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K500/575 External DAS Driver

USER'S GUIDE

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K500/575 External DAS Driver User's Guide

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Preface

The *K500/575 External DAS Driver User's Guide* provides the information you need to use the K500/575 External DAS Driver with a Keithley 500 or 575 system and the following Keithley data acquisition and analysis software packages:

- VIEWDAC®
- EASYEST LX®
- EASYEST AG™
- ASYST®

This manual is intended for applications programmers. Use this manual in conjunction with your hardware user manuals and with the documentation for the data acquisition software you are using.

Note: The K500/575 External DAS Driver may support options your software does not; likewise, your software may support options this external DAS driver does not.

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Using the K500/575 External DAS Driver

The K500/575 External DAS Driver allows your VIEWDAC, EASYEST LX, EASYEST AG, or ASYST application program to exchange data with the Keithley 500/575 system. This document describes how to use the K500/575 External DAS Driver.

Supported Hardware

The K500/575 External DAS Driver supports the Keithley model 500A, 500P, and 575 systems; these models are referred to in this document as the Keithley 500/575 system. The K500/575 External DAS Driver does *not* support the model 570 system.

The Keithley 500/575 system consists of an external chassis, the modules installed in the chassis, and the interface card (installed in the PC). Refer to the Keithley hardware manual for an overview of the Keithley system and for information on the external chassis. The following subsections describe the supported modules and interface cards.

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Modules

The K500/575 External DAS Driver supports the modules listed in Table 1.

Table 1. Modules Supported

AIM2	AIM8	AOM4	PCM2
AIM3	AIM9	AOM5	PCM3[1]
AIM3A	AMM1A	DIM1	PIM1
AIM4	AMM2	DIO1	PIM2
AIM5	AOM1	DIO1A	TRG1
AIM6	AOM2	DOM1	WAV1
AIM7	AOM3	PCM1	3B Input Series

Notes

[1] The PCM3 is controlled by the PCM2 I/O ports or by the relay control connector on the System 575. PCM3 support is provided via support of the PCM2 and System 575 digital I/O.

The K500/575 External DAS Driver *does not* support the modules listed in Table 2.

Table 2. Modules Not Supported

ADM1	AIM1	GPIB	STEP1
ADM2	AMM1	PROTO	STEP2

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Interface Cards

The K500/575 External DAS Driver supports the following interface cards:

- IBIN-A
- IBIN-LP
- IBIN-PS2

The original Keithley 500 IBM interface card and the 570 interface card are *not* supported.

Files on Disk

The following files are included on the K500/575 External DAS Driver disk:

- **K500.EXE** - This file is the external DAS driver for the Keithley 500/575. K500.EXE is a terminate-and-stay-resident (TSR) program that is loaded from DOS.
- **KCONFIG.EXE** - This file is the menu-driven configuration program used to select the module slot assignments and parameters. This program generates a .TBL file that is read by K500.EXE.
- **K500.UTL** - This is a utility file for use in setting up triggering parameters of the TRG1 module with ASYST. This file contains word definitions that you can load into ASYST; when invoked, these word definitions set up the required triggering parameters. Refer to “Controlling the TRG1 Module Using K500.UTL” on page 37 for more information.

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Quick Start

This section briefly discusses the process of configuring, loading, and accessing the K500/575 External DAS Driver. For specific information, refer to the appropriate sections of this manual.

Configuring the K500/575 External DAS Driver

Create a \K500DRV directory on your hard disk and copy all files on the K500/575 External DAS Driver disk into this directory.

To configure the K500/575 External DAS Driver using the menu-driven configuration program, enter the following at the DOS prompt:

```
CD \K500DRV
KCONFIG
```

Then, set your system and module parameters using the menu selections. Refer to “Running the KCONFIG Configuration Program” on page 7 for more information on using the configuration program.

Use the KCONFIG configuration program any time you make a hardware change to the Keithley 500/575 system or wish to change the software settings of the external DAS driver.

Note: Empty slots at the end of the slot list do not take up memory when the driver is loaded. When configuring the Keithley 500 system, it is suggested (although not required) that you position the modules such that the slots are filled from the low slot numbers to the high slot numbers leaving all the empty slots at the end of the chassis.

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Loading the K500/575 External DAS Driver

The K500/575 External DAS Driver is a terminate-and-stay-resident (TSR) program that you must run each time your PC is booted in order for your application program to recognize it.

To load the K500/575 external DAS driver, enter the following lines at the DOS prompt:

```
CD \K500DRV
K500 [-a####] [-irq$] [@filename]
```

where *####* is the IBIN-A segment address, *$* is the IRQ channel number, and *filename* is the name of the .TBL file generated upon configuration.

Alternatively, you can add these lines to your AUTOEXEC.BAT file to load the driver automatically upon booting your PC. The driver remains in memory until the computer is turned off or rebooted.

Note: If you are using an 80386 software expanded memory manager you must exclude the addresses used by the interface card from the memory available for the expanded memory manager. The Keithley 500/575 system takes up a 128 byte block of memory.

For example, if you are using Quarterdeck's QEMM expanded memory manager with the Keithley 500/575 system at address CFF8h, add the following line in the DEVICE=QEMM.SYS declaration of your CONFIG.SYS file.

```
EXCLUDE=CFF8-D000
```

Similarly, if you are using a Qualitas' 386MAX expanded memory manager, add the following line in the DEVICE=386MAX.SYS declaration of your CONFIG.SYS file.

```
RAM=CF00-D000
```


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If you are using the EMM386 that is shipped with DOS, change the DEVICE = C:\DOS\EMM386.EXE line in your CONFIG.SYS file to the following:

```
DEVICE = C:\DOS\EMM386.EXE x = CF00-D000
```

Accessing the K500/575 External DAS Driver

Some application programs such as EASYEST LX, EASYEST AG, and VIEWDAC access the K500/575 External DAS Driver automatically; refer to the documentation for these software packages for more information.

If you are using ASYST, use the following steps to access the K500/575 External DAS Driver:

1. After loading the driver, boot ASYST 2.10 or greater and load the External DAS Driver Support system overlay permanently.

   ASYST automatically searches for and creates a DAS device called K500.

2. Upon entering the ASYST environment, enter the following at the OK prompt to make K500 the current DAS device:

   ```
   K500
   ```

Note: It is not necessary to load the internal Series 500 system overlay.

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Running the KCONFIG Configuration Program

The K500/575 External DAS Driver requires information about your specific Keithley 500/575 setup in order for it to function properly. The KCONFIG configuration program allows you to enter this information.

To run the menu-driven K500 configuration program, enter the following at the DOS prompt:

```
CD \K500DRV
KCONFIG [575-1] or [575-2] or [filename]
```

The parameters in brackets are optional (do not enter the brackets themselves). The *575-1* parameter starts the KCONFIG program set up for a System 575 with an AMM1A module. Similarly, the *575-2* parameter uses the setup of the System 575 with an AMM2 module. *filename* is the name of a saved configuration table (.TBL file), which may be reloaded for further modifications. If no parameter is specified, all slots are configured as empty upon entering the configuration program.

Note: Use the *575-1* and *575-2* parameters only when setting up a 575 the first time. Subsequent modifications should be made by loading the existing .TBL file with KCONFIG *filename*.

The menu for the KCONFIG.EXE program is the same as the CONFIG.EXE program that was shipped with your Keithley 500/575 hardware. Refer to the KDAC500 manual that came with the Series 500 hardware for information on running the configuration program.

The following section describes the special parameters and the command line parameters used to configure the external DAS driver.

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Note: The KCONFIG program does not provide a means of differentiating between the AOM1/2 and the AOM1/5 or between the AOM2/1 and the AOM2/2. When the K500/575 External DAS Driver is initialized, the driver checks the module ID codes for these AOM modules to determine the number of channels available. Some older modules do not have module ID sensing and, in these cases, the K500/575 External DAS Driver defaults to the AOM1/5 and the AOM2/2 modules.

Special Configuration Parameters

The K500/575 External DAS Driver uses information entered in the CHANNEL SETUP portion of the KCONFIG program only when the following modules are used:

- **AIM8** - For application programs that do not support programmable filters, select the desired filter under “FILTER.” The selected filter value for the IONAME of the last channel defined is used for all channels.

  Under “OFFSET/COUPLING” select ENABLE or DISABLE. The selected value for the IONAME of the last channel defined is used for all channels.

- **AIM9** - For application programs that do not support programmable filters, select the desired filter under “FILTER.” The selected filter value for the IONAME of the last channel defined is used for all channels.

- **A0M5** - Under “MODE/RANGE” select the appropriate range for each channel. If no IONAME is defined for a channel, the default range as set in the HARDWARE SETUP menu is used.

Note: At the time of the release of the K500/575 External DAS Driver, independent channel ranges and programmable filters were not supported by ASYST, EASYEST LX, EASYEST AG, and VIEWDAC).

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The other areas of CHANNEL SETUP that are not used by the K500/575 External DAS Driver are used by other drivers such as the KDAC500 software supplied with the hardware. It is not necessary to configure the unused options in the CHANNEL SETUP portion of the KCONFIG program if you intend to use only the K500/575 External DAS Driver with your Keithley 500/575 system.

Command-Line Configuration Parameters

Once you have run the KCONFIG.EXE program and the .TBL file has been generated, you need to load the driver into memory. The final configuration parameters (base segment address and IRQ channel) are specified at this time. To load the K500/575 External DAS Driver, enter the following lines at the DOS prompt:

```
CD \K500DRV
K500 [-a####] [-irq$] [@filename]
```

The parameters in brackets are optional (do not enter the brackets themselves). If any parameter is not specified, its default value is used. Table 3 lists the values for the command line parameters.

Table 3. Command-Line Configuration Parameters

Parameter	Function
####	IBIN segment address (default = CFF8h)
$	IRQ channel number (default = 5)
filename	Configuration filename (default = KCONFIG.TBL)

For example, to configure a system using IRQ 3 at address DFF8h, and using the configuration setup saved in TEST.TBL, enter the following at the DOS prompt:

```
K500 -aDFF8 -irq3 @TEST.TBL
```


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If no configuration file is found, the default configuration is used; the default configuration specifies a Keithley 575 system with an AMM1A module in slot 1 and an empty slot 3).

K500/575 External DAS Driver Characteristics

The following sections describe the characteristics of the K500/575 External DAS Driver.

System Support

When using the K500/575 External DAS Driver, you can access only one Keithley 500/575 system from each copy of the driver loaded into memory. To control multiple systems, load the driver multiple times. If you are using more than one system, make sure that each system and external DAS driver is configured for a different address. The number of drivers that you can load is limited by the amount of available memory in the computer.

Module Access

The K500/575 External DAS Driver addresses each slot in the Keithley 500/575 system as a separate board. Slot 1 is accessed through the first logical board, slot 2 is accessed through the second logical board, and so on.

The Keithley 575 system is a special version of the Series 500 hardware that combines the functionality of several modules. Even though the hardware does not have physical slots in the same manner as the Keithley 500 system, software accesses the different capabilities of the Keithley 575 system through the same “slot” mechanism. The Keithley 575 slot/module map is shown in Table 4.

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Table 4. Keithley 575 Slot/Module Map

Slot	Module
1	AMM1A/AMM2
2	TRG1
3	empty (option slot)
4	AOM5 (2 channels)
5	DIO1A
6	3B Input

Analog Input

The following sections describe the analog input characteristics of the K500/575 External DAS Driver.

CJR Access

You can access the Cold Junction Reference (CJR) by reading channel 32 of the AIM3, AIM5, or AIM7 modules. None of these modules (except the AIM3 in single-ended mode) actually has 33 channels (0 to 32), resulting in a “hole” in the range of usable channels. For example, the AIM7 allows access to channels of 0 to 15 and 32 (CJR). If you request data from a channel in the range of 16 to 31, an error is generated. Refer to page 15 for more information about accessing the CJR on the AIM3, AIM5, and AIM7 modules.

Gain Codes

Some application programs (such as ASYST) use gain codes to select A/D input ranges. The K500/575 External DAS Driver combines the use of local and global gains in the implementation of each module's gain code table. For a list of valid gain codes and their gain values, refer to Table 12 on page 29.

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Note: You can access the AIM6 module only in the x50 RTD mode. The x166 gain and strain gauge modes are not supported.

AIM8 module channels 4 to 7 are not affected by the local gain amplifier. Therefore, only gain codes 0, 1, 2, and 3 are valid for channels 4 to 7. If a gain code specifying a local gain value other than 1 for channels 4 to 7 is used, the external DAS driver generates error 30.

Auto-Acquire Mode

Auto-acquire mode is a special mode of operation that allows high-speed acquisition at a single frequency. Using this mode, the Keithley 500/575 system is capable of performing A/D conversions at 50 kHz using the AMM2 module and at 62.5 kHz using the AMM1A module (100 kHz filter only). You can also realize these rates using the following analog multiplexer modules:

- AIM2
- AIM3 (with logical gain of 1)
- AIM3A (all gains)
- 3B Input (single channel only)

Auto-acquire mode is automatically selected by the external DAS driver whenever A/D conversions are requested with a conversion delay of .02 ms (AMM2) or .016 ms (AMM1A).

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Conversion Rates

The maximum conversion rate you can obtain is dependent on two factors: computer speed and the AIM or AMM module used.

The maximum speed attainable by the Keithley hardware for multi-channel (scanned) acquisitions is determined by the ADC's conversion time and the module's settling time; whichever is longer is the limiting factor. Table 5 shows the maximum conversion rate for the AIM and AMM modules. The rates given are aggregate (not per channel).

Table 5. Conversion Rates for Modules

Module	Maximum Conversion Rate
AIM2	AAR[1]
AIM3	AAR[1] (x1 gain) 33 kHz (x10 gain) 13.3 kHz (x100 gain)
AIM3A	AAR[1]
AIM4	400 Hz
AIM5	400 Hz
AIM6	2.5 Hz
AIM7	454 Hz
AIM8	4.0 Hz (10 Hz filter) 400 Hz (1kHz filter) 1.43 KHz (3 kHz filter)
AIM9	909 Hz
AMM1A	62.5 kHz (AAR)
AMM2	50.0 kHz (AAR)

Notes

[1] AAR = Auto-Acquire Rate. These modules' maximum rate is the auto-acquire rate and is dependent on the AMM module used.

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Note: The 3B input module on the Keithley 575 system is unable to do multi-channel auto-acquire acquisition, and its settling time is not a limiting factor to conversion rate. Therefore, the maximum acquisition rate for the 3B input module is limited by computer speed.

Computer speed is the limiting factor in determining the maximum nonauto-acquire conversion rate for the AIM2, AIM3, AIM3A, AMM1A, AMM2, and 3B input modules as well as the maximum single-channel conversion rate for the AIM4, AIM5, AIM6, AIM7, AIM8, and AIM9. When using nonauto-acquire mode, an error is generated if computer cannot keep up with the conversion rate. A faster method of collecting data is used in auto-acquire mode than in normal mode. Consequently, you will observe a "hole" in the range of possible conversion rates. For example, on a given computer the maximum nonauto-acquire conversion rate may be 25 kHz. Rates between 25 kHz and the auto-acquire rate cause errors.

The slowest conversion rate for all AIM and AMM modules is .00023 Hz (one sample every 71.5 minutes).

Module Voltage Ranges

In ASYST, you must enter the minimum and maximum values of the voltage range of the module used in order to scale the raw digital data to voltage data. Collected data is represented in digital units. The full voltage range for AIM modules is either –10 to +10 V (bipolar) or 0 to +10 V (unipolar), selectable from the configuration program.

The voltage range of the physical signal is the full voltage values (minimum and maximum) divided by the total gain applied:

$$\text{physical voltage minimum} = \frac{\text{full voltage minimum}}{\text{total gain}}$$

$$\text{physical voltage maximum} = \frac{\text{full voltage maximum}}{\text{total gain}}$$

For example, suppose the full voltage range is –10 to +10 V and the total gain applied is x100. The voltage range of the physical signal is –0.10 to +0.10 V. The signal is clipped by the ADC if it exceeds that range.

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Using the 3B Input Module

The Keithley 575 system includes a special 3B input connector that allows for eight analog input channels. The 3B input is represented as a module in slot 6.

Note: If you have an AIM module installed in the option slot (slot 3), only seven channels are available on the 3B input (channels 0 to 6).

Using the AMM2 Module

The AMM2 module returns analog-to-digital data in 16-bit unsigned format. Some application programs (such as ASYST) interpret this data as signed and, therefore, require conversion to unsigned format. The ASYST word >UNSIGNED performs this operation.

Using the AIM3 Module

When using the cold junction reference channel (channel 32) of the AIM3 module with EASYEST LX or EASYEST AG, you must divide the CJR sensitivity by the gain used on the AIM3 board. For example, if the gain of the AIM3 module is x10, enter the CJR sensitivity as 10 mV/°C, not 100 mV/°C as specified in the hardware manual.

Using the AIM4 Module

The AIM4 module is capable of having different hardware-settable gains for each channel. At this time, VIEWDAC supports this feature, but ASYST, EASYEST LX, and EASYEST AG do not support this feature.

If your application does not support this capability, the K500/575 External DAS Driver uses the gain set for channel 0 as the gain for all channels.

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Using the AIM5 and AIM7 Modules

When using the cold junction reference channel (channel 32) on the AIM5 or the AIM7 module with EASYEST LX or EASYEST AG, you must enter the CJR sensitivity as 1 mV/°C, not 100 mV/°C as specified in the hardware manual. EASYEST LX and EASYEST AG interpret channel 32 as having a range of ±0.1 V when the actual range of the channel is ±10 V (assuming bipolar configuration). Since the range seen by EASYEST LX and EASYEST AG is 100 times too small, the CJR sensitivity must be divided by 100 to compensate.

Using the AIM6 Module

When using the AIM6 module with a x50 gain (AMM module set to a ±10 V range), the voltage seen by the ADC is ±0.2 V (10 V/ 50 = 0.2 V). Note that the AIM6 can accept voltage only in the ±0.1 V range. In order to get full resolution from the ADC, it is recommended that you use at least a x100 gain (gain code 1, 2, or 3).

Using the AIM9 Module

The AIM9 module is designed for use with LVDTs and RVDTs; therefore, it is necessary to calibrate each LVDT with the AIM9. When the K500/575 External DAS Driver is used with programs such as EASYEST LX, EASYEST AG, and VIEWDAC that automatically scale A/D data, the data is normalized to a value between –1.0 and 1.0 V (at a global gain of 1.0). ASYST returns data in raw digital format.

To convert AIM9 data to meaningful units (displacement), first perform the calibration procedure described in the AIM9 hardware documentation. Then, boot your application program and perform the following steps:

1. Accurately position your LVDT at zero displacement.

2. Take a single A/D reading and remember the value (call it x_1).

3. Accurately position your LVDT at a large displacement. Remember the value (call it y).

4. Take another single A/D reading (call it x_2).

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You can convert the data from the AIM9 to displacement units according to the following formula:

$$\text{Displacement} = mx + b$$

where,

$$m = \frac{y}{x_2 - x_1}$$

$$b = -mx_1$$

$$x = \textit{raw A/D Data}$$

m and *b* are constants as long as you do not change or recalibrate your LVDT setup.

Analog Output Using the AOM Modules

The maximum speed attainable on AOM modules is dependent on the module's settling time. The K500/575 External DAS Driver limits the conversion delay for all AOM modules to 5 µs (200 kHz). Since this rate is faster than your computer can operate, you should never experience problems with this limit.

Keep the settling times listed in Table 6 in mind when using AOM modules.

Table 6. AOM Module Settling Times

AOM Module	Settling Time to .01%
AOM1	5 µs (200 kHz)
AOM2	20 µs (50 kHz)
AOM3	1 µs (1 kHz)
AOM4	500 µs (2 kHz)
AOM5	5 µs (200 kHz)

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Pulse Output Using the WAV1 Module

The WAV1 module is supported by the driver as a pulse output device. The WAV1 output waveform frequency and duty cycle are controlled by setting pulse width and duty cycle. The waveform amplitude and offset are set via pulse amplitude and pulse offset parameters.

Currently, ASYST and VIEWDAC do not allow you to set pulse amplitude and offset directly. You can set these parameters only by programming the pseudo-D/A channels listed in Table 7. The WAV1 module software was designed so that the WAV1 appears to have two analog output channels. By writing to these D/A channels, you can control the amplitude and offset.

Table 7. D/A Channels

D/A Channel	Function	Range
0	WAV1 amplitude	0 to 10 V
1	WAV1 offset	± 10 V

Selecting the output function is accomplished by setting the pulse output channel number. Table 8 lists the channel functions.

Table 8. Channel Function

Channel	Function
0	DC
1	sine
2	triangle
3	square

Note: For DC output, only the offset parameter is used. Pulse period, duty cycle, and amplitude are ignored.

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For example, to output a 35% duty cycle, 10 kHz triangle wave with a 2 V amplitude and –1 V offset in VIEWDAC, perform the following steps:

1. Set D/A channel 0 to 2.0 V.

2. Set D/A channel 1 to –1.0 V.

3. Execute a pulse output task to output a 35% duty cycle, 10 kHz waveform on pulse output channel 2.

You can output haver waves through the one-shot pulse output function. All other parameters of the waveform are set in the same manner as continuous output.

Frequency Measurement Using the PIM1 Module

The maximum input frequency for each channel is as follows:

- Channel 0: 1.0 MHz

- Channels 1 to 7: 8.0 MHz (nonisolated)

Frequency measurement is supported through the use of the PIM1 module. The K500/575 External DAS Driver takes requested gate times and rounds them to the nearest PIM1 gate time. The actual value used is reported to the application program.

The PIM1 has eight frequency measurement channels. You can use only one PIM1 channel at a time for frequency measurement.

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Event Counting

Event counting is available through the use of the PIM1 and PIM2 modules, which are described in the following subsections.

Using the PIM1 Module

The maximum count of the PIM1 module is 65535.

The PIM1 has eight physical channels but is shown by the external DAS driver as having twelve channels. The additional four channels provide a means of specifying gated or nongated counting. PIM1 channels 0 to 3 are gated channels and channels 4 to 11 are nongated. For example, driver channel 0 = PIM1 channel 0 gated with channel 4; driver channel 4 = PIM1 channel 0 (nongated).

You can use only one PIM1 channel at a time for event counting. If the number of events exceeds the maximum count, the external DAS driver generates error 16 “Event counter overflow.”

Using the PIM2 Module

The maximum count for the PIM2 module is 65,535 for 16-bit counters and 4,294,967,295 for 32-bit counters.

The PIM2 has four 16-bit event counting channels. You can combine counters 1 and 2 and counters 3 and 4 to form a 32-bit counter. Since the PIM2 module has four independent counter circuits, all channels can count simultaneously. If the number of events exceeds the maximum count, the external DAS driver generates error 16 “Event counter overflow.”

Note: ASYST, EASYEST LX, EASYEST AG, and VIEWDAC do not use unsigned, double-precision integers. The largest count interpretable by these programs is 2,147,483,647.

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Timed Interrupts Using the PIM1 and WAV1 Modules

One timed interrupt channel is supported on all modules except the PIM1 and the WAV1. Currently, VIEWDAC, EASYEST LX, EASYEST AG, and ASYST do not use timed interrupts. The maximum interrupt rate is 100 kHz, and the minimum interrupt rate is one interrupt every 71.5 minutes. If timed interrupts are active, no A/D, D/A, or digital I/O is allowed on any module.

Digital I/O

The K500/575 External DAS Driver supports the DIM1, DOM1, DIO1, DIO1A, PCM1, and PCM2 modules for performing digital data transfer and power control. All digital I/O is performed through 8-bit channels. You can control single or specific bits using digital masks in ASYST, EASYEST LX, EASYEST AG, and VIEWDAC. The following subsections describe the digital modules in more detail.

Using the DIM1 Module

The DIM1 module is a 16-bit digital input board. The K500/575 External DAS Driver reads the 16 bits as two 8-bit channels. Channel 0 reads bits 0 to 7 and channel 1 reads bits 8 to 15.

Using the DOM1 Module

The DOM1 module is a 16-bit digital output board. The K500/575 External DAS Driver controls the 16 bits as two 8-bit channels. Channel 0 controls bits 0 to 7 and channel 1 controls bits 8 to 15.

Using the DIO1/DIO1A Module

The DIO1 and DIO1A modules are 32-bit digital I/O boards. The 32 digital bits are accessed as four 8-bit digital ports. You can set each 8-bit port as input or output using the configuration program. Channel numbers are assigned to the 8-bit ports in ascending order. For example, consider a DIO1 module configured with Ports A and B as input and Ports C and D as output. The digital channel numbers are assigned as shown in Table 9.

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Table 9. Digital I/O Channels

Port	Digital Input Channel	Digital Output Channel
A	0	–
B	1	–
C	–	0
D	–	1

Using the PCM1 Module

The PCM1 module is a 4-bit digital output board. The K500/575 External DAS Driver controls the 4 bits as one digital output channel.

Using the PCM2

The PCM2 module is a digital I/O board that controls 16 digital bits. The K500/575 External DAS Driver accesses the 16 bits as two 8-bit ports. Since you can set each individual bit of the PCM2 as either input or output, the K500/575 External DAS Driver shows the PCM2 as having two digital input channels and two digital output channels.

Digital input channel 0 reads PCM bits 0 to 7 regardless of the direction of the bits. In other words, input channel 0 reads the value of the input bits and the current status of the output bits of PCM2 bits 0 to 7.

Digital output channel 0 controls the output bits of PCM2 bits 0 to 7 (values written to the input bits are ignored). Digital input channel 1 and digital output channel 1 control/read PCM2 bits 8 to 15 in the same manner as described for the digital input channel 0.

Using the PCM3 Module

The PCM3 relay board is controlled by the I/O ports on the PCM2 or by the relay control connector on the Keithley 575 system.

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Triggering Using the TRG1 Module

Refer to the Keithley TRG1 module documentation for information on the hardware connections necessary to use trigger operations using the TRG1 module. Also refer to the KDAC500 software manual included with your hardware for application examples on using the TRG1 module.

You can use the TRG1 module to trigger any module that supports auto-acquire mode. Refer to “Auto-Acquire Mode” on page 12 for the modules supporting auto-acquire mode. The Keithley 500/575 supports up to two TRG1 modules in a system.

Since ASYST, EASYEST LX, EASYEST AG, and VIEWDAC currently do not allow you to set the TRG1 triggering parameters directly, the K500/575 External DAS Driver provides a means of programming the TRG1 via pseudo-digital ports. When used with the K500/575 External DAS Driver, the TRG1 module appears to have twelve 8-bit digital output ports and one 8-bit digital input port. Of course, the TRG1 module does not actually perform digital input or output—the K500/575 External DAS Driver intercepts any digital output values and interprets them as external triggering parameters.

Note: If you are using two TRG1 boards, you can access/control the second TRG1 only via the pseudo-digital ports.

If when using the TRG1, no external trigger signal is found, the external DAS driver waits indefinitely for the trigger signal and the machine may appear to be locked. You must provide the TRG1 with a valid trigger before machine execution resumes.

If you are using ASYST with the TRG1 module, the K500.UTL file may be useful to set the TRG1 parameters. Refer to “Controlling the TRG1 Module Using K500.UTL” on page 37 for more information on K500.UTL.

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Table 10 describes the functions of the TRG1 digital ports.

Table 10. TRG1 Digital Port Functions

Digital Output Channel	Digital Input Channel	Function	Value	Setting
0	–	Number of TRG modules to use. The value output to port 0 sets the number of TRG1 modules used in the triggering operation.	0	0 trig boards
			1	1 trig board (default)
			2	2 trig boards
1	–	Current TRG module being programmed The value output to port 1 sets which TRG module is currently being programmed.	0	TRG1 in slot 2 is presently being programmed (default)
			1	TRG1 in slot 3 is presently being programmed.
2	–	Method of resetting trigger flag The value output to port 2 sets the method used to reset the trigger flag.	0	automatic
			1	manual (default)
3	–	Periodicity of acquisition after trigger condition has been met The value output to port 3 sets the number of points to be converted once the trigger condition has been met.	0	continuous (default)
			1	one shot
4	–	Mode of operation The value output to port 4 sets the mode to use every time the trigger condition is met	0	normal (default)
			1	single event
5	–	Input source The value output to port 5 sets the input source to use for the trigger condition.	0	none
			1	global strobe
			2	global amp output[1]
			3	external analog input

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Table 10. TRG1 Digital Port Functions (cont.)

Digital Output Channel	Digital Input Channel	Function	Value	Setting
6	–	Filtering The value output to port 6 sets the low-pass filter frequency used for the trigger source.	0	1 MHz (default)
			1	300 kHz
			2	100 kHz
			3	30 kHz
			4	10 kHz
			5	3 kHz
			6	1 kHz
			7	300 Hz
7	–	Voltage range The value output to port 7 sets the voltage range used for the trigger condition.	0	0 to 1 V
			1	0 to 10 V (default)
8	–	Polarity of voltage range The value output to port 8 sets the polarity of the trigger voltage range. The value written to this port is used in conjunction with the voltage range setting (port 7).	0	negative
			1	positive (default)
9	–	Coupling on input source The value output to port 9 sets the type of coupling used on the trigger source.	0	DC (default)
			1	AC
10	–	Edge triggering The value output to port 10 sets the TRG1 module for rising-edge or falling-edge sensitivity.	0	falling-edge sensitive
			1	rising-edge sensitive (default)

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Table 10. TRG1 Digital Port Functions (cont.)

Digital Output Channel	Digital Input Channel	Function	Value	Setting
11	–	Voltage The value output to port 11 sets the trigger voltage level.	0 to 255	A value between 0 and 255 is used in conjunction with the trigger voltage range (port 7) and the range polarity (port 8). The programmed range consists of 255 steps. For example, if the range were –1 to 0 V, a value of 128 sets the trigger level to –0.5 V. Default: 51 (i.e., 2 V at the 0 – 10 V. default range. This value was chosen as the correct level for TTL triggering.)
–	0	Trigger status The value returned from port 0 is the status of the trigger. Reading this port also resets the trigger condition.	–	–

Notes

[1] If you are using the global amp output and your application does not support explicit selection of the trigger channel (as is the case with ASYST, EASYEST LX, EASYEST AG, and VIEWDAC), the A/D channel routed to the global amp output is that of the last A/D channel from which data was acquired. A single-point A/D from the desired trigger channel could be performed immediately before the triggered acquisition to set the A/D channel that is connected to the global amp output.

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Software Interrupt Vectors

This driver uses three software interrupt vectors to communicate with the application program. The interrupt vectors used are three of the MS-DOS "user interrupts" (interrupts 60h to 67h). To ensure that conflicts with other devices, hardware, or programs do not exist, you can set each of the interrupt vectors to use a different interrupt number than the default.

You can change the interrupt vector numbers from the default by using the SET command from DOS. This command saves a string in the DOS environment that the external DAS driver searches for when loading. These strings are specified in Table 11.

Table 11. Software Interrupt Vectors

Interrupt	Default Interrupt Number	Environment String[1]
Device linking vector	66h	DAS DS=*xx*
Critical error vector	65h	DAS CE=*xx*
Timer interrupt vector	64h	DAS TI=*xx*

Notes
[1] *xx* is between 60h and 67h.

Note: Do not confuse these interrupt vectors with the hardware interrupt lines used by the Keithley 500/575 system.

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K500/575 External DAS Driver Operating Specifications

The following sections describe the operating specifications of the K500/575 External DAS Driver.

Analog Input

The K500/575 External DAS Driver supports the following analog input operations:

- **Synchronous A/D** - All AIM and AMM modules support internal triggering with the internal clock in synchronous A/D mode. The AMM1A, AMM2, AIM2, AIM3, AIM3A, and 3B input modules also support external triggering with the internal clock while in auto-acquire mode only.

- **Interrupt A/D** - All AIM and AMM modules support internal clocking/internal triggering in interrupt mode using any of the buffering modes (single buffer/noncyclic, single buffer/cyclic, double buffer/noncyclic, double buffer/cyclic).

The K500/575 External DAS Driver does not support external clocking, DMA mode, or channel-gain arrays for analog input operations.

Refer to Table 12 for the gains supported by each analog input module. Note that g*lobal gain* is the gain of the global gain amplifier on the module and that *local gain* is the gain of the local gain amplifier on the module.

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Table 12. Gains Supported by Analog Input Modules

Module	Gain Code	Local Gain	Global Gain	Total Gain
AMM1A AMM2	0	1	1	1
	1	1	2	2
	2	1	5	5
	3	1	10	10
	4	10	1	10
	5	10	2	20
	6	10	5	50
	7	10	10	100
AIM2 AIM3 AIM4 AIM5 AIM9 3B Input	0	–	–	1
	1	–	–	2
	2	–	–	5
	3	–	–	10
AIM3A	0	1	1	1
	1	1	2	2
	2	1	5	5
	3	1	10	10
	4	10	1	10
	5	10	2	20
	6	10	5	50
	7	10	10	100
	8	100	1	100
	9	100	2	200
	10	100	5	500
	11	100	10	1000

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Table 12. Gains Supported by Analog Input Modules (cont.)

Module	Gain Code	Local Gain	Global Gain	Total Gain
AIM6	0	–	–	50
	1	–	–	100
	2	–	–	250
	3	–	–	500
AIM7	0	–	–	100
	1	–	–	200
	2	–	–	500
	3	–	–	1000
AIM8[1]	0	1	1	1
	1	1	2	2
	2	1	5	5
	3	1	10	10
	4	10	1	10
	5	10	2	20
	6	10	5	50
	7	10	10	100
	8	100	1	100
	9	100	2	200
	10	100	5	500
	11	100	10	1000
	12	1000	1	1000
	13	1000	2	2000
	14	1000	5	5000
	15	1000	10	10000

Notes

[1] Only gain codes 0, 1, 2, and 3 are valid for channels 4 to 7.

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Table 13 lists the programmable filter frequencies for each module.

Table 13. Programmable Filter Frequencies for Modules

Module Model Number	Filter Number	Low-Pass Frequency
AMM1A AMM2 AIM2 AIM3 AIM3A AIM4 AIM5 AIM6 AIM7 3B Input	0	100 kHz
	1	2 kHz
AIM9	0	200 Hz
	1	20 Hz
	2	2 Hz
AIM8	0	3000 Hz
	1	1000 Hz
	2	10 Hz
	3	2000 Hz

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Analog Output

The K500/575 External DAS Driver supports the following analog output operations:

- **Synchronous D/A** - All AOM and WAV1 modules support internal triggering with the internal clock in synchronous A/D mode.
- **Interrupt D/A** - All AOM modules support internal clocking/internal triggering in interrupt mode using any of the following buffering modes: single buffer/noncyclic, single buffer/cyclic, double buffer/noncyclic, double buffer/cyclic.

The K500/575 External DAS Driver does not support external clocking, external triggering, or DMA mode for analog output operations.

Digital Input

The K500/575 External DAS Driver supports the following digital input operations:

- **Synchronous Digital Input** - The DIM1, DIO1, DIO1A, PCM2, and TRG1 modules support internal triggering with the internal clock in synchronous digital input mode.
- **Interrupt Digital Input** - The DIM1, DIO1, DIO1A, and PCM2 modules support internal clocking/internal triggering in interrupt mode using any of the following buffering modes: single buffer/noncyclic, single buffer/cyclic, double buffer/noncyclic, double buffer/cyclic.

The K500/575 External DAS Driver does not support external triggering, external clocking, or DMA mode for digital input operations.

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Digital Output

The K500/575 External DAS Driver supports the following digital output operations:

- **Synchronous Digital Output** - The DIO1, DIO1A, TRG1, DOM1, PCM1, and PCM2 modules support internal triggering with the internal clock in synchronous digital output mode.

- **Interrupt Digital Output** - The DIO1, DIO1A, DOM1, PCM1, and PCM2 modules support internal clocking/internal triggering in interrupt mode using any of the following buffering modes: single buffer/noncyclic, single buffer/cyclic, double buffer/noncyclic, double buffer/cyclic.

The K500/575 External DAS Driver does not support external triggering, external clocking, or DMA mode for digital output operations.

Counter/Timer

The K500/575 External DAS Driver supports the following counter/timer operations:

- Frequency Measurement (using the PIM1 module)
- Event Counting (using the PIM1 and PIM2 modules)
- Pulse Output (using the WAV1 module)
- One-Shot Pulse Output (using the WAV1 module)
- Timer Interrupt Generation (using all modules except WAV1 and PIM1)

The K500/575 External DAS Driver does not support time interval measurements.

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New Features to Version 2.0 of the K500/575 External DAS Driver

This section describes the new features in version 2.0 of the K500/575 External DAS Driver and differences between this version and version 1.00.

New Module Support

Version 2.0 of the K500/575 External DAS Driver supports the PCM1, PCM2, PIM1, PIM2, and the WAV1 modules. These modules were not supported in version 1.00.

Multi-Channel Auto-Acquire

Version 2.0 of the K500/575 External DAS Driver supports the ability to scan a range of channels in auto-acquire mode.

New Configuration Process

Version 2.0 of the K500/575 External DAS Driver uses a version of the Keithley 500/575 configuration program to configure the driver. If you have already configured your system using the Keithley 500/575 CONFIG.EXE you can use the .TBL file generated to configure the K500/575 External DAS Driver.

The K500CFG.EXE configuration program used with version 1.00 of the K500/575 External DAS Driver is not used by version 2.0 of the external DAS driver.

Faster Conversion Rates

Version 1.00 of the K500/575 External DAS Driver required that the conversion delay be twice the settling time specification of the AIM or AMM module used. Version 2.0 requires only that the conversion delay be no smaller than the settling time.

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AIM9 Support

Version 1.00 of the K500CFG.EXE configuration program allowed you to enter a local gain value for the AIM9 module. The new KCONFIG.EXE configuration program does not allow you to enter the gain of the AIM9 board as it is irrelevant when used with LVDTs. See page 16 for more information on using the AIM9 module.

New A/D Gain Codes

Version 2.0 of the K500/575 External DAS Driver uses different gain codes for analog input than version 1.00. If you are using ASYST, you may have to use different gain codes. Refer to Table 12 on page 29 for the new gain codes.

TRG1 and WAV1 Support

The K500/575 External DAS Driver provides a means of controlling the TRG1 and WAV1 features via pseudo-digital and pseudo-D/A ports for use with ASYST and VIEWDAC.

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External DAS Driver vs. ASYST Internal Driver

The K500/575 External DAS Driver supports the Keithley 500/575 system. If you are using ASYST, Module 3 includes an internal driver for the Keithley 500/575 system. Hence, the Keithley 500 system is supported by both an internal and an external DAS driver. Consider the differences between the external and internal drivers when determining which driver is appropriate for your needs. These differences are described in the sections that follow.

Module Support

The K500/575 External DAS Driver supports several modules that are not supported by the internal driver. The AIM3A, AIM8, AIM9, AOM5, DIO1, DIO1A, TRG1, PIM1, PIM2, and WAV1 are supported only by the external DAS driver. The following modules are considered obsolete and are supported only by the internal driver: AIM1, ADM1, ADM2, and AMM1.

Interface Card Support

The original IBM interface card and the 570 interface card are considered obsolete and are supported only by the internal driver.

CJR Reading Capability

The internal driver does not allow for reading the Cold Junction Reference (CJR) using the words A/D.IN and A/D.IN>ARRAY, which restricts the use of the CJR with ASYST multitasking. The K500/575 External DAS Driver reads the CJR by accessing channel 32 on the AIM3, AIM5, and AIM7 modules with the words A/D.IN and A/D.IN>ARRAY, which allows for the use of the CJR with ASYST multitasking.

The word K500.CJR is not usable with the K500/575 External DAS Driver.

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Module Referencing

The internal driver references all installed modules as a single board. Therefore, the DAS templates can reference channels from more than one module, allowing for continuous data collection over a large number of channels. However, referencing all installed modules as a single board restricts the use of the special features of the individual modules.

The K500/575 External DAS Driver references each module as a separate board, thus preserving the availability of all special features of each module. To access a specific module, reference the board corresponding to the slot number where the module is located. For example, to access the module in slot 3 of the 500 chassis, enter the following at the ASYST prompt:

```
3 BOARD
```

Any templates now created access the module in slot 3.

ASYST versions 2.1 and 3.0 can reference 8 modules; version 3.1 can reference 10 modules.

Controlling the TRG1 Module Using K500.UTL

The TRG1 module is supported only by the external DAS driver. In ASYST, you can control the TRG1 module by writing to the TRG1 digital ports as described in “Triggering Using the TRG1 Module” on page 23or by using the words defined in the K500.UTL file. To use these words simply load K500.UTL as you would any other ASYST source file. The words in the K500.UTL file are described as follows:

- `K500.NUM.OF.BOARD [n – ]`

  This word sets the number of trigger modules used for the triggering operation.

- `K500.TRG.SLOT2 [ – ]`
  `K500.TRG.SLOT3 [ – ]`

  These words set the TRG1 module being programmed.

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- `K500.TRG.AUTO.RESET [ – ]`
  `K500.TRG.MANUAL.RESET [ – ]`

  These words set the method used by the TRG1 module to reset the trigger latch.

- `K500.TRG.CONTINUOUS [ – ]`
  `K500.TRG.ONE.SHOT [ – ]`

  These words set the number of conversions the system performs once the trigger conditions are satisfied.

- `K500.TRG.NORMAL.MODE [ – ]`
  `K500.TRG.SINGLE.MODE [ – ]`

  These words set the TRG1 module mode used each time a trigger condition is met.

- `K500.TRG.DISABLE [ – ]`
  `K500.TRG.STROBE.IN [ – ]`
  `K500.TRG.AMP.IN [ – ]`
  `K500.TRG.EXT.IN [ – ]`

  These words set the TRG1 module input source used in trigger operations for none, the Global Strobe, the Global Amp Output, or the External Analog Input, respectively.

- `K500.TRG.FILTER [n – ]`

  This word sets the TRG1 module filter frequency used in waveform processing, where *n* can have the following values:

  – *n*=0 1 MHz

  – *n*=1 300 kHz

  – *n*=2 100 kHz

  – *n*=3 30 kHz

  – *n*=4 10 kHz

  – *n*=5 3 kHz

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– *n*=6 1 kHz

– *n*=7 300 Hz

- `K500.TRG.RANGE.LOW [ – ]`
  `K500.TRG.RANGE.HIGH [ – ]`

  These words set the TRG1 module voltage range. The low range is 0 to 1 V; the high range is 0 to 10 V.

- `K500.TRG.POLARITY+ [ – ]`
  `K500.TRG.POLARITY– [ – ]`

  These words set the TRG1 module voltage range polarity. They are used with the ASYST words K500.TRG.RANGE.LOW and K500.TRG.RANGE.HIGH to set the overall range to 0 to 1 V, –1 to 0 V, 0 to 10 V, or –10 to 0 V.

- `K500.TRG.COUPLING.AC [ – ]`
  `K500.TRG.COUPLING.DC [ – ]`

  These words set the TRG1 module coupling mode used for the triggering signal.

- `K500.TRG.EDGE+ [ – ]`
  `K500.TRG.EDGE– [ – ]`

  These words set the TRG1 module for rising edge (+) or falling edge (–) sensitivity.

- `K500.TRG.VOLTAGE [n – ]`

  This word sets the TRG1 module triggering voltage. The value written to this word must be between 0 and 255.

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K500/575 Driver Error Messages

The K500/575 External DAS Driver may return the error messages listed in Table 14 during operation.

Table 14. Error Messages

Error Number	Message	Description
0	No error	No error message.
1	Function not supported	A function was requested that is not supported by the external DAS driver.
2	Function out of bounds	A requested function number was not defined.
3	Invalid board number	A requested board number is out of the range of configured boards. This external DAS driver can support a maximum of 10 boards.
4	Invalid error number	An invalid error number was detected by the K500/575 external DAS driver. For this driver, 31 error numbers have been defined. A request for an error message string not defined returns this error code.
5	Interrupt overrun	This error occurs when the conversion rate is too fast for interrupt operations.
6	Invalid channel number	The specified channel is outside the valid range for the board and is not channel 32 (CJR). This error is returned only for modules that support CJR (AIM3, AIM5, AIM7).
7	A/D not initialized	This error is returned by any of the A/D start functions when the A/D subsection of the K500/575 external driver has not been initialized.
8	CJR must be accessed as a single channel	An A/D conversion used to reference the CJR (cold junction reference) must read channel 32 only.
9	Conversion delay is too small	The specified conversion delay is too small for the settling time of the module. This error occurs only during multiple channel analog input operations.

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Table 14. Error Messages (cont.)

Error Number	Message	Description
10	D/A not initialized	This error is returned by any of the D/A start functions when the D/A subsection of the K500/575 external driver has not been initialized.
11	TRG1 module operates only in the auto-acquire mode	The trigger is set to use a module that does not run in auto-acquire mode or is not correctly configured to run in auto-acquire mode. Refer to “Triggering Using the TRG1 Module” on page 23.
12	The module does not support auto-acquire mode	An A/D conversion was requested using a module that does not run in the auto-acquire mode.
13	Digital I/O not initialized	This error is returned by any of the digital start functions when the digital subsection of the K500/575 external driver has not been initialized.
14	The IBIN card is not present at configured address	The interface card is either set to the wrong address or is not in the PC.
15	Module does not support multiple conversions	An attempt was made to run the module with the number of conversions greater than 1.
16	Event counter overflow	An event counter overflow has occurred on the PIM1 or PIM2 module.
17	Frequency measurement overflow	This error is generated by the external DAS driver when the signal whose frequency is being measured has overflowed the measurement counter. The solution is to reduce the gate period of the frequency measurement operation.
18	Interrupts currently active	An attempt was made to start an interrupt operation or an operation that uses the IBIN timer while an interrupt operation is in progress.
19	Interrupt auto-acquire mode not allowed	Auto-acquire mode is not allowed with interrupt operations.
20	Multi-channel auto-acquire not allowed with 3B input series	Auto-acquire mode is not possible across multiple channels on the 3B input module.
21	Unable to update VCPI interrupt vectors	The driver was unable to update the VCPI interrupt vectors used by the current expanded memory manager.

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Table 14. Error Messages (cont.)

Error Number	Message	Description
22	Unable to calibrate the A/D	The device initialization was unable to calibrate the AMM module in slot 1.
23	PIM1 currently active	An attempt was made to start a frequency measurement or event counting operation on the PIM1 while another PIM1 channel is currently active. Only one PIM1 channel can be active at a time.
24	Event counting currently active	An attempt was made to start event counting on a channel that is currently active.
25	Timer not initialized	This error is returned by any of the timer start functions when the timer subsection of the K500/575 has not been initialized.
26	Event counting not active.	An attempt was made to read the current count when no event counting operation had been started.
27	Frequency measurement not active	An attempt was made to read the frequency count when no frequency measurement operation had been started.
28	Conversion overrun	The specified conversion delay is too small for the driver to keep up with.
29	Auto-acquire mode not allowed with 2 kHz filter	An attempt was made to perform auto-acquire A/D with the 2 kHz filter selected. Only the 100 kHz filter can be used with the auto-acquire mode.
30	Selected gain not allowed for specified A/D channel	This error is generated if a gain code other than 0, 1, 2, or 3 is used with AIM8 channels 4 to 7.

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