acquisition proceeds and is paced by the external clock until the requested amount of data is acquired.

Synchronous, DMA, and Interrupt Operations

Keep the following in mind when performing a synchronous, DMA, or interrupt operation:

- Only one operation can be active on a board at one time.

- Burst mode and continuous acquisition are not supported for synchronous operations.

- DMA mode is allowed only for analog input operations. DMA supports burst mode acquisition. The use of channel-gain queues is not allowed for DMA mode. DMA cannot be performed on EXP-16 / EXP-GP channels. Only non-cyclic (single cycle) and cyclic (continuous) single buffering are supported for DMA operations; double buffering is not supported.

- Interrupt mode is supported for analog input, analog output, and digital I/O operations. Burst mode is not supported for interrupt operations. Only non-cyclic (single cycle) and cyclic (continuous) single buffering are supported for interrupt operations; double buffering is not supported.

Note: Because the DAS-1600 External Driver cannot detect all interrupt overrun conditions, ensure that interrupt operation speeds are valid for your system.

Counter/Timer Functions

Table 11 shows the counter/timer functions supported by the DAS-1600 External Driver. The supported functions are described in the following subsections.

Table 11. Counter/Timer Functions

Function	Supported
Timer Interrupt Generation	No
Frequency Measurement	No
Event Counting	Yes
Pulse Output	Yes
One-Shot Pulse Output	No
Time Interval Measurement	No

Event Counting

To perform event counting, connect the signal to be counted to CTR 0 IN. The maximum count is 65,535; any count greater than 65,535 causes driver error 32791, "Event counter overflow." Note that if the signal being counted starts high, with events driving it temporarily low, each event is counted correctly. However, if the signal being counted starts low, with events driving it temporarily high, the first event is skipped and subsequent counts return one less than the actual number of events.

Pulse Output

A pulse output generates a pulse train on CTR 2 OUT. The duty cycle of the pulse train is fixed at 50% due to the nature of the 8254 counter/timer circuitry.

Pseudo-Digital Output: Extended Functions

DAS-1600/1400/1200 Series boards provide some features that are not standard features of Keithley software. To access these additional features, the DAS-1600 External Driver uses pseudo-digital output channels. Pseudo-digital output channels are digital output channels supported by Keithley software; these channels are used by DAS-1600/1400/1200 Series boards for control only, not for output. (DAS-1600/1400/1200 Series boards support digital output channel 0 for output operations.)

Note: Only values written to digital output channel 0 affect the digital output lines on the board. Values written to the pseudo-digital output channels are intercepted by the DAS-1600 External Driver and are used to set up the non-standard features.

Table 12 lists the pseudo-digital channels available in the DAS-1600 External Driver and the functions they perform.

Table 12. Pseudo-Digital Output Channels

Digital Output Channel	Function	Description
32	Analog trigger channel	The analog input channel on which the trigger event occurs. The value written to this channel can be any valid logical analog input channel except an SSH-4/A channel that is sampled and held (the SSH-4/A cannot be configured as the Master). Refer to page 25 for more information about analog triggers.
33	Trigger signal source	The type of trigger you want to use to begin conversions. The value written to this channel can be one of the following: 0 = a hardware digital trigger using the IP1 pin. 1 = an analog trigger. An analog trigger event occurs when the conditions specified by digital output channels 34, 35, 38, and 39 are met by the analog input signal on the channel specified by digital output channel 32. Refer to page 25 for more information about analog triggers.
34	Trigger sensitivity	Edge triggering or level triggering. The value written to this channel can be one of the following: 0 = edge triggering. Edge triggering specifies that triggering will occur at the instant the trigger signal rises above or falls below (determined by pseudo-digital output channel 35) the voltage level specified by pseudo-digital output channel 38 (using the hysteresis value specified by pseudo-digital output channel 39, if applicable). 1 = level triggering. Level triggering specifies that triggering will occur at any time the trigger signal is above or below (determined by pseudo-digital output channel 35) the specified voltage level.

Table 12. Pseudo-Digital Output Channels (cont.)

Digital Output Channel	Function	Description
35	Trigger polarity	Positive triggering or negative triggering. The value written to this channel can be one of the following:

0 = positive triggering. The analog input signal must rise above or be above (determined by pseudo-digital output channel 34) the voltage level specified by pseudo-digital output channel 38 (using the hysteresis value specified by pseudo-digital output channel 39, if applicable).

1 = negative triggering. The analog input signal must fall below or be below (determined by pseudo-digital output channel 34) the voltage level specified by pseudo-digital output channel 38 (using the hysteresis value specified by pseudo-digital output channel 39, if applicable).

Refer to page 25 for more information about analog triggers. |
| 38 | Analog voltage level | The voltage level at which an analog trigger event occurs. The value written to this channel is a raw count value between 0 and 4095. The voltage equivalent of the raw count value depends on the input range type (unipolar or bipolar). For example, a level of 0 is interpreted as 0 V if the analog input range is 0 to 10 V, but it is interpreted as −5 V if the analog input range is ±5 V.

Refer to page 25 for more information about analog triggers. |
| 39 | Hysteresis value | The amount of hysteresis applied to an analog trigger signal. The value written to this channel is a raw count value between 0 and 4095. A hysteresis value of 0 disables the option.

Refer to page 25 for more information about analog triggers. |

Table 12. Pseudo-Digital Output Channels (cont.)

Digital Output Channel	Function	Description
41	Acquisition mode	SSH mode or normal mode. The value written to this channel can be one of the following: 0 = normal mode 1 = SSH mode. An SSH-4A must be connected to select SSH mode. Refer to page 27 for more information about SSH mode.
42	Burst mode enable/disable	This mode is supported only for DMA operations. The value written to this channel can be one of the following: 1 = enables the burst mode feature 0 = disables the burst mode feature Refer to page 27 for more information about burst mode.
43	Set burst mode conversion rate for gain code 0	Using a count value, alters the burst mode conversion rate associated with a gain code of 0. The value written to this channel depends on a number of factors. Refer to page 29 for more information.
44	Set burst mode conversion rate for gain code 1	Using a count value, alters the burst mode conversion rate associated with a gain code of 1. The value written to this channel depends on a number of factors. Refer to page 29 for more information.
45	Set burst mode conversion rate for gain code 2	Using a count value, alters the burst mode conversion rate associated with a gain code of 2. The value written to this channel depends on a number of factors. Refer to page 29 for more information.
46	Set burst mode conversion rate for gain code 3	Using a count value, alters the burst mode conversion rate associated with a gain code of 3. The value written to this channel depends on a number of factors. Refer to page 29 for more information.

Analog Triggers

> **Note:** When using analog triggering, make sure that you provide a valid trigger to the DAS-1600 External Driver. If no trigger is found, the computer will appear to be hung as the DAS-1600 External Driver waits indefinitely for the trigger.

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

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

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

- The analog input signal is above a specified voltage level (positive, level-sensitive trigger).

- The analog input signal is below a specified voltage level (negative, level-sensitive trigger).

You specify the voltage level as a raw count value between 0 and 4095.

Figure 1 illustrates these analog trigger conditions, where the specified voltage level is +5 V.
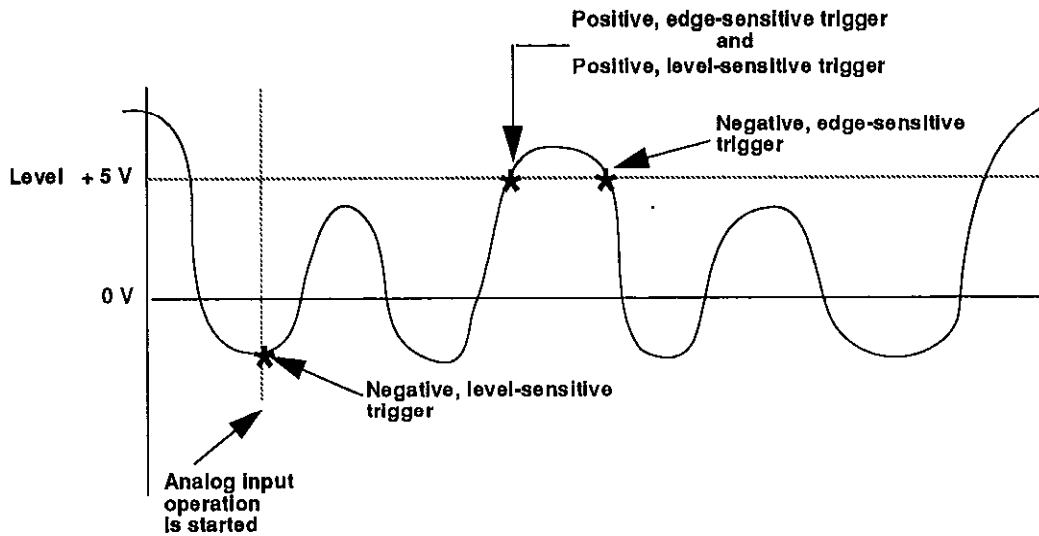
Figure 1. Analog Trigger Conditions

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

The hysteresis value is an absolute number, which you specify as a raw count value between 0 and 4095.

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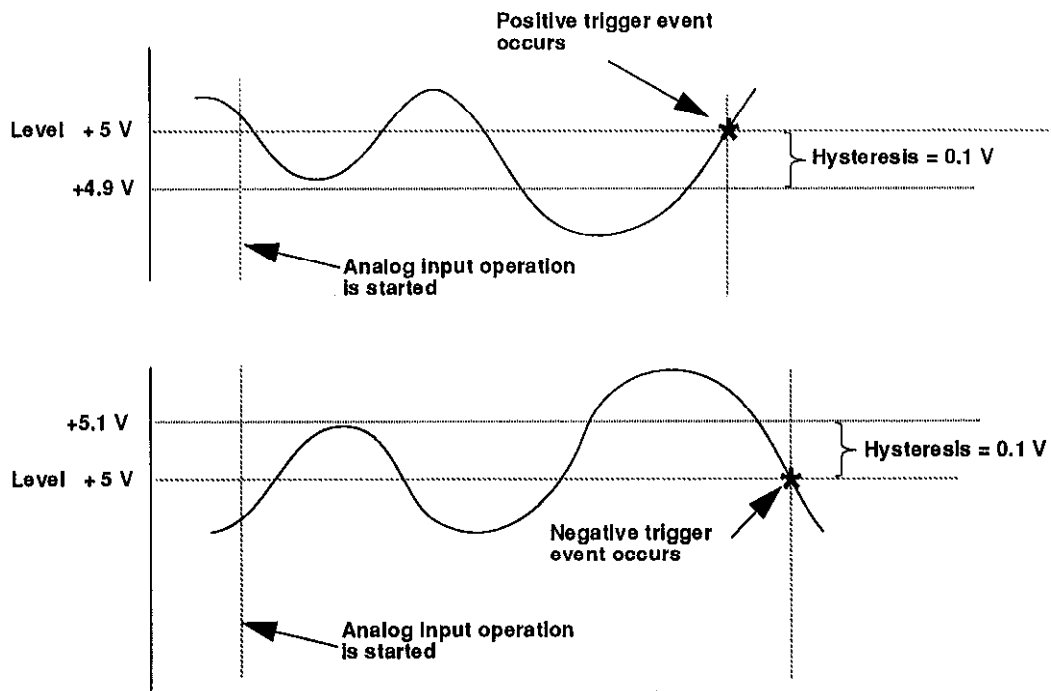
Figure 2. Using a Hysteresis Value

Burst Mode and SSH Mode

Burst mode is a software simulated simultaneous sample-and-hold feature in which successive analog input channels are sampled as quickly as possible. Burst mode is supported only for DMA operations. The burst mode conversion rate defaults to a gain-dependent value that you can alter. Refer to page 29 for information on altering the burst mode conversion rate.

SSH (simultaneous sample-and-hold) mode is a hardware feature that requires use of an SSH-4A. The requested channels are sampled nearly instantaneously and held until read. The rate between scans is set by the sample frequency.

Note: In burst mode, the data is skewed slightly. In SSH mode, the data is not skewed.

When using VIEWDAC or EASYEST LX / AG, you specify the sampling frequency as the per channel rate. For example, specifying a frequency of 1 kHz when acquiring from two channels in paced (normal) mode results in an aggregate board rate of 2 kHz. When using burst or SSH mode, the specified sampling frequency is also a per channel rate. For example, if you specify a frequency of 1 kHz when acquiring from two channels in burst or SSH mode, the two channels are sampled nearly instantaneously and are sampled again after 1 ms (1 kHz).

When using ASYST, you specify the conversion delay rather than the per channel rate. The conversion delay is the time between conversions, which translates to a sampling rate that is dependent on the number of channels to scan. For example, specifying a conversion delay of 1 ms when acquiring from one channel equates to a 1 kHz sampling rate. Adding a second channel drops the per channel rate to 500 Hz. When using burst or SSH mode, the conversion delay is interpreted the same way even though the time between channels is nearly instantaneous. For example, to sample two channels at a 1 kHz sampling rate, you would specify a conversion delay of 0.5 ms for each channel, even though the time between scans is actually 1 ms. This interpretation allows you to calculate sampling rates that apply with or without burst or SSH mode.

The scan sequence in ASYST is as follows:

Paced (normal) mode:

   0 [cd] 1 [cd] 2 [cd] ... (n-1) [cd] 0 [cd] 1 [cd] ...

Burst or SSH mode:

   0 1 2 3 ... (n-1) [cd*n] 0 1 2 3 .. (n-1) [cd*n] 0 1 2 3

where

   cd = conversion delay specified;   n = number of channels

   0 = start channel;   [ ] = actual time delay

Altering the Burst Mode Conversion Rate

When a DAS-1600 Series board operates in DMA burst mode, it acquires data in a burst from the channels specified by the start/stop parameters. The burst is programmed to run at the maximum possible rate, which is determined by the gain setting. The higher the gain, the more settling time is required and the slower the burst mode conversion rate.

In some computers, the built-in memory cache can slow the maximum burst mode conversion rate because caching takes precedence over DMA operations and causes data loss. In this event, you can adjust the burst mode conversion rate (settling time) to slow the acquisition rate. Table 13 contains the default settling times for each DAS-1600/1400/1200 Series board gain and the corresponding count value.

Table 13. Default Settling Times

Board	Gain	Settling Time	Count
DAS-1601 DAS-1401	1	10 μs	2
	10	10 μs	2
	100	14 μs	3
	500	32 μs	8
DAS-1602 DAS-1402 DAS-1202	1	10 μs	2
	2	10 μs	2
	4	10 μs	2
	8	10 μs	2
DAS-1201	1	22 μs	5
	10	22 μs	5
	100	10 μs	5
	500	102 μs	25

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If you wish to use a settling time other than the default, you can specify a count value to alter the burst mode conversion rate. Use the following formula to determine the appropriate count value:

$$Count = \frac{Settling\ Time\ (in\ \mu s) - 2}{4}$$

The relationship between the settling time and the burst mode conversion rate is shown in the following equation:

$$Settling\ Time\ (in\ \mu s) = \frac{1\ MHz}{Burst\ Mode\ Conversion\ Rate}$$

For reference, Table 14 lists some of the most common settling times, along with their corresponding burst mode conversion rates and counts. However, you can use any count value between 2 and 255.

Table 14. Common Settling Times

Settling Time (μs)	Burst Mode Conversion Rate (kHz)	Count
10	100	2
14	71.428	3
18	55.55	4
22	45.45	5
26	38.46	6
30	33.33	7
34	29.4	8
38	26.3	9
42	23.8	10

Software Interrupt Vectors

The DAS-1600 External Driver uses two software interrupt vectors for communicating with the application program. The interrupt vectors used are two of the user interrupts (interrupts 60h to 67h) set aside by DOS. To ensure that conflicts with other devices, hardware, or programs do not exist, you can set each of the interrupt vectors to use an interrupt number that is different from the default.

You can change the interrupt vector numbers by using the SET command from DOS. This command saves a string in the DOS environment that the DAS-1600 External Driver searches for on loading. These strings are specified in Table 15.

Table 15. Interrupt Vectors

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

Notes

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

Note: Do not confuse these software interrupt vectors with the hardware interrupt levels used by DAS-1600/1400/1200 Series boards.

DAS-1600 External Driver Error Messages

Table 16 lists the error messages that may occur during operation of the DAS-1600 External Driver.

Table 16. Error Messages

Error Number	Error Message	Description
0	No error	No errors were encountered.
28698	Bad Rev. Number	An invalid DAS Specification version was passed to the driver.
28699	Resource Busy	An attempt was made to execute interrupt and DMA operations simultaneously. Only one of these operations is allowed at one time.
28700	Unknown Error Number	A request for an undefined message string was made.
28701	Channel Gain Array Not Supported	A DMA operation was attempted with a channel-gain queue. This is an illegal operation.
28702	DMA not supported on EXP channels	A DMA operation was attempted on an EXP board. This is an illegal operation.
28703	Incorrect A/D Uni/Bip switch setting	The Unipolar/ Bipolar switch on the board does not match the setting that you configured in the driver.
28704	Counter Not Active	The counter/timer circuitry has not been activated.
28705	Incorrect A/D 16/8 Channel switch setting	The single-ended/ differential switch on the board does not match the setting that you configured in the driver.
28706	Illegal Settling Time	An invalid burst mode conversion rate count is set.
32769	Function not supported	A function was requested that is not supported by the DAS driver.
32770	Function out of bounds	A function number not defined by the DAS Driver Specification was requested.
32771	Non-valid board number	A board number that is out of range of configured boards was requested. This driver can support a maximum of two boards.

Table 16. Error Messages (cont.)

Error Number	Error Message	Description
32772	Non-valid error number	An invalid error number was requested by the DAS driver function Report Error Message. A request was made for an error message string that is not defined.
32773	Board not found at configured address	The board was not found at the configured address. The address select switches on the board must match the settings you configured for the driver.
32774	A/D not initialized	An A/D conversion was requested before the A/D circuitry was initialized.
32775	D/A not initialized	A D/A operation was requested before the D/A circuitry was initialized.
32776	Digital input not initialized	A digital input operation was requested before the digital input ports were initialized.
32777	Digital output not initialized	A digital output operation was requested before the digital output ports were initialized.
32778	Timer not initialized	The counter/timer circuitry has not been initialized.
32779	Conversion overrun	A software-detected conversion overrun occurred.
32780	Conversion delay is too small	The conversion delay value passed to the driver was too small.
32782	Pulse output period is too small	The pulse period value passed to the driver was too small.
32783	Pulse output duty cycle is too small	The pulse duty cycle was too small for the number of period ticks.
32785	Conversion delay is too large	The conversion delay value passed to the driver was greater than a software set limit.
32787	Pulse output period is too large	The pulse period value passed to the driver was too large.
32788	Pulse output duty cycle is too large	The pulse duty cycle was too large for the number of period ticks.
32790	Interrupt overrun	An interrupt was generated before the program was ready to handle it. This usually occurs when the interrupt generator is running too fast.

Table 16. Error Messages (cont.)

Error Number	Error Message	Description
32791	Event counter overflow	The count exceeded 65535 during an event counting operation.
32794	Interrupts already active	An interrupt function was called while another interrupt function was in use. Do not use more than one function that uses the interrupt channel concurrently.
32795	DMA already active	A DMA function was called while DMA was being used by another function. An interrupt function was called while another interrupt function was in use. Do not use more than one function that uses the interrupt channel concurrently.
32797	Event counting not active	The counter/timer circuitry has not been activated.