

CTM-05  
External DAS Driver

**USER'S GUIDE**

# **CTM-05 External DAS Driver User's Guide**

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# Preface

The CTM-05 External DAS Driver allows you to use Keithley's CTM-05 and  $\mu$ CCTM-05 counter/timer boards with the following Keithley data acquisition and analysis software:

- VIEWDAC<sup>®</sup>
- ASYST<sup>®</sup>

This manual provides the information needed to use the CTM-05 External DAS Driver with data acquisition and analysis software. Use this manual in conjunction with your board user's guide and with the documentation for the data acquisition software you are using.

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**Note:** The CTM-05 External DAS Driver may support options your software does not; likewise, your software may support options this external driver does not.

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If you need help, contact your local sales office or Keithley's Applications Engineering Department between 8 am and 6pm (Eastern Time), Monday through Friday:

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# Using the CTM-05 External DAS Driver

The CTM-05 External DAS Driver allows your VIEWDAC or ASYST application program to exchange data with CTM-05 and  $\mu$ CCTM-05 counter/timer boards. This document describes how to use the CTM-05 External DAS Driver.

## Supported Hardware

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The CTM-05 External DAS Driver supports the following Keithley data acquisition (DAS) boards.

- CTM-05 (standard architecture)
- $\mu$ CCTM-05 (Micro Channel™ architecture)

## Options Supported

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The CTM-05 External DAS Driver supports the following options:

- Counter/timers
  - Up to 5 counter/timer channels
  - Event counting (16-bit or 32-bit)
  - Frequency measurement
  - Pulse output (including one-shot variant)
  - Time interval measurement



- Synchronous digital I/O
  - Up to eight bits of digital input
  - Up to eight bits of digital output
  - Internal and external clocking
  - Internal and external triggering

## Files on Disk

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The driver disk contains the file CTM05.EXE. CTM05.EXE controls the boards and allows communication between an application program and the boards. CTM05.EXE executes as a terminate-and-stay-resident (TSR) program that occupies a small amount of memory in your computer.

## Quick Start

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This section briefly describes how to configure, load, and access the CTM-05 External DAS Driver.

## Setting up the Board

Refer to your board user's guide for information on setting the jumpers for the base address. Remember this setting when you use the CTM-05 External DAS Driver configuration program.

## Running the Configuration Program

The CTM-05 External DAS Driver is set up for the following default configuration:

- Board number = 1
- Board type = CTM-05
- Base address = 300h
- Interrupt level = 0 (disabled)

- Time interval resolution = 1  $\mu$ s
- Event count resolution = 16 bits

You must run the configuration program or configure the driver from DOS if your board's settings differ from these default settings. In addition, whenever you change the hardware or software settings, you must run the configuration program or reconfigure the driver from DOS in order for the external DAS driver to function properly.

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**Note:** Each memory resident image of the CTM-05 External DAS Driver can support two CTM-05 or  $\mu$ CCTM-05 boards. If you are using more than one CTM-05 or  $\mu$ CCTM-05 board, you must configure the parameters for each board, ensuring that the base address does not conflict between the two boards.

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Perform the following steps to run the configuration program:

1. Create a CTM05 subdirectory on your hard disk. For example, at the DOS prompt, enter the following:

```
MKDIR CTM05
```

2. Copy CTM05.EXE from the driver disk into the CTM05 directory.
3. Enter the following at the DOS prompt:

```
CD \CTM05  
CTM05 -MENU
```

Configure the board parameters using the configuration program, as described in See "Using the Configuration Program" on page 5.

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**Note:** If you wish, you can also configure the CTM-05 External DAS Driver from DOS instead of using the configuration program; refer to page 8 for more information.

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## Loading the CTM-05 External DAS Driver

You must load the CTM-05 External DAS Driver each time you start up your computer in order for an application program to recognize it. The external DAS driver remains in memory until the computer is turned off or rebooted.

To load the CTM-05 External DAS Driver, access the directory containing CTM05.EXE and enter the following at the DOS prompt:

```
\CTM05\CTM05
```

---

**Note:** You can also load the CTM-05 External DAS Driver automatically whenever you start the computer by adding the preceding line to your AUTOEXEC.BAT file.

If you want to access more than two boards, load the driver multiple times.

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## Accessing the CTM-05 External DAS Driver

Some application programs access the CTM-05 External DAS Driver automatically. For information on accessing external DAS drivers, see the documentation for your application program.

If you are using the ASYST program, perform the following steps to access the CTM-05 External DAS Driver:

1. After loading the CTM-05 External DAS Driver, boot *ASYST* 2.10 or greater and permanently load the *Ext DAS Driver Support* system overlay from the Data Acquisition menu. *ASYST* automatically searches for and creates a DAS device called CTM05.
2. Enter the following at the OK prompt to make CTM-05 the current device:

```
CTM05
```

# Using the Configuration Program

---

This section describes the configuration program's menu items and special purpose keys, and how to exit from the configuration program.

## Menu Items

When you run the configuration program, the configuration menu is displayed. The menu options, choices, and default values are listed in Table 1.

**Table 1. Configuration Program Menu Items**

Menu Item	Choices	Default Value
Number of Boards	1, 2	1
Board Type	0 = CTM-05; 1 = $\mu$ CCTM-05	0 (CTM-05)
Base I/O Address	For CTM-05: 100h to 3BCh (in multiples of four)  For $\mu$ CCTM-05 <sup>1</sup> : 300h, 3E0h, 500h, 600h, 800h, F00h, 1000h, 1500h, 1800h, 2000h, 3000h, 4000h, 8000h, A000h, F000h, and FF00h	300h
Interrupt Level	0 to disable interrupts <sup>2</sup>	0 (disabled)
Timed Interval Measurement Resolution	1 $\mu$ s, 16 $\mu$ s, 256 $\mu$ s, 4096 $\mu$ s, 65536 $\mu$ s	1 $\mu$ s
Event Count Resolution <sup>3</sup>	16-bit, 32-bit	16-bit

### Notes

<sup>1</sup> You can set and check the address for the  $\mu$ CCTM-05 using the reference disk supplied with your Micro Channel machine.

<sup>2</sup> Timed interrupt mode is not supported at this time.

<sup>3</sup> If you select 16-bit resolution, five 16-bit counters are available; if you select 32-bit resolution, a maximum of two 32-bit counters are available.

When you specify the time interval measurement resolution, you are also specifying the range. Table 2 lists the ranges that correspond to the available time interval measurement resolutions.

**Table 2. Time Interval Ranges and Resolution**

Resolution ( $\mu$ s)	Range (s)	Time Interval Code <sup>1</sup>
1	0.000001 to 0.065535	1
16	0.000016 to 1.048560	2
256	0.000256 to 16.776960	3
4,096	0.004096 to 268.43136	4
65,536	0.065536 to 4294.901760	5

**Notes**

<sup>1</sup>Time interval codes are necessary if you are configuring the external DAS driver using DOS; see page 8 for more information.

## Special Purpose Keys

Table 3 describes the keys used for special purposes in the configuration program.

**Table 3. Configuration Menu Special Keys**

Keys	Description
[w]	Write a response file. A response file is an ASCII file containing the command line options for the current configuration of the driver.
[q]	Quit the configuration program without loading the driver.
[d]	Reset the driver settings to their default values.
[Esc]	Exit the configuration menu with the option of saving the current settings and loading the driver into memory.
[Tab]	Toggle between boards 1 and 2 when two boards are being configured.
[?]	Invoke help on the current menu item.

## Exiting the CTM-05 Configuration Program

To exit the program without saving any changes press [q]. Otherwise, to exit the configuration program press [Esc]. The following prompt is displayed:

```
Do you want to permanently save this configuration?  
[Y/N]
```

Type [Y] to save the configuration; type [N] if you do not want to save the configuration settings. If the configuration is saved, the program displays the message:

```
Remembering...
```

Then, you are prompted with the following message:

```
Exit Configuration Program? [Y/N]
```

Type [Y] to exit from the configuration program; type [N] to remain in the configuration program.

## Configuring the CTM-05 External DAS Driver from DOS

If you wish, you can also change the configuration of the CTM-05 External DAS Driver using DOS command line options instead of using the configuration program. The command line syntax is as follows:

```
CTM05 [bd #1 options],[bd #2 options] [-menu ]
```

The command line options are described in Table 4.

**Table 4. Command Line Options**

Option	Function
-a###	Board I/O address = ### (in hexadecimal); see Table 1 on page 5
-bt#	Board type = # (0 - CTM-05 , 1 - $\mu$ CCTM-05)
-irq#	Interrupt level = 0 (disabled)
-ti#	Time interval code = # (1 to 5); see Table 2 on page 6
-er#	Event count resolution = # (16 or 32)
-def	Recall original default settings
-h	Help
-menu	Invoke menu-driven setup
@xxx	Indicates use of response file xxx. A response file is an ASCII file containing the command line options for the driver.

To display command line options, enter the following at the DOS prompt:

```
CTM05 ?
```

## CTM-05 External DAS Driver Characteristics

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The following sections describe the various attributes of the CTM-05 External DAS Driver and the restrictions imposed by the external DAS driver on various modes of operations and resources.

### Digital I/O Clocking and Triggering

Keep the following in mind when performing digital I/O clocking and triggering:

- **Internal Clocking and Triggering** - For this mode of operation, the data transfer begins without waiting for any external event and proceeds at the specified rate until finished. No external connections to the timer are required.
- **External Clocking** - For this mode, the driver waits for a TTL, rising-edge signal at the clock input before each data point is transferred. The operation proceeds paced by the external clock signal until the requested amount of data is transferred.

The clocking signal is rising-edge sensitive. Each data transfer occurs on successive rising edges of the external clock signal. Connect the external clocking signal to the CTR 1 SOURCE pin.

- **External Triggering** - For this mode, the driver waits for a logic high signal at the trigger input before starting the data transfer. Data transfer then proceeds at the specified rate until finished. The triggering signal is TTL, level-sensitive. If the trigger level is brought low during the operation, data transfer is halted until the trigger signal is brought high again. Connect the external triggering signal to the CTR 1 GATE pin.
- **Timer Resources** - The CTM-05 uses the Am9513A counter/timer circuitry from Advanced Micro Devices. The Am9513A has five timer channels (counters), any of which can be used for counter/timer functions. When referencing timer resources, the driver uses the term *channel*. Timer channels are zero-based (0 to 4). The CTM-05 hardware uses the term *counter* to refer to timer resources. Counter numbering is one-based (1 to 5). For example, driver channel 0 is the same as CTM-05 counter 1.



Certain counters have special uses. Counter 1 is used for digital I/O clocking and triggering. The driver holds a counter/timer allocation table that is checked to see if any given timer channel is currently in use. If the channel is in use, the driver returns a “Timer Channel in Use” error.

## Timer Connections

Keep the following in mind when connecting to counter/timer channels:

- **Frequency Measurement** - Available channels: 0, 1, 2, 3;  
Maximum gate: 2,147 s; maximum frequency: 7.5 MHz.

Frequency measurement requires two adjacent counters. The timer chosen is referred to as the pulse counter. The next channel is referred to as the gate counter. The input must be connected to the source of the pulse counter. The output of the gate counter must be connected to the gate of the pulse counter.

- **Event Counting (16-bit)** - Available channels: 0, 1, 2, 3, 4;  
maximum count: 65,535.

The input must be connected to the source of the counter being used.

- **Event Counting (32-bit)** - Available channels: 0, 1, 2, 3;  
maximum count: 4,294,901,760.

The input signal must be connected to the source of the counter specified. The output of that counter must be connected to the source of the next consecutive channel.

- **Pulse Output** - Available channels: 0, 1, 2, 3, 4;  
minimum pulse width: 2  $\mu$ s; minimum pulse period: 4  $\mu$ s;  
maximum pulse period: 2,147 s.

The pulse output signal is generated on the output of the counter being used.

- **Asynchronous Time Interval** - Available channel: 0, 1, 2, 3, 4.

Asynchronous time interval measurement requires either one or two of the available counters, depending on your application. One counter is needed if the events being timed occur on the same input. Two counters are needed if the events being timed occur on different inputs. The input signals must be connected to the gates of the appropriate counters. The timer interval measurement range and resolution are configuration dependent. See Table 2 on page 6 for a list of ranges and resolutions.

## Software Interrupt Vectors

The CTM-05 External DAS Driver uses two software interrupt vectors to communicate with the application program. The interrupt vectors used are two of the MS-DOS “user interrupts” (interrupts 60h to 67h). To ensure that conflicts with other devices, hardware, or programs do not exist, each of the interrupt vectors can be set to use a different interrupt number than the default.

The interrupt vector numbers can be changed from the default by using the SET command from DOS. This command saves a string in the DOS environment that the driver searches for upon loading. These strings are specified in Table 5.

**Table 5. Interrupts and Environment Strings**

Interrupt	Default Interrupt Number	Environment String <sup>1</sup>
Device linking vector	66h	DAS DS= <i>xx</i>
Critical error vector	65h	DAS CE= <i>xx</i>

**Notes**

<sup>1</sup>*xx* is between 60h and 67h.

## CTM-05 External DAS Driver Error Messages

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Table 6 lists the error messages that may occur during operation of the CTM-05 External DAS Driver.

**Table 6. Error Messages from CTM-05 External DAS Driver**

Error Number	Error Message	Description
0	No error	No error message.
1	Function not supported	A function was requested that is not supported by the CTM-05 External DAS Driver.
2	Function out of bounds	A function number not defined by the CTM-05 External DAS Driver was requested.
3	Non-valid board number	A board that is out of range of configured boards was requested.
4	Non-valid error number	A non-valid error number was detected by the external DAS driver function 0 "REPORT ERROR MESSAGE." For this external DAS driver, 15 error messages have been defined. A request for an error message string not defined returns this error code.
6	Timer channel in use	The timers on the CTM-05/ $\mu$ CCTM-05 are shared by many of the CTM-05 external DAS driver functions. This error code is returned if a function request is issued to the external DAS driver that needs to use a timer channel already in use by another external DAS driver function.
7	Digital output not initialized	This error is returned by the digital output start function when the digital output subsection of the CTM-05/ $\mu$ CCTM-05 board has not been initialized.
8	Digital input not initialized	This error is returned by the digital output start function when the digital input subsection of the CTM-05/ $\mu$ CCTM-05 board has not been initialized.
9	Timer not initialized	This error is returned by the timer/counter functions when the timer subsection of the CTM-05/ $\mu$ CCTM-05 board has not been initialized.

**Table 6. Error Messages from CTM-05 External DAS Driver (cont.)**

<b>Error Number</b>	<b>Error Message</b>	<b>Description</b>
10	Frequency measurement not active	This error is returned by the external DAS driver function "FREQUENCY MEASUREMENT STATUS/READ" when a frequency measurement task is not active.
11	Frequency measurement overrun	This error is generated by the external DAS driver when the signal whose frequency is being measured has overflowed the frequency measurement counter. The solution is to reduce the gate period of the frequency measurement task.
12	Event count not active	This error is returned by the external DAS driver function "EVENT COUNT READ" when an event counting task is not active.
13	Event count overrun	This error occurs when an event counting channel has overflowed.
14	Time interval measurement not active	This error is returned by the external DAS driver functions "ASYNCHRONOUS TIME INTERVAL STATUS/READ" and "ASYNCHRONOUS TIME INTERVAL STOP" when an asynchronous time interval task is not active.
15	Time interval measurement timer overflow	This error occurs when an asynchronous time interval measurement has overflowed one or both timers. The solution is to increase the value of the timer prescale for the asynchronous time interval measurement function; see See "Using the Configuration Program" on page 5.