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Data Acquisition and Control Programming Tools

User's Guide

MEASUREMENTCOMPUTING™

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Universal Library™

User's Guide

MEASUREMENT COMPUTING™

Document Revision 7.9, October, 2007

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Management committed to your satisfaction!

Refer to www.mccdaq.com/execteam.html for the names, titles, and contact information of each key executive at Measurement Computing.

Thank you for choosing a Measurement Computing product—and congratulations! You own the finest, and you can now enjoy the protection of the most comprehensive warranties and unmatched phone tech support. It's the embodiment of our mission:

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Simple installations minimize the time between setting up your system and actually making measurements. We offer quick and simple access to outstanding live FREE technical support to help integrate MCC products into a DAQ system.

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Introducing the Universal Library

Congratulations and thank you for selecting the Universal Library (UL). We believe it is the most comprehensive and easiest-to-use data acquisition software interface available anywhere. As easy as Universal Library is to use, significant documentation and explanation is still required to help new users get going, and to allow previous users to take advantage of all the package's powerful features.

The fast changing nature of the software industry makes it very difficult to provide a totally up to date user guide in written form. Adding to this complexity are the new features and functions that are constantly being added to the library. To provide the most complete information possible and at the same time keep the information current, the Universal Library documentation is offered in four parts:

- **Universal Library User's Guide:** The User's Guide provides a general description of the UL, offers an overview of the various features and functions, and discusses and how they can be used in different operating systems and languages. The User's Guide also provides board-specific information relating to the features and functions that are included with the Universal Library.
- **Universal Library Function Reference:** The Function Reference contains detailed information about the Universal Library functions, usage, and options. This document is available on our web site at www.mccdaq.com/PDFmanuals/sm-ul-functions.pdf.
- **Example programs:** The examples programs demonstrate the use of many of the most frequently used functions, and are valuable learning tools. They are written for many popular languages. Each example program is fully functional, and provides an ideal starting place for your own programming effort. You can cut and paste from the example programs to create your own programs. It's easier to cut-and-paste pieces from a known, working program than to start writing everything from scratch.
- **Readme files:** The best way to get the latest, most up to date information is through Readme files. We incorporate this information into our documentation as quickly as we can, but for the latest, greatest information, read the Readme file.

Universal Library overview

The Universal Library is the software that you need to write your own programs for use with any of Measurement Computing’s data acquisition and control boards. The library is universal in three ways:

Universal across boards: The library contains high level functions for all of the common operations for all boards. Each of the boards has different hardware but the Universal Library hides these differences from your program. So, for example, a program written for use with one A/D board will work "as is" with a different A/D board.

Universal across languages: The Universal Library provides the identical set of functions and arguments for each supported language. If you switch languages, you will not have to learn a new library, with new syntax, and different features.

If you are programming for the .NET framework, you will find that the Universal Library for .NET has the same "look and feel" as the Universal Library for 32-bit windows applications, and is just as easy to program.

32-bit languages supported by the Universal Library at the time the library was released are listed in the following table.

Microsoft Windows Languages	.NET Languages	Borland Windows Languages
Visual Basic	VB .NET	Borland C++
Visual C/C++	C# .NET	Borland C++ Builder
Quick C for Windows		Delphi
Microsoft C		

Universal across platforms: The Universal Library provides the same sets of functions for Windows 2000, Windows XP, and Windows Vista. Additionally, these functions have been extended to support the .NET environment.

Windows Vista support

USB, PCI, WLS, and WEB devices are supported under Windows Vista. PCMCIA devices (PC-CARD and PCM hardware) are not supported under Windows Vista.

Installation and Configuration

Installing the Universal Library

To install the Universal Library, follow the steps below.

1. Place *the Measurement Computing Data Acquisition Software* CD in your CD drive.
The **MCC DAQ** dialog opens.
2. Select **InstaCal & Universal Library** and click the **Install** button.
3. Follow the installation instructions as prompted.

*Insta*Cal is a powerful installation, test, and calibration software package that is installed with the Universal Library application. Refer to the *Quick Start Guide* for examples of using *Insta*Cal with Measurement Computing's DEMO-BOARD.

The CB.CFG file and *Insta*Cal

All board-specific information, including current installed options, is stored in the file CB.CFG file, which is read by Universal Library. *Insta*Cal creates and/or modifies this file when board configuration information is added or updated. The Universal Library does not function without the CB.CFG file.

For this reason, you must use *Insta*Cal to modify all board setups and configurations as well as to install or remove boards from your system.

Installation – .NET support

Universal Library support for .NET requires that the Microsoft .NET framework already be installed on the system before you install the Universal Library.

Licensing information

Each original copy of Universal Library is licensed for development use on one CPU at a time. It is theft to make copies of this program for simultaneous program development.

Redistributing a custom UL application

The easiest way to distribute an application written with the Universal Library is to include a copy of Measurement Computing's *Insta*Cal installation package with the application. Instruct the end user to install *Insta*Cal before installing the application.

Some developers may want to integrate the installation of the required Universal Library drivers into the custom application's installation. This should only be attempted by developers experienced in installation development.

Following is an overview of the two methods.

Distributing *Insta*Cal in addition to your custom UL application

If you create an application using the Universal Library, you may distribute the necessary runtime files (Universal Library driver files) with the application royalty free. These files can be installed from

Measurement Computing's *Insta*Cal installation package. To distribute a custom UL application, provide the end user with two CDs or disks:

- One CD or disk that contains Measurement Computing's *Insta*Cal application. *Insta*Cal must be installed before the custom UL application.
- One CD or disk that contains the setup program for their custom VB or C++ application.

You may not distribute any files that give the end user the ability to develop applications using the Universal Library.

Integrating *Insta*Cal into your custom UL installation CD or disk

For developers who wish to distribute their application on one CD, refer to the *Universal Library Redistribution Guide*. This document contains procedures to merge the setup programs for both *Insta*Cal and the custom UL application into one setup program that you can distribute on one CD or disk. The merging process is complicated — only experienced programmers should attempt to do this.

When you install the software, the *Universal Library Redistribution Guide* (ULRedistribution.pdf) is copied to the default installation directory "`C:\Program Files\Measurement Computing\DAQ\Documents`" on your local drive.

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Getting Started

The Universal Library is callable from many languages and environments, including Visual Basic®, Visual C++, Borland C++ Builder, and Delphi. A list of the languages currently supported by the Universal Library is provided on page 11. Additionally, the UL is now callable from any language supported by the .NET framework. This chapter describes how to use the library from each of the languages. The first section of the chapter describes details of the library that apply to all languages. The following sections describe the differences for each language.

Before starting your application, you should perform the following:

- Set up and test your boards with *Insta*Cal. The Universal Library will not function until *Insta*Cal has created a configuration file (CB.CFG).
- Run the example programs for the language you program in.

Example programs

You can install example programs for supported languages when you install the Universal Library software. If selected, the example programs are installed into the following installation subdirectories:

- C
- C#
- CWIN
- DELPHI
- VB.NET
- VBWIN

On Windows 2000 and Windows XP, the example programs are installed by default to \Program Files\Measurement Computing\DAQ.

On Windows Vista, the example programs are installed by default to \Users\Public\Documents\Measurement Computing\DAQ. When you install the example programs, an "Examples" shortcut is added to the directory where you installed the Universal Library software. When selected, the directory containing the example programs opens in Windows Explorer.

For a complete list of example programs, refer to the Universal Library Function Reference

The *Universal Library Function Reference* contains tables that list the UL and UL for .NET example programs. Each table contains the name of the sample program and the functions that the program demonstrates. This document is available on our web site at www.mccdaq.com/PDFmanuals/sm-ul-functions.pdf.

Universal Library Description and Use

The Universal Library consists of a set of functions that are callable from your program. These functions are grouped according to their purpose. All of the groups except for *Miscellaneous* are based on which type of device they are used with.

Important - Read the UL documentation, Readme file, and run the example programs

In order to understand the functions, please read the board-specific information section contained in this manual and in the Readme files supplied on the Universal Library disk. We also urge you to examine and run one or more of the example programs supplied prior to attempting any programming of your own. Following this advice can save you hours of frustration and wasted time.

General UL language interface description

The interface to all languages is a set of function calls and a set of constants. The list of function calls and constants are identical for each language. All of the functions and constants are defined in a "header" file for each language. Refer to the sections below, and especially to the example programs for each language. This manual is brief with respect to details of language use and syntax. For more detailed information, review the example programs. Example programs for each language are located in the installation directory.

Function arguments

Each library function takes a list of arguments and most return an error code. Some functions also return data via their arguments. For example, one of the arguments to `cbAIn()` is the name of a variable in which the analog input value will be stored. All function arguments that return data are listed in the "**Returns**" section of the function description.

Constants

Many functions take arguments that must be set to one of a small number of choices. These choices are all given symbolic constant names. For example, `cbTIn()` takes an argument called `Scale` that must be set to `CELSIUS`, `FAHRENHEIT`, or `KELVIN`. These constant names are defined, and are assigned a value in the "header" file for each language. Although it is possible to use the numbers rather than the symbolic constant names, we strongly recommend that you use the names. Using constant names make your programs more readable and more compatible with future versions of the library. The numbers may change in future versions, but the symbolic names always remain the same.

Options arguments

Some library functions have an argument called `Options`. The `Options` argument is used to turn on and off various optional features associated with the function. If you set `Options = 0`, the function sets all of these options to the default value, or `OFF`.

Some options can have an alternative value, such as `DTCONNECT` and `NODTCONNECT`. If an option can have more than one value, one of the values is designated as the default. Individual options can be turned on by adding them to the `Options` argument. For example:

- `Options = BACKGROUND` will turn on the "background execution" feature.
- `Options = BACKGROUND+CONTINUOUS` will select both the "background execution" and the "continuous execution" feature.

Error handling

Most library functions return an error code. If no errors occurred during a library call, 0 (or `NOERRORS`) is returned as the error code. Otherwise, it is set to one of the codes listed in the *Universal Library Function Reference* "Error Codes" chapter. This document is available on our web site at www.mccdaq.com/PDFmanuals/sm-ul-functions.pdf.

If a non-zero error code is returned, you can use `cbGetErrMsg()` to convert the error code to a specific error message. As an alternative to checking the error code after each function call, you can turn on the library's internal error handling with `cbErrHandling()`.

16-bit values using a signed integer data type

When using functions that require 16-bit values, the data is normally in the range of 0 to 65535. However, some programming languages such as Visual Basic only provide signed data types. When using signed integers, reading values above (32767) can be confusing.

The number (32767) in decimal is equivalent to (`0111 1111 1111 1111`) binary. The next increment (`1000 0000 0000 0000`) binary has a decimal value of (-32768). The maximum value (`1111 1111 1111 1111`) binary translates to (-1) decimal. Keep this in mind if you are using Visual Basic (up to version 6) or other languages that don't support unsigned integers.

There is additional information on this topic in the *Universal Library Function Reference*. This document is available on our web site at www.mccdaq.com/PDFmanuals/sm-ul-functions.pdf. Also, refer to the documentation supplied with your language compiler.

Using the Universal Library in Windows

All 32-bit applications (including console applications) access the 32-bit Windows Dynamic Link Library (DLL) version of the Universal Library (CBW32.DLL). Example programs that illustrate the use of CBW32.DLLs are provided for each supported language.

The Universal Library contains four functions for managing Windows global memory buffers:

- `cbWinBufAlloc()`
- `cbWinBufFree()`
- `cbWinArrayToBuf()`
- `cbWinBufToArray()`

Real-time acquisition under Windows

Real-time acquisition is available for Windows. To operate at full speed in Windows, the A/D board must have an onboard FIFO buffer. All of our advanced designs have FIFO buffers, including our PCI-DAS boards (except for the PCI-DAS08), and many of our CIO- boards, such as the CIO-DAS80*x*, CIO-DAS160*x*, CIO-DAS140*x*, and CIO-DAS16/330*x*. All of these data acquisition boards will operate at full speed in Windows.

Applying software calibration factors in real time on a per-sample basis eats up machine cycles. If your CPU is slow, or if processing time is at a premium, withhold calibration until after the acquisition run is complete. Turning off real-time software calibration saves CPU time during a high speed acquisition run.

Processor speed

Processor speed remains a factor for DMA transfers and for real-time software calibration. Processors of less than a 150 megahertz (MHz) Pentium class may impose speed limits below the capability of the board (refer to specific board information.)

If your processor is less than a 150 MHz Pentium and you need an acquisition speed in excess of 200 kilohertz (kHz), use the `NOCALIBRATEDATA` option to a turn off real-time software calibration and save CPU time. After the acquisition is run, calibrate the data with `cbACalibrateData()`.

Visual Basic for Windows

To use the Universal Library with Visual Basic, include the Universal Library declaration file CBW.BAS in your program. Include the file as a module in the project, or include it by reference inside those Forms which call into the Universal Library. Once the declarations for the Universal Library have been added to your project, call the library functions from any Form's event handlers.

For Visual Basic 6.0 and older, Windows memory buffers cannot be mapped onto arrays. As a consequence, the `cbWinArrayToBuf()` and `cbWinBufToArray()` functions must be used to copy data between arrays and Windows buffers.

Example:
```
Count = 100
MemHandle = cbWinBufAlloc (Count)
cbAInScan (......, MemHandle,...)
cbWinBufToArray (MemHandle, DataArray(0), 0, Count)
For i = 0 To Count
   Print DataArray(i)
Next i
cbWinBufFree (MemHandle)
```

Visual Basic example programs

A complete set of Visual Basic example programs is included in the VBWIN folder of the Universal Library installation directory. Each program illustrates the use of a Universal Library function from within a Visual Basic program. The .FRM files contain the programs, and the corresponding .VBP files are the project files used to build the programs for Visual Basic.

Microsoft Visual C++

To use the Universal Library with MS Visual C++, include the Universal Library header file CBW.H in your C/C++ program and add the library file CBW32.LIB to your library modules for linking to the CBW32.DLL.

Microsoft Visual C++ example programs

The CWIN folder of the Universal Library installation directory contains three sample programs - `Wincai01`, `Wincai02` and `Wincai03`. Each program is an example of a simple C program that calls a few of the Universal Library functions from a Windows application. Use the .DSP project files to build a 32-bit application.

The non-Windows C examples in the C folder of the installation directory provide a more complete set of examples. You can compile these programs as 32-bit console applications for Windows by using the MAKEMC32.BAT file.

Borland C /C++ for Windows

For 32-bit Borland (or Inprise) C/C++ compilers, include the Universal Library header file CBW.H in your program and link with the import library file CBW32BC.LIB.

Borland C/C++ example programs

The non-Windows C examples provide an extensive set of examples. These can be compiled as 32-bit console applications using the MAKEBC32.BAT file.

Delphi example programs

A complete set of Delphi example programs is included in the DELPHI folder of the Universal Library installation directory. Each program illustrates the use of one Universal Library function from within a Delphi program. The .PAS files contain the programs. The corresponding .DPR file is the Project file used to build the program in a 32-bit Delphi environment.

In 32-bit Delphi environments use the `cbw32.dll` header. Where integers are passed by reference to a Universal Library function, use the `SmallInt` data type in 32-bit environments. The relevant functions are defined this way in the 32-bit header, so if you try to pass an `Integer` data type you will get a compiler error.

Universal Library for .NET Description & Use

Programming the Universal Library API is now available through the various languages supported by the Microsoft .NET framework. All .NET applications access the 32-bit Windows Universal Library (CBW32.DLL) through the MccDaq .NET assembly (MCCDAQ.DLL). The MccDaq assembly provides an interface that exposes each Universal Library function that is callable from the .NET language.

The Universal Library for .NET is designed to provide the same "look and feel" as the Universal Library for 32-bit Windows. This design makes it easier to port over existing data acquisition programs, and minimizes the learning curve for programmers familiar with the CBW32.DLL interface.

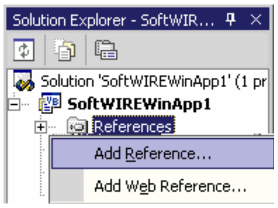
In the Universal Library for .NET, each function is exposed as a class method with virtually the same parameter set as their UL counterparts.

Configuring a UL for .NET project

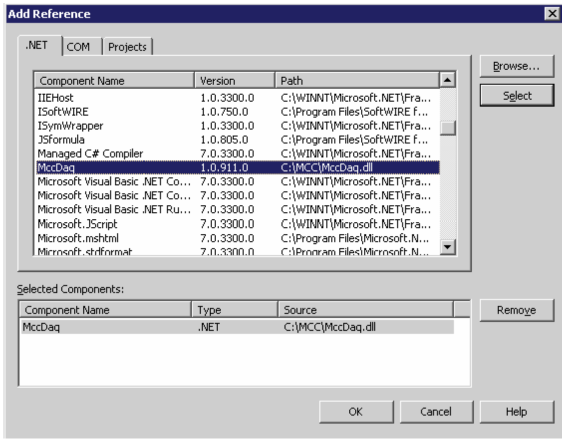
In a .NET application, there are no header files to include in your project. You define methods and constants by adding the MccDaq assembly, or Namespace, as a reference to your project. You access UL for .NET methods through a class that has the Universal Library as a member.

To add the MccDaq Namespace as a reference in a Visual Studio .NET project:

1. Start a new Visual Basic or C# project in Visual Studio .NET.
2. From the Visual Studio .NET Solution Explorer window, right-click on **References** and select **Add Reference**.

   
   Solution Explorer - SoftWIR...
   Solution 'SoftWIREWinApp1' (1 pr
   SoftWIREWinApp1
   References
   Add Reference...
   Add Web Reference...

   The **Add Reference** window appears.
3. From the **.NET** tab, select the **MccDaq** option from the displayed list of .NET assemblies and click on the **Select** button.

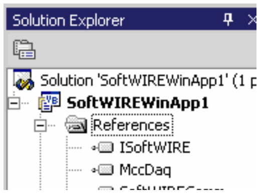
   

Component Name	Version	Path
IIEHost	1.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
ISoftWIRE	1.0.750.0	C:\Program Files\SoftWIRE f...
ISymWrapper	1.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
JSformula	1.0.805.0	C:\Program Files\SoftWIRE f...
Managed C# Compiler	7.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
MccDaq	1.0.911.0	C:\MCC\MccDaq.dll
Microsoft Visual Basic .NET Co...	7.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
Microsoft Visual Basic .NET Co...	7.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
Microsoft Visual Basic .NET Ru...	7.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
Microsoft.JScript	7.0.3300.0	C:\WINNT\Microsoft.NET\Fra...
Microsoft.mshtml	7.0.3300.0	C:\Program Files\Microsoft.N...
Microsoft.stdformat	7.0.3300.0	C:\Program Files\Microsoft.N...

Component Name	Type	Source
MccDaq	.NET	C:\MCC\MccDaq.dll

   MccDaq displays in the **Selected Components** area on the window.
4. Click on the **OK** button.

MccDaq appears under the **References** folder in the Solution Explorer window.



The MccDaq Namespace is now referenced by your Visual Studio .NET project.

General UL for .NET language interface description

The **MccDaq Namespace** provides an interface that exposes each Universal Library for .NET method as a member of a class with virtually the same parameters set as their UL counterparts. The MccDaq Namespace is a logical naming scheme for grouping related types. The .NET Framework uses a hierarchical naming scheme for grouping types into logical categories of related functionality.

When you develop a .NET application that uses the Universal Library, you add the MccDaq Namespace as a reference to your project. There are no "header" files in a .NET project.

The MccDaq Namespace contains the classes and enumerated values by which UL for .NET applications access the Universal Library data types and functions. The MccDaq Namespace contains five main classes:

- `MccBoard` class
- `ErrorInfo` class
- `MccService` class
- `GlobalConfig` class
- `DataLogger class`

The MccDaq assembly allows you to design Common Language Specification (CLS)-compliant programs. A CLS-compliant program contains methods that can be called from any existing or future language developed for the Microsoft .NET framework. Use CLS-compliant data types to ensure future compatibility.

MccBoard class

The `MccBoard` class provides access to all of the methods for data acquisition and properties providing board information and configuration for a particular board.

Class Constructors

The `MccBoard` class provides two constructors; one which accepts a board number argument and one with no arguments.

The following code examples demonstrate how to create a new instance of the `MccBoard` class using the latter version with a default board number of 0:

Visual Basic	`Private DaqBoard As MccDaq.MccBoard`
	`DaqBoard = New MccDaq.MccBoard()`

C#	`private MccDaq.MccBoard DaqBoard;`
	`DaqBoard = new MccDaq.MccBoard();`

The following code examples demonstrate how to create a new instance of the `MccBoard` class with the board number passed to it:

Visual Basic	`Private DaqBoard As MccDaq.MccBoard`
	`DaqBoard = New MccDaq.MccBoard(BoardNumber)`

C#	`private MccDaq.MccBoard DaqBoard;`
	`DaqBoard = new MccDaq.MccBoard(BoardNumber);`

Class properties

The `MccBoard` class also contains six properties that you can use to examine or change the configuration of your board. The configuration information for all boards is stored in the CB.CFG file, and is loaded from CB.CFG by all programs that use the library.

Properties	**Description**
`BoardName`	Name of the board associated with an instance of the MccBoard class.
`BoardNum`	Number of the board associated with an instance of the MccBoard class.
`BoardConfig`	Gets a reference to a cBoardConfig class object. Use this class reference to get or set various board settings.
`CtrConfig`	Gets a reference to a cCtrConfig class object. Use this class reference to get or set various counter settings.
`DioConfig`	Gets a reference to a cDioConfig class object. Use this class reference to get or set various digital I/O settings.
`ExpansionConfig`	Gets a reference to a cExpansionConfig class object. Use this class reference to get or set various expansion board settings.

Class methods

The `MccBoard` class contains close to 80 methods that are equivalents of the function calls used in the standard Universal Library. The `MccBoard` class methods have virtually the same parameters set as their UL counterparts.

The following code examples demonstrate how to call the `AIn()` method of the MccBoard object MccDaq:

Visual Basic	`ULStat = DaqBoard.AIn(Chan, Range, DataValue)`
C#	`ULStat = DaqBoard.AIn(Chan, Range, out DataValue);`

Many of the arguments are MccDaq enumerated values. Enumerated values take settings such as range types or scan options and put them into logical groups. For example, to set a range value, reference a value from the `MCCDaq.Range` enumerated type, such as `Range.Bip5Volts`. Refer to Table 1 on page 23 for a list of MccDaq enumerated values.

The *Universal Library Function Reference* contains detailed information about all MccBoard class methods. This document is available on our web site at www.mccdaq.com/PDFmanuals/sm-ul-functions.pdf.

ErrorInfo class

Most UL methods return ErrorInfo objects. These objects contain two properties that provide information on the status of the method called:

- `ErrorInfo.Message` property gets the text of the error message associated with a specific error code.
- `ErrorInfo.Value` property gets the named constant value associated with the ErrorInfo object.

The `ErrorInfo` class also includes error code enumerated values, which define the error number and associated message which can be returned when you call a method.

MccService class

The `MccService` class contains all members for calling utility UL functions. This class contains the following static methods (you do not need to create an instance of the `MccService` class to call these methods):

- `DeclareRevision()`
- `ErrHandling()`
- `FileGetInfo()`
- `FileRead()`
- `GetBoardName()`
- `GetRevision()`
- `WinArrayToBuf()`
- `WinBufAlloc()`
- `WinBufAlloc32()`
- `WinBufFree()`
- `WinBufToArray()`
- `WinBufToArray32()`

The following code examples demonstrate how to call a UL for .NET memory management method from within a Universal Library program:

```
WindowHandle=MccService.WinBuffAlloc(1000)
MccService.WinBuffFree(WindowHandle)
```

GlobalConfig class

The `GlobalConfig` class contains all of the members for getting global configuration information. This class contains three properties:

- `MccDaq.GlobalConfig.NumBoards` property returns the maximum number of boards that you can install at one time. `ConfigGlobal=MccDaq.GlobalConfig.NumBoards`
- `MccDaq.GlobalConfig.NumExpBoards` property returns the maximum number of expansions boards that are allowed to be installed on the board. `ConfigGlobal=MccDaq.GlobalConfig.NumExpBoards`
- `MccDaq.GlobalConfig.Version` property is used to determine compatibility with the library version. `ConfigGlobal=MccDaq.GlobalConfig.Version`

Each of these properties is typed as an Integer.

DataLogger Class

The DataLogger class contains all members for reading and converting the data contained in binary log files. This class contains one property and 14 methods:

- `FileName` property returns the file name associated with an instance of the DataLogger class.
- `ConvertFile()` converts a binary log file to a comma-separated values (.CSV) text file or another text file format that you specify.
- `GetAIChannelCount()` retrieves the total number of analog channels that were logged in a binary file.
- `GetAIInfo()` retrieves the channel number and unit value of each analog input channel logged in a binary file.
- `GetCJCInfo()` retrieves the number of CJC temperature channels logged in a binary file.
- `GetDIOInfo()` retrieves the number of digital I/O channels logged in a binary file.
- `GetFileInfo()` retrieves the version level and byte size of a binary file.

- `GetFileName()` retrieves the name of the nth file in the directory containing binary log files.
- `GetPreferences` retrieves API preference settings for time stamp data, analog temperature data, and CJC temperature data. Returns the default values unless changed using `SetPreferences()`.
- `GetSampleInfo()` retrieves the sample interval, sample count, and the date and time of the first data point in a binary file.
- `ReadAIChannels()` retrieves analog input data from a binary file, and stores the values in an array.
- `ReadCJCChannels()` retrieves CJC temperature data from a binary file, and stores the values in an array.
- `ReadDIOChannels()`retrieves digital I/O channel data from a binary file, and stores the values in an array.
- `ReadTimeTags()` retrieves date and time values logged in a binary file. This method stores date values in the dateTags array, and time values in the timeTags array.
- `SetPreferences()` sets formatting preferences for returned time stamp data, analog data, and CJC temperature data.

The following code examples demonstrate how to use the `GetFileName()`method from within a Universal Library program to retrieve the name of a binary log file:

Visual Basic	`Status = DataLogger.GetFileName(MccService.GetFirst, path, filename)`
C#	`status = DataLogger.GetFileName(MccService.GetFirst, ref path, ref filename);`

MccDaq enumerations

The MccDaq Namespace contains enumerated values which are used by many of the methods available from the MccDaq classes (see Table 1). Refer to specific method descriptions in the Universal Library Function Reference for the values of each enumerated type. This document is available on our web site at www.mccdaq.com/PDFmanuals/sm-ul-functions.pdf.

Table 1. MccDaq Enumerated Values

Enumeration Name	**Description**
MccDaq.BCDMode	Lists BCD mode options (enabled/disabled).
MccDaq.C8254Mode	Lists all of the operating modes for 8254 counters.
MccDaq.C8536OutputControl	Lists all of the types of output from an 8536 counters.
MccDaq.C8536TriggerType	Lists all of the options for specifying the trigger type for 8536 counters.
MccDaq.C9513OutputControl	List all of the types of output from a 9513 counters.
MccDaq.CompareValue	List all options for comparing values while configuring a 9513 counter.
MccDaq.ConnectionPin	Defines the connector pins to associate with the signal type and direction when calling the `SelectSignal()` method.
MccDaq.CounterControl	Defines the possible state of each counter channel (enabled/disabled).
MccDaq.CountDirection	Defines the count direction when configuring counters.
MccDaq.CountEdge	Defines the edge used for counting.
MccDaq.CounterRegister	Lists all of the register names used to load counters.
MccDaq.CounterSource	Lists all counter input sources.
MccDaq.CountingMode	Lists all valid modes for a C7266 counter configuration.
MccDaq.CtrlOutput	Lists all of the options for linking counter 1 to counter 2.
MccDaq.DACUpdate	Defines the available DAC update modes
MccDaq.DataEncoding	Lists the format of the data that is returned by a counter.
MccDaq.DigitalPortDirection	Configures a digital I/O port as input or output.
MccDaq.DigitalLogicState	Defines all digital logic states.
MccDaq.DigitalPortType	Defines all digital port types.
MccDaq.DTMode	Lists all modes to transfer to/from the memory boards.
MccDaq.ErrorHandling	Defines all error handling options.
MccDaq.ErrorInfo.ErrorCode	Defines all error constants.

Enumeration Name	**Description**
MccDaq.ErrorReporting	Defines all error reporting options.
MccDaq.EventType	Lists all available event conditions.
MccDaq.FieldDelimiter	Lists all options for specifying the delimiter character used to separate fields in a converted binary log file.
MccDaq.FlagPins	Lists all signals types that can be routed to the FLG1 and FLG2 pins on the 7266 counters.
MccDaq.FunctionType	List all valid function types used with data acquisition methods.
MccDaq.GateControl	List all of the gating modes for configuring a 9513 counter.
MccDaq.IndexMode	List the actions to be taken when the index signal is received by a 7266 counter.
MccDaq.LoggerUnits	Lists the options used to specify the units for analog data in a binary file
MccDaq.OptionState	Enables or disables various options.
MccDaq.PrimaryBitConfigPortType	Defines digital port types for bit level configuration.
MccDaq.PrimaryDigitalPortType	Defines digital port types for bit level input/output methods.
MccDaq.Quadrature	Lists all of the resolution multipliers for quadrature input.
MccDaq.Range	Defines the set of ranges within the UL for A/D and D/A operations.
MccDaq.RecycleMode	Lists the recycle mode options for 9513 and 8536 counters.
MccDaq.Reload	Lists the options for reloading the 9513 counter.
MccDaq.ScanOptions	List the available scan options for paced input/output methods.
MccDaq.SignalType	List all signal types associated with a connector pin on boards supporting a DAQ-Sync connector.
MccDaq.SignalDirection	Lists all of the directions available from a specified signal type assigned to a connector pin.
MccDaq.SignalPolarity	List all available polarities for a specified signal.
MccDaq.SignalSource	List all of the signal sources of the signal from which the frequency will be calculated.
MccDaq.SoftwareTriggerType	Defines trigger types for software triggering.
MccDaq.StatusBits	List all status bits available when reading counter status.
MccDaq.TempScale	Lists the options used to specify the units for analog data in a converted file.
MccDaq.TimeFormat	Lists all options for specifying the time format of timestamp data.
MccDaq.TimeOfDay	List all time of day options for initializing a 9513 counter.
MccDaq.TimeZone	Lists all options for specifying the time zone of timestamp data
MccDaq.TriggerType	List all valid trigger types for the `MccBoard.SetTrigger` method.
MccDaq.ThermocoupleOptions	Specifies whether or not to apply smoothing to temperature readings.

Parameter data types

Many of the Universal Library for .NET methods are overloaded to provide for signed or unsigned data types as parameters. The `AConvertData()` method is shown below using both signed and unsigned data types.

VB.NET	`Public Function AConvertData(ByVal numPoints As Integer, ByRef adData As Short, ByRef chanTags As Short) As MccDaq.ErrorInfo` `Member of MccDaq.MccBoard`
	`Public Function AConvertData(ByVal numPoints As Integer, ByRef adData As System.UInt16, ByRef chanTags As System.UInt16) As MccDaq.ErrorInfo` `Member of MccDaq.MccBoard`
C# .NET	`public MccDaq.ErrorInfo AConvertData (System.Int32 numPoints, System.Int16 adData, System.Int16 chanTags)` `Member of MccDaq.MccBoard`
	`public MccDaq.ErrorInfo AConvertData (System.Int32 numPoints, System.UInt16 adData, System.UInt16 chanTags)` `Member of MccDaq.MccBoard`

For most data acquisition applications, unsigned data values are easier to manage. However, since Visual Basic (version 6 and earlier) does not support unsigned data types, it may be easier to port these programs to .NET if the signed data types are used for the method parameters. For additional information on using signed data types, refer to the section "16-bit values using a signed integer data type" on page 16.

The short (Int16) data type is Common Language Specification (CLS) compliant, is supported in VB, and will be included in any future .NET language developed for the .NET framework. Using CLS-compliant data types ensures future compatibility. Unsigned data types are not CLS compliant, but are still supported by various .NET languages, such as C#.

Differences between the UL and UL for .NET

Table 2 lists the differences between the Universal Library and the Universal Library for .NET.

Table 2. Differences between UL and UL for .NET

	Universal Library	**Universal Library for .NET**
Board Number	The board number is included as a parameter to the board functions.	An MccBoard class is created for each board installed, and the board number is passed to that board class.
Functions	Set of function calls defined in a header.	Set of methods. Methods of MccBoard or MccService classes. To access a method, instantiate a UL for .NET class and call the appropriate method using that class.
Constants	Constants are defined and assigned a value in the "header" file.	Constants are defined as enumerated types.
Return value	The return value is an Error code.	The return value is an ErrorInfo object that contains the error's number and message.

Board number

In a .NET application, multiple boards may be programmed by creating an `MccBoard` Class object for each board installed:

```
Board0 = new MccBoard(0)
Board1 = new MccBoard(1)
Board2 = new MccBoard(2)
```

Note that the board number may be passed into the MccBoard class, which eliminates the need to include the board number as a parameter to the board methods.

MCC classes

To use board-specific Universal Library functions inside a .NET application, you use methods of the appropriate class. UL for .NET classes are listed in Table 3.

Table 3. UL for .NET Board Classes

UL for .NET Class	Description
MccBoard	Access board-related Universal Library functions.
ErrorInfo	Utility class for storing and reporting error codes and messages.
BoardConfig	Gets and sets board configuration settings.
CtrConfig	Gets and sets counter configuration settings.
DioConfig	Gets and sets digital I/O configuration settings.
ExpansionConfig	Gets and sets expansion board configuration settings.
GlobalConfig	Gets and sets global configuration settings.
MccService	Access utility Universal Library functions.
DataLogger	Reads and converts binary log files.

Refer to the *Universal Library Function Reference (*available on our web site at www.mccdaq.com/PDFmanuals/sm-ul-functions.pdf) for additional class information.

Methods

Methods are accessed through the class containing them. The following example demonstrates how to call the `AIn()` method from within a 32-bit Windows application and also from a .NET application.

VB Application using CBW32.DLL	VB .NET Application using MCCDAQ.DLL

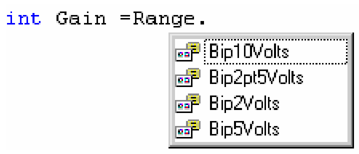
`Dim Board As Integer`
`Dim Channel As Integer`
`Dim Range As Integer`
`Dim ULStat As Integer`
`Dim DataValue As Short`
 	
`Board =0`
`Channel = 0`
`Range =BIP5VOLTS;`
`ULStat =cbAIn(Board, Channel, Range, DataValue)`
	`Dim Board0 As MccBoard`
	`Board0 = new MccDaq.MccBoard(0)`
	`Dim Channel As Integer`
	`Dim Range As MccDaq.Range`
	`Dim ULStat As ErrorInfo`
	`Dim DataValue As UInt16`
	
	`Channel = 0`
	`Range =Range.BIP5VOLTS;`
	`ULStat =Board0.AIn(Channel, Range, DataValue)`

Enumerated types

Instead of using constants such as `BIP5VOLTS`, the Universal Library for .NET uses enumerated types. An enumerated type takes settings such as range types, scan options or digital port numbers and puts them into logical groups. Some examples are:

`Range.Bip5Volts`
`Range.Bip10Volts`
`Range.Uni5Volts`
`Range.Uni10Volts`
`ScanOptions.Background`
`ScanOptions.Continuous`
`ScanOptions.BurstMode`
`TimeZone.GMT`
`FileType.Text`

If you are programming inside of Visual Studio .NET, the types that are available for a particular enumerated value display automatically when you type code:



```
int Gain =Range.
```

Error handling

For .NET applications, the return value for the Universal Library functions is an object (ErrorInfo), rather than a single integer value. The ErrorInfo object contains both the numeric value for the error that occurred, as well as the associated error message. Within a .NET application, error checking may be performed as follows:

```
ULStat=Board0.AIn(Channel, Range, DataValue)
'check the numeric value of ULStat
If Not ULStat.Value = ErrorInfo.ErrorCode.NoErrors Then
   'if there was an error, then display the error message
   MsgBox ULStat.Message
EndIf
```

Service methods

You can access other Universal Library functions that are not board-specific through the MccService class. This class contains a set of static methods you can access directly, without having to instantiate an `MccService` object. The following examples demonstrate library calls to .NET memory management methods:

```
WindowHandle = MccService.WinBuffAlloc(1000)
MccService.WinBuffFree(WindowHandle)
```

Configuration methods

In 32-bit Windows applications, you access board configuration information by calling the `cbGetConfig` and `cbSetConfig` API functions. In .NET applications, you access board configuration information through separate classes, such as `cBoardConfig`, `cCtrConfig`, `cDioConfig`, and `cExpansionConfig`. Each configuration item has a separate get and set method.

Some examples of how to access board configuration within a .NET application are shown below:

- `UlStat = Board0.BoardConfig.GetRange(RangeValue)`
- `UlStat = Board1.DioConfig.GetNumBits(DevNumber, Number)`
- `UlStat = Board2.CtrConfig.GetCtrType(DevNumber, CounterType)`
- `UlStat = Board3.BoardConfig.SetClock(ClockSource)`
- `UlStat = Board4.ExpansionConfig.SetCJCChan(DevNumber, CjcChan)`

Data Logger methods

In 32-bit Windows applications, you access information contained in binary log files by calling the API functions. In .NET applications, you access this information by calling the DataLogger class and its methods.

The following example demonstrates how to retrieve the name of the first binary log file using the `cbLogGetFileName()` function and `GetFileName()` method.

C/C++ application	**C# application**
`char    filename(50);`	`string      filename = new string('\0',50);`
`char*   path = "C:\\LogData";`	`string      path = "C:\\LogData";`
`int     retval = 0;`	`ErrorInfo   status;`
`retval =`	`status =`
`cbLogGetFileName(GetFirst, path,`	`DataLogger.GetFileName(MccService.GetFirst,`
`filename);`	`ref path, ref filename);`

Analog Input Boards

Introduction

All boards that have analog input support the `cbAIn()/AIn()` and `cbAInScan()/AInScan()` functions, except expansion boards, which only support `cbAIn()`. Boards released after the printing of this manual are described in Readme files contained on the Universal Library disk.

When hardware-paced A/D conversion is not supported, `cbAInScan()/AInScan()` loops through software paced conversions. The scan will execute at the maximum speed possible. This speed will vary with CPU speed. The only valid option in this case is `CONVERTDATA`.

Concurrent analog input and output for paced analog inputs, paced analog outputs

For boards with both paced analog inputs and paced analog outputs, concurrent analog input and output scans are supported. That is, these boards allow operations with analog input functions (`cbAInScan/AInScan()` and `cbAPretrig/APretrig`) and analog output functions (`cbAOutScan/AOutScan()`) to overlap without having to call `cbStopBackground()/StopBackground()` between the start of input and output scans.

Trigger support

Digital trigger

If trigger support is "Polled gate" (as opposed to "Hardware"), you implement a trigger by gating the on-board pacer. This disables the on-board pacer. The trigger input is then polled continuously until the trigger occurs. When that happens, the software disables the gate input so that when the trigger returns to its original state, it does not affect the pacer, and acquisition continues until the requested number of samples has been acquired. There are two side effects to this type of trigger:

- The polling portion of the function does not occur in the background, even if the `BACKGROUND` option was specified (although the actual data acquisition does).
- The trigger does not necessarily occur on the rising edge. Acquisition can start at any time after the function is called if the trigger input is at "active" level. For this reason, it is best to use a trigger that goes active for a much shorter time than it is inactive.

Similar to ‘Polled gate’ triggering is ‘Polled digital input’ triggering, where the pacer is disabled while the state of a digital input is polled. When the state changes to active, the pacer is enabled by the software. The polled digital input trigger type limitations are very similar to the polled gate type explained above.

Analog trigger

You set up the trigger levels for an analog trigger using the function cbSetTrigger / SetTrigger, and passing the appropriate values to the `HighThreshold` and `LowThreshold` arguments.

For most boards that support analog triggering, you can calculate the `HighThreshold` and `LowThreshold` values by passing the required trigger voltage level and the appropriate `Range` to the `cbFromEngUnits / FromEngUnits` function.

However, for some boards, you must manually calculate `HighThreshold` and `LowThreshold`. If a board requires manual calculation, that information will be included in the Trigger information for the specific product in this section. The procedure for manually calculating these values is detailed in the Universal Library Function Reference in the description of the cbSetTrigger / SetTrigger function.

Pretrigger implementations

Pretrigger functionality may be implemented through software or hardware. These two methods have different limitations and requirements. Most Measurement Computing products with pretrigger capability are implemented in hardware.

When implemented in hardware, the buffer created using `cbWinBufAlloc()` must be large enough to hold 512 samples more than the requested `TotalCount`. The trigger location is tracked by a counter on the board. When the trigger condition is met, data is acquired and the library functions return the actual number of pretrigger points that were acquired. When run in `BACKGROUND` mode, the `cbGetStatus()` function will typically show `CurCount` rise to the value of `PretrigCount` and remain there while `CurIndex` cycles from 0 to `TotalCount` continuously until the trigger is received.

With the software implementation of pretrigger, the additional space in the buffer is not required. The trigger location is tracked by software. Any triggers that occur before the number of samples defined by the pretrigger count argument are ignored. When run in `BACKGROUND` mode, the `cbGetStatus()` function will typically show `CurCount` at a value of 0 and `CurIndex` at a value of -1 until the trigger is received. They will then rise from of `PretrigCount` to `TotalCount`.

Sampling rate using SINGLEIO

When using this mode of data transfer, the maximum analog sampling rate is dependent on the speed of the computer in which the board is installed. In general, it is in the range of 5 to 50 kHz. If the requested speed cannot be sustained, an overrun error will occur. Data will be returned, but likely there will be gaps. Some boards, such as the **CIO-DAS08**, support this mode only, so the maximum rate attainable with these boards is system-dependent.

PCI-2500 Series

The PCI-2500 Series includes the PCI-2511, PCI-2513, PCI-2515, and PCI -2517 boards.

Analog input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbFileAInScan()`, `cbAPretrig()`*, `cbATrig()`, `cbALoadQueue()`
UL for .NET:	`AIn()`, `AInScan()`, `FileAInScan()`, `APretrig()`*, `ATrig()`, `ALoadQueue()`

* Pretrigger capability is implemented in software. `PretrigCount` must be less than the `TotalCount` and cannot exceed 100000 samples. `TotalCount` must be greater than the `PretrigCount`. If a trigger occurs while the number of collected samples is less than the `PretrigCount`, that trigger will be ignored. Requires a call to `cbSetTrigger` (`SetTrigger`) for the analog trigger type.

Analog input argument values

`Options` — `BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `CONVERTDATA`, `DMAIO`, `BLOCKIO`, `EXTTRIGGER`

With `EXTTRIGGER` mode, the first channel in the scan is the analog trigger channel.

`HighChan` — **PCI-2517**, **PCI-2515**, **PCI-2513**:

0 to 15 in single-ended mode, 0 to 7 in differential mode

PCI-2511:

0 to 15 in single-ended mode.

`Rate` — Up to 1 MHz

`Range` — **PCI-2517**, **PCI-2515**, **PCI-2513**:

`BIP10VOLTS`	(± 10 V)
`BIP5VOLTS`	(± 5 V)
`BIP2VOLTS`	(± 2 V)
`BIP1VOLTS`	(± 1 V)
`BIPPT5VOLTS`	(± 0.5 V)
`BIPPT2VOLTS`	(± 0.2 V)
`BIPPT1VOLTS`	(± 0.1 V)

PCI-2511:

`BIP10VOLTS`	(± 10 V)

Analog output (PCI-2517 and PCI-2515 only)

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options` — `BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `SIMULTANEOUS`, `NONSTREAMEDIO`, `ADCCLOCKTRIG`, `ADCCLOCK`

`NONSTREAMEDIO` can only be used with the number of samples set equal to the size of the FIFO or less. The FIFO holds 524288 samples.

`HighChan` — **PCI-2517**: 0 to 3

PCI-2515: 0 to 1

`Rate`	1 MHz
`Range`	Ignored - Not programmable; fixed at `BIP10VOLTS` (±10 volts)
`DataValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers).
`Pacing`	Hardware pacing, external or internal clock supported.

Digital I/O

Configuration functions, methods, and argument values supported

UL:	`cbDConfigPort()`
UL for .NET:	`DConfigPort()`
`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTC`
`PortType`	`FIRSTPORTA`

Port I/O functions, methods, and argument values supported

UL:	`cbDIn()`, `cbDOut()`, `cbDInScan()`, `cbDOutScan()`*
UL for .NET:	`DIn()`, `DOut()`, `DInScan()`, `DOutScan()`*
	*`FIRSTPORTA` and `FIRSTPORTB` must be set for output to use this function. Refer to *DIO PortNum* on page 36 for more information.
`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `EXTTRIGGER`, `WORDXFER`, `NONSTREAMEDIO`, `ADCCLOCKTRIG`, `ADCCLOCK`
	The `EXTTRIGGER` option can only be used with the `cbDInScan()` function. You can use the `cbSetTrigger()` function to program the trigger for rising edge, falling edge, or the level of the digital trigger input (TTL).
	The `WORDXFER` option can only be used with `FIRSTPORTA`.
	The `NONSTREAMEDIO`, `ADCCLOCKTRIG`, and `ADCCLOCK` options can only be used with the `cbDOutScan()` function.
	The `NONSTREAMEDIO` option can only be used with the number of samples set equal to the size of the FIFO or less. The FIFO holds 524288 samples.
`Rate`	12 MHz
`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTC`
`DataValue`	0 to 255
	0 to 65535 using the `WORDXFER` option with `FIRSTPORTA`

Bit I/O functions, methods, and argument values supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`FIRSTPORTA`
`BitNum`	0 to 23

Counter input

Counter functions and methods supported

UL:	`cbCIn()`, `cbCIn32()`, `cbCConfigScan()`, `cbCInScan()`, `cbCClear()`

UL for .NET:	`CIn()`, `CIn32()`, `CConfigScan()`, `CInScan()`, `CClear()`

Note: Counters on these boards are zero-based (the first counter number is "0").

Counter argument values

`Rate`	6 MHz
`CounterNum`	0 to 3
`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTTRIGGER` You can use the `cbSetTrigger()` function to program the trigger for rising edge, falling edge, or the level of the digital trigger input (TTL).
`LoadValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)

Timer output

Timer functions and methods supported

UL:	`cbTimerOutStart()`, `cbTimerOutStop()`
UL for .NET:	`TimerOutStart()`, `TimerOutStop()`

Timer argument values

`TimerNum`	0 to 1
`Frequency`	15.260 Hz to 1.0 MHz

Triggering

Trigger functions and methods supported

UL:	`cbSetTrigger()`
UL for .NET:	`SetTrigger()`

Trigger argument values

`TrigType`	`TRIGABOVE`, `TRIGBELOW`, `TRIGHIGH`, `TRIGLOW`, `TRIGPOSEDGE`, `TRIGNEGEDGE` Digital triggering (`TRIGHIGH`, `TRIGLOW`, `TRIGPOSEDGE`, `TRIGNEGEDGE`) is not supported for pre-trigger acquisitions (`cbAPretrig()` function). Analog triggering (`TRIGABOVE`, `TRIGBELOW`) is not supported for the `cbDInScan()` function and the `cbCInScan()` function.
`Threshold`	Analog hardware triggering, 12-bit resolution: 0 to 4095 (supported for `cbAInScan()` only) Analog software triggering, 16-bit resolution: 0 to 65535 (supported for `cbAPretrig()` only)

DAQ input

DAQ input functions and methods supported

UL:	`cbDaqInScan()`
UL for .NET:	`DaqInScan()`

DAQ input argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `CONVERTDATA`, `DMAIO`, `BLOCKIO`, `EXTTRIGGER`
`ChanTypeArray`	`ANALOG`, `DIGITAL8`, `DIGITAL16`, `CTR16`, `CTR32LOW`, `CTR32HIGH`, `SETPOINTSTATUS`
`ChanArray`	`ANALOG`: **PCI-2517**, **PCI-2515**, **PCI-2513**: 0 to 15 in single-ended mode,

		0 to 7 in differential mode
		PCI-2511: 0 to 15 in single-ended mode
	`DIGITAL8`:	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTC`
	`DIGITAL16`:	`FIRSTPORTA`
	`CTR16`:	0-3 counters
	`CTR32LOW`:	0-3 counters
	`CTR32HIGH`:	0-3 counters
	`SETPOINTSTATUS`:	16-bit port that indicates the current state of the 16 possible setpoints.
	`ChanTypeArray` flag value:	
	`SETPOINT_ENABLE`:	Enables a setpoint. Refer to *Hardware Considerations* on page 36 for more information.
`Rate`	Analog:	Up to 1 MHz
	Digital:	Up to 12 MHz if no analog channel is selected. Otherwise up to 1 MHz.
	Counter:	Up to 12 MHz if no analog channel is selected. Otherwise up to 1 MHz.
`GainArray`	`ANALOG` only; ignore for other `ChanTypeArray` values.	
	PCI-2517, **PCI-2515**, **PCI-2513**:	
	`BIP10VOLTS`	(± 10 V)
	`BIP5VOLTS`	(± 5 V)
	`BIP2VOLTS`	(± 2 V)
	`BIP1VOLTS`	(± 1 V)
	`BIPPT5VOLTS`	(± 0.5 V)
	`BIPPT2VOLTS`	(± 0.2 V)
	`BIPPT1VOLTS`	(± 0.1 V)
	PCI-2511: Ignored – fixed at `BIP10VOLTS` (± 10 V)	
`ChanCount`	Number of elements in `ChanArray`, `ChanTypeArray` and `GainArray`. Up to 512 elements max.	
`PretrigCount`	100000 max. This argument is ignored if the `EXTTRIGGER` option is not specified.	

DAQ triggering

DAQ trigger functions and methods supported

UL:	`cbDaqSetTrigger()`
UL for .NET:	`DaqSetTrigger()`

DAQ trigger argument values

`TrigSource`	`TRIG_IMMEDIATE`, `TRIG_EXTTTL`, `TRIG_ANALOGHW`, `TRIG_ ANALOGSW`, `TRIG_DIGPATTERN`, `TRIG_COUNTER`, `TRIG_SCANCOUNT`
`TrigSense`	`RISING_EDGE`, `FALLING_EDGE`, `ABOVE_LEVEL`, `BELOW_LEVEL`, `EQ_LEVEL`, `NE_LEVEL`
`TrigEvent`	`START_EVENT`, `STOP_EVENT`

DAQ setpoint

DAQ setpoint functions and methods supported

UL:	`cbDaqSetSetpoints()`
UL for .NET:	`DaqSetSetpoints()`

DAQ setpoint argument values

`SetpointFlagsArray`	`SF_EQUAL_LIMITA`, `SF_LESSTHAN_LIMITA`, `SF_GREATERTHAN_LIMITB`, `SF_OUTSIDE_LIMITS`, `SF_HYSTERESIS`, `SF_UPDATEON_TRUEONLY`, `SF_UPDATEON_TRUEANDFALSE`

`SetpointOutputArray`	`SO_NONE`, `SO_FIRSTPORTC`, `SO_TMR0`, `SO_TMR1`
	also available for PCI-2515 and PCI-2517:
	`SO_DAC0`, `SO_DAC1`
	also available for PCI-2517:
	`SO_DAC2`, `SO_DAC3`

`LimitAArray`	Any value valid for the associated input channel Ignored for `SF_GREATERTHAN_LIMITB`
`LimitBArray`	Any value valid for the associated input channel and less than LimitA Ignored for `SF_EQUAL_LIMITA`, `SF_LESSTHAN_LIMITA`
`Output#Array`	For `SetpointOutputArray` = `SO_NONE`: Ignored For `SetpointOutputArray` = `SO_FIRSTPORTC`: 0 to 65535 For `SetpointOutputArray` = `SO_TMR#`: 0 (to disable timer) or 15.26 to 1000000 (to set output frequency) For `SetpointOutputArray` = `SO_DAC#`: Voltage values between -10 and +10
`OutputMask#Array`	For `SetpointOutputArray` = `SO_FIRSTPORTC`: 0 to 65535 For `SetpointOutputArray` = all other values: Ignored
`SetpointCount`	0 (to disable setpoints) to 16

DAQ output (PCI-2517 and PCI-2515 only)

DAQ output functions and methods supported

UL:	`cbDaqOutScan()`
UL for .NET:	`DaqOutScan()`

DAQ output argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `SIMULTANEOUS`, `NONSTREAMEDIO`, `ADCCLOCKTRIG`, `ADCCLOCK`	
`ChanType`	`ANALOG, DIGITAL16`	
`ChanArray`	`ANALOG`:	**PCI-2517**: 0 to 3 **PCI-2515**: 0 to 1

	`DIGITAL16`:	`FIRSTPORTA` (`FIRSTPORTB` must be configured as an output)
`Rate`	`ANALOG`:	Up to 1 MHz
	`DIGITAL16`:	Up to 12 MHz if no analog channel is selected. Otherwise up to 1 MHz.
`Range`	Ignored	

Hardware considerations

Channel count

For input and output scans, the count must be set to an integer multiple of the number of channels or a `BADCOUNT` error is returned.

Sampling and update rates

Sampling and update rates are system-dependent. Data overruns/underruns may occur with higher sampling rates when using `BACKGROUND` and `CONTINUOUS` modes. To avoid this, use a larger buffer/count size, or use `NONSTREAMEDIO` mode, if supported. The minimum size buffer is 256 for `cbAOutScan()`. Values less than that result in a `BADBUFFERSIZE` error.

Settling time

For most applications, settling time should be left at the default value of 1 µs. However, if you are scanning multiple channels and one or more channels are connected to a high impedance source, you may get better results by increasing the settling time. Keep in mind that increasing the settling time reduces the maximum acquisition rate. You can set the time between A/D conversions with the ADC Settling Time option in *Insta*Cal. Select between 1 µs, 5 µs, 10 µs, or 1 ms.

Setpoints

You enable setpoints with the `SETPOINT_ENABLE` flag. This flag must be OR'ed with the `ChanTypeArray` argument values. You set the setpoint criteria with the `cbDaqSetSetpoints()/DaqSetSetpoints()`. The number of channels set with the `SETPOINT_ENABLE` flag must match the number of setpoints set by the `SetpointCount` argument (`cbDaqSetSetpoints()/DaqSetSetpoints()`).

Output non-streamed data to a DAC output channel

With `NONSTREAMEDIO` mode, you can output non-streamed data to a specific DAC output channel. The aggregate size of the data output buffer must be less than or equal to the size of the internal data output FIFO in the device. The FIFO holds 524288 samples. This allows the data output buffer to be loaded into the device’s internal output FIFO. Once the sample data are transferred or downloaded to the device, the device is responsible for outputting the data. You can't make any changes to the output buffer once the output begins.

Trigger DAC output operations with the ADC clock

Specify the `ADCCLOCKTRIG` option to trigger a data output operation upon the start of the ADC clock.

DIO PortNum

For `cbDOutScan()/DOutScan()` and `cbDaqOutScan()/DaqOutScan()`, `FIRSTPORTA` and `FIRSTPORTB` are treated as one 16-bit port. These functions can only be used with `FIRSTPORTA`. You must configure both `FIRSTPORTA` and `FIRSTPORTB` for output using the `cbDConfigPort()` function.

Synchronous scanning with multiple boards

You can operate up to four PCI-2500 Series boards synchronously by setting the direction of the A/D and D/A pacer pins (**XAPCR** or **XDPCR**) in *Insta*Cal.

On the board used to pace each device, set the pacer pin that you want to use (XAPCR or XDPCR) for *Output*. On the board(s) that you want to synchronize with this board, set the pacer pin that you want to use (XAPCR or XDPCR) for *Input*.

You set the direction using the *Insta*Cal configuration dialog's **XAPCR Pin Direction** and **XDPCR Pin Direction** settings. If you have an older version of *Insta*Cal, these settings might be labeled "ADC Clock Output" (set to *Enabled* to configure XAPCR for output) or "DAC Clock Output" (set to *Enabled* to configure XDPCR for output).

Wire the pacer pin configured for output to each of the pacer input pins that you want to synchronize.

PCI-DAS6000 Series

Analog input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbAPretrig()`, `cbFileAInScan()`, `cbFilePretrig()`, `cbALoadQueue()`
UL for .NET:	`AIn()`, `AInScan()`, `ATrig()`, `APretrig()`, `FileAInScan()`, `FilePretrig()`, `ALoadQueue()`

Analog input argument values

`Options` — `BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `CONVERTDATA`, `SINGLEIO`, `DMAIO`, `BLOCKIO`, `BURSTMODE`, `EXTTRIGGER`

Packet size is 512 for all PCI-6000 Series in most configurations. The exceptions are shown below.

Device	Aggregate rate	Packet size
PCI-DAS6040	400 kHz – 800 kHz	1024
PCI-DAS6070 PCI-DAS6071	Greater than 800 kHz	2048

`HighChan` — 0 to 15 in single-ended mode, 0 to 7 in differential mode

For **PCI-DAS6031**, **PCI-DAS6033**, and **PCI-DAS6071**, the following additional argument values are also valid:

16 to 63 in single-ended mode, 8 to 31 in differential mode

`Rate` — **PCI-DAS6030**, **PCI-DAS6031**, **PCI-DAS6032**, and **PCI-DAS6033**

Up to 100000

PCI-DAS6013, **PCI-DAS6014**, **PCI-DAS6023**, **PCI-DAS6025**, **PCI-DAS6034**, **PCI-DAS6035**, and **PCI-DAS6036**

Up to 200000

PCI-DAS6040

Up to 500000 Single-channel
Up to 250000 Multi-channel

PCI-DAS6052

Up to 333000

PCI-DAS6070, PCI-DAS6071

Up to 1250000

`Range` — **PCI-DAS6013***, **PCI-DAS6014***, **PCI-DAS6023**, **PCI-DAS6025**, **PCI-DAS6034***, **PCI-DAS6035***, and **PCI-DAS6036***

`BIP10VOLTS`	(± 10 V)
`BIP5VOLTS`	(± 5 V)
`BIPPT5VOLTS`	(± 0.5 V)
`BIPPT05VOLTS`	(± 0.05 V)

*** Note**: Mixing high gains (`BipPt05Volts`, `BipPt5Volts`) with low gains (`Bip5Volts`, `Bip10Volts`) within an `AInScan()` function is not supported.

PCI-DAS6030, PCI-DAS6031, PCI-DAS6032 and PCI-DAS6033

BIP10VOLTS	(± 10 V)	UNI10VOLTS	(0 to 10 V)
BIP5VOLTS	(± 5 V)	UNI5VOLTS	(0 to 5 V)
BIP2VOLTS	(± 2 V)	UNI2VOLTS	(0 to 2 V)
BIP1VOLTS	(± 1 V)	UNI1VOLTS	(0 to 1 V)
BIPPT5VOLTS	(± 0.5 V)	UNIPT5VOLTS	(0 to 0.5 V)
BIPPT2VOLTS	(± 0.2 V)	UNIPT2VOLTS	(0 to 0.2 V)
BIPPT1VOLT	(± 0.1 V)	UNIPT1VOLTS	(0 to 0.1 V)

PCI-DAS6040, PCI-DAS6052, PCI-DAS6070 and **PCI-DAS6071**

BIP10VOLTS	(± 10 V)	UNI10VOLTS	(0 to 10 V)
BIP5VOLTS	(± 5 V)	UNI5VOLTS	(0 to 5 V)
BIP2PT5VOLTS	(± 2.5 V)	UNI2VOLTS	(0 to 2 V)
BIP1VOLTS	(± 1 V)	UNI1VOLTS	(0 to 1 V)
BIPPT5VOLTS	(± 0.5 V)	UNIPT5VOLTS	(0 to 0.5 V)
BIPPT25VOLTS	(± 0.25 V)	UNIPT2VOLTS	(0 to 0.2 V)
BIPPT1VOLTS	(± 0.1 V)	UNIPT1VOLTS	(0 to 0.1 V)
BIPPT05VOLTS	(± 0.05 V)		

Analog output

PCI-DAS6014, PCI-DAS6025, PCI-DAS6030, PCI-DAS6031, PCI-DAS6035, PCI-DAS6036, PCI-DAS6040, PCI-DAS6052, PCI-DAS6070 and PCI-DAS6071

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options` SIMULTANEOUS, BACKGROUND, EXTCLOCK, CONTINUOUS (packet size = 512)

`HighChan` 0 to 1

`Rate` **PCI-DAS6014**, **PCI-DAS6025, PCI-DAS6035, PCI-DAS6036**

10 kHz

PCI-DAS6030 and **PCI-DAS6031**

100 kHz

PCI-DAS6040

1 MHz single-channel
500 kHz multi-channel

PCI-DAS6052

333 kHz

PCI-DAS6070 and **PCI-DAS6071**

1.0 MHz

`Range` **PCI-DAS6014, PCI-DAS6025, PCI-DAS6035** and **PCI-DAS6036**

Ignored - Not programmable; fixed at BIP10VOLTS (±10 V)

	PCI-DAS6030, PCI-DAS6031, PCI-DAS6040, PCI-DAS6052, PCI-DAS6070 and **PCI-DAS6071** BIP10VOLTS (± 10 V) UNI10VOLTS (0 to 10 V)
DataValue	0 to 4095 For the **PCI-DAS6014**, **PCI-DAS6030**, **PCI-DAS6031, PCI-DAS6036** and **PCI-DAS6052**, the following additional argument value is also valid: 0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers).
Pacing	Hardware pacing, external or internal clock supported.

Digital I/O

Digital I/O functions and methods supported

UL:	cbDOut(), cbDIn(), cbDBitIn(), cbDBitOut(), cbDConfigBit(), cbDConfigPort()
UL for .NET:	DOut(), DIn(), DBitIn(), DBitOut(), DConfigBit(), DConfigPort(), GetDInMask(), GetDOutMask()

Digital I/O argument values

PortNum	AUXPORT*
DataValue	0 to 255
BitNum	0 to 7

For the **PCI-DAS6025,** the following additional argument values are also valid

PortNum	FIRSTPORTA, FIRSTPORTB, FIRSTPORTCL, FIRSTPORTCH
DataValue	0 to 15 for FIRSTPORTCL or FIRSTPORTCH; 0 to 255 for FIRSTPORTA or FIRSTPORTB
BitNum	0 to 23 for FIRSTFIRSTPORTA

*AUXPORT is bitwise configurable for these boards, and must be configured using cbDConfigBit()/DConfigBit() or cbDConfigPort()/DConfigPort() before use.

Counter I/O

Counter functions and methods supported

UL:	cbC8254Config(), cbCIn(), cbCLoad()
UL for .NET:	C8254Config(), CIn(), CLoad()

Counter argument values

CounterNum	1 to 2
Config	HIGHONLASTCOUNT, ONESHOT, RATEGENERATOR, SQUAREWAVE, SOFTWARESTROBE, HARDWARESTROBE
LoadValue	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)
RegNum:	LOADREG1, LOADREG2

Triggering

Trigger functions and methods supported

UL:	`cbSetTrigger()`
UL for .NET:	`SetTrigger()`

Trigger argument values

`TrigType`	`TRIGPOSEDGE`, `TRIGNEGEDGE`, `GATEHIGH`, `GATELOW`
	For the **PCI-DAS6030**, **PCI-DAS6031**, **PCI-DAS6032**, **PCI-DAS6033**, **PCI-DAS6040**, **PCI-DAS6052**, **PCI-DAS6070** and **PCI-DAS6071**, the following additional argument values are valid:
	`TRIGABOVE`, `TRIGBELOW`, `GATENEGHYS`, `GATEPOSHYS`, `GATEABOVE`, `GATEBELOW`, `GATEINWINDOW`, `GATEOUTWINDOW`

`Threshold`	**PCI-DAS6040**, **PCI-DAS6070** and **PCI-DAS6071** 0 to 255 **PCI-DAS6030**, **PCI-DAS6031**, **PCI-DAS6032**, **PCI-DAS6033**, and **PCI-DAS6052** 0 to 4095

Event notification

Event notification functions and methods supported

UL:	`cbEnableEvent()`, `cbDisableEvent()`
UL for `.NET`:	`EnableEvent()`, `DisableEvent()`

Event notification argument values

`EventType`	`ON_SCAN_ERROR`, `ON_PRETRIGGER*`, `ON_DATA_AVAILABLE`, `ON_END_OF_AI_SCAN`, `ON_END_OF_AO_SCAN**`

*Note that the `EventData` for `ON_PRETRIGGER` events may not be accurate. In general, this value will be below the actual number of pretrigger samples available in the buffer.

Not supported for **PCI-DAS6013, **PCI-DAS6023**, **PCI-DAS6032**, **PCI-DAS6033**, and **PCI-DAS6034**.

Hardware considerations

Advanced timing and control configuration

You can access the advanced features provided by the Auxiliary Input/Output and DAQ-Sync interfaces through the board configuration page of *Insta*Cal and the UL functions `cbGetSignal()` and `cbSelectSignal()`, or the UL for .NET methods `GetSignal()` and `SelectSignal()*`.

`ADC_TB_SRC` and `DAC_TB_SRC` are intended to synchronize the timebase of the analog input and output pacers across two or more boards. Internal calculations of sampling and update rates assume that the external timebase has the same frequency as its internal clock. Adjust sample rates to compensate for differences in clock frequencies.

For example, if the external timebase has a frequency of 10 MHz on a board that has an internal clock frequency of 40 MHz, the scan function samples or updates at a rate of about 1/4 the rate entered. However, while compensating for differences in the external timebase and internal clock frequency, if the rate entered results in an invalid pacer count, the function returns a `BADRATE` error.

*Although the PCI-DAS6013 and PCI-DAS6014 both support `cbSelectSignal/SelectSignal()`, these boards do not support DAQ-Sync. Therefore:

- Using the `DS_CONNECT` option with the `Connection` argument for the `cbSelectSignal()` function generates a `BADCONNECTION` error.
- Using the `DsConnector` option with the `connectionPin` parameter for the `SelectSignal()` method generates a `BADCONNECTION` error.

Pacing analog input

Hardware pacing, external or internal clock supported. The clock edge is selectable through *Insta*Cal and `cbSelectSignal` / `SelectSignal()`.

When using `EXTCLOCK` and `BURSTMODE` together, do not use the A/D External Pacer to supply the clock. Use the A/D Start Trigger input instead. Since `BURSTMODE` is actually paced by the internal burst clock, specifying `EXTCLOCK` when using `BURSTMODE` is equivalent to specifying `EXTTRIGGER`.

Except for `SINGLEIO` transfers, `CONTINUOUS` mode scans require enough memory for two packets, or 1024 samples. The packet size is 512 samples.

Analog input configuration

16 channel boards: The analog input mode may be 8 channel differential, 16 channel single-ended referenced to ground or 16 channel single-ended non-referenced, and may be selected using *Insta*Cal.

64-channel boards: The analog input mode may be 32 channel differential, 64 channel single-ended referenced to ground, or 64 channel single-ended non-referenced, and may be selected using *Insta*Cal.

Triggering and gating

Digital (TTL) hardware triggering is supported for the entire series. `cbSetTrigger()` / `SetTrigger()` is supported for `GATEHIGH`, `GATELOW`, `TRIGPOSEDGE`, `TRIGNEGEDGE`.

The `A/D PACER GATE` input is used for gating with `GATEHIGH` or `GATELOW`. The `A/D START TRIGGER` input is used for triggering with `TRIGPOSEDGE` and `TRIGNEGEDGE`.
When using `cbAPretrig()` or `cbFilePretrig()` / `APretrig()` or `FilePretrig()` , use the A/D Stop Trigger input to supply the trigger.

For the **PCI-DAS6030, PCI-DAS6031, PCI-DAS6032, PCI-DAS6033, PCI-DAS6040, PCI-DAS6052, PCI-DAS6070** and **PCI-DAS6071**: Analog hardware triggering and gating are supported. `cbSetTrigger()`/`SetTrigger()` is supported for `TRIGABOVE`, `TRIGBELOW`, `GATENEGHYS`, `GATEPOSHYS`, `GATEABOVE`, `GATEBELOW`, `GATEINWINDOW`, `GATEOUTWINDOW`.

The analog trigger source may be set via *Insta*Cal as either the ATRIG input (pin #43 on the I/O connector), or as the first channel in the scan (CH# IN). To use the ATRIG input as the trigger source, set the *Insta*Cal "Analog Input Trig Source" to "Analog Trigger Pin." To use the first scanned channel as the trigger source, set *Insta*Cal to "1st Chan in the Scan."

Recommended trigger source when using analog gating features

If using analog gating features, we strongly recommend setting the ATRIG input as the trigger source.

Using the ATRIG input as the Trigger Input

When the trigger source is set to "Analog Trigger Pin," analog thresholds are set relative to the ± 10 V range.

Using the "First Channel in Scan" as the Trigger Input

When the trigger source is set to "1st Chan in Scan," the range used for the thresholds is the same as the A/D channel. When using analog gating features with "1st Channel in Scan" as the trigger source, be careful to only scan a single channel.

Calculating Analog Trigger Thresholds

Analog thresholds for the **PCI-DAS6030**, **PCI-DAS6031, PCI-DAS6032, PCI-DAS6033** and **PCI-DAS6052** are 12-bit values. For example: a threshold value of 0 equates to -10 volts (V), while a threshold value of 4095 equates to +9.9976 volts (V). Analog thresholds for the **PCI-DAS6040**, **PCI-DAS6070** and **PCI-DAS6071** are 8-bit values. For example: a threshold value of 0 equates to -10 V, while a threshold value of 255 equates to +9.92188 V.

You need to manually calculate trigger threshold values for these PCI-DAS6000 Series boards. For information on calculating thresholds, refer to the "Notes" section in the "`cbSetTrigger()`" and "`SetTrigger()`" in the *Universal Library Function Reference*.

Channel-Gain queue

When using `cbALoadQueue()`/`ALoadQueue()`, up to 8k elements may be loaded into the queue. For Models **PCI-DAS6013**, **PCI-DAS6014**, **PCI-DAS6034**, **PCI-DAS6035**, and **PCI-DAS6036**: Mixing high gains (`BipPt05Volts`, `BipPt5Volts`) with low gains (`Bip5Volts`, `Bip10Volts`) within an `AInScan()` function is not supported.

Analog Output

Using `cbAOutScan()/AOutScan()` in `CONTINUOUS` mode requires a minimum sample size of two packets. A packet is 512 samples.

Digital I/O configuration

`AUXPORT` is bitwise configurable for these boards, and must be configured using `cbDConfigBit()` or `cbDConfigPort()` / `DConfigBit()` or `DConfigPort()` before use.

Counters

The source for counters 1 and 2 may be internal 10 MHz, internal 100 kHz, or external, and is selectable using *Insta*Cal.

PCI-DAS4020 Series

Analog Input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbAPretrig()`, `cbFileAInScan()`, `cbFilePretrig()`
UL for .NET:	`AIn()`, `AInScan()`, `ATrig()`, `APretrig()`, `FileAInScan()`, `FilePretrig()`

Analog input argument values

`Options` — `BACKGROUND`, `BLOCKIO`*, `CONTINUOUS`, `CONVERTDATA`, `DMAIO`, `EXTCLOCK`, `EXTTRIGGER`, and `SINGLEIO`

* PCI-4020 Series packet size based on `Options` settings is as follows:

Options setting	**Packet size**
`BLOCKIO`	2048 See details on chain and packet size in "Memory configuration" on page 46.

`HighChan`	3 max. When scanning multiple channels, the number of channels scanned must be even.
`Rate`	Up to 20000000. Contiguous memory may be required to achieve maximum performance. Refer to "Memory configuration" on page 46 for details.
`Range`	`BIP5VOLTS` (± 5 V) `BIP1VOLTS` (± 1 V)

Analog output

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	NONE
`HighChan`	1 max
`Count`	2
`Rate`	Ignored
`Range`	`BIP10VOLTS` (± 10 V) `BIP5VOLTS` (± 5 V)
`DataValue`	0 to 4095
`Pacing`	Software only

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`, `cbDConfigPort()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`, `DConfigPort()`

Digital I/O argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`

`DataValue`	0 to 255 for `FIRSTPORTA` or `FIRSTPORTB`; 0 to 15 for `FIRSTPORTCL` or `FIRSTPORTCH`
`BitNum`	0 to 23 for `FIRSTPORTA`

Counter I/O

Counter functions and methods supported

None

Triggering

Trigger functions and methods supported

UL:	`cbSetTrigger()`
UL for .NET:	`SetTrigger()`

Trigger argument values

`TrigType`	`TRIGPOSEDGE`, `TRIGNEGEDGE`, `TRIGABOVE`, `TRIGBELOW`, `GATEHIGH`, `GATELOW`, `GATENEGHYS`, `GATEPOSHYS`, `GATEABOVE`, `GATEBELOW`, `GATEINWINDOW`, `GATEOUTWINDOW`
`Threshold`	0 to 4095

Event notification

Event notification functions and methods supported

UL:	`cbEnableEvent()`, `cbDisableEvent()`
UL for .NET:	`EnableEvent()`, `DisableEvent()`

Event notification argument values

`EventType`	`ON_SCAN_ERROR`, `ON_PRETRIGGER`†, `ON_DATA_AVAILABLE`, `ON_END_OF_AI_SCAN`

Hardware considerations

Pacing analog input

Hardware pacing, external or internal clock supported. The clock source can be set via *Insta*Cal to either the "Trig/Ext Clk" BNC input or the "A/D External Clock" input on the 40 pin connector (P3). Configuring for the BNC clock input will disable the clock input (pin 10) on the 40-pin connector. When the `EXTCLOCK` option is used, the clock signal presented to the "Trig/Ext Clk" BNC input or the "A/D External Clock" input is divided by 2 in one or two channel mode and is divided by 4 in four channel mode. If both `EXTCLOCK` and `EXTTRIGGER` are used, both the Trigger BNC and pin 10 on the 40-pin connector require signals. This is further explained in the "Triggering and gating" section below. When using `EXTCLOCK`, the `Rate` argument *is used* by the Universal Library to calculate the appropriate chain size. Set the `Rate` argument to the approximate rate used by the external clock to pace acquisitions.

When executing `cbAInScan()`/`AInScan()` with the `EXCLOCK` option, the first three clock pulses are used to set up the PCI-DAS4020/12, and the first sample is actually taken on the fourth clock pulse.

The packet size varies. See "Memory configuration" on page 46 for more information.

Triggering and gating

Digital (TTL) hardware triggering supported. The trigger source can be set via *Insta*Cal to either the "`Trig/Ext Clk`" BNC input, the "A/D Start Trigger" input on the 40-pin connector (P3) or the "A/D Stop

† The EventData for `ON_PRETRIGGER` events may not be accurate. In general, this value is below the actual number of pretrigger samples available in the buffer.

Trigger" input on the 40-pin connector (P3). Use the A/D Start Trigger input for the `cbAInScan()` and `cbFileAInScan()` functions, and `AInScan()` and `FileAInScan()` methods. For the `cbAPretrig()` or `cbFilePretrig()` functions, and the `APretrig()` or `FilePretrig()` method, use the A/D Stop Trigger input.

When using both `EXTCLOCK` and `EXTTRIGGER` options, one of the signals (either clock or trigger) must be assigned to the Trig/Ext Clk BNC input. The function of the Trigger BNC is determined by the setting of "Trig/Ext Clock Mode" in *Insta*Cal. The Trig/Ext Clock BNC can be set to function as either the trigger ("A/D Start Trigger") or the clock ("A/D External Clock"). Pin 10 on the 40-pin connector then assumes the opposite function.

Analog hardware triggering supported. The trigger source can be set via *Insta*Cal to any of the analog BNC inputs. `cbSetTrigger()/SetTrigger()` is supported for `TRIGBELOW` and `TRIGABOVE` trigger types. Analog thresholds are set relative to the voltage range set in the scan. For example, using a range of `BIP1VOLTS` during a `cbAInScan()/AInScan()`, (0) corresponds to –1 volt (V) and 4095 corresponds to +1 V.

When using the `cbAPretrig()` function or the `APretrig()` method, use either the TRIGGER BNC or pin 8 of the 40 pin connector. To use the BNC, set *Insta*Cal "Trig/Ext Clock Mode" to A/D Stop Trigger; otherwise, if not set to this selection, pin 8 of the 40-pin connector is used.

When using `cbAPretrig()/APretrig()` with `EXTCLOCK`, the two inputs are required. The TRIGGER BNC can be set to function as either the pacer clock or the trigger. For the BNC to be setup as the pacer clock, set *Insta*Cal "Trig/Ext Clk Mode" to A/D External Clock. To use the BNC as the trigger, set this *Insta*Cal option to A/D Stop Trigger. If neither of these selections are used, the 40-pin connector will be used for both inputs; pin 8 will be input for A/D Stop Trigger, and pin 10 will be input for the pacer clock signal.

Digital (TTL) hardware gating supported. The gate source can be set via *Insta*Cal to either the "Trig/Ext Clk" BNC input or the "A/D Pacer Gate" input on the 40-pin connector (P3).

Analog hardware gating supported. Analog thresholds are set relative to the voltage range set in the scan. For example, using a range of `BIP1VOLTS` during a `cbAInScan()/AInScan()`, (0) corresponds to (-1V) and 4095 corresponds to +1V.

The gate must be in the active (enabled) state before starting an acquisition.

For `EXTCLOCK` or `EXTTRIGGER` (digital triggering) using the BNC connector, *Insta*Cal provides a configuration setting for thresholds. The selections available are either 0 V or 2.5 V. Use 0 V if the incoming signal is BIPOLAR. Use the 2.5 V option if the signal is UNIPOLAR, for example, standard TTL.

When using both `EXTCLOCK` and `EXTTRIGGER` options, one of the signals (either clock or trigger) must be assigned to the Trig/Ext Clk BNC input.

Memory configuration

In order to achieve the maximum sample rate under some conditions, a contiguous area of memory must be set up. The following is a guide that can be used to determine whether or not you need to set up this memory, and how to accomplish it using *Insta*Cal.

If the number of samples you are acquiring is less than 2k samples (2,048), then you do NOT need to set up contiguous memory (leave the **Memory Size** edit box in *Insta*Cal at zero).

If you are acquiring more than 2,048 samples, contiguous memory may be required, depending on sample rate. Use the table below to determine if contiguous memory is required.

# of Channels	**Rate requiring contiguous memory (when sample count > 2048)**
1	> 4 MHz
2	>2 MHz
4	>1 MHz

If contiguous memory is required, follow the *Insta*Cal procedures below to set the size of the contiguous memory to reserve:

1. Run *Insta*Cal, select the **PCI-DAS4020** board and click the **Configure** tab.
2. In the **Memory Size** edit box for the **Contiguous Memory Settings**, enter the amount of memory in kilobytes that you need for the acquisition.

To calculate the number of kilobytes required, use the following formula:

(# of kilobytes (KB)) = {(# of samples) x (2 bytes/sample) x (1 KB/1024 bytes)}

or

(# of KB) = {(# of samples)/512}

Memory is allocated in blocks of 4 KB. As a consequence, *Insta*Cal adjusts the amount entered upward to the nearest integer multiple of 4 KB. For example, the contiguous memory requirements for a 10,000-sample acquisition would be:

(10,000/512) = 19.5 rounded up to multiple of 4 KB = 20 KB.

The maximum number of samples allowed for the given contiguous memory size is displayed as the **Sample Count** (displayed below the **Memory Size** edit box).

Note: You can set the size of the contiguous memory up to 262144k, or 134,217,728 samples.

3. Reboot the computer. The Universal Library attempts to reserve the desired amount of contiguous memory at boot up time. If it is unable to reserve all the memory requested, the amount successfully reserved memory displays in the **Memory Size** entry when you run *Insta*Cal.
4. Run *Insta*Cal. In the **Memory Size** entry, verify the size of the contiguous memory that was successfully reserved.

Repeat this procedure to change or free the contiguous memory.

The size of the block shown in *Insta*Cal is the *total contiguous memory* that is available to *all boards installed*. Other installed boards that call the `cbWinBufAlloc()` function or `WinBufAlloc()` method will also use this contiguous memory, so plan the size of the contiguous memory buffer accordingly.

With the following functions and methods, be aware of packet size, and adjust the number of samples acquired accordingly:

- `cbAPretrig()`/`APretrig()`
- `cbAInScan()`/`AInScan()` with the `CONTINUOUS` scan option.

These functions and methods use a circular buffer. Align the data by packets in the buffer. For these functions, the total number of samples must be greater than one packet (refer to the following table), and must be an integer multiple of packet size. In addition, contiguous memory must be used if noted in the following table. The minimum value for contiguous memory is calculated using the formula from step 2 above:

(# of KB) = {(# of samples) / 512}

For example, to run `cbAInScan` on one channel at 18 MHz with the `CONTINUOUS` option set, determine the minimum sample size from the table to be 262,144 (since the `Rate` is between 14 and 20 MHz). The minimum contiguous memory is calculated as:

(262,144 / 512) = 512 KB

Number of Channels	**Rate in MHz**	**Packet Size in Samples**	**Minimum Sample Size (two packets)**	**Contiguous Memory**	**Min Contiguous Memory (based on Min Sample Size)**
1	20 ≥ Rate ≥13.3	131,072	262,144	Required	512 KB
	13.3 > Rate > 4	65,536	131,072	Required	256 KB
	4 ≥ Rate ≥ 2	4,096	8,192	Not Required	0 KB
	2 > Rate	2,048	4,096	Not Required	0 KB
2	20 ≥ Rate ≥ 6.6	131,072	262,144	Required	512 KB
	6.6 > Rate ≥ 2	65,536	131,072	Required	256 KB
	2 > Rate ≥ 1	4,096	8,192	Not Required	0 KB
	1 > Rate	2,048	4,096	Not Required	0 KB
4	10 ≥ Rate ≥ 3.3	131,072	262,144	Required	512 KB
	3.3 > Rate ≥ 1	65,536	131,072	Required	256 KB
	1 > Rate ≥ 0.5	4,096	8,192	Not Required	0 KB
	0.5 > Rate	2,048	4,096	Not Required	0 KB

*Note that the `EventData` for `ON_PRETRIGGER` events may not be accurate. In general, this value will be below the actual number of pretrigger samples available in the buffer.

PCI-DAS64/Mx/16 Series

Analog input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbAPretrig()`, `cbFileAInScan()`, `cbFilePretrig()`, `cbALoadQueue()`
UL for .NET:	`AIn()`, `AInScan()`, `ATrig()`, `APretrig()`, `FileAInScan()`, `FilePretrig()`, `ALoadQueue()`

Analog input argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `CONVERTDATA`, `SINGLEIO`, `DMAIO`, `BLOCKIO`, `BURSTMODE`, `EXTTRIGGER`
`HighChan`	0 to 63 in single-ended mode, 0 to 31 in differential mode
`Rate`	**PCI-DAS64/M3/16** Single-channel, Single-range: Up to 3000000 Multi-channel, Single-range: Up to 1500000 Channel/Gain Queue: Up to 750000 **PCI-DAS64/M2/16** Single-channel, Single-range: Up to 2000000 Multi-channel, Single-range: Up to 1500000 Channel/Gain Queue: Up to 750000 **PCI-DAS64/M1/16** Single-channel, Single-range: Up to 1000000 Multi-channel, Single-range: Up to 1000000 Channel/Gain Queue: Up to 750000

`Range`	`BIP5VOLTS`	`(±5 V)`	`UNI5VOLTS`	`(0-5 V)`
	`BIP2PT5VOLTS`	`(±2.5 V)`	`UNI2PT5VOLTS`	`(0-2.5 V)`
	`BIP1PT25VOLTS`	`(±1.25 V)`	`UNI1PT25VOLTS`	`(0-1.25 V)`
	`BIPPT625VOLTS`	`(±.625 V)`		

Analog output

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `SIMULTANEOUS`
`HighChan`	1 max
`Rate`	Up to 100000
`Range`	Ignored - Not programmable; fixed at `BIP5VOLTS` (±5 V)
`DataValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`, `cbDConfigPort()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`, `DConfigPort()`

Digital I/O argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`, `AUXPORT`
`DataValue`	0 to 15 for `FIRSTPORTCL` or `FIRSTPORTCH` or `AUXPORT` 0 to 255 for `FIRSTPORTA` or `FIRSTPORTB`
`BitNum`	0 to 23 for `FIRSTPORTA` 0 to 3 for `AUXPORT`

Counter I/O

Counter functions and methods supported

UL:	`cbC8254Config()`, `cbCIn()`, `cbCLoad()`
UL for .NET:	`C8254Config()`, `CIn()`, `CLoad()`

Counter argument values

`CounterNum`	1
`Config`	`HIGHONLASTCOUNT`, `ONESHOT`, `RATEGENERATOR`, `SQUAREWAVE`, `SOFTWARESTROBE`, `HARDWARESTROBE`
`LoadValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)
`RegNum`:	`LOADREG1`

Triggering

Trigger functions and methods supported

UL:	`cbSetTrigger()`
UL for .NET:	`SetTrigger()`

Trigger argument values

`TrigType`	`TRIGPOSEDGE`, `TRIGNEGEDGE`, `TRIGABOVE`, `TRIGBELOW`, `GATEHIGH`, `GATELOW`, `GATENEGHYS`, `GATEPOSHYS`, `GATEABOVE`, `GATEBELOW`, `GATEINWINDOW`, `GATEOUTWINDOW`
`Threshold`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)

Event notification

Event notification functions and methods supported

UL:	`cbEnableEvent()`, `cbDisableEvent()`
UL for .NET:	`EnableEvent()`, `DisableEvent()`

Event notification argument values

`EventType`	`ON_SCAN_ERROR`, `ON_PRETRIGGER`, `ON_DATA_AVAILABLE`, `ON_END_OF_AI_SCAN`, `ON_END_OF_AO_SCAN`

Hardware considerations

Pacing analog input

- Hardware pacing, external or internal clock supported.
- The clock edge used to trigger acquisition for the external pacer may be rising or falling and is selectable using *Insta*Cal.
- The packet size is 512 samples.

Analog Input configuration

The analog input mode may be 32 channel differential or 64 channel single-ended and may be selected using *Insta*Cal.

Analog Input options

Except for `SINGLEIO` transfers, `CONTINUOUS` mode scans require enough memory for half FIFO of memory.

Triggering and gating

Digital (TTL) hardware triggering supported. Use the A/D Start Trigger Input (pin 55) for triggering and gating with `cbAInScan()` and `cbFileAInScan()` / `AInScan()` and `FileAInScan()`. Use the A/D Stop Trigger Input (pin 54) for `cbAPretrig()` and `cbFilePretrig()` / `APretrig()` and `FilePretrig()`.

Analog hardware triggering and gating are supported. `cbSetTrigger()` / `SetTrigger()` are supported for `TRIGABOVE`, `TRIGBELOW`, `GATENEGHYS`, `GATEPOSHYS`, `GATEABOVE`, `GATEBELOW`, `GATEINWINDOW`, `GATEOUTWINDOW`. Use the Analog Trigger Input (pin 56) for analog triggering. Analog thresholds are set relative to the ±5 V range. For example: a threshold of 0 equates to -5 V, and a threshold of 65535 equates to +4.999847 V.

When using analog trigger feature, one or both of the DACs are used to set the threshold and are unavailable for other functions. If the trigger function requires a single reference (`GATEABOVE`, `GATEBELOW`, `TRIGABOVE`, `TRIGBELOW`) then DAC0 is available. If the trigger function requires two references (`GATEINWINDOW`, `GATE OUTWINDOW`, `GATENEGHYS`, `GATEPOSHYS`) then neither DAC is available for other functions.

Caution! Gating should NOT be used with `BURSTMODE` scans.

Pacing analog output

- Hardware pacing, external or internal clock supported.
- The clock edge used to trigger analog output updates for the external pacer may be rising or falling and is selectable using *Insta*Cal.
- `EventData` for `ON_PRETRIGGER` events may not be accurate. In general, this value will be below the actual number of pretrigger samples available in the buffer.

These boards support concurrent analog input and output scans. That is, these boards allow for operations of analog input functions and methods (`cbAInScan()` and `cbAPretrig()` / `AInScan()` and `APretrig()`) and analog output functions and methods (`cbAOutScan()` / `AOutScan()`) to overlap without having to call `cbStopBackground()` between the start of input and output scans.

Output pin 59 configuration

Pin 59 may be configured as the DAC Pacer Output, SSH Output with hold configured as high level, or SSH Output with hold configured as low level. These options are selected via *Insta*Cal

PCI- and CIO-DAS6402 and DAS3202 Series

Analog Input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbAPretrig()`, `cbFileAInScan()`, `cbFilePretrig()`
	For **PCI-Versions**, the following function also applies:
	`cbALoadQueue()`

UL for .NET:	`AIn()`, `AInScan()`, `ATrig()`, `APretrig()`, `FileAInScan()`, `FilePretrig()`
	For **PCI-Versions**, the following method also applies:
	`ALoadQueue()`

Analog input argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `CONVERTDATA`, `SINGLEIO`, `BLOCKIO*`, `BURSTMODE`, `EXTTRIGGER` *Packet size: 512 for both CIO- and PCI- boards.		
`HighChan`	**PCI-DAS6402** and **CIO-DAS6402** 0 to 63 in single-ended mode, 0 to 31 in differential mode **PCI-DAS3202** 0 to 31		
`Rate`	**CIO-DAS6402/12** Up to 330000	**CIO-DAS6402/16** Up to 100000	**All others** Up to 200000

`Range`	`BIP10VOLTS`
	`BIP5VOLTS`
	`BIP2PT5VOLTS`
	`BIP1PT25VOLTS`
		`UNI10VOLTS`
		`UNI5VOLTS`
		`UNI2PT5VOLTS`
		`UNI1PT25VOLTS`	

Analog output

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	`SIMULTANEOUS`
	For **PCI Versions**, the following argument values are also valid:
	`BACKGROUND`, `EXTCLOCK`, `CONTINUOUS`	

`HighChan`	1 max	
`Rate`	**PCI Versions** Up to 100000	**CIO Versions** Ignored

`Range`	**PCI Versions**, **CIO-DAS6402/12**
	`BIP10VOLTS`
	`BIP5VOLTS`
	`UNI10VOLTS`
	`UNI5VOLTS`
		CIO-DAS6402/16
		Ignored - Not programmable

`DataValue`	0 to 4095 For **PCI-DAS6402/16, PCI-DAS3202/16, CIO-DAS6402/16**, the following additional argument values are also valid: 0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()` For **PCI- Versions**, the following additional function is also valid: `cbDConfigPort()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()` For **PCI- Versions**, the following additional method is also valid: `DConfigPort()`

Digital I/O argument values

`PortNum`	`AUXPORT`*
`DataValue`	0 to 15
`BitNum`	0 to 3

* `AUXPORT` is not configurable for these boards.

For **PCI- Versions**, the following additional argument values are also valid:

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`
`DataValue`	0 to 15 for `PORTCL` or `PORTCH`; 0 to 255 for `PORTA` or `PORTB`
`BitNum`	0 to 23 for `FIRSTPORTA`

Counter I/O

Counter functions and methods supported

UL:	`cbC8254Config()`, `cbCIn()`, `cbCLoad()`
UL for .NET:	`C8254Config()`, `CIn()`, `CLoad()`

Counter argument values

`CounterNum`	1
`Config`	`HIGHONLASTCOUNT`, `ONESHOT`, `RATEGENERATOR`, `SQUAREWAVE`, `SOFTWARESTROBE`, `HARDWARESTROBE`
`LoadValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)
`RegNum`:	`LOADREG1`

Triggering

Trigger functions and methods supported

UL:	`cbSetTrigger()`
UL for .NET:	`SetTrigger()`

Trigger argument values

`TrigType`	`TRIGPOSEDGE`, `TRIGNEGEDGE`, `GATEHIGH`, `GATELOW` For **PCI- versions**, the following additional argument values are also valid: `TRIGABOVE`, `TRIGBELOW`, `GATENEGHYS`, `GATEPOSHYS`, `GATEABOVE`, `GATEBELOW`, `GATEINWINDOW`, `GATEOUTWINDOW`
`Threshold`	0 to 4095 For **/16 versions** the following argument values are also valid: 0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers).

Event notification

Event notification functions and methods supported (PCI versions Only)

UL:	`cbEnableEvent()`, `cbDisableEvent()`
UL for .NET:	`EnableEvent()`, `DisableEvent()`

Event notification argument values

`EventType`	`ON_SCAN_ERROR`, `ON_PRETRIGGER`, `ON_DATA_AVAILABLE`, `ON_END_OF_AI_SCAN`, `ON_END_OF_AO_SCAN`

Hardware considerations

Pacing Analog input

Hardware pacing, external or internal clock supported. The packet size is 512 samples for both **CIO versions** and for **PCI versions**.

Triggering and gating

Digital (TTL) hardware triggering supported. The **PCI version** also supports analog hardware triggering. Analog thresholds are set relative to the ±10 V range. For example, a threshold of 0 equates to -10 V and a threshold of 65535 equates to +9.999695 V.

When using the UL functions `cbAPretrig()` or `cbFilePretrig()` (or the UL for .NET methods `APretrig()` or `FilePretrig()`) on the **PCI-DAS6402/16** or **PCI-DAS3202/16**, use the A/D Stop Trigger In (pin 47) input to supply the trigger.

When using both `EXTCLOCK` and `BURSTMODE` on the **PCI-DAS6402/16** or **PCI-DAS3202/16**, use the A/D Start Trigger In (pin 45) input to supply the clock and not the A/D External Pacer (pin 42). Since `BURSTMODE` is actually paced by the internal burst clock, specifying `EXTCLOCK` when using `BURSTMODE` is equivalent to specifying `EXTTRIGGER`.

When using analog trigger feature, one or both of the DACs are used to set the threshold and are unavailable for other functions. If the trigger function requires a single reference (`GATEABOVE`, `GATEBELOW`, `TRIGABOVE`, `TRIGBELOW`) then DAC0 is available. If the trigger function requires two references (`GATEINWINDOW`, `GATE OUTWINDOW`, `GATENEGHYS`, `GATEPOSHYS`), then neither DAC is available for other functions.

Caution! Gating should NOT be used with `BURSTMODE` scans.

Gain queue

When using the UL function `cbALoadQueue()` or the UL for .NET method `ALoadQueue()` with the **PCI version**, up to 8k elements can be loaded into the queue.

Pacing analog output

CIO Version: Software only

PCI Version: Hardware pacing, external or internal clock supported.

Output pin 49 configuration

On the PCI version, pin 49 may be configured as the DAC Pacer Output, SSH Output with hold configured as high level or SSH Output with hold configured as low level. These options are selected via *Insta*Cal.

Event notification

The PCI versions of these boards support concurrent analog input and output scans. That is, these boards allow for operations of analog input functions (`cbAInScan()` and `cbAPretrig()`) and analog output functions (`cbAOutScan()`) to overlap without having to call `cbStopBackground()` between the start of input and output scans. Equivalent UL for .NET methods are `AInScan()`, `APretrig()`, `AOutScan()` and `StopBackground()`.

PCI-DAS1602, PCI-DAS1200 & PCI-DAS1000 Series

Analog input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbAPretrig()`, `cbFileAInScan()`, `cbFilePretrig()`
UL for .NET:	`AIn()`, `AInScan()`, `ATrig()`, `APretrig()`, `FileAInScan()`, `FilePretrig()`

Analog input argument values

`Options`	BACKGROUND, CONTINUOUS, EXTCLOCK, CONVERTDATA, SINGLEIO, BLOCKIO, BURSTMODE, EXTTRIGGER
`HighChan`	0 to 15 in single-ended mode, 0 to 7 in differential mode
`Rate`	**PCI-DAS1602/12, PCI-DAS1200, PCI-DAS1200/JR** Up to 330000
	PCI-DAS1000 Up to 250000
	PCI-DAS1602/16, PCI-DAS1002 Up to 200000
	PCI-DAS1001 Up to 150000
`Range`	**PCI-DAS1602/12, PCI-DAS1602/16, PCI-DAS1200, PCI-DAS1200Jr, PCI-DAS1002, PCI-DAS1000**

```
BIP10VOLTS     UNI10VOLTS
BIP5VOLTS      UNI5VOLTS
BIP2PT5VOLTS   UNI2PT5VOLTS
BIP1PT25VOLTS  UNI1PT25VOLTS
```

PCI-DAS1001

```
BIP10VOLTS     UNI10VOLTS
BIP1VOLTS      UNI1VOLTS
BIPPT1VOLTS    UNIPT1VOLTS
BIPPT01VOLTS   UNIPT01VOLTS
```

Analog output

Excludes **PCI-DAS1200Jr**.

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	SIMULTANEOUS		
	For **PCI-DAS1602 Series**, the following argument values are also valid: BACKGROUND, CONTINUOUS, EXTCLOCK		
`HighChan`	0 to 1		
`Rate`	**PCI-DAS1602/16** Up to 100000	**PCI-DAS1602/12** Up to 250000	**All others** Ignored
`Range`	BIP10VOLTS	UNI10VOLTS	
	BIP5VOLTS	UNI5VOLTS	

`DataValue`	0 to 4095 For **PCI-DAS1602/16**, the following argument values are also valid: 0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`, `cbDConfigPort()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`, `DConfigPort()`

Digital I/O argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`
`DataValue`	0 to 15 for `PORTCL` or `PORTCH` 0 to 255 for `PORTA` or `PORTB`
`BitNum`	0 to 23 for `FIRSTPORTA`

Counter I/O

Counter functions and methods supported

UL:	`cbC8254Config()`, `cbCIn()`, `cbCLoad()`
UL for .NET:	`C8254Config()`, `CIn()`, `CLoad()`

Counter argument values

`CounterNum`	4 to 6
`Config`	`HIGHONLASTCOUNT`, `ONESHOT`, `RATEGENERATOR`, `SQUAREWAVE`, `SOFTWARESTROBE`, `HARDWARESTROBE`
`LoadValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)
`RegNum`:	`LOADREG4`, `LOADREG5`, `LOADREG6`

Triggering

PCI-DAS1602/16 and **PCI-DAS1602/12** only

Trigger functions and methods supported

UL:	`cbSetTrigger()`
UL for .NET:	`SetTrigger()`

Trigger argument values

`TrigType`	`TRIGPOSEDGE`, `TRIGNEGEDGE`, `TRIGABOVE`, `TRIGBELOW`, `GATEHIGH`, `GATELOW`, `GATENEGHYS`, `GATEPOSHYS`, `GATEABOVE`, `GATEBELOW`, `GATEINWINDOW`, `GATEOUTWINDOW`
`Threshold`	**PCI-DAS1602/16**: 0 to 65535 **PCI-DAS1602/12**: 0 to 4095

Event notification

Event notification functions and methods supported

PCI Versions Only

UL:	`cbEnableEvent()`, `cbDisableEvent()`

UL for .NET:	`EnableEvent()`, `DisableEvent()`

Event notification argument values

`EventType`	`ON_SCAN_ERROR`, `ON_PRETRIGGER`, `ON_DATA_AVAILABLE`, `ON_END_OF_AI_SCAN`
	For **PCI-DAS1602/16** and **PCI-DAS1602/12** the following argument values are also valid:
	`ON_END_OF_AO_SCAN`

Hardware considerations

Pacing analog input

Hardware pacing, external or internal clock supported.

The clock edge used to trigger acquisition for the external pacer may be *rising* or *falling*, and is selectable using *Insta*Cal.

For the **PCI-DAS1602/16**, the packet size is 256 samples. All others in this series have a packet size of 512 samples.

Analog input configuration

The analog input mode is selectable via *Insta*Cal for either 8-channel differential or 16-channel single-ended.

Triggering and gating - PCI-DAS1602 Series

Digital (TTL) and analog hardware triggering supported.

Analog thresholds are set relative to the ±10 V range. For example: a threshold of 0 equates to -10 V. Thresholds of 65535 and 4095 correspond to +9.999695 and +9.995116 V for the 16-bit and 12-bit boards, respectively.

When using analog trigger feature, one or both of the DACs are unavailable for other functions. If the trigger function requires a single reference (`GATE_ABOVE`, `GATE_BELOW`, `TRIGABOVE`, and `TRIGBELOW`), DAC0 is available. If the trigger function requires two references (`GATE_IN_WINDOW`, `GATE_ OUT_WINDOW`, `GATE_NEG_HYS` and `GATE_ POS_HYS`), neither DAC is available for other functions.

Triggering and gating - PCI-DAS1200, PCI-DAS1000 Series

Digital (TTL) hardware triggering supported.

Concurrent operations - PCI-DAS1602 Series

Concurrent analog input and output scans supported. That is, PCI-DAS1602 Series boards allow for operations of analog input functions (`cbAInScan()` and `cbAPretrig()`) and analog output functions (`cbAOutScan()`) to overlap without having to call `cbStopBackground()` between the start of input and output scans. Equivalent UL for .NET methods are `AInScan()`, `APretrig()`, `AOutScan()`, and `StopBackground()`.

Pacing analog output - PCI-DAS1602 Series

Hardware pacing, external or internal clock supported.

The clock edge used to trigger analog output updates for the external pacer may be rising or falling and is selectable using *Insta*Cal.

Counters

The source for counter 4 may be internal or external and is selectable using *Insta*Cal.

Although counters 4, 5 and 6 are programmable through the counter functions, the primary purpose for some of these counters may conflict with these functions.

Potential conflicts include:

- **PCI-DAS1200**, **PCI-DAS1000** Series: Counters 5 and 6 are always available to the user. Counter 4 is used as a residual counter by some of the analog input functions and methods.
- **PCI-DAS1602** Series: Counters 5 and 6 are used as DAC pacers by some analog output functions and methods. Counter 4 is used as a residual counter by some of the analog input functions and methods.

PCIM-DAS1602 and PCIM-DAS16JR Series

Analog input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`,`cbFileAInScan()`, `cbATrig()`
UL for .NET:	`AIn()`, `AInScan()`,`FileAInScan()`,`ATrig()`

Analog input argument values

`Options`	BACKGROUND, CONTINUOUS, EXTCLOCK, CONVERTDATA, SINGLEIO, BLOCKIO, BURSTMODE, EXTTRIGGER	
`HighChan`	0 to 15 in single-ended mode, 0 to 7 in differential mode	
`Rate`	100000	
`Range`	BIP10VOLTS	UNI10VOLTS
	BIP5VOLTS	UNI5VOLTS
	BIP2PT5VOLTS	UNI2PT5VOLTS
	BIP1PT25VOLTS	UNI1PT25VOLTS

Analog output (PCIM-DAS1602/16 only)

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	Ignored
`HighChan`	1 max
`Count`	2
`Rate`	Ignored
`Range`	Ignored - Not programmable
`DataValue`	0 to 4095

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`

The PCIM-DAS1602/16 also supports:

UL:	`cbDConfigPort()`
UL for .NET:	`DConfigPort()`

Digital I/O argument values

PortNum:	AUXPORT*

The PCIM-DAS1602/16 also supports:

PortNum:	FIRSTPORTA, FIRSTPORTB, FIRSTPORTCL, FIRSTPORTCH
DataValue:	0 to 15 FIRSTPORTCL, FIRSTPORTCH or AUXPORT*
	0 to 255 for FIRSTPORTA or FIRSTPORTB
BitNum:	0 to 23 for FIRSTPORTA
	0 to 3 for AUXPORT*
	*AUXPORT is not configurable for these boards.

Counter I/O

Counter functions and methods supported

UL:	cbC8254Config(), cbCIn(), cbCLoad()
UL for .NET:	C8254Config(), CIn(), CLoad()

Counter argument values

CounterNum	1 to 3
Config	HIGHONLASTCOUNT, ONESHOT, RATEGENERATOR, SQUAREWAVE, SOFTWARESTROBE, HARDWARESTROBE
LoadValue	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)
RegNum:	LOADREG1, LOADREG2, LOADREG3

Event notification

Event notification functions and methods supported

UL:	cbEnableEvent(), cbDisableEvent()
UL for .NET:	EnableEvent(), DisableEvent()

Event notification argument values

EventType	ON_SCAN_ERROR, ON_DATA_AVAILABLE, ON_END_OF_AI_SCAN

Triggering

Trigger functions and methods supported

UL:	cbSetTrigger()
UL for .NET:	SetTrigger()

Trigger argument values

TrigType	TRIGPOSEDGE, TRIGNEGEDGE, GATEHIGH, GATELOW

Hardware considerations

Pacing analog input

Hardware pacing, external or internal clock supported.

Analog input ranges

For the **PCIM-DAS1602/16**, the A/D ranges are configured with a combination of a switch (Unipolar / Bipolar) and a programmable gain code. The state of this switch is set in the configuration file using *Insta*Cal. After the UNI/BIP switch setting is selected, only matching ranges can be used in Universal Library programs.

Triggering and gating

Digital (TTL) hardware triggering supported.

Pacing analog output

Software pacing only

CIO-DAS800 Series

Analog input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbFileAInScan()`
UL for .NET:	`AIn()`, `AInScan()`, `ATrig()`, `FileAInScan()`

Analog input argument values

`Options` BACKGROUND, CONTINUOUS, EXTCLOCK, CONVERTDATA, SINGLEIO, BLOCKIO, EXTTRIGGER

`HighChan` 0 to 7

`Rate`
CIO-DAS802/16
100000

All others in series
50,000

`Range`
CIO-DAS800
Ignored - Not programmable.

CIO-DAS801 supports the following A/D ranges

BIP10VOLTS	UNI10VOLTS
BIP5VOLTS	UNI1VOLTS
BIP1VOLTS	UNIPT1VOLTS
BIPPT5VOLTS	UNIPT01VOLTS
BIPPT05VOLTS	
BIPPT01VOLTS	

CIO-DAS802 supports the following A/D ranges

BIP10VOLTS	UNI10VOLTS
BIP5VOLTS	UNI5VOLTS
BIP2PT5VOLTS	UNI2PT5VOLTS
BIP1PT25VOLTS	UNI1PT25VOLTS
BIPPT625VOLTS	

CIO-DAS802/16 supports the following A/D ranges

BIP10VOLTS	UNI10VOLTS
BIP5VOLTS	UNI5VOLTS
BIP2PT5VOLTS	UNI2PT5VOLTS
BIP1PT25VOLTS	UNI1PT25VOLTS

Analog Output

These boards do not have D/A converters and do not support analog output functions.

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`

Digital I/O argument values

`PortNum` AUXPORT (not configurable for these boards)

`DataValue`	`cbDOut()` 0 to 15	`cbDIn()` 0 to 7
`BitNum`	`cbDOut()` 0 to 3	`cbDIn()` 0 to 2

Counter I/O

Counter functions and methods supported

UL:	`cbC8254Config()`, `cbCIn()`, `cbCLoad()`
UL for .NET:	`C8254Config()`, `CIn()`, `CLoad()`

Counter argument values

`CounterNum`	1 to 3
`Config`	`HIGHONLASTCOUNT`, `ONESHOT`, `RATEGENERATOR`, `SQUAREWAVE`, `SOFTWARESTROBE`, `HARDWARESTROBE`
`LoadValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)
`RegNum`:	`LOADREG1`, `LOADREG2`, `LOADREG3`

Hardware considerations

Pacing analog input

Hardware pacing, external or internal clock supported.

The packet size is 128 samples. Note that digital output is not compatible with concurrent `cbAInScan()/AInScan()` operation, since the channel multiplexer control shares the register with the digital output control. Writing to this register during a scan may adversely affect the scan.

Triggering and gating

Digital hardware triggering supported.

CIO-, PCI-, and PC104-DAS08 Series

Analog input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbFileAInScan()`
UL for .NET:	`AIn()`, `AInScan()`, `ATrig()`, `FileAInScan()`

Analog input argument values

`Options` BACKGROUND, CONTINUOUS, EXTCLOCK, CONVERTDATA, SINGLEIO, EXTTRIGGER

`HighChan` 0 to 7

`Rate` From 63 up to 50000 (Refer to the "Sampling Rate using `SINGLEIO`" on page 30.)

`Range`

DAS08 series
Since the **DAS08** series does not have programmable gain, the `Range` arguments for the analog input functions are ignored.

PCI-DAS08
BIP5VOLTS (±5 V)

CIO-DAS08 and **PC104-DAS08**

BIP10VOLTS	UNI10VOLTS
BIP5VOLTS	

CIO-DAS08-PGH and **CIO-DAS08-AOH**

BIP10VOLTS	UNI10VOLTS
BIP5VOLTS	UNI1VOLTS
BIP1VOLTS	UNIPT1VOLTS
BIPPT5VOLTS	UNIPT01VOLTS
BIPPT1VOLTS	BIPPT01VOLTS
BIPPT05VOLTS	BIPPT005VOLTS

CIO-DAS08-PGL and **CIO-DAS08-AOL**

BIP10VOLTS	UNI10VOLTS
BIP5VOLTS	UNI5VOLTS
BIP2PT5VOLTS	UNI2PT5VOLTS
BIP1PT25VOLTS	UNI1PT25VOLTS
BIPPT625VOLTS	

CIO-DAS08-PGM and **CIO-DAS08-AOM**

BIP10VOLTS	UNI10VOLTS
BIP5VOLTS	UNI1VOLTS
BIPPT5VOLTS	UNIPT1VOLTS
BIPPT1VOLTS	UNIPT01VOLTS
BIPPT05VOLTS	

Analog output

AO, -AOH, -AOM, -AOL versions only

Analog output functions and methods supported

UL:	`cbAOut()`, `AOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	SIMULTANEOUS
`HighChan`	1 max
`Rate`	Ignored

`Count`	2 max
`Range`	Ignored - Not programmable
`DataValue`	0 to 4095

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`
	For **CIO-DAS08** and **CIO-DAS08-AOx**, the following function and method is also supported:
UL:	`cbDConfigPort()`
UL for .NET:	`DConfigPort()`

Digital I/O argument values

`PortNum`	`AUXPORT`
`DataValue`	0 to 15 using `cbDOut()` or `DOut()`
	0 to 7 using `cbDIn()` or `DIn()`
`BitNum`	0 to 3 using `cbDBitOut()` or `DBitOut()` 0 to 2 using `cbDBitIn()` or `DBitIn()`
	For **CIO-DAS08** and **CIO-DAS08-AOx** the following argument values are also valid:
	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`
`PortNum`	0 to 15 for `FIRSTPORTCL` or `FIRSTPORTCH` 0 to 255 for `FIRSTPORTA` or `FIRSTPORTB`
`DataValue`	0 to 15 for `FIRSTPORTCL` or `FIRSTPORTCH` 0 to 255 for `FIRSTPORTA` or `FIRSTPORTB`
`BitNum`	0 to 23 for `FIRSTPORTA`

Counter I/O

Counter functions and methods supported

UL:	`cbC8254Config()`, `cbCIn()`, `cbCLoad()`
UL for .NET:	`C8254Config()`, `CIn()`, `CLoad()`

Counter argument values

`CounterNum`	1 to 3
`Config`	`HIGHONLASTCOUNT`, `ONESHOT`, `RATEGENERATOR`, `SQUAREWAVE`, `SOFTWARESTROBE`, `HARDWARESTROBE`
`LoadValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)
`RegNum`:	`LOADREG1`, `LOADREG2`, `LOADREG3`

Hardware considerations

Pacing analog input

Hardware pacing, external or internal clock supported.

Before using the `cbAInScan()` function or the `AInScan()` method for timed analog input with a **CIO-** or **PC104-** series board, the output of counter 1 must be wired to the Interrupt input; if you have a **CIO-DAS08** board revision 3 or higher, a jumper is provided on the board to accomplish this. An interrupt level must have been selected in *Insta*Cal and the CB.CFG file saved.

Triggering and gating

Polled digital input triggering (TTL) supported. Refer to "Trigger support" on page 29 for more information. Use pin 25 as the trigger input.

Pacing analog output

Software pacing only

Digital Output

Since the channel settings and DOut bits share a register, attempting to change the digital output value during an analog input scan may result in no change or unexpected values in digital output ports.

CIO-DAS08/Jr and CIO-DAS08/Jr/16 Series

Analog Input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbFileAInScan()`
UL for .NET:	`AIn()`, `AInScan()`, `ATrig()`, `FileAInScan()`

Analog input argument values

`Options`	`CONVERTDATA`
`HighChan`	0 to 7
`Rate`	Ignored
`Range`	Since these boards do not have programmable gain, the `Range` arguments for the analog input functions are ignored.

Analog output

(If optional D/A converters are installed)

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	`SIMULTANEOUS`
`HighChan`	1 max
`Rate`	Ignored
`Count`	2 max
`Range`	Ignored - Not programmable; fixedat `BIP5VOLTS` (±5 V)
`DataValue`	0 to 4095 For **CIO-DAS08/Jr/16-AO**, the following argument values are also valid: 0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`

Digital I/O argument values

`PortNum`	`AUXPORT*`
`DataValue`	0 to 255
`BitNum`	0 to 7

* `AUXPORT` is not configurable for these boards.

Counter I/O

Counter functions and methods supported

None

Hardware considerations

Pacing analog input

Software pacing only

PCM-DAS08

Analog Input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbFileAInScan()`
UL for .NET	`AIn()`, `AInScan()`, `ATrig()`, `FileAInScan()`

Analog input argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `CONVERTDATA`, `SINGLEIO`, `NOTODINTS`, `EXTTRIGGER`, `NOCALIBRATEDATA`
`HighChan`	0 to 7
`Rate`	25000 max. For other restrictions, refer to the PCM-DAS08 User's Manual at www.mccdaq.com/PDFmanuals/pcm-das08.pdf.
`Range`	This board does not have programmable gain, so the `Range` argument to analog input functions is ignored.

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDIn()`, `cbDOut()`, `cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DIn()`, `DOut()`, `DBitIn()`, `DBitOut()`

Digital I/O argument values

`PortNum`	`AUXPORT`
`DataValue`	0 to 7
`BitNum`	0 to 2

Hardware considerations

Pacing analog input

Internal or external clock

Maximizing sampling rates

When paced by the onboard clock, the rate is set by an onboard oscillator running at 25 kHz. The oscillator output may be divided by 2, 4 or 8, resulting in rates of 12.5 kHz, 6.25 kHz or 3.13 kHz. When pacing a single channel from the onboard clock, these are the four choices of rate available. When a rate is requested within the range of 3000 to 25000, the library selects the closest of the four available rates.

Scanning more than one channel divides the rate requested among the number of channels requested. The maximum rate when scanning eight channels is 3130 (25000 divided by eight channels).

PPIO-AI08

Analog Input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbFileAInScan()`
UL for .NET:	`AIn()`, `AInScan()`, `ATrig()`, `FileAInScan()`

Analog input argument values

`Options`	`CONVERTDATA`
`HighChan`	0 to 7
`Rate`	Ignored
`Range`	This board does not have programmable gain, so the `Range` arguments for the analog input functions are ignored.

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`

Digital I/O argument values

`PortNum`	`AUXPORT*`	
`DataValue`	`cbDOut()` 0 to 15	`cbDIn()` 0 to 7
`BitNum`	`cbDOut()` 0 to 3	`cbDIn()` 0 to 2

* `AUXPORT` is not configurable for this board.

Hardware considerations

Pacing analog input

Software pacing only

CIO- and PC104-DAS16

Analog Input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbFileAInScan()`
UL for .NET:	`AIn()`, `AInScan()`, `ATrig()`, `FileAInScan()`
	The **DAS16/330**, **DAS16/330i**, **DAS16/M1**, and **DAS16/M1/16** also support:
UL:	`cbAPretrig()`, `cbFileAInScan()`, `cbFilePretrig()`
UL for .NET:	`APretrig()`, `FileAInScan()`, `FilePretrig()`
	The **DAS16/330i** and **DAS16/M1** also support:
UL:	`cbALoadQueue()`
UL for .NET:	`cbALoadQueue()`

Analog input argument values

`Options` — `BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `CONVERTDATA`, `EXTTRIGGER`

For **DAS16/330, DAS16/330i, DAS16/M1** and **DAS16/M1/16**, the following argument values are also valid:
`DTCONNECT`, `BLOCKIO` (packet size: 512), `EXTMEMORY`

For **DAS16, DAS16/F, DAS16/Jr, DAS16/Jr/16** and **PC104-DAS16Jr** series, the following argument values are also valid:
`SINGLEIO`, `DMAIO`

For **DAS16/M1/16**, the following argument value is also valid:
`BURSTMODE`

`HighChan` — **DAS16/M1** and **DAS16/M1/16**
0 to 7

All others
0 to 15 in single-ended mode, 0 to 7 in differential mode

`Rate`

DAS16/M1 & **DAS16/M1/16** Up to 1000000	**DAS16/330** & **330i** Up to 330000
PC104-DAS16Jr/12 Up to 160000	**CIO-DAS16Jr** Up to 130000
DAS16/F & **DAS16Jr/16** Up to 100000	**CIO-DAS16** Up to 50000

`Range` — **CIO-DAS16 & CIO-DAS16/F**
These boards do not have programmable gain so the `Range` argument to analog input functions is ignored.

All other boards in this series support the following ranges:

`BIP5VOLTS`	`UNI10VOLTS`
`BIP2PT5VOLTS`	`UNI5VOLTS`
`BIP1PT25VOLTS`	`UNI2PT5VOLTS`
	`UNI1PT25VOLTS`

For all programmable gain boards in this series **except** the **DAS16/M1/16**, the following argument value is also valid:
`BIP10VOLTS`

For all programmable gain boards in this series **except** the **CIO-DAS16Jr/16** and **PC104-DAS16Jr/16**, the following argument value is also valid:
`BIPPT625VOLTS`

Analog output

CIO-DAS16 & **CIO-DAS16/F** only

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	`SIMULTANEOUS`
`HighChan`	1 max
`Rate`	Ignored
`Count`	2 max
`Range`	Ignored - Not programmable
`DataValue`	0 to 4095

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`

The **CIO-DAS16 & 16/F**, **CIO-DAS16/M1** and **CIO-DAS16/M1/16**, the following function is also supported:

UL:	`cbDConfigPort()`
UL for `.NET`:	`DConfigPort()`

Digital I/O argument values

`PortNum`	`AUXPORT*`
`DataValue`	0 to 15
`BitNum`	0 to 3
	* `AUXPORT` is not configurable for these boards.

For **CIO-DAS16 & 16/F**, **CIO-DAS16/M1** and **CIO-DAS16/M1/16** the following additional argument values are also valid:

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`
`DataValue`	0 to 15 for `FIRSTPORTCL` or `FIRSTPORTCH` 0 to 255 for `FIRSTPORTA` or `FIRSTPORTB`
`BitNum`	0 to 23 for `FIRSTPORTA`

Counter I/O

Counter functions and methods supported

UL:	`cbC8254Config()`, `cbCIn()`, `cbCLoad()`
UL for .NET:	`C8254Config()`, `CIn()`, `CLoad()`

Counter argument values

`CounterNum`	1 to 3 The **CIO-DAS16/M1/16** also supports these argument values: 4 to 6
`Config`	`HIGHONLASTCOUNT`, `ONESHOT`, `RATEGENERATOR`, `SQUAREWAVE`, `SOFTWARESTROBE`, `HARDWARESTROBE`
`LoadValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)

`RegNum`:	`LOADREG1`, `LOADREG2`, `LOADREG3`
	For **CIO-DAS16/M1/16** the following argument values are also valid
	`LOADREG4`, `LOADREG5`, `LOADREG6`

Triggering (CIO-DAS16/M1/16 only)

Trigger functions and methods supported

UL:	`cbSetTrigger()`
UL for .NET:	`SetTrigger()`

Trigger argument values

`TrigType`	`TRIGPOSEDGE`, `TRIGNEGEDGE`, `GATEHIGH`, `GATELOW`
`Threshold`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)

Hardware considerations

Pacing analog input

- Hardware pacing, external or internal clock supported.
- The packet size is 512 samples
- The `DMAIO` option cannot be used while using the chan/gain queue on the **DAS-330i** board.

CIO-DAS16/M1

If you use the timed analog functions with the **CIO-DAS16/M1** board to acquire more than 2048 data points, you may not be able to achieve the full 1 MHz rate. On slow machines, these functions may hang if the scan rate is fast, generally in the range of 500 to 700 kHz.

Determine the maximum rate by passing in different high rates until the maximum rate is achieved without hanging the system. If the full 1.0 MHz rate is required, add a **MEGA FIFO** memory board and specify the `EXTMEMORY` option on the call to `cbAInScan()` or `AInScan()`.

CIO-DAS16/M1/16 also supports counter numbers 4 through 6, with counter 4 being the only independent user counter.

Triggering and gating

- For the **CIO-DAS16/M1/16**, Digital (TTL) and analog hardware triggering is supported.

- For **all others in this series**, digital (TTL) polled gate triggering is supported. Refer to "Trigger support" on page 29

Pacing analog output

Software only

PCM- and PC-CARD-DAS16 Series

Analog Input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbFileAInScan()`
UL for .NET:	`AIn()`, `AInScan()`, `ATrig()`, `FileAInScan()`

Analog input argument values

`Options` BACKGROUND, CONTINUOUS*, EXTCLOCK, CONVERTDATA, SINGLEIO, BLOCKIO, EXTTRIGGER, NOTODINTS, NOCALIBRATEDATA

The **PC-CARD-DAS16** series also supports BURSTMODE.

`HighChan` **DAS16/S and DAS16/330**

0 to 15

DAS16/D

0 to 7

`Rate` **DAS16/330**

330000

PC-CARD-DAS16/16

200000

All others in series

100000

`Range` For **DAS16x/12**, the following A/D ranges are valid:

BIP10VOLTS	UNI10VOLTS
BIP5VOLTS	UNI5VOLTS
BIP2PT5VOLTS	UNI2PT5VOLTS
BIP1PT25VOLTS	UNI1PT25VOLTS

For **DAS16x/16**, the following A/D ranges are valid:

BIP10VOLTS	BIP5VOLTS
BIP2PT5VOLTS	BIP1PT25VOLTS

For **DAS16/330**, the following A/D ranges are valid:

BIP10VOLTS	BIP5VOLTS

Analog output

PCM-DAS16D/12AO and **PC-CARD-DAS16/xx-AO** only

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	SIMULTANEOUS (**PCM** version only)
`HighChan`	1 max

`Rate`	Ignored
`Count`	2 max

`Range`	Ignored - Not programmable; fixedat `BIP10VOLTS` (±10 V)
	For **PC-CARD-DAS16/12AO** and **PCM-DAS16D/12AO**, the following argument values are also valid:
	`BIP10VOLTS`
	`BIP5VOLTS`

`DataValue`	0 to 4095 For **PC-CARD-DAS16/16AO**, the following argument values are also valid: 0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16.)

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`, `cbDConfigPort()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`, `DConfigPort()`

Digital I/O argument values

`PortNum`	**PC-CARD-DAS16/xxAO**
	`FIRSTPORTA`
	All others in this series:
	`FIRSTPORTA`, `FIRSTPORTB`

`DataValue`	**PC-CARD-DAS16/xxAO** 0 to 15 for `FIRSTPORTA` **All others** in this series: 0 to 15 for `FIRSTPORTA` or `FIRSTPORTB`
`BitNum`	**PC-CARD-DAS16/xxAO** 0 to 3 for `FIRSTPORTA` **All others** in this series: 0 to 7 for `FIRSTPORTA`

Counter I/O

Counter functions and methods supported

UL:	`cbC8254Config()`, `cbCIn()`, `cbCLoad()`
UL for .NET:	`C8254Config()`, `CIn()`, `CLoad()`

Counter argument values

`CounterNum`	1 to 3
`Config`	`HIGHONLASTCOUNT`, `ONESHOT`, `RATEGENERATOR`, `SQUAREWAVE`, `SOFTWARESTROBE`, `HARDWARESTROBE`
`LoadValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)
`RegNum`:	`LOADREG1`, `LOADREG2`, `LOADREG3`

Triggering

PC-Card Only

Trigger functions and methods supported

UL:	`cbSetTrigger()`
UL for .NET:	`SetTrigger()`

Trigger argument values

`TrigType`	`TRIGPOSEDGE`, `TRIGNEGEDGE`, `GATEHIGH`, `GATELOW` (All at A/D External trigger input)

Hardware considerations

Pacing analog input

- Internal or external clock
- The packet size is 256 samples for **PCM** boards; 2048 samples for **PC-CARD** boards.
  For `CONTINUOUS` mode scans, the sample count should be at least one packet size (>=2048 samples) for the **PC-CARD-** boards.

These cards do not have residual counters, so `BLOCKIO` transfers must acquire integer multiples of the packet size before completing the scan. This can be lengthy for the **PC-CARD**s which must acquire 2048 samples between interrupts for `BLOCKIO` transfers. In general, it is best to allow the library to determine the best transfer mode (`SINGLEIO` vs. `BLOCKIO`) for these boards.

Triggering and gating

- External digital (TTL) polled gate trigger supported on **PCM** versions. Refer to "Trigger support" on page 29.
- External digital (TTL) hardware trigger supported on **PC-CARD** versions.

CIO-DAS1400 and CIO-DAS1600 Series

Analog Input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbFileAInScan()`
UL for .NET:	`AIn()`, `AInScan()`, `ATrig()`,`FileAInScan()`

Analog input argument values

`Options`	BACKGROUND, CONTINUOUS, EXTCLOCK, CONVERTDATA, SINGLEIO, DMAIO, BURSTMODE, EXTTRIGGER For **CIO-DAS1600**, the following argument values are also valid: DTCONNECT, EXTMEMORY.
HighChan	0 to 15 in single-ended mode, 0 to 7 in differential mode
Rate	**DAS1401/12, DAS1402/12, DAS1601/12, DAS1602/12** 160000 **DAS1602/16, DAS1402/16** 100000 **DAS1401/12, DAS1402/12, DAS1601/12, DAS1602/12** to external memory 330000
Range	**CIO-DAS1402, CIO-DAS1602, CIO-DAS1402/16** and **CIO-DAS1602/16** BIP10VOLTS UNI10VOLTS BIP5VOLTS UNI5VOLTS BIP2PT5VOLTS UNI2PT5VOLTS BIP1PT25VOLTS UNI1PT25VOLTS **CIO-DAS1401** and **CIO-DAS1601** BIP10VOLTS UNI10VOLTS BIP1VOLTS UNI1VOLTS BIPPT1VOLTS UNIPT1VOLTS BIPPT01VOLTS UNIPT01VOLTS

Analog output (CIO-DAS1600 series only)

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	SIMULTANEOUS
`HighChan`	1 max
`Count`	2 max
`Rate`	Ignored
`Pacing`	Software pacing only
`Range`	Analog output gain is not programmable, so the `Range` argument is ignored.
`DataValue`	0 to 4095

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`

For **DAS1600**, the following function and method are also valid:

UL:	`cbDConfigPort()`
UL for .NET:	`DConfigPort()`

Digital I/O argument values

`PortNum`	`AUXPORT`*
`DataValue`	0 to 15
`BitNum`	0 to 3

* `AUXPORT` is not configurable for these boards.

For **DAS1600**, the following additional argument values are also valid:

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`
`DataValue`	0 to 15 for `FIRSTPORTCL` or `FIRSTPORTCH`; 0 to 255 for `FIRSTPORTA` or `FIRSTPORTB`
`BitNum`	0 to 23 for `FIRSTPORTA`

Counter I/O

Counter functions and methods supported

UL:	`cbC8254Config()`, `cbCIn()`, `cbCLoad()`
UL for `.NET`:	`C8254Config()`, `CIn()`, `CLoad()`

Counter argument values

`CounterNum`	1 to 3
`Config`	`HIGHONLASTCOUNT`, `ONESHOT`, `RATEGENERATOR`, `SQUAREWAVE`, `SOFTWARESTROBE`, `HARDWARESTROBE`
`LoadValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)
`RegNum`:	`LOADREG1`, `LOADREG2`, `LOADREG3`

Hardware considerations

Pacing analog input

Hardware pacing, external or internal clock supported.

Specifying `SINGLEIO` while also specifying `BURSTMODE` is not recommended. If this combination is used, the Count value should be set as low as possible, preferably to the number of channels in the scan. Otherwise, overruns may occur.

When `EXTMEMORY` is used with the **CIO-DAS1600** the `cbGetStatus()` function or `GetStatus()` method does not return the current count and current index. This is a limitation imposed by maintaining identical registers to the KM-DAS1600.

Triggering and gating

External digital (TTL) polled gate trigger supported. Refer to "Trigger support" on page 29.

Range

The **CIO-DAS1400** and **CIO-DAS1600** A/D ranges are configured with a combination of a switch (Unipolar / Bipolar) and a programmable gain code. The state of this switch is set in the configuration file using *Insta*Cal. After the UNI/BIP switch setting is selected, only matching ranges can be used in Universal Library programs.

CIO-DAS48/PGA

Analog Input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbFileAInScan()`
UL for .NET:	`AIn()`, `AInScan()`, `ATrig()`, `FileAInScan()`

Analog input argument values

`Options`	`CONVERTDATA`
`HighChan`	47 (23 differential)
`Rate`	This board does not have a timer, so the `Rate` argument to the analog scanning functions is ignored.
`Range`	The board may be configured with a jumper for either voltage or current input.

In voltage mode

`BIP10VOLTS`	`UNI10VOLTS`
`BIP5VOLTS`	`UNI5VOLTS`
`BIP2PT5VOLTS`	`UNI2PT5VOLTS`
`BIP1PT25VOLTS`	`UNI1PT25VOLTS`
`BIPPT625VOLTS`	

In current mode

`MA4TO20`	`MA2TO10`
`MA1TO5`	`MAPT5TO2PT5`

Analog output

Analog output functions and methods supported

The **CIO-DAS48/PGA** board does not support any of the analog output functions.

Digital I/O

Digital I/O functions and methods supported

The **CIO-DAS48/PGA** does not support any of the digital I/O functions.

Counter I/O

Counter functions and methods supported

The **CIO-DAS48/PGA** does not support any of the counter I/O functions.

miniLAB 1008

The miniLAB 1008 supports the following UL and UL for .NET features.

Analog Input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbALoadQueue()*`, `cbFileAInScan()`, `cbATrig()`
UL for .NET:	`AIn()`, `AInScan()`, `ALoadQueue()*`, `FileAInScan()`, `ATrig()`
	*The channel-gain queues are limited to eight channel-gain pairs.

Analog input argument values

Options: `BACKGROUND`, `BLOCKIO***`, `BURSTIO**`, `CONTINUOUS`, `EXTTRIGGER`, `CONVERTDATA`, and `NOCALIBRATEDATA`.

**`BURSTIO` cannot be used with the `CONTINOUS` option.

** `BURSTIO` can only be used with sample count scans of 4096 or less.

*** The `BLOCKIO` packet size is 64 samples wide.

HighChan: 0 to 7 in single-ended mode, 0 to 3 in differential mode.

Rate: 8000 maximum for `BURSTIO` mode (1200 maximum for all other modes.)

When using `cbAInScan()` or `AInScan()`, the minimum rate is 100 S/s aggregate.

Range: **Single-ended mode:**

`BIP10VOLTS`	(± 10 V)

Differential mode:

`BIP20VOLTS`	(± 20 V)	`BIP2PT5VOLTS`	(± 2.5 V)
`BIP10VOLTS`	(± 10 V)	`BIP2VOLTS`	(± 2 V)
`BIP5VOLTS`	(± 5 V)	`BIP1PT25VOLTS`	(± 1.25 V)
`BIP4VOLTS`	(± 4 V)	`BIP1VOLTS`	(± 1 V)

`Pacing`: Hardware pacing, internal clock supported.

Triggering

Trigger functions and methods supported

UL:	`cbSetTrigger()`
UL for .NET:	`SetTrigger()`

Trigger argument values

`TrigType`: `TRIGHIGH`, `TRIGLOW`

Digital (TTL) hardware triggering supported. The hardware trigger is source selectable via *Insta*Cal (`AUXPORT` inputs 0–3).

Analog output

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`HighChan`	1
`Range`	Ignored - Not programmable; fixedat `UNI5VOLTS` (0 to 5 V)
`DataValue`	0 to 1023

Digital I/O

Configuration functions, methods, and argument values supported

UL:	`cbDConfigBit()`, `cbDConfigPort()`
UL for .NET:	`DConfigBit()`, `DConfigPort()`
`PortNum`	`AUXPORT`*, `FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`
`PortType`	`AUXPORT*`
	`* Only AUXPORT` is bitwise configurable on this board, and must be configured using `cbDConfigBit()` or `cbDConfigPort()` (or the UL for .NET methods `DConfigBit()` or `DConfigPort()`) before use for output.

Port I/O functions, methods, and argument values supported

UL:	`cbDIn()`,`cbDOut()`
UL for .NET:	`DIn()`, `DOut()`
`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`, `AUXPORT`
`DataValue`	0 to 15 for `AUXPORT`, `FIRSTPORTCL` or `FIRSTPORTCH` 0 to 255 for `FIRSTPORTA` or `FIRSTPORTB`

Bit I/O functions, methods, and argument values supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`AUXPORT`, `FIRSTPORTA`
`BitNum`	0 to 3 on `AUXPORT` 0 to 23 on `FIRSTPORTA`

Counter I/O

Counter I/O functions and methods supported

UL:	`cbCIn()`*, `cbCIn32()`, `cbCLoad()`**, `cbCLoad32()`**
UL for .NET:	`CIn()`*, `CIn32()`, `CLoad()`**, `CLoad32()`**

*Although `cbCIn()` and `CIn()` are valid for use with this counter, `cbCIn32() or CIn32()` may be more appropriate. The values returned may be greater than the data types that are used by `cbCIn()` and `CIn()` can handle.

**`cbCLoad()`, `CLoad32()`, `CLoad()` and `CLoad32()` only accept `Count=0`. These functions are used to reset the counter.

Counter I/O argument values

`CounterNum`	`1`
`Count`:	2^{32}-1 when reading the counter.
`LoadValue`	0 when loading the counter.
	`cbCLoad()` and `cbCLoad32()` / `CLoad()` and `CLoad32()` are only used to reset the counter for this board to 0. No other values are valid.
	The "Basic signed integers" guidelines on page 134 apply when using `cbCIn() or CIn()` for values greater than 32767, and when using `cbCIn32()` or `CIn32()` for values greater than 2147483647.
`RegNum`:	`LOADREG1`

Event notification

Even notification functions and methods supported

UL:	`cbEnableEvent()`, `cbDisableEvent()`
UL for .NET:	`EnableEvent()`, `DisableEvent()`
Event types:	`ON_SCAN_ERROR`, `ON_DATA_AVAILABLE`, `ON_END_OF_AI_SCAN`

Hardware considerations

Resolution

When configured for single-ended mode, the resolution of the data is 11-bits (data values between 0 and 2047). However, the Universal Library maps this data to 12-bit values, so the range of data is no different from the differential configuration. Consequently, the data returned contains only even numbers between 0 and 4094 when the `NOCALIBRATEDATA` option is used.

BURSTIO

Allows higher sampling rates (up to 8000 Hz) for sample counts up to 4096. Data is collected into the miniLAB 1008's local FIFO. Data is collected into the USB device's local FIFO. Data transfers to the PC don't occur until the scan completes. For `BACKGROUND` scans, the `Count` and `Index` returned by `cbGetStatus()` and `GetStatus()` remain 0, and `Status=RUNNING` until the scan finishes. The `Count` and `Index` are not updated until the scan is completed. When the scan is complete and the data is retrieved, `cbGetStatus()` and `GetStatus()` are updated to the current `Count` and `Index`, and `Status` = `IDLE`.

`BURSTIO` is the default mode for non-`CONTINUOUS` fast scans (aggregate sample rates above 1000 Hz) with sample counts up to 4096. `BURSTIO` mode allows higher sampling rates (up to 8000 Hz) for sample counts up to 4096. Non-`BURSTIO` scans are limited to a maximum of 1200 Hz. To avoid the `BURSTIO` default, specify `BLOCKIO` mode.

Continuous scans

When running cbAInScan() with the CONTINUOUS option, you should consider the packet size and the number of channels being scanned. In order to keep the data aligned properly in the array, make the total number of samples an integer multiple of the packet size and the number of channels.

Concurrent operations

Concurrent operations on a particular USB device are not allowed. If you invoke a UL or UL for .NET function on a USB device while another function is running on that USB device, the `ALREADYACTIVE` error is returned.

Miscellaneous functions and methods supported

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

Causes the LED on a Measurement Computing USB device to blink.

When you have several USB devices connected to the computer, use these functions to identify a particular device by making its LED blink.

USB-1208 Series

The USB-1208LS and USB-1208FS support the following UL and UL for .NET features.

Analog input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbALoadQueue()`, `cbFileAInScan()`, `cbATrig()`
UL for .NET:	`AIn()`, `AInScan()`, `ALoadQueue()`, `FileAInScan()`, `ATrig()`

Analog input argument values

`Options`

USB-1208LS

BACKGROUND, BLOCKIO*, BURSTIO**, CONTINUOUS, EXTTRIGGER, NOCALIBRATEDATA, and CONVERTDATA

USB-1208FS

BACKGROUND, BLOCKIO*, CONTINUOUS, EXTCLOCK, EXTTRIGGER, RETRIGMODE***, NOCALIBRATEDATA, and SINGLEIO

* USB-1208 Series packet size based on `Options` settings are as follows:

Device	Options setting	Packet size
USB-1208LS	BLOCKIO	64
USB-1208FS	BLOCKIO	31
	SINGLEIO	1

** BURSTIO can only be used with the number of samples (`Count`) set equal to the size of the FIFO or less. The USB-1208LS FIFO holds 4096 samples. BURSTIO cannot be used with the CONTINUOUS option.

*** RETRIGMODE can only be used with `cbAInScan()`/`AInScan()`.

`HighChan`

0 to 7 in single-ended mode

0 to 3 in differential mode

`Count`

In CONTINUOUS mode, `Count` *must* be an integer multiple of the packet size.

`Rate`

USB-1208LS

8000 Hz maximum for BURSTIO mode. The maximum rate is 1200 Hz for all other modes. When using `cbAInScan()` or `AInScan()`, the minimum sample rate is 100 Hz.

USB-1208FS

50 kHz maximum for BLOCKIO mode. The throughput is system dependant. Most systems will be able to achieve 40 kHz aggregate. Best results are obtained when using Windows XP or Windows Vista. When using `cbAInScan()` or `AInScan()`, the minimum sample rate is 1 Hz.

`Range`

Single-ended mode:

BIP10VOLTS	(± 10 V)

Differential mode:

BIP20VOLTS	(± 20 V)	BIP2PT5VOLTS	(± 2.5 V)
BIP10VOLTS	(± 10 V)	BIP2VOLTS	(± 2 V)
BIP5VOLTS	(± 5 V)	BIP1PT25VOLTS	(± 1.25 V)
BIP4VOLTS	(± 4 V)	BIP1VOLTS	(± 1 V)

Pacing	Hardware pacing, internal clock supported. External clock supported via the SYNC pin.

Triggering

Trigger functions and methods supported

UL:	`cbSetTrigger()`
UL for .NET:	`SetTrigger()`

Trigger argument values

`TrigType`	**USB-1208LS**
	`TRIGHIGH` and `TRIGLOW`
	USB-1208FS
	`TRIGPOSEDGE` and `TRIGNEGEDGE`
	Both products support external digital (TTL) hardware triggering. Use the `Trig_In` input for the external trigger signal.

Analog output

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	**USB-1208LS** Ignored **USB-1208FS** `BACKGROUND`, `CONTINUOUS` For the USB-1208FS, the number of samples (`Count`) in a `CONTINUOUS` scan needs to be an integer multiple of the packet size (32).
`HighChan`	0 to 1
`Count`	**USB-1208LS** (`HighChan – LowChan`) + 1 **USB-1208FS** `Count` must be an integer multiple of the number of channels in the scan. In a `CONTINUOUS` scan, `Count` must be an integer multiple of the packet size (32).
`Rate`	**USB-1208LS** Ignored **USB-1208FS** Up to 10 kHz maximum for a single channel Up to 5 kHz maximum for two channels Performance varies when operating on systems other than Windows XP or Windows Vista.
`Range`	**USB-1208LS** Ignored - Not programmable; fixedat `UNI5VOLTS` (0 to 5 V)

	USB-1208FS Ignored - Not programmable; fixedat `UNI4VOLTS` (0 to 4 V, nominal. Actual range is 0 to 4.096 V)
`DataValue`	**USB-1208LS** 0 to 1023 **USB-1208FS** 0 to 4095

Digital I/O

Configuration functions, methods, and argument values supported

UL:	`cbDConfigPort()`
UL for .NET:	`DConfigPort()`
`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`

Port I/O functions, methods, and argument values supported

UL:	`cbDOut()`, `cbDIn()`
UL for .NET:	`DOut()`, `DIn()`
`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`
`DataValue`	0 to 255 for `FIRSTPORTA` or `FIRSTPORTB`

Bit I/O functions, methods, and argument values supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`FIRSTPORTA`
`BitNum`	0 to 15 on `FIRSTPORTA`

Counter I/O

Counter I/O functions and methods supported

UL:	`cbCIn()`*, `cbCIn32()`, `cbCLoad()`**, `cbCLoad32()`**
UL for .NET:	`CIn()`*, `CIn32()`, `CLoad()`**, `CLoad32()`**

*Although `cbCIn()` and `CIn()` are valid for use with this counter, `cbCIn32()` or `CIn32()` may be more appropriate, since the values returned may be greater than the data types used by `cbCIn()` and `CIn()` can handle.
**`cbCLoad()`, `cbCLoad32()`, `CLoad()` and `CLoad32()` only accept `Count`=0. These functions are used to reset the counter.

Counter I/O argument values

`CounterNum`	1
`Count`	2^{32}-1 when reading the counter. 0 when loading the counter. `cbCLoad()` and `cbCLoad32()` / `CLoad()` and `CLoad32()`are only used to reset the counter for this board to 0. No other values are valid. The "Basic signed integers" guidelines on page 134 apply when using `cbCIn()` or `CIn()` for values greater than 32767, and when using `cbCIn32()` or `CIn32()` for values greater than 2147483647.

`RegNum`	`LOADREG1`

Event notification

Even notification functions and methods supported

UL:	`cbEnableEvent()`, `cbDisableEvent()`
UL for .NET:	`EnableEvent()`, `DisableEvent()`
Event types:	`ON_SCAN_ERROR` (analog input), `ON_DATA_AVAILABLE`, `ON_END_OF_AI_SCAN`
	The **USB-1208FS** also supports `ON_END_OF_AO_SCAN` and `ON_SCAN_ERROR` (analog output)

Hardware considerations

Acquisition Rate (USB-1208FS)

Since the maximum data acquisition rate depends on the system connected to the USB-1208FS, it is possible to "lose" data points when scanning at higher rates. The Universal Library cannot always detect this data loss. Maximum rates may be lower in Windows operating systems that predate Windows XP.

Most systems can sustain rates of 40 kS/s aggregate in `BLOCKIO` mode, and 1 kS/s aggregate in `SINGLEIO` mode.

`BURSTIO` (USB-1208LS)

`BURSTIO` mode allows higher sampling rates for sample counts up to the size of the FIFO. The USB-1208LS FIFO holds 4096 samples. Data is collected into the device's local FIFO. Data transfers to the PC don't occur until the scan completes. For `BACKGROUND` scans, the `Count` and `Index` returned by `cbGetStatus()` and `GetStatus()` remain 0, and `Status=RUNNING` until the scan finishes. The `Count` and `Index` are not updated until the scan is completed. When the scan is complete and the data is retrieved, `cbGetStatus()` and `GetStatus()` are updated to the current `Count` and `Index`, and `Status` = `IDLE`.

The USB-1208LS uses `BURSTIO` as the default mode for non-`CONTINUOUS` fast scans with sample counts up to the size of the FIFO (4096 samples). `BURSTIO` mode allows higher sampling rates for sample counts up to the size of the FIFO. Maximum `Rate` values of non-`BURSTIO` scans are limited (see `Rate` on page 87). To avoid the `BURSTIO` default, specify `BLOCKIO` mode.

`EXTCLOCK` (USB-1208FS)

By default, the **SYNC** pin is configured for pacer output and provides the internal pacer A/D clock signal. To configure the pin for pacer input, use the `EXTCLOCK` option.

If you use the `EXTCLOCK` option, make sure that you disconnect from the external clock source when you test or calibrate the device with *Insta*Cal, as the **SYNC** pin drives the output.

`RETRIGMODE` **(USB-1208FS)**

When using `cbAInScan()/AInScan()`, you can use `RETRIGMODE` to set up repetitive trigger events.

Resolution

When configured for single-ended mode, the resolution of the data is 11 bits (data values between 0 and 2047). However, the Universal Library maps this data to 12-bit values, so the range of data is no different from the differential configuration. Consequently, the data returned contains only even numbers between 0 and 4094 when the `NOCALIBRATEDATA` option is used.

Continuous scans

When running `cbAInScan()` with the `CONTINUOUS` option, consider the packet size and the number of channels being scanned. To keep the data aligned properly in the array, make the total number of samples an integer multiple of the packet size and the number of channels in the scan.

Concurrent operations

USB-1208LS: Concurrent operations are not allowed. If you invoke a UL or UL for .NET function on a USB-1208LS while another function is running on that same unit, the `ALREADYACTIVE` error is returned.

USB-1208FS: The following table lists the concurrent operations supported by the USB-1208FS.

UL function/method	**Can be run with…**
`cbAOutScan()/AOutScan()` (`BACKGROUND` mode)	▪ `cbDOut()/DOut()` ▪ `cbCLoad()/CLoad()` ▪ `cbCLoad32()/CLoad32()`
`cbAInScan()/AInScan()` (`BACKGROUND` mode)	▪ `cbAOut()/AOut()` ▪ `cbDIn()/DIn()` ▪ `cbDBitIn()/DBitIn()` ▪ `cbDOut()/DOut()` ▪ `cbDBitOut()/DBitOut()` ▪ `cbDConfigPort()/DConfigPort()` ▪ `cbCIn()/CIn()` ▪ `cbCIn32()/CIn32()` ▪ `cbCLoad()/CLoad()` ▪ `cbCLoad32()/CLoad32()`

Channel-gain queue

USB-1208LS: When using `cbALoadQueue()/ALoadQueue()`, the channel gain queue is limited to eight elements.

USB-1208FS: When using `cbALoadQueue()/ALoadQueue()`, the channel gain queue is limited to 16 elements.

The queue accepts any combination of valid channels and gains in each element.

Analog output (USB-1208FS)

When you include both analog output channels in `cbAOutScan()/AOutScan()`, the two channels are updated simultaneously.

Miscellaneous functions and methods supported

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

Causes the LED on a USB device to blink.

When you have several USB devices connected to the computer, use these functions to identify a particular device by making its LED blink.

USB-1408FS

The USB-1408FS supports the following UL and UL for .NET features.

Analog input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbALoadQueue()`, `cbFileAInScan()`, `cbATrig()`
UL for .NET:	`AIn()`, `AInScan()`, `ALoadQueue()`, `FileAInScan()`, `ATrig()`

Analog input argument values

`Options` — `BACKGROUND`, `BLOCKIO`*, `CONTINUOUS`, `EXTCLOCK`, `EXTTRIGGER`, `NOCALIBRATEDATA`, `RETRIGMODE**`, and `SINGLEIO`

* USB-1408FS packet size based on `Options` settings are as follows:

Device	Options setting	Packet size
USB-1408FS	`BLOCKIO`	31
	`SINGLEIO`	1

`** RETRIGMODE can only be used with cbAInScan()/AInScan().`

`HighChan` — 0 to 7 in single-ended mode

0 to 3 in differential mode

`Count` — In `CONTINUOUS` mode, `Count` *must* be an integer multiple of the packet size.

`Rate` — 48 kHz maximum for `BLOCKIO` mode. The throughput is system dependent. Most systems will be able to achieve 40 kHz aggregate. Best results are obtained when using Windows XP or Windows Vista. When using `cbAInScan()` or `AInScan()` the minimum sample rate is 1 Hz.

`Range` — **Single-ended mode:**

`BIP10VOLTS`	(± 10 V)

Differential mode:

`BIP20VOLTS`	(± 20 V)	`BIP2PT5VOLTS`	(± 2.5 V)
`BIP10VOLTS`	(± 10 V)	`BIP2VOLTS`	(± 2 V)
`BIP5VOLTS`	(± 5 V)	`BIP1PT25VOLTS`	(± 1.25 V)
`BIP4VOLTS`	(± 4 V)	`BIP1VOLTS`	(± 1 V)

Pacing — Hardware pacing, internal clock supported.

External clock supported via the SYNC pin.

Triggering

Trigger functions and methods supported

UL:	`cbSetTrigger()`
UL for .NET:	`SetTrigger()`

Trigger argument values

`TrigType` — `TRIGPOSEDGE` and `TRIGNEGEDGE`

External digital (TTL) hardware triggering supported. Use the `Trig_In` input for the external trigger signal.

Analog output

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	`BACKGROUND`, `CONTINUOUS`
	The number of samples (`Count`) in a `CONTINUOUS` scan needs to be an integer multiple of the packet size (32).
`HighChan`	0 to 1
`Count`	The `Count` needs to be an integer multiple of the number of channels in the scan. In a `CONTINUOUS` scan, `Count` needs to be an integer multiple of the packet size (32).
`Rate`	Up to 10 kHz maximum for a single channel
	Up to 5 kHz maximum for two channels
	Performance varies when operating on systems other than Windows XP or Windows Vista.
`Range`	Ignored - Not programmable; fixedat `UNI4VOLTS` (0 to 4 V, nominal. Actual range is 0 to 4.096 V)
`DataValue`	0 to 4095

Digital I/O

Configuration functions, methods, and argument values supported

UL:	`cbDConfigPort()`
UL for .NET:	`DConfigPort()`
`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`

Port I/O functions, methods, and argument values supported

UL:	`cbDIn()`, `cbDOut()`
UL for .NET:	`DIn()`, `DOut()`
`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`
`DataValue`	0 to 255 for `FIRSTPORTA` or `FIRSTPORTB`

Bit I/O functions, methods, and argument values supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`FIRSTPORTA`
`BitNum`	0 to 15 on `FIRSTPORTA`

Counter I/O

Counter I/O functions and methods supported

UL:	`cbCIn()`*, `cbCIn32()`, `cbCLoad()`**, `cbCLoad32()`**
UL for .NET:	`CIn()`*, `CIn32()`, `CLoad()`**, `CLoad32()`**

*Although `cbCIn()` and `CIn()` are valid for use with this counter, `cbCIn32()` or `CIn32()` may be more appropriate, since the values returned may be greater than the data types used by `cbCIn()` and `CIn()` can handle.
**`cbCLoad()`, `cbCLoad32()`, `CLoad()` and `CLoad32()` only accept `Count`=0. These functions are used to reset the counter.

Counter I/O argument values

`CounterNum`	1
`Count`	2^{32}-1 when reading the counter. 0 when loading the counter. `cbCLoad()` and `cbCLoad32()` / `CLoad()` and `CLoad32()`are only used to reset the counter for this board to 0. No other values are valid. The "Basic signed integers" guidelines on page 134 apply when using `cbCIn()` or `CIn()` for values greater than 32767, and when using `cbCIn32()` or `CIn32()` for values greater than 2147483647.
`RegNum`	`LOADREG1`

Event notification

Event notification functions and methods supported

UL:	`cbEnableEvent()`, `cbDisableEvent()`
UL for .NET:	`EnableEvent()`, `DisableEvent()`
Event types:	`ON_SCAN_ERROR` (analog input), `ON_DATA_AVAILABLE`, `ON_END_OF_AI_SCAN`, `ON_END_OF_AO_SCAN` and `ON_SCAN_ERROR` (analog output)

Hardware considerations

Acquisition Rate

Since the maximum data acquisition rate depends on the system connected to the USB-1408FS, it is possible to "lose" data points when scanning at higher rates. The Universal Library cannot always detect this data loss.

Maximum rates may be lower in Windows operating systems that predate Windows XP. Most systems can sustain rates of 40 kS/s aggregate in `BLOCKIO` mode, and 1 kS/s aggregate in `SINGLEIO` mode.

`EXTCLOCK`

By default, the SYNC pin is configured for pacer output and provides the internal pacer A/D clock signal. To configure the pin for pacer input, use the `EXTCLOCK` option.

If you use the `EXTCLOCK` option, make sure that you disconnect from the external clock source when you test or calibrate the device with *Insta*Cal, as the SYNC pin drives the output.

`RETRIGMODE`

When using `cbAInScan()`/`AInScan()`, you can use `RETRIGMODE` to set up repetitive trigger events.

Resolution

When configured for single-ended mode, the resolution of the data is 13 bits (data values between 0 and 8191). However, the Universal Library maps this data to 14-bit values, so the range of data is no different from the differential configuration. Consequently, the data returned contains only even numbers between 0 and 16383 when the `NOCALIBRATEDATA` option is used.

Continuous scans

When running `cbAInScan()` with the `CONTINUOUS` option, consider the packet size and the number of channels being scanned. To keep the data aligned properly in the array, set the total number of samples to be an integer multiple of the packet size and the number of channels in the scan.

Concurrent operations

The following table lists the concurrent operations supported by the USB-1408FS.

UL function/method	Can be run with…
`cbAOutScan()/AOutScan()` (`BACKGROUND` mode)	▪ `cbDOut()/DOut()` ▪ `cbCLoad()/CLoad()` ▪ `cbCLoad32()/CLoad32()`
`cbAInScan()/AInScan()` (`BACKGROUND` mode)	▪ `cbAOut()/AOut()` ▪ `cbDIn()/DIn()` ▪ `cbDBitIn()/DBitIn()` ▪ `cbDOut()/DOut()` ▪ `cbDBitOut()/DBitOut()` ▪ `cbDConfigPort()/DConfigPort()` ▪ `cbCIn()/CIn()` ▪ `cbCIn32()/CIn32()` ▪ `cbCLoad()/CLoad()` ▪ `cbCLoad32()/CLoad32()`

Channel-gain queue

When using `cbALoadQueue()/ALoadQueue()`, the channel gain queue is limited to 16 elements. The queue accepts any combination of valid channels and gains in each element.

Analog output

When you include both analog output channels in `cbAOutScan()/AOutScan()`, the two channels are updated simultaneously.

Miscellaneous functions and methods supported

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

Causes the LED on a USB device to blink.

When you have several USB devices connected to the computer, use these functions to identify a particular device by making its LED blink.

USB-1608FS

The USB-1608FS supports the following UL and UL for .NET features:

Analog input

Analog input functions and methods supported

UL: `cbAIn()`, `cbAInScan()`, `cbALoadQueue()`*, `cbFileAInScan()`, `cbATrig()`

UL for .NET: `AIn()`, `AInScan()`, `ALoadQueue()`*, `FileAInScan()`, `ATrig()`

* The channel-gain queue is limited to eight elements. The USB-1608FS accepts only unique contiguous channels in each element, but the gains may be any valid value.

Analog input argument values

`Options` BACKGROUND, BLOCKIO*, SINGLEIO*, BURSTIO**, CONTINUOUS, EXTTRIGGER, CONVERTDATA, NOCALIBRATEDATA, and EXTCLOCK

*The packet size is based on the `Options` setting as follows:

Options setting	Packet size
BLOCKIO	31
SINGLEIO	Equals the number of channels being sampled.

** BURSTIO can only be used with the number of samples (`Count`) set equal to the size of the FIFO or less. The USB-1608FS FIFO holds 32,768 samples. BURSTIO cannot be used with the CONTINUOUS option.

Mode Single-ended

`HighChan` 0 to 7 in single-ended mode

`Count` In BURSTIO mode, `Count` *must* be an integer multiple of the number of channels in the scan.

- For one-, two- , four-, and eight-channel scans, the maximum `Count` is 32768 samples.
- For three- and six-channel scans, the maximum `Count` is 32766 samples.
- For five-channel scans, the maximum `Count` is 32765 samples.
- For seven-channel scans, the maximum `Count` is 32767 samples.

`Rate` 200 kHz maximum for BURSTIO mode (50 kHz for any one channel). The maximum rate is 100 kHz for all other modes (50 kHz for any one channel). When using `cbAInScan()` or `AInScan()`, the minimum sample rate is 1 Hz. In BURSTIO mode, the minimum sample rate is 20 Hz/channel.

`Range` BIP10VOLTS (± 10 V) BIP2VOLTS (± 2 V)

BIP5VOLTS (± 5 V) BIP1VOLTS (± 1 V)

`Pacing` Hardware pacing, internal clock supported. External clock supported via the SYNC pin.

Triggering

Trigger functions and methods supported

UL: `cbSetTrigger()`

UL for .NET: `SetTrigger()`

Trigger argument values

`TrigType`	Digital triggering: `TRIGPOSEDGE`, `TRIGNEGEDGE`. External digital (TTL) hardware triggering supported. Set the hardware trigger source with the `Trig_In` input.

Digital I/O

Configuration functions, methods, and argument values supported

UL:	`cbDConfigBit()`, `cbDConfigPort()`
UL for .NET:	`DConfigBit()`, `DConfigPort()`
`PortNum`	`AUXPORT`
`PortType`	`AUXPORT`

Port I/O functions, methods, and argument values supported

UL:	`cbDOut()`, `cbDIn()`
UL for .NET:	`DOut()`, `DIn()`
`PortNum`	`AUXPORT` (eight bits, bit-configurable)
`DataValue`	0 to 255 for `AUXPORT`

Bit I/O functions, methods, and argument values supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`AUXPORT`
`BitNum`	0 to 7 on `AUXPORT`

Counter I/O

Counter I/O functions and methods supported

UL:	`cbCIn()`*, `cbCIn32()`, `cbCLoad()`**, `cbCLoad32()`**
UL for .NET:	`CIn()`*, `CIn32()`, `CLoad()`**, `CLoad32()`**

*Although `cbCIn()` and `CIn()` are valid for use with this counter, `cbCIn32()` or `CIn32()` may be more appropriate, since the values returned may be greater than the data types used by `cbCIn()` and `CIn()` can handle.

**`cbCLoad()`, `cbCLoad32()`, `CLoad()` and `CLoad32()` only accept `Count`=0. These functions are used to reset the counter.

Counter I/O argument values

`CounterNum`	1
`Count`	2^{32}-1 when reading the counter.
`LoadValue`	0 when loading the counter.

`cbCLoad()` and `cbCLoad32()` / `CLoad()` and `CLoad32()` are only used to reset the counter for this board to 0. No other values are valid.

The “Basic signed integers” guidelines on page 134 apply when using `cbCIn()` or `CIn()` for values greater than 32767, and when using `cbCIn32()` or `CIn32()` for values greater than 2147483647.

`RegNum`	`LOADREG1`

Event notification

Even notification functions and methods supported

UL:	`cbEnableEvent()`, `cbDisableEvent()`
UL for .NET:	`EnableEvent()`, `DisableEvent()`
Event types:	`ON_SCAN_ERROR`, `ON_DATA_AVAILABLE`, `ON_END_OF_AI_SCAN`

Hardware considerations

Acquisition rate

Since the maximum data acquisition rate depends on the system connected to the device, it is possible to "lose" data points when scanning at higher rates. If the requested speed cannot be sustained, an `OVERRUN` error will occur.

Maximum rates may be lower in Windows operating systems that predate Windows XP.

Continuous scans

When running `cbAInScan()` with the `CONTINUOUS` option, you should consider the packet size and the number of channels being scanned. In order to keep the data aligned properly in the array, make the total number of samples an integer multiple of the packet size and the number of channels.

EXTCLOCK

You can set the **SYNC** pin on the USB-1608FS as a pacer input or a pacer output from *Insta*Cal. By default, this pin is set for pacer input. If set for output when using the `cbAInScan()`/`AInScan()` option, `EXTCLOCK` results in a `BADOPTION` error.

BURSTIO

`BURSTIO` mode allows higher sampling rates for sample counts up to the size of the FIFO. The USB-1608FS device's FIFO holds 32,768 samples. Data is collected into the device's local FIFO. Data transfers to the PC don't occur until the scan completes. For `BACKGROUND` scans, the `Count` and `Index` returned by `cbGetStatus()` and `GetStatus()` remain 0, and `Status=RUNNING` until the scan finishes. The `Count` and `Index` are not updated until the scan is completed. When the scan is complete and the data is retrieved, `cbGetStatus()` and `GetStatus()` are updated to the current `Count` and `Index`, and `Status` = `IDLE`.

`BURSTIO` is required for aggregate `Rate` settings above 100 kHz, but `Count` is limited to sample counts up to the size of the FIFO (32,768 samples). `Count` settings must be an integer multiple of the number of channels in the scan.

Miscellaneous functions and methods supported

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

Causes the LED on a USB device to blink. When you have several USB devices connected to the computer, use these functions to identify a particular device by making its LED blink.

USB-1608HS, USB-1608HS-2AO

The USB-1608HS and USB-1608HS-2AO support the following UL and UL for .NET features:

Analog input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbFileAInScan()`, `cbATrig()`, `cbALoadQueue()`*
UL for .NET:	`AIn()`, `AInScan()`, `FileAInScan()`, `ATrig()`, `ALoadQueue()`*

* The channel-gain queue is limited to eight elements. The USB-1608HS series accepts only unique contiguous channels in each element, but the gains may be any valid value.

Analog input argument values

`Options` — `BACKGROUND`, `BLOCKIO`*, `SINGLEIO`*, `CONTINUOUS`, `EXTTRIGGER`, `CONVERTDATA`, `NOCALIBRATEDATA`, `RETRIGMODE`, and `EXTCLOCK`

* The packet size is rate-dependent. The following table lists the aggregate rates and packet sizes when using `cbAInScan()`/`AInScan()` with devices connected to a high-speed USB 2.0 port:

Options setting	Aggregate rate	Packet size
`BLOCKIO`	<100 kHz	256 samples
	100 kHz to 200 kHz	512 samples
	200 kHz to 500 kHz	1024 samples
	500 kHz to 1 MHz	2048 samples
	> 1 MHz	4096 samples
`SINGLEIO`		Equals the number of channels being sampled.

Mode	Single-ended and differential
`HighChan`	0 to 7 in single-ended and differential mode
`Rate`	250 kHz per channel
`Range`	`BIP10VOLTS` (± 10 V) `BIP2VOLTS` (± 2 V)
	`BIP5VOLTS` (± 5 V) `BIP1VOLTS` (± 1 V)
`Pacing`	Hardware pacing, internal clock supported.
	External clock supported via the SYNC_IN pin.

Analog output (USB-1608HS-2AO only)

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options` — `BACKGROUND`, `CONTINUOUS`

`NONSTREAMEDIO` can only be used with the number of samples set equal to the size of the FIFO or less. The FIFO holds 524288 samples.

`HighChan`	0 to 1
`Rate`	70 kHz for one channel

	47 kHz for two channels
Range	BIP10VOLTS (±10 volts)
Packet size	512 samples
DataValue	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers).
Pacing	Hardware pacing, internal clock supported.

Triggering

Trigger functions and methods supported

UL:	cbSetTrigger()
UL for .NET:	SetTrigger()

Trigger argument values

TrigType	Analog triggering: TRIGABOVE, TRIGBELOW. Digital triggering: TRIGPOSEDGE, TRIGNEGEDGE, TRIGHIGH, TRIGLOW. External digital (TTL) hardware triggering supported. Set the hardware trigger source with the Trig_In input.
Threshold	0 to 65535 (BIP10VOLTS) (Hardware actually has 12 bit resolution, but the library uses a 16 bit value so that cbFromEngUnits() can be used to obtain the trigger value.)

Digital I/O

Configuration functions, methods, and argument values supported

UL:	cbDConfigPort()
UL for .NET:	DConfigPort()
PortNum	AUXPORT
PortType	AUXPORT

Port I/O functions, methods, and argument values supported

UL:	cbDOut(), cbDIn()
UL for .NET:	DOut(), DIn()
PortNum	AUXPORT
DataValue	0 to 255 for AUXPORT

Bit I/O functions, methods, and argument values supported

UL:	cbDBitIn(), cbDBitOut()
UL for .NET:	DBitIn(), DBitOut()
PortType	AUXPORT
BitNum	0 to 7 on AUXPORT

Counter I/O

Counter I/O functions and methods supported

UL:	cbCIn()*, cbCIn32(), cbCLoad()**, cbCLoad32()**
UL for .NET:	CIn()*, CIn32(), CLoad()**, CLoad32()**

*Although `cbCIn()` and `CIn()` are valid for use with this counter, `cbCIn32()` or `CIn32()` may be more appropriate, since the values returned may be greater than the data types used by `cbCIn()` and `CIn()` can handle.

**`cbCLoad()`, `cbCLoad32()`, `CLoad()` and `CLoad32()` only accept `Count`=0. These functions are used to reset the counter.

Counter I/O argument values

`CounterNum`	1
`Count`	2^{32}-1 when reading the counter.
`LoadValue`	0 when loading the counter. `cbCLoad()` and `cbCLoad32()` / `CLoad()` and `CLoad32()` are only used to reset the counter for this board to 0. No other values are valid. The "Basic signed integers" guidelines on page 134 apply when using `cbCIn()` or `CIn()` for values greater than 32767, and when using `cbCIn32()` or `CIn32()` for values greater than 2147483647.
`RegNum`	`LOADREG1`

Configuration

Configuration functions and methods supported

UL:	`cbGetConfig()`, `cbSetConfig()`, `cbGetConfigString()`, `cbSetConfigString()`
ConfigItem:	`BIADTRIGCOUNT`, `BINODEID`
Device Number:	0
`maxConfigLen`:	At least 64 for `BINODEID`

Event notification

Even notification functions and methods supported

UL:	`cbEnableEvent()`, `cbDisableEvent()`
UL for .NET:	`EnableEvent()`, `DisableEvent()`
Event types:	`ON_SCAN_ERROR`, `ON_DATA_AVAILABLE`, `ON_END_OF_AI_SCAN`

Hardware considerations

Acquisition rate

Since the maximum data acquisition rate depends on the system connected to the device, it is possible to "lose" data points when scanning at higher rates. If the requested speed cannot be sustained, an `OVERRUN` error will occur.

Maximum rates may be lower in Windows operating systems that predate Windows XP.

Continuous scans

When running `cbAInScan()` with the `CONTINUOUS` option, you should consider the packet size and the number of channels being scanned. In order to keep the data aligned properly in the array, make the total number of samples an integer multiple of the packet size and the number of channels.

Device identifier

You can enter up to 64 characters for the value of the device's text identifier using the `ConfigItem` option `BINODEID` with `cbSetConfigString()`.

Output scan restriction

You cannot access `cbSetTrigger()`/`SetTrigger()` or call `BINODEID` while an analog output scan is in progress.

Analog triggering

When using `cbAInScan()`/`AInScan()` with `EXTTRIGGER`, the value entered to `cbSetTrigger()` threshold arguments for analog trigger modes should be a 16 bit value. The resolution of the circuitry is actually 12 bits, but the library uses a 16 bit value so that `cbFromEngUnits()` can be used to obtain the trigger value.

Retriggering

When using `cbAInScan()`/`AInScan()`, you can use `RETRIGMODE` to set up repetitive trigger events. When using `RETRIGMODE`, it is best to set the values for the `Count` argument (`cbAInScan()`/`AInScan()`) and the `BIADTRIGCOUNT` argument (`cbSetConfig()`/`SetAdRetrigCount()`) to an integer multiple of the packet size (and the number of channels if using `CONTINUOUS`). That way, the entire buffer, or the portion of the buffer defined by `BIADTRIGCOUNT`, will contain updated data.

Remote sensing (USB-1608HS-2AO)

You can enable remote sensing for each of the two analog outputs on the USB-1608HS-2AO with *Insta*Cal. The remote sensing feature compensates for the voltage drop error that occurs in applications where the USB-1608HS-2AO's analog outputs are connected to its load through a long wire or cable type interconnect.

The remote sensing feature can compensate for I*R induced voltage losses up to 750 mV, and for any series resistance up to 75 Ω between its remote sensing terminal pins and its output load.

- To configure the remote sensing connection, connect two separate output wires — one from the VDACn_F (force) output terminal, and one from the VDACn_S (sense) output terminal — to the high side or positive input terminal of the field device (load).
- If you are not using the remote sensing feature, simply connect a single output wire or cable from the VDACn_F (force) output terminal to the load, and leave the VDACn_S (sense) terminal unconnected.

Refer to the *USB-1608HS-2AO User's Guide* for more information about remote sensing.

Miscellaneous functions and methods supported

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

Causes the LED on a USB device to blink. When you have several USB devices connected to the computer, use these functions to identify a particular device by making its LED blink.

USB-1616FS

The USB-1616FS supports the following UL and UL for .NET features.

Analog input

Analog input functions and methods supported

UL: `cbAIn()`, `cbAInScan()`, `cbALoadQueue()`*, `cbFileAInScan()`, `cbATrig()`

UL for .NET: `AIn()`, `AInScan()`, `ALoadQueue()`*, `FileAInScan()`, `ATrig()`

*The channel-gain queue is limited to 16 elements. The USB-1616FS accepts only unique contiguous channels in each element, but the gains may be any valid value.

Analog input argument values

`Options`: `BACKGROUND`, `BLOCKIO`**, `BURSTIO`***, `CONTINUOUS`, `EXTTRIGGER`, `SINGLEIO`**, and `EXTCLOCK`

**USB-1616 Series packet size based on `Options` settings

Device	Options setting	Packet size
USB-1616FS	`BLOCKIO`	62
	`SINGLEIO`	Equals the number of channels being sampled.

*** `BURSTIO` can only be used with the number of samples (`Count`) set equal to the size of the FIFO or less. The USB-1616FS FIFO holds 32,768 samples. Also, `BURSTIO` cannot be used with the `CONTINUOUS` option.

`HighChan` 0 to 15 in single-ended mode

`Count` In `BURSTIO` mode, `Count` needs to be an integer multiple of the number of channels in the scan.

- For one-, two- , four-, eight-, and 16-channel scans, the maximum `Count` is 32768 samples.
- For three- and six-channel scans, the maximum `Count` is 32766 samples
- For five-channel scans, the maximum `Count` is 32765 samples
- For seven-channel scans, the maximum `Count` is 32767 samples
- For 9-, 10-, 12-, 13-, 14-, and 15-channel scans, the maximum `Count` is 32760 samples
- For 11-channel scans, the maximum `Count` is 32758 samples.

`Rate`: 200 kilohertz (kHz) maximum for `BURSTIO` mode (50 kHz for any one channel). For all other modes, the maximum rate per channel depends on the number of channels being scanned.

No. of channels in the scan	Maximum rate
1 or 2	50 kHz
3	36 kHz
4	30 kHz
5	25 kHz
6	22 kHz
7	19 kHz
8	17 kHz
9	15 kHz

No. of channels in the scan	Maximum rate
10	14 kHz
11	12.5 kHz
12	12 kHz
13	11.25 kHz
14	10.5 kHz
15	10 kHz
16	9.5 kHz

When using `cbAInScan()` or `AInScan()`, the minimum sample rate is 1 Hz. In `BURSTIO` mode, the minimum sample rate is 20 Hz/channel.

`Range`:	Single-ended:	
	`BIP10VOLTS` (± 10 volts)	`BIP5VOLTS` (± 5 volts)
	`BIP2VOLTS` (± 2 volts)	`BIP1VOLTS` (± 1 volt)
Pacing:	Hardware pacing, internal clock supported.	
	External clock supported via the SYNC pin.	

Triggering

Triggering functions and methods supported

UL:	`cbSetTrigger()`
UL for .NET:	`SetTrigger()`

Trigger argument values

`TrigType`:	`TRIGPOSEDGE`, `TRIGNEGEDGE`
	External digital (TTL) hardware triggering supported. You set the hardware trigger source with the TRIG_IN input terminal.

Digital I/O

Configuration functions, methods, and argument values supported

UL:	`cbDConfigBit()`, `cbDConfigPort()`
UL for .NET:	`DConfigBit()`, `DConfigPort()`
`PortNum`	`AUXPORT`
`PortType`	`AUXPORT`

Port I/O functions, methods, and argument values supported

UL:	`cbDOut()`, `cbDIn()`
UL for .NET:	`DOut()`, `DIn()`
`PortNum`	`AUXPORT`
`DataValue`	0 to 255 for `AUXPORT`

Bit I/O functions, methods, and argument values supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`AUXPORT`
`BitNum`	0 to 7 on `AUXPORT`

Counter I/O

Counter I/O functions and methods supported

UL:	`cbCIn()`*, `cbCIn32()`, `cbCLoad()`**, `cbCLoad32()`**
UL for .NET:	`CIn()`*, `CIn32()`, `CLoad()`**, `CLoad32()`** *
	Although `cbCIn()` and `CIn()` are valid for use with this counter, `cbCIn32()` or `CIn32()` may be more appropriate, since the values returned may be greater than the data types used by `cbCIn()` and `CIn()` can handle. **`cbCLoad()`, `cbCLoad32()`, `CLoad()` and `CLoad32()` only accept `Count`=0. These functions are used to reset the counter.

Counter I/O argument values

`CounterNum`:	1
`Count`	2^{32}-1 when reading the counter.
	0 when loading the counter.
	`cbCLoad()` and `cbCLoad32()` / `CLoad()` and `CLoad32()`are only used to reset the counter for this board to 0. No other values are valid.

The "Basic signed integers" guidelines on page 134 apply when using `cbCIn()` or `CIn()` for values greater than 32767, and when using `cbCIn32()` or `CIn32()` for values greater than 2147483647.

Event notification

Even notification functions and methods supported

UL:	`cbEnableEvent()`, `cbDisableEvent()`
UL for .NET:	`EnableEvent()`, `DisableEvent()`
Event types:	`ON_SCAN_ERROR`, `ON_DATA_AVAILABLE`, `ON_END_OF_AI_SCAN`

Hardware considerations

Acquisition rate

Since the maximum data acquisition rate depends on the system connected to the USB-1616FS, it is possible to "lose" data points when scanning at higher rates. The Universal Library cannot always detect this data loss. Maximum rates may be lower in Windows operating systems that predate Windows XP. Most systems can sustain rates of 80 kS/s aggregate. If you need to sample at higher rates than this, consider using the `BURSTIO` option explained later in this topic.

`EXTCLOCK`

You can set the SYNC pin as a pacer input or a pacer output from *Insta*Cal. By default, this pin is set for pacer input. If set for output, using the `cbAInScan()`/`AInScan()` option `EXTCLOCK` results in a `BADOPTION` error.

`BURSTIO`

Allows higher sampling rates up to the size of the FIFO. The USB-1616FS FIFO holds 32,768 samples. Data is collected into the USB device's local FIFO. Data transfers to the PC don't occur until the scan completes. For `BACKGROUND` scans, the `Count` and `Index` returned by cb`GetStatus`() and `GetStatus()` remain 0, and STATUS=RUNNING until the scan finishes. The `Count` and `Index` are not updated until the scan is completed. When the scan is complete and the data is retrieved, `cbGetStatus()` and `GetStatus()` are updated to the current `Count` and `Index`, and STATUS=IDLE.

`BURSTIO` is required for aggregate `Rate` settings above 100 kHz, but `Count` is limited to sample counts up to the size of the FIFO (32,768 samples). `Count` settings must be an integer multiple of the number of channels in the scan (see `Count` above).

Continuous scans

When running `cbAInScan()`/`AInScan()` with the `CONTINUOUS` option, you should consider the packet size and the number of channels being scanned. In order to keep the data aligned properly in the array, make the total number of samples an integer multiple of the packet size and the number of channels.

When running `cbAInScan()`/`AInScan()` with the `CONTINUOUS` option, you must set the count to an integer multiple of the packet size (62) and the number of channels in the scan.

Miscellaneous functions and methods supported

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

Causes the USB LED on a Measurement Computing USB module to blink.

When you have several modules connected to the computer, use these functions to identify a particular module by making its LED blink.

USB-1616HS Series

The USB-1616HS Series includes the USB-1616HS, USB-1616HS-2, and USB-1616HS-4.

Analog input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbALoadQueue()`, `cbFileAInScan()`, `cbATrig()`, `cbAPretrig()*`
UL for .NET:	`AIn()`, `AInScan()`, `ALoadQueue()`, `FileAInScan()`, `ATrig`, `APretrig()*`
	* Pretrigger capability is implemented in software. `PretrigCount` must be less than the `TotalCount` and cannot exceed 100000 samples. `TotalCount` must be greater than the `PretrigCount`. If a trigger occurs while the number of collected samples is less than the `PretrigCount`, that trigger will be ignored. Requires a call to `cbSetTrigger` (`SetTrigger`) for the analog trigger type.

Analog input argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `CONVERTDATA`, `DMAIO`, `BLOCKIO`, `EXTTRIGGER*`
	* With `EXTTRIGGER` mode, the first channel in the scan is the analog trigger channel.
`HighChan`	0 to 15 in single-ended mode, 0 to 7 in differential mode. (0 to 63 single-ended, 0 to 31 differential if the AI-EXP48 expansion board is installed.)
`Rate`	Up to 1 MHz
`Range`	`BIP10VOLTS` (± 10 V)
	`BIP5VOLTS` (± 5 V)
	`BIP2VOLTS` (± 2 V)
	`BIP1VOLTS` (± 1 V)
	`BIPPT5VOLTS` (± 0.5 V)
	`BIPPT2VOLTS` (± 0.2 V)
	`BIPPT1VOLTS` (± 0.1 V)

Analog output (USB-1616HS-4 and USB-1616HS-2 only)

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `SIMULTANEOUS`, `NONSTREAMEDIO`, `ADCCLOCKTRIG`, `ADCCLOCK`
	`NONSTREAMEDIO` can only be used with the number of samples set equal to the size of the FIFO or less. The FIFO holds 524288 samples.
`HighChan`	USB-1616HS-4: 0 to 3 USB-1616HS-2: 0 to 1
`Rate`	1 MHz
`Range`	Ignored - Not programmable; fixed at `BIP10VOLTS` (±10 volts)
`DataValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers).
`Pacing`	Hardware pacing, external or internal clock supported.

Digital I/O

Configuration functions, methods, and argument values supported

UL:	`cbDConfigPort()`
UL for .NET:	`DConfigPort()`
`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTC`

Port I/O functions, methods, and argument values supported

UL:	`cbDIn()`, `cbDOut()`, `cbDInScan()`, `cbDOutScan()`*
UL for .NET:	`DIn()`, `DOut()`, `DInScan()`, `DOutScan()`*
	*`FIRSTPORTA` and `FIRSTPORTB` must be set for output to use this function. Refer to *DIO PortNum* on page 113 for more information.
`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `EXTTRIGGER`, `WORDXFER`, `NONSTREAMEDIO`, `ADCCLOCKTRIG`, `ADCCLOCK`
	The `EXTTRIGGER` option can only be used with the `cbDInScan()` function. You can use the `cbSetTrigger()` function to program the trigger for rising edge, falling edge, or the level of the digital trigger input (TTL).
	The `WORDXFER` option can only be used with `FIRSTPORTA`.
	The `NONSTREAMEDIO`, `ADCCLOCKTRIG`, and `ADCCLOCK` options can only be used with the `cbDOutScan()` function.
	The `NONSTREAMEDIO` option can only be used with the number of samples set equal to the size of the FIFO or less. The FIFO holds 524288 samples.
`Rate`	12 MHz
`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTC`
`DataValue`	0 to 255
	0 to 65535 using the `WORDXFER` option with `FIRSTPORTA`

Bit I/O functions, methods, and argument values supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`FIRSTPORTA`
`BitNum`	0 to 23

Counter input

Counter functions and methods supported

UL:	`cbCIn()`, `cbCIn32()`, `cbCConfigScan()`, `cbCInScan()`, `cbCClear()`
UL for .NET:	`CIn()`, `CIn32()`, `CConfigScan()`, `CInScan()`, `CClear()`

Note: Counters on these devices are zero-based (the first counter number is "0").

Counter argument values

`Rate`	6 MHz
`CounterNum`	0 to 3
`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTTRIGGER`

	You can use the `cbSetTrigger()` function to program the trigger for rising edge, falling edge, or the level of the digital trigger input (TTL).
`LoadValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)

Timer output

Timer functions and methods supported

UL:	`cbTimerOutStart()`, `cbTimerOutStop()`
UL for .NET:	`TimerOutStart()`, `TimerOutStop()`

Timer argument values

`TimerNum`	0 to 1
`Frequency`	15.260 Hz to 1.0 MHz

Triggering

Trigger functions and methods supported

UL:	`cbSetTrigger()`
UL for .NET:	`SetTrigger()`

Trigger argument values

`TrigType`	TRIGABOVE, TRIGBELOW, TRIGHIGH, TRIGLOW, TRIGPOSEDGE, TRIGNEGEDGE Digital triggering (TRIGHIGH, TRIGLOW, TRIGPOSEDGE, TRIGNEGEDGE) is not supported for pre-trigger acquisitions (`cbAPretrig()` function). Analog triggering (TRIGABOVE, TRIGBELOW) is not supported for the `cbDInScan()` function and the `cbCInScan()` function.
`Threshold`	Analog hardware triggering, 12-bit resolution: 0 to 4095 (supported for `cbAInScan()` only) Analog software triggering, 16-bit resolution: 0 to 65535 (supported for `cbAPretrig()` only)

Temperature input

Temperature input functions and methods supported

UL:	`cbTIn()`, `cbTInScan()`, `cbGetTCValues()`
UL for .NET:	`TIn()`, `TInScan()`, `GetTCValues()`

Temperature input argument values

`Options`	NOFILTER
`Scale`	CELSIUS, FAHRENHEIT, KELVIN
`HighChan`	0 to 7 (0 to 31 if the AI-EXP48 expansion board is installed.)

DAQ input

DAQ input functions and methods supported

UL:	`cbDaqInScan()`
UL for .NET:	`DaqInScan()`

DAQ input argument values

`Options`	BACKGROUND, CONTINUOUS, EXTCLOCK, CONVERTDATA, DMAIO, BLOCKIO, EXTTRIGGER

ChanTypeArray	ANALOG, DIGITAL8, DIGITAL16, CTR16, CTR32LOW, CTR32HIGH, CJC, TC, SETPOINTSTATUS	
	Note: for information on associating CJC channels with TC channels, refer to Hardware considerations on page 112.	
ChanArray	ANALOG:	0 to 15 in single-ended mode, 0 to 7 in differential mode (0 to 63 single-ended, 0 to 31 differential if the AI-EXP48 expansion board is installed.)
	DIGITAL8:	FIRSTPORTA, FIRSTPORTB, FIRSTPORTC
	DIGITAL16:	FIRSTPORTA
	CTR16:	0-3 counters
	CTR32LOW:	0-3 counters
	CTR32HIGH:	0-3 counters
	CJC:	0 to 5 (0 to 11 if the AI-EXP48 expansion board is installed.)
	TC:	0 to 7 (0 to 31 if the AI-EXP48 expansion board is installed.)
	SETPOINTSTATUS: 16-bit port that indicates the current state of the 16 possible setpoints.	
	ChanTypeArray flag value:	
	SETPOINT_ENABLE: Enables a setpoint. Refer to Hardware considerations on page 112 for more information.	
Rate	Analog:	Up to 1 MHz
	Digital:	Up to 12 MHz if no analog channel is selected. Otherwise up to 1 MHz.
	Counter:	Up to 12 MHz if no analog channel is selected. Otherwise up to 1 MHz.
GainArray	ANALOG only; ignore for other ChanTypeArray values.	
	BIP10VOLTS	(± 10 V)
	BIP5VOLTS	(± 5 V)
	BIP2VOLTS	(± 2 V)
	BIP1VOLTS	(± 1 V)
	BIPPT5VOLTS	(± 0.5 V)
	BIPPT2VOLTS	(± 0.2 V)
	BIPPT1VOLT	(± 0.1 V)
PreTrigCount	100000 max	

DAQ triggering

DAQ trigger functions and methods supported

UL:	`cbDaqSetTrigger()`
UL for .NET:	`DaqSetTrigger()`

DAQ trigger argument values

TrigSource	TRIG_IMMEDIATE, TRIG_EXTTTL, TRIG_ANALOGHW, TRIG_ ANALOGSW, TRIG_DIGPATTERN, TRIG_COUNTER, TRIG_SCANCOUNT
TrigSense	RISING_EDGE, FALLING_EDGE, ABOVE_LEVEL, BELOW_LEVEL, EQ_LEVEL, NE_LEVEL

`TrigEvent`	`START_EVENT`, `STOP_EVENT`

DAQ setpoint

DAQ setpoint functions and methods supported

UL:	`cbDaqSetSetpoints()`
UL for .NET:	`DaqSetSetpoints()`

DAQ setpoint argument values

`SetpointFlagsArray`	`SF_EQUAL_LIMITA`, `SF_LESSTHAN_LIMITA`, `SF_GREATERTHAN_LIMITB`, `SF_OUTSIDE_LIMITS`, `SF_HYSTERESIS`, `SF_UPDATEON_TRUEONLY`, `SF_UPDATEON_TRUEANDFALSE`

`SetpointOutputArray`	`SO_NONE`, `SO_FIRSTPORTC`, `SO_TMR0`, `SO_TMR1`
	also available for USB-1616HS-2:
	`SO_DAC0`, `SO_DAC1`
	also available for USB-1616HS-4:
	`SO_DAC0`, `SO_DAC1`, `SO_DAC2`, `SO_DAC3`

`LimitAArray`	Any value valid for the associated input channel Ignored for `SF_GREATERTHAN_LIMITB`
`LimitBArray`	Any value valid for the associated input channel and less than LimitA Ignored for `SF_EQUAL_LIMITA`, `SF_LESSTHAN_LIMITA`
`Output#Array`	For `SetpointOutputArray` = `SO_NONE`: Ignored For `SetpointOutputArray` = `SO_FIRSTPORTC`: 0 to 65535 For `SetpointOutputArray` = `SO_TMR#`: 0 (to disable timer) or 15.26 to 1000000 (to set output frequency) For `SetpointOutputArray` = `SO_DAC#`: Voltage values between -10 and +10
`OutputMask#Array`	For `SetpointOutputArray` = `SO_FIRSTPORTC`: 0 to 65535 For `SetpointOutputArray` = all other values: Ignored
`SetpointCount`	0 (to disable setpoints) to 16

DAQ output (USB-1616HS-4 and USB-1616HS-2 only)

DAQ output functions and methods supported

UL:	`cbDaqOutScan()`
UL for .NET:	`DaqOutScan()`

DAQ output argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `SIMULTANEOUS`, `NONSTREAMEDIO`, `ADCCLOCKTRIG`, `ADCCLOCK`
`ChanType`	`ANALOG`, `DIGITAL16`

`ChanArray`	`ANALOG`:	USB-1616HS-4: 0 to 3 USB-1616HS-2: 0 to 1
	`DIGITAL16`:	`FIRSTPORTA` (`FIRSTPORTB` must be configured as an output)
`Rate`	`ANALOG`:	Up to 1 MHz
	`DIGITAL16`:	Up to 12 MHz (system-dependent) if no analog channel is selected. Otherwise up to 1 MHz.
`Range`	`BIP10VOLTS`	(± 10 V)

Hardware considerations

Associating CJC channels with TC channels

The TC channels must immediately follow their associated CJC channels in the channel array. For accurate thermocouple readings, associate CJC channels with the TC channels as listed in the following table:

CJC channels	**TC channels**
CJC0	TC0
CJC1	TC1 and TC2
CJC2	TC3
CJC3	TC4
CJC4	TC5 and TC6
CJC5	TC7
When the AI-EXP48 board is installed:	
CJC6	TC8 through TC11
CJC7	TC12 through TC15
CJC8	TC16 through TC19
CJC9	TC20 through TC23
CJC10	TC24 through TC27
CJC11	TC28 through TC31

The board must be configured for differential inputs when using thermocouples

TC inputs are supported by differential mode configuration only.

Channel count

For input and output scans, the count must be set to an integer multiple of the number of channels or a `BADCOUNT` error is returned.

Sampling and update rates

Sampling and update rates are system-dependent. Data overruns/underruns may occur with higher sampling rates when using `BACKGROUND` and `CONTINUOUS` modes. To avoid this, use a larger buffer/count size, or use `NONSTREAMEDIO` mode, if supported. The minimum size buffer is 256 for `cbAOutScan()`. Values less than that result in a `BADBUFFERSIZE` error.

Settling time

For most applications, settling time should be left at the default value of 1 µs. However, if you are scanning multiple channels and one or more channels are connected to a high impedance source, you may get better results by increasing the settling time. Keep in mind that increasing the settling time reduces the maximum acquisition rate. You can set the time between A/D conversions with the ADC Settling Time option in *Insta*Cal. Select between 1 µs, 5 µs, 10 µs, or 1 ms.

Setpoints

You enable setpoints with the `SETPOINT_ENABLE` flag. This flag must be OR'ed with the `ChanTypeArray` argument values. You set the setpoint criteria with `cbDaqSetSetpoints()/DaqSetSetpoints()`. The number of channels set with the `SETPOINT_ENABLE` flag must match the number of setpoints set by the `SetpointCount` argument (`cbDaqSetSetpoints()/DaqSetSetpoints()`).

Output non-streamed data to a DAC output channel

With `NONSTREAMEDIO` mode, you can output non-streamed data to a specific DAC output channel. The aggregate size of the data output buffer must be less than or equal to the size of the internal data output FIFO in the device. The FIFO holds 524288 samples. This allows the data output buffer to be loaded into the device's internal output FIFO. Once the sample updates are transferred or downloaded to the device, the device is responsible for outputting the data. You can't change the output buffer once the output begins.

Trigger DAC output operations with the ADC clock

Specify the `ADCCLOCKTRIG` option to trigger a data output operation upon the start of the ADC clock.

DIO PortNum

`For cbDOutScan()/DOutScan()` and `cbDaqOutScan()/DaqOutScan()`, `FIRSTPORTA` and `FIRSTPORTB` are treated as one 16-bit port. These functions can only be used with `FIRSTPORTA`. You must configure both `FIRSTPORTA` and `FIRSTPORTB` for output using the `cbDConfigPort()` function.

Synchronous scanning with multiple boards

You can operate up to four USB-1616HS Series boards synchronously by setting the direction of the A/D and D/A pacer pins (**APR** or **DPR**) in *Insta*Cal.

On the board used to pace each device, set the pacer pin that you want to use (APR or DPR) for *Output*. On the board(s) that you want to synchronize with this board, set the pacer pin that you want to use (APR or DPR) for *Input*.

You set the direction using the *Insta*Cal configuration dialog's **APR Pin Direction** and **DPR Pin Direction** settings

Wire the pacer pin configured for output to each of the pacer input pins that you want to synchronize.

Quadrature encoder operations

To configure a counter channel as a multi-axis quadrature encoder, use the `cbCConfigScan()/CConfigScan()` `Mode` argument values to set a specified counter to encoder mode, set the encoder measurement mode to X1, X2, or X4, and then set the count to be latched either by the internal "start of scan" signal (default) or by the signal on the mapped counter.

You can optionally perform the following operations:

- Enable gating, so that the counter is enabled when the mapped channel to gate the counter is high. When the mapped channel is low, the counter is disabled but holds the count value.
- Enable "latch on Z" to latch counter outputs using the Encoder Z mapped signal.
- Enable "clear on Z" so that the counter is cleared on the rising edge of the mapped (Z) counter. By default, clear on Z" is disabled, and the counter is not cleared.

USB-2500 Series

The USB-2500 Series includes the USB-2523, USB-2527, USB-2533, and USB-2537 devices.

Analog input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbALoadQueue()`, `cbFileAInScan()`, `cbATrig()`, `cbAPretrig()`*
UL for .NET:	`AIn()`, `AInScan()`, `ALoadQueue()`, `FileAInScan()`, `ATrig()`, `APretrig()`*
	* Pretrigger capability is implemented in software. `PretrigCount` must be less than the `TotalCount` and cannot exceed 100000 samples. `TotalCount` must be greater than the `PretrigCount`. If a trigger occurs while the number of collected samples is less than the `PretrigCount`, that trigger will be ignored. Requires a call to `cbSetTrigger` (`SetTrigger`) for the analog trigger type.

Analog input argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `CONVERTDATA`, `DMAIO`, `BLOCKIO`, `EXTTRIGGER`	
	With `EXTTRIGGER` mode, the first channel in the scan is the analog trigger channel.	
`HighChan`	**USB-2537**, **USB-2533**:	
	0 to 63 in single-ended mode, 0 to 31 in differential mode	
	USB-2527, **USB-2523**:	
	0 to 15 in single-ended mode, 0 to 7 in differential mode	
`Rate`	Up to 1 MHz	
`Range`	`BIP10VOLTS`	(± 10 V)
	`BIP5VOLTS`	(± 5 V)
	`BIP2VOLTS`	(± 2 V)
	`BIP1VOLTS`	(± 1 V)
	`BIPPT5VOLTS`	(± 0.5 V)
	`BIPPT2VOLTS`	(± 0.2 V)
	`BIPPT1VOLTS`	(± 0.1 V)

Analog output (USB-2537 and USB-2527 only)

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `SIMULTANEOUS`, `NONSTREAMEDIO`, `ADCCLOCKTRIG`, `ADCCLOCK`
	`NONSTREAMEDIO` can only be used with the number of samples set equal to the size of the FIFO or less. The FIFO holds 524288 samples.
`HighChan`	0 to 3
`Rate`	1 MHz
`Range`	Ignored - Not programmable; fixed at `BIP10VOLTS` (±10 volts)
`DataValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers).

`Pacing`	Hardware pacing, external or internal clock supported.

Digital I/O

Configuration functions, methods, and argument values supported

UL:	`cbDConfigPort()`
UL for .NET:	`DConfigPort()`
`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTC`

Port **I/O functions, methods, and argument values supported**

UL:	`cbDIn()`, `cbDOut()`, `cbDInScan()`, `cbDOutScan()`*
UL for .NET:	`DIn()`, `DOut()`, `DInScan()`, `DOutScan()`*
	*`FIRSTPORTA` and `FIRSTPORTB` must be set for output to use this function. Refer to *DIO PortNum* on page 120 for more information.
`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `EXTTRIGGER`, `WORDXFER`, `NONSTREAMEDIO`, `ADCCLOCKTRIG`, `ADCCLOCK`
	The `EXTTRIGGER` option can only be used with the `cbDInScan()` function. You can use the `cbSetTrigger()` function to program the trigger for rising edge, falling edge, or the level of the digital trigger input (TTL).
	The `WORDXFER` option can only be used with `FIRSTPORTA`.
	The `NONSTREAMEDIO`, `ADCCLOCKTRIG`, and `ADCCLOCK` options can only be used with the `cbDOutScan()` function.
	The `NONSTREAMEDIO` option can only be used with the number of samples set equal to the size of the FIFO or less. The FIFO holds 524288 samples.
`Rate`	12 MHz
`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTC`
`DataValue`	0 to 255
	0 to 65535 using the `WORDXFER` option with `FIRSTPORTA`

Bit **I/O functions, methods, and argument values supported**

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`FIRSTPORTA`
`BitNum`	0 to 23

Counter input

Counter functions and methods supported

UL:	`cbCIn()`, `cbCIn32()`, `cbCConfigScan()`, `cbCInScan()`, `cbCClear()`
UL for .NET:	`CIn()`, `CIn32()`, `CConfigScan()`, `CInScan()`, `CClear()`

Note: Counters on these devices are zero-based (the first counter number is "0").

Counter argument values

`Rate`	6 MHz
`CounterNum`	0 to 3
`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTTRIGGER`

	You can use the `cbSetTrigger()` function to program the trigger for rising edge, falling edge, or the level of the digital trigger input (TTL).
`LoadValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)

Timer output

Timer functions and methods supported

UL:	`cbTimerOutStart()`, `cbTimerOutStop()`
UL for .NET:	`TimerOutStart()`, `TimerOutStop()`

Timer argument values

`TimerNum`	0 to 1
`Frequency`	15.260 Hz to 1.0 MHz

Triggering

Trigger functions and methods supported

UL:	`cbSetTrigger()`
UL for .NET:	`SetTrigger()`

Trigger argument values

`TrigType`	`TRIGABOVE`, `TRIGBELOW`, `TRIGHIGH`, `TRIGLOW`, `TRIGPOSEDGE`, `TRIGNEGEDGE`
	Digital triggering (`TRIGHIGH`, `TRIGLOW`, `TRIGPOSEDGE`, `TRIGNEGEDGE`) is not supported for pre-trigger acquisitions (`cbAPretrig()` function). Analog triggering (`TRIGABOVE`, `TRIGBELOW`) is not supported for the `cbDInScan()` function and the `cbCInScan()` function.
`Threshold`	Analog hardware triggering, 12-bit resolution: 0 to 4095 (supported for `cbAInScan()` only)
	Analog software triggering, 16-bit resolution: 0 to 65535 (supported for `cbAPretrig()` only)

Temperature input

Temperature input functions and methods supported

UL:	`cbTIn()`, `cbTInScan()`, `cbGetTCValues()`
UL for .NET:	`TIn()`, `TInScan()`, `GetTCValues()`

Temperature input argument values

`Options`	`NOFILTER`
`Scale`	`CELSIUS`, `FAHRENHEIT`, `KELVIN`
`HighChan`	0 to 3

DAQ input

DAQ input functions and methods supported

UL:	`cbDaqInScan()`
UL for .NET:	`DaqInScan()`

DAQ input argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `CONVERTDATA`, `DMAIO`, `BLOCKIO`, `EXTTRIGGER`

`ChanTypeArray`	`ANALOG`, `DIGITAL8`, `DIGITAL16`, `CTR16`, `CTR32LOW`, `CTR32HIGH`, `CJC`, `TC`, `SETPOINTSTATUS`	
	Note: for information on associating CJC channels with TC channels, refer to Hardware considerations on page 119.	
`ChanArray`	`ANALOG`:	**USB-2537**, **USB-2533**: 0 to 63 in single-ended mode, 0 to 31 in differential mode
		USB-2527, **USB-2523**: 0 to 15 in single-ended mode, 0 to 7 in differential mode
	`DIGITAL8`:	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTC`
	`DIGITAL16`:	`FIRSTPORTA`
	`CTR16`:	0-3 counters
	`CTR32LOW`:	0-3 counters
	`CTR32HIGH`:	0-3 counters
	`CJC`:	0 to 2
	`TC`:	0 to 3
	`SETPOINTSTATUS`: 16-bit port that indicates the current state of the 16 possible setpoints.	
	`ChanTypeArray` flag value:	
	`SETPOINT_ENABLE`: Enables a setpoint. Refer to Hardware considerations on page 119 for more information.	
`Rate`	Analog:	Up to 1 MHz
	Digital:	Up to 12 MHz if no analog channel is selected. Otherwise up to 1 MHz.
	Counter:	Up to 12 MHz if no analog channel is selected. Otherwise up to 1 MHz.
`GainArray`	`ANALOG` only; ignore for other `ChanTypeArray` values.	
	`BIP10VOLTS`	(± 10 V)
	`BIP5VOLTS`	(± 5 V)
	`BIP2VOLTS`	(± 2 V)
	`BIP1VOLTS`	(± 1 V)
	`BIPPT5VOLTS`	(± 0.5 V)
	`BIPPT2VOLTS`	(± 0.2 V)
	`BIPPT1VOLT`	(± 0.1 V)
`PreTrigCount`	100000 max	

DAQ triggering

DAQ trigger functions and methods supported

UL:	`cbDaqSetTrigger()`
UL for .NET:	`DaqSetTrigger()`

DAQ trigger argument values

`TrigSource`	`TRIG_IMMEDIATE`, `TRIG_EXTTTL`, `TRIG_ANALOGHW`, `TRIG_ ANALOGSW`, `TRIG_DIGPATTERN`, `TRIG_COUNTER`, `TRIG_SCANCOUNT`

`TrigSense`	`RISING_EDGE`, `FALLING_EDGE`, `ABOVE_LEVEL`, `BELOW_LEVEL`, `EQ_LEVEL`, `NE_LEVEL`
`TrigEvent`	`START_EVENT`, `STOP_EVENT`

DAQ setpoint

DAQ setpoint functions and methods supported

UL:	`cbDaqSetSetpoints()`
UL for .NET:	`DaqSetSetpoints()`

DAQ setpoint argument values

`SetpointFlagsArray`	`SF_EQUAL_LIMITA`, `SF_LESSTHAN_LIMITA`, `SF_GREATERTHAN_LIMITB`, `SF_OUTSIDE_LIMITS`, `SF_HYSTERESIS`, `SF_UPDATEON_TRUEONLY`, `SF_UPDATEON_TRUEANDFALSE`

`SetpointOutputArray`	`SO_NONE`, `SO_FIRSTPORTC`, `SO_TMR0`, `SO_TMR1`
	also available for USB-2537 and USB-2527:
	`SO_DAC0`, `SO_DAC1`, `SO_DAC2`, `SO_DAC3`

`LimitAArray`	Any value valid for the associated input channel Ignored for `SF_GREATERTHAN_LIMITB`
`LimitBArray`	Any value valid for the associated input channel and less than LimitA Ignored for `SF_EQUAL_LIMITA`, `SF_LESSTHAN_LIMITA`
`Output#Array`	For `SetpointOutputArray` = `SO_NONE`: Ignored For `SetpointOutputArray` = `SO_FIRSTPORTC`: 0 to 65535 For `SetpointOutputArray` = `SO_TMR#`: 0 (to disable timer) or 15.26 to 1000000 (to set output frequency) For `SetpointOutputArray` = `SO_DAC#`: Voltage values between -10 and +10
`OutputMask#Array`	For `SetpointOutputArray` = `SO_FIRSTPORTC`: 0 to 65535 For `SetpointOutputArray` = all other values: Ignored
`SetpointCount`	0 (to disable setpoints) to 16

DAQ output (USB-2537 and USB-2527 only)

DAQ output functions and methods supported

UL:	`cbDaqOutScan()`
UL for .NET:	`DaqOutScan()`

DAQ output argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `SIMULTANEOUS`, `NONSTREAMEDIO`, `ADCCLOCKTRIG`, `ADCCLOCK`
`ChanType`	`ANALOG`, `DIGITAL16`
`ChanArray`	`ANALOG`: 0 to 3

	`DIGITAL16`:	`FIRSTPORTA` (`FIRSTPORTB` must be configured as an output)
`Rate`	`ANALOG`:	Up to 1 MHz
	`DIGITAL16`:	Up to 12 MHz (system-dependent) if no analog channel is selected. Otherwise up to 1 MHz.
`Range`	Ignored	

Hardware considerations

Associating CJC channels with TC channels

The TC channels must immediately follow their associated CJC channels in the channel array. For accurate thermocouple readings, associate CJC0 with TC0, CJC1 with TC1 and TC2, and CJC2 with TC3.

The board must be configured for differential inputs when using thermocouples

TC inputs are supported by differential mode configuration only.

Channel count

For input and output scans, the count must be set to an integer multiple of the number of channels or a `BADCOUNT` error is returned.

Sampling and update rates

Sampling and update rates are system-dependent. Data overruns/underruns may occur with higher sampling rates when using `BACKGROUND` and `CONTINUOUS` modes. To avoid this, use a larger buffer/count size, or use `NONSTREAMEDIO` mode, if supported. The minimum size buffer is 256 for `cbAOutScan()`. Values less than that result in a `BADBUFFERSIZE` error.

Settling time

For most applications, settling time should be left at the default value of 1 µs. However, if you are scanning multiple channels and one or more channels are connected to a high impedance source, you may get better results by increasing the settling time. Keep in mind that increasing the settling time reduces the maximum acquisition rate. You can set the time between A/D conversions with the ADC Settling Time option in *Insta*Cal. Select between 1 µs, 5 µs, 10 µs, or 1 ms.

Setpoints

You enable setpoints with the `SETPOINT_ENABLE` flag. This flag must be OR'ed with the `ChanTypeArray` argument values. You set the setpoint criteria with `cbDaqSetSetpoints()`/`DaqSetSetpoints()`. The number of channels set with the `SETPOINT_ENABLE` flag must match the number of setpoints set by the `SetpointCount` argument (`cbDaqSetSetpoints()`/`DaqSetSetpoints()`).

Output non-streamed data to a DAC output channel

With `NONSTREAMEDIO` mode, you can output non-streamed data to a specific DAC output channel. The aggregate size of the data output buffer must be less than or equal to the size of the internal data output FIFO in the device. The FIFO holds 524288 samples. This allows the data output buffer to be loaded into the device's internal output FIFO. Once the sample updates are transferred or downloaded to the device, the device is responsible for outputting the data. You can't change the output buffer once the output begins.

Trigger DAC output operations with the ADC clock

Specify the `ADCCLOCKTRIG` option to trigger a data output operation upon the start of the ADC clock.

DIO PortNum

`For cbDOutScan()/DOutScan()` and `cbDaqOutScan()/DaqOutScan()`, `FIRSTPORTA` and `FIRSTPORTB` are treated as one 16-bit port. These functions can only be used with `FIRSTPORTA`. You must configure both `FIRSTPORTA` and `FIRSTPORTB` for output using the `cbDConfigPort()` function.

Synchronous scanning with multiple boards

You can operate up to four USB-2500 Series boards synchronously by setting the direction of the A/D and D/A pacer pins (**XAPCR** or **XDPCR**) in *Insta*Cal.

On the board used to pace each device, set the pacer pin that you want to use (XAPCR or XDPCR) for *Output*. On the board(s) that you want to synchronize with this board, set the pacer pin that you want to use (XAPCR or XDPCR) for *Input*.

You set the direction using the *Insta*Cal configuration dialog's **XAPCR Pin Direction** and **XDPCR Pin Direction** settings. If you have an older version of *Insta*Cal, these settings might be labeled "ADC Clock Output" (set to *Enabled* to configure XAPCR for output) or "DAC Clock Output" (set to *Enabled* to configure XDPCR for output).

Wire the pacer pin configured for output to each of the pacer input pins that you want to synchronize.

DEMO-BOARD

The **DEMO-BOARD** is a software simulation of a data acquisition board that simulates analog input and digital I/O operations.

Analog Input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbFileAInScan()`
UL for .NET:	`AIn()`, `AInScan()`, `ATrig()`, `FileAInScan()`

Analog input argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `SINGLEIO`, `DMAIO`
`HighChan`	7 max
`Rate`	300000

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDIn()`, `cbDBitIn()`, `cbDInScan()`, `cbDOut()`, `cbDBitOut()`, `cbDOutScan()`, `cbDConfigPort()`
UL for .NET:	`DIn()`, `DBitIn()`, `DInScan()`, `DOut()`, `DBitOut()`, `DOutScan()`, `DConfigPort()`

Digital I/O argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `AUXPORT`
`DataValue`	0 to 255 using `FIRSTPORTA`, `FIRSTPORTB`, or `AUXPORT`
`BitNum`	0 to 15 using `FIRSTPORTA` 0 to 7 using `AUXPORT`

Using the DEMO-BOARD

Analog input

The **DEMO-BOARD** simulates eight channels of 16-bit analog input. *Insta*Cal is used to configure the following waveforms on the analog input channels:

- sine wave
- square wave
- saw-tooth, ramp
- damped sine wave
- input from a data file

The data file is a streamer file, so any data that has been previously saved in a streamer file can be used as a source of demo data by the board. Data files are named `DEMO0.DAT` through `DEMO7.DAT`. When a data file is assigned to a channel, the library tries to extract data for that channel from the streamer file. If data for that channel does not exist, then the first (and possibly only) channel data in the streamer is extracted and used.

For example, `DEMO2.DAT` is assigned as the data source for channel 5 on the DEMO-BOARD. The library will try to extract data from the file that corresponds to channel 5. If `DEMO2.DAT` has scan data that corresponds to channels 0 through 15, then channel 5 data is extracted. If `DEMO2.DAT` only has data for a single channel, the data for that channel is used as the data source for channel 5.

Digital I/O

The **DEMO-BOARD** simulates the following:

- One eight-bit `AUXPORT` configurable digital input/output port. Each bit of the `AUXPORT` generates a square wave with a different period.
- Two eight-bit configurable digital I/O ports—`FIRSTPORTA`, `FIRSTPORTB`—which can be used for high speed scanning. `FIRSTPORTA` functions like `AUXPORT` in that it generates square waves. Each bit of `FIRSTPORTB` generates a pulse with a different frequency.

Analog Output Boards

Introduction

All boards with analog outputs support the `cbAOut()` and `cbAOutScan()` functions. Boards released after the printing of this manual are described in Readme files on the Universal Library disk.

`cbAOutScan()/AOutScan()` are designed primarily for boards that support hardware-paced analog output, but it is also useful when simultaneous update of all channels is desired. If the hardware is configured for simultaneous update, this function loads each DAC channel with the appropriate value before issuing the update command.

DAC04 HS Series

Analog output

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `SIMULTANEOUS`
`HighChan`	0 to 3
`Rate`	500000
`Range`	Ignored - Not programmable
`DataValue`	0 to 4095

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`

Digital I/O argument values

`PortNum`	`AUXPORT`*
`DataValue`	0 to 255
`BitNum`	0 to 7

* `AUXPORT` is not configurable for these boards.

Hardware considerations

Pacing analog output

Hardware pacing, external or internal clock supported.

The external clock is hardwired to the DAC pacer. If an internal clock is to be used, do not connect a signal to the External Pacer input.

DAC Series (Excluding HS Series)

Analog output

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	`SIMULTANEOUS`	
`HighChan`	**DAC02** 0 to 1	**DAC08** 0 to 7
	DAC06 0 to 5	**DAC16** 0 to 15
`Rate`	Ignored	
`Count`	`HighChan` - `LowChan` + 1 max	
`Range`	Ignored - Not programmable	
`DataValue`	0 to 4095	
	For the **/16 series**, the following argument values are also valid: 0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)	

Hardware considerations

Pacing analog output

Software only

PCI-DAC6700 Series

Analog output

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`HighChan`:	**PCI-DAC6702**: 7
	PCI-DAC6703: 15
`Count`:	`HighChan` - `LowChan` + 1 max
`Rate`:	Ignored
`Range`:	Ignored - Not programmable; fixed at `BIP10VOLTS` (±10.1 V)
`DataValue`:	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`, `cbDConfigPort()`, `cbDConfigBit()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`, `DConfigPort()`, `DConfigBit()`

Digital I/O argument values

`PortNum`:	`AUXPORT` is bitwise configurable for these boards, and must be configured using `cbDConfigBit()` or `cbDConfigPort()` before use as output.
`DataValue`	0 to 255
`BitNum`	0 to 7

Configuration

Configuration functions and methods supported

UL:	`cbGetConfig()`, `cbSetConfig()`
UL for .NET:	`GetDACStartup()`, `GetDACUpdateMode()`, `SetDACStartup()`, `SetDACUpdateMode()`

Configuration argument values

ConfigItem:	`BIDACSTARTUP`, `BIDACUPDATEMODE`, `BIDACUPDATECMD`

Hardware considerations

Pacing analog output

Software only

PCM- and PC-CARD- DAC Series

Analog output

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	**PCM-DAC02** Ignored **PCM-DAC08** and **PC-CARD-DAC08** `SIMULTANEOUS`
`HighChan`	**DAC02**: 0 to 1 **DAC08**: 0 to 7
`Rate`	Ignored
`Count`	`HighChan` - `LowChan` + 1 max

`Range`	**PCM-DAC08** and **PC-CARD-DAC08**
	Ignored - Not programmable; fixed at `BIP5VOLTS` (±5 V)
	PCM-DAC02
	`BIP10VOLTS` `BIP5VOLTS`
	`UNI10VOLTS` `UNI5VOLTS`

`DataValue`	0 to 4095

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`, `cbDConfigPort()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`, `DConfigPort()`

Digital I/O argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`
`DataValue`	0 to 15 for `FIRSTPORTA` or `FIRSTPORTB`
`BitNum`	0 to 7 using `FIRSTPORTA`

Hardware considerations

Pacing analog output

Software only

Digital configuration

Supports two configurable 4-bit ports—`FIRSTPORTA` and `FIRSTPORTB`. Each can be independently configured as either inputs or outputs via `cbDConfigPort()` or `DConfigPort()`.

PCIM- and CIO- DDA06 Series

Analog output

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument values

`Options`	`SIMULTANEOUS` (CIO-DDA06 Series only)
`HighChan`	0 to 5
`Count`	`HighChan` - `LowChan` + 1 max
`Rate`	Ignored
`Range`	Ignored - Not programmable
`DataValue`	0 to 4095
	For the **/16 series**, the following argument values are also valid 0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16.)

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`, `cbDConfigPort()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`, `DConfigPort()`

Digital I/O argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`
`DataValue`	0 to 15 for `FIRSTPORTC` 0 to 255 for `FIRSTPORTA` or `FIRSTPORTB`
`BitNum`	0 to 23 using `FIRSTPORTA`

Hardware considerations

Pacing analog output

Software only

Initializing the 'zero power-up' state

When using the **CIO-DDA06** "zero power-up state" hardware option, use `cbAOutScan()` or `AOutScan()` to set the desired output value and enable the DAC outputs.

PCI- and CPCI- DDA Series

Analog output

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument ranges

`Options`	`SIMULTANEOUS`	
`HighChan`	**DDA02:** 0 to 1 **DDA04:** 0 to 3 **DDA08:** 0 to 7	
`Rate`	Ignored	
`Count`	`HighChan` - `LowChan` + 1 max	

`Range`	`BIP10VOLTS`
	`BIP5VOLTS`
	`BIP2PT5VOLTS`
		`UNI10VOLTS`
		`UNI5VOLTS`
		`UNI2PT5VOLTS`

`DataValue`	0 to 4095 For the **/16 series**, the following argument values are also valid 0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)	

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`, `cbDConfigPort()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`, `DConfigPort()`

Digital I/O argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`, `SECONDPORTA`, `SECONDPORTB`, `SECONDPORTCL`, `SECONDPORTCH`
`DataValue`	0 to 15 for `PORTCH` and `PORTCL` 0 to 255 for `PORTA` or `PORTB`
`BitNum`	0 to 47 using `FIRSTPORTA`

Hardware considerations

Pacing analog output

Software only.

cSBX-DDA04

Analog output

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument ranges

`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `SIMULTANEOUS`
`Rate`	300,000
Pacing	Hardware pacing, external or internal clock supported

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDIn()`, `cbDOut()`, `cbDBitIn()`, `cbDBitOut()`, `cbDInScan()`, `cbDOutScan()`
UL for .NET:	`DIn()`, `DOut()`, `DBitIn()`, `DBitOut()`, `DConfigPort()`

Digital I/O argument values

`PortNum`	`AUXPORT*`
`DataValue`	0 to 255 using `cbDIn()` or `cbDInScan()`, 0 to 16383
`BitNum`	0 to 7 using `cbDBitIn()` 0 to 13 using `cbDBitOut()`
`Rate`	500 kHz (refer to "Notes" below).
Pacing	Hardware * AUXPORT is not configurable for this board.

Notes

The cSBX-DDA04 board allows interleaving of analog and digital output data. To support interleaving, a control bit indicates the data type. The control bit is the MSB of each 16-bit word of analog or digital data. The MSB = 0 for analog data, and 1 for digital data. The data is passed to the board and then directed to the correct output type by hardware on the board which detects and acts on the MSB control bit.

- To use this interleaving capability with the UL, set HighChan and LowChan to NOTUSED, and indicate the data type and channel in the most significant four bits of the data values in the buffer.
- To use this interleaving capability with the UL for .NET, set HighChan and LowChan to NOTUSED, and indicate the data type and channel in the most significant four bits of the data values in the buffer.

USB-3100 Series

The USB-3100 Series includes the USB-3101, USB-3102, USB-3103, USB-3104, USB-3105, USB-3106, USB-3110, USB-3112, and USB-3114 devices.

Analog output

Analog output functions and methods supported

UL:	`cbAOut()`, `cbAOutScan()`
UL for .NET:	`AOut()`, `AOutScan()`

Analog output argument ranges

`Options`	`SIMULTANEOUS (cbAOutScan()` / `AOutScan()` only)
`HighChan`	USB-3101, USB-3102, and USB-3110: 0 to 3
	USB-3103, USB-3104, and USB-3112: 0 to 7
	USB-3105, USB-3106, and USB-3114: 0 to 15
`Rate`	Ignored
`Count`	`HighChan` – `LowChan` + 1 max
`Range`	Ignored - Not programmable; selectable for `BIP10VOLTS` (±10 V), `UNI10VOLTS` (0 to 10 V), or `MA0TO20` (0 to 20 mA) via *Insta*Cal
	USB-3102, USB-3104, USB-3106: Also selectable for `MA0TO20` (0 to 20mA) via *Insta*Cal
`DataValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16.)

Digital I/O

Configuration functions, methods, and argument values supported

UL:	`cbDConfigBit()`, `cbDConfigPort()`
UL for .NET:	`DConfigBit()`, `DConfigPort()`
`PortNum`	`AUXPORT`
`PortType`	`AUXPORT`

Port I/O functions, methods, and argument values supported

UL:	`cbDOut()`, `cbDIn()`
UL for .NET:	`DOut()`, `DIn()`
`PortNum`	`AUXPORT`
`DataValue`	0 to 255 for `AUXPORT`

Bit I/O functions, methods, and argument values supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`AUXPORT`
`BitNum`	0 to 7 on `AUXPORT`

Counter I/O

Counter I/O functions and methods supported

UL:	`cbCIn()`*, `cbCIn32()`, `cbCLoad()`**, `cbCLoad32()`**
UL for .NET:	`CIn()`*, `CIn32()`, `CLoad()`**, `CLoad32()`**

*Although `cbCIn()` and `CIn()` are valid for use with this counter, `cbCIn32()` or `CIn32()` may be more appropriate, since the values returned may be greater than the data types used by `cbCIn()` and `CIn()` can handle.

**`cbCLoad()`, `cbCLoad32()`, `CLoad()` and `CLoad32()` only accept `Count`=0. These functions are used to reset the counter.

Counter I/O argument values

`CounterNum`	1
`Count`	2^{32}-1 when reading the counter.
`LoadValue`	0 when loading the counter.

`cbCLoad()` and `cbCLoad32()` / `CLoad()` and `CLoad32()`are only used to reset the counter for this board to 0. No other values are valid.

The "Basic signed integers" guidelines on page 134 apply when using `cbCIn()` or `CIn()` for values greater than 32767, and when using `cbCIn32()` or `CIn32()` for values greater than 2147483647.

`RegNum`	`LOADREG1`

Hardware considerations

Scan options

The `SIMULTANEOUS` scan option can only be used with `cbAOutScan()` / `AOutScan()`.

Simultaneous mode

Set the direction of the SYNCLD pin (pin 49) with the **Simultaneous Mode** option in *Insta*Cal to be either Master (output) or Slave (input).

- Specify the `SIMULTANEOUS` scan option and set the Simultaneous Mode option to **Master** to output the internal D/A LOAD signal on the SYNCLD pin.
- Specify the `SIMULTANEOUS` scan option and set the Simultaneous Mode option to **Slave** to configure the SYNCLD pin to receive the D/A LOAD signal from an external source. Output channels are updated simultaneously when the SYNCLD receives the signal.

  In slave mode, analog outputs may either be updated immediately or when a positive edge is seen on the SYNCLD pin (this is under software control.) The SYNCLD pin must be at a low logic level for DAC outputs to update immediately. If an external source is pulling the pin high, no update will occur.

When you do not specify `SIMULTANEOUS`, the analog outputs are updated in sequential order, and the SYNCLD pin is ignored.

External current limiting may be required for high drive devices (USB-3110, USB-3112, USB-3114)

The voltage outputs on the USB-3110, USB-3112, and USB-3114 incorporate high-drive current output capability. The high drive current outputs allow each of the voltage outputs to sink/source up to 40 mA (maximum) of load current.

The voltage outputs should not be kept in a short-circuit condition for longer than the specified 100 ms. For those applications that may potentially exceed the 40 mA maximum current limit or the 100 ms short-circuit condition, external current limiting must be used to prevent potential damage to the USB-3100 series device.

Simultaneous update of voltage and current outputs (USB-3102, USB-3104, USB-3106)

Each voltage output channel on the USB-3102, USB-3104, and USB-3106 has an associated current output. The voltage and current outputs are grouped as channel pairs. Each D/A converter output controls a voltage and current channel pair simultaneously. When you write to a voltage output, its associated current output is also updated. Each channel pair can be updated individually or simultaneously.

Each voltage/current channel pair can be updated individually or simultaneously. Leave each pair of unused voltage and current outputs disconnected.

Miscellaneous functions and methods supported

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

Causes the USB LED on a USB device to blink.

When you have several USB devices connected to the computer, use these functions to identify a particular device by making its USB LED blink.

Digital Input/Output Boards

Introduction

This section has details on using digital I/O boards in conjunction with the Universal Library. Boards released after the printing of this manual will be described in Readme files on the Universal Library disk.

Basic signed integers

When reading or writing ports that are 16-bits wide, be aware of the following issue using signed integers (as you are forced to do when using Basic):

On some boards, for example the **PDISO16**, the `AUXPORT` digital ports are set up as one 16-bit port. When using `cbDOut()` or `DOut()`, the digital values are written as a single 16-bit word. Using signed integers, writing values above `0111 1111 1111 1111` (32767 decimal) can be confusing. The next increment, `1000 0000 0000 0000`, has a decimal value of -32768. Using signed integers, this is the value that you would use for turning on the MSB only. The value for all bits on is −1. Keep this in mind if you are using Basic, since Basic does not supply unsigned integers (values from 0 to 65536).

To fully understand and maximize the performance of this and other digital input function calls, refer to the 82C55 data sheet in the *Documents* subdirectory of the installation. This data sheet is also available from our web site at www.mccdaq.com/PDFmanuals/82C55A.pdf. Also refer to the 8536 data sheet (this data sheet file is not available in PDF format).

AC5 Series

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`, `cbDConfigPort()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`, `DConfigPort()`

Digital I/O argument values

All boards in this series support:

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`
`DataValue`	0 to 15 using `FIRSTPORTCL or FIRSTPORTCH` 0 to 255 using `FIRSTPORTA` or `FIRSTPORTB`
`BitNum`	0 to 23 using `FIRSTPORTA`

DUAL-AC5 and **QUAD-AC5** boards also support:

`PortNum`	`SECONDPORTA`, `SECONDPORTB`, `SECONDPORTCL`, `SECONDPORTCH`
`DataValue`	0 to 15 using `SECONDPORTCL` or `SECONDPORTCH` 0 to 255 using `SECONDPORTA` or `SECONDPORTB`
`BitNum`	0 to 47 using `FIRSTPORTA`

QUAD-AC5 boards also support:

`PortNum`	`THIRDPORTA`, `THIRDPORTB`, `THIRDPORTCL`, `THIRDPORTCH`, `FOURTHPORTA`, `FOURTHPORTB`, `FOURTHPORTCL`, `FOURTHPORTCH`
`DataValue`	0 to 15 using `THIRDPORTCL` or `THIRDPORTCH` 0 to 255 using `THIRDPORTA` or `THIRDPORTB`
`BitNum`	0 to 95 using `FIRSTPORTA`

DIO Series

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`, `cbDConfigPort()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`, `DConfigPort()`

Digital I/O argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`
	For **DIO48, DIO48H, DIO96**, and **DIO192**, the following values are also valid: `SECONDPORTA`, `SECONDPORTB`, `SECONDPORTCL`, `SECONDPORTCH`
	For **DIO96**, and **DIO192**, the following argument values are also valid: `THIRDPORTA`, `THIRDPORTB`, `THIRDPORTCL`, `THIRDPORTCH`, `FOURTHPORTA`, `FOURTHPORTB`, `FOURTHPORTCL`, `FOURTHPORTCH`
	For **DIO192**, the following values are also valid: `FIFTHPORTA` through `EIGHTHPORTCH`
`DataValue`	0 to 15 for `PORTCL` or `PORTCH` 0 to 255 for `PORTA` or `PORTB`
`BitNum`	0 to 23 using `FIRSTPORTA`
	For **DIO48, DIO48H, DIO96**, and **DIO192**, the following values are also valid: 24 to 47 using `FIRSTPORTA`
	For **DIO96**, and **DIO192**, the following values are also valid: 48 to 95 using `FIRSTPORTA`
	For **DIO192**, the following values are also valid: 96 to 191

Event notification (CIO- and PCI- DIO24 and DIO24H; PCI-DIO24/LP and PCI-DIO24/S only)

Event notification functions and methods supported

UL:	`cbEnableEvent()`, `cbDisableEvent()`
UL for .NET:	`EnableEvent()`, `DisableEvent()`

Event notification argument values

`EventType`	`ON_EXTERNAL_INTERRUPT` (UL)/`OnExternalInterrupt` (UL for .NET)

Hardware considerations

Event Notification

DIO Series boards that support event notification only support external rising edge interrupts.

DIO24/CTR3 and D24/CTR3 Series

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`, `cbDConfigPort()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`, `DConfigPort()`

Digital I/O argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`
`DataValue`	0 to 15 for `FIRSTPORTCL` or `FIRSTPORTCH` 0 to 255 for `FIRSTPORTA` or `FIRSTPORTB`
`BitNum`	0 to 23 using `FIRSTPORTA`

Counter I/O

Counter functions and methods supported

UL:	`cbC8254Config()`, `cbCIn()`, `cbCLoad()`
UL for .NET:	`C8254Config()`, `CIn()`, `CLoad()`

Counter argument values

`CounterNum`	1 to 3
`Config`	`HIGHONLASTCOUNT`, `ONESHOT`, `RATEGENERATOR`, `SQUAREWAVE`, `SOFTWARESTROBE`, `HARDWARESTROBE`
`LoadValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16.)
`RegNum`	`LOADREG1`, `LOADREG2`, `LOADREG3`

Event notification

CIO-DIO24/CTR3 and **PC-CARD-D24/CTR3**

Event notification functions and methods supported

UL:	`cbEnableEvent()`, `cbDisableEvent()`
UL for .NET:	`EnableEvent()`, `DisableEvent()`

Event notification argument values

`EventType`	`ON_EXTERNAL_INTERRUPT`

Hardware considerations

Counter configuration

Counter source functions are programmable using *Insta*Cal.

PCI-DIO48/CTR15

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`, `cbDConfigPort()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`, `DConfigPort()`

Digital I/O argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`, `SECONDPORTA`, `SECONDPORTB`, `SECONDPORTCL`, `SECONDPORTCH`
`DataValue`	0 to 15 for `FIRSTPORTCL` or `FIRSTPORTCH` 0 to 255 for `FIRSTPORTA` or `FIRSTPORTB`
`BitNum`	0 to 47 using `FIRSTPORTA`

Counter I/O

Counter functions and methods supported

UL:	`cbC8254Config()`, `cbCIn()`, `cbCLoad()`
UL for .NET:	`C8254Config()`, `CIn()`, `CLoad()`

Counter argument values

`CounterNum`	1 to 15
`Config`	`HIGHONLASTCOUNT`, `ONESHOT`, `RATEGENERATOR`, `SQUAREWAVE`, `SOFTWARESTROBE`, `HARDWARESTROBE`
`LoadValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)
`RegNum`:	`LOADREG1 - LOADREG15`

Event notification

Event notification functions and methods supported

UL:	cbEnableEvent(), cbDisableEvent()
UL for .NET:	EnableEvent(), DisableEvent()

Event notification argument values

`EventType`	`ON_EXTERNAL_INTERRUPT`

PDISO8 and PDISO16 Series

Digital I/O

Port I/O functions, methods, and argument values supported

UL:	`cbDOut()`, `cbDIn()`
UL for .NET:	`DOut()`, `DIn()`
PortNum	`AUXPORT`
DataValue	**PDISO8** 0 to 255 for `AUXPORT` **PDISO16** 0 to 65535 for `AUXPORT` (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)

Bit I/O functions, methods, and argument values supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
PortType	`AUXPORT`
BitNum	**PDISO8** 0 to 7 on `AUXPORT` **PDISO16** 0 to 15 on `AUXPORT`

Miscellaneous

Miscellaneous functions and methods supported (USB-PDISO8, USB-PDISO8/40, and E-PDISO16 only)

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

These functions cause the **USB** LED on a Measurement Computing USB module to blink, and the **LINK** LED on a Measurement Computing Ethernet module to blink.

When you have several USB modules connected to the computer, or Ethernet modules on the network, use these functions to identify a particular module by making its LED blink.

Establishing and requesting control of an E-PDISO16

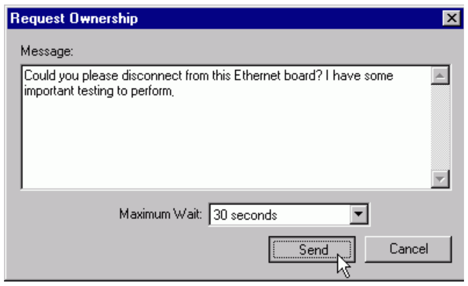
Through *Insta*Cal, you can configure the system to automatically attempt to establish control over the E-PDISO16 when an application starts up. To do this, check the "**Try to acquire ownership on application startup**" option on *Insta*Cal's **Ethernet Settings** tab. Note that only one computer should have this option selected; otherwise, two or more computers might compete for control over the E-PDISO16. To manually request control over the E-PDISO16, press the **Request Ownership** button on the **Ethernet Settings** tab.

Only one computer can establish control over an E-PDISO16 at a time. Additional computers that contact the device can only query the state of the device and its ports. The name of the computer with control over the E-PDISO16 appears in the **Device Owner** property on the **Ethernet Settings** tab.

Sending a request for control of an E-PDISO16

If another computer already has control over E-PDISO16 when you connect to it, you can send a message to the controlling computer. Do the following.

1. From *Insta*Cal's main window, double-click on the E-PDISO16.
2. From the **Ethernet Settings** tab, click on the **Request Ownership** button.
3. On the **Request Ownership** dialog, enter your message (up to 256 characters). Press **Ctrl** and **Enter** to go to a new line. You can set how long the message is displayed on the computer that controls the E-PDISO16 from the **Maximum Wait** drop-down list box.
4. Click on the **Send** button to send the message.

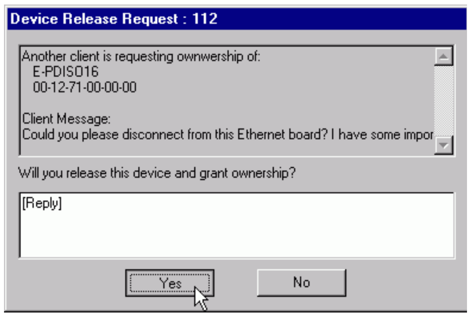


Could you please disconnect from this Ethernet board? I have some important testing to perform.

Maximum Wait: 30 seconds

Receiving a request for control of an E-PDISO16

If your computer controls an E-PDISO16 and you receive a message from another person requesting control of the device, the message shows on your screen for the time set in the **Maximum Wait** drop-down list.



Another client is requesting ownwership of:
E-PDISO16
00-12-71-00-00-00

Client Message:
Could you please disconnect from this Ethernet board? I have some impor

Will you release this device and grant ownership?

[Reply]

- To disconnect and give control of the E-PDISO16 to the person requesting, click on the Yes button.
- To retain control of the E-PDISO16, click on the No button.

Receiving a message

When a computer sends a message to the computer controlling the device, the message displays on the monitor of the controlling computer for the time specified by the **Time-out** value.

The message box has two buttons used to respond to the message. When you receive a message, enter a response in the message box and click on one of the following buttons.

- Yes: Click on Yes to give up ownership/control over the network device.
  The computer automatically disconnects from the network connection, and control over the device transfers to the computer that sent the message. The Device Owner property in *Insta*Cal updates with the name of the computer that gained control of the device.
- No: Click on No when you do not agree to give up ownership or control over the network device.
  When you click on a button, the message box and selected response displays on the computer that sent the message.

CIO-PDMA16 and CIO-PDMA32

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOutScan()`, `cbDInScan()`, `cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`, `cbDConfigPort()`
UL for .NET:	`DOutScan()`, `DInScan()`, `DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`, `DConfigPort()`

Digital I/O argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `AUXPORT`
`DataValue`	0 to 7 using `AUXPORT` (only `cbDOut()` is supported), 0 to 255 using `FIRSTPORTA` and `FIRSTPORTB`, 0 to 65535 using `WORDXFER` `FIRSTPORTA`.
`BitNum`	0 to 2 using `AUXPORT` (only `cbDBitOut()` and `DBitOut()` are supported), 0 to 15 using `PORTA`.
`Rate`	**CIO-PDMA16**: 125 Kwords **CIO-PDMA32**: 750 Kwords
`Options`	`BACKGROUND`, `CONTINUOUS`, `EXTCLOCK`, `WORDXFER`

Hardware considerations

Digital I/O Pacing

Hardware pacing, external or internal clock supported.

USB-1024 and USB-DIO24 Series

The USB-1024LS, USB-1024HLS, USB-DIO24/37, and USB-DIO24H/37 support the following UL and UL for .NET features.

Digital I/O

Configuration functions, methods, and argument values supported

UL:	`cbDConfigPort()`
UL for .NET:	`DConfigPort()`
`PortNum`	FIRSTPORTA, FIRSTPORTB, FIRSTPORTCL, FIRSTPORTCH

Port I/O functions, methods, and argument values supported

UL:	`cbDOut()`, `cbDIn()`
UL for .NET:	`DOut()`, `DIn()`
`PortNum`	FIRSTPORTA, FIRSTPORTB, FIRSTPORTCL, FIRSTPORTCH
`DataValue`	0 to 15 for `FIRSTPORTCL` or `FIRSTPORTCH` 0 to 255 for `FIRSTPORTA` or `FIRSTPORTB`

Bit I/O functions, methods, and argument values supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	FIRSTPORTA
`BitNum`	0 to 23 on `FIRSTPORTA`

Counter I/O

Counter functions and methods supported

UL:	`cbCIn()`*, `cbCIn32()`, `cbCLoad()`**, `cbCLoad32()`**
UL for .NET:	`CIn()`*, `CIn32()`, `CLoad()`**, `CLoad32()`** *Although `cbCIn()` and `CIn()` are valid for use with this counter, `cbCIn32()` or `CIn32()` may be more appropriate, since the values returned may be greater than the data types used by `cbCIn()` and `CIn()` can handle. **`cbCLoad()`, `cbCLoad32()`, `CLoad()` and `CLoad32()` only accept `Count`=0. These functions are used to reset the counter.

Counter argument values

`CounterNum`	1
`Count`	0 to 2^{32}-1 when reading the counter.
`LoadValue`	0 when loading the counter.
	`cbCLoad()` and `cbCLoad32()` / `CLoad()` and `CLoad32()` are only used to reset the counter for this board to 0. No other values are valid. The "Basic signed integers" guidelines on page 134 apply when using `cbCIn()` or `CIn()` for values greater than 32767, and when using `cbCIn32()` or `CIn32()` for values greater than 2147483647.
`RegNum`	LOADREG1

Miscellaneous functions and methods supported

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

Causes the LED on a USB device to blink.

When you have several USB devices connected to the computer, use these functions to identify a particular device by making its LED blink.

USB-DIO96 Series (formerly USB-1096 Series)

The USB-DIO96H, USB-DIO96H/50, and USB-1096HFS support the following UL and UL for .NET features.

Digital I/O

Configuration functions, methods, and argument values supported

UL:	`cbDConfigPort()`
UL for .NET:	`DConfigPort()`
`PortNum`	FIRSTPORTA, FIRSTPORTB, FIRSTPORTCL, FIRSTPORTCH, SECONDPORTA, SECONDPORTB, SECONDPORTCL, SECONDPORTCH, THIRDPORTA, THIRDPORTB, THIRDPORTCL, THIRDPORTCH, FOURTHPORTA, FOURTHPORTB, FOURTHPORTCL, FOURTHPORTCH

Port I/O functions, methods, and argument values supported

UL:	`cbDOut()`, `cbDIn()`
UL for .NET:	`DOut()`, `DIn()`
`PortNum`	PORTA, PORTB, PORTCL, PORTCH
`DataValue`	0 to 15 for `PORTCL` or `PORTCH` 0 to 255 for `PORTA` or `PORTB`

Bit I/O functions, methods, and argument values supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	FIRSTPORTA
`BitNum`	0 to 95 on `FIRSTPORTA`

Counter I/O

Counter functions and methods supported

UL:	`cbCIn()`*, `cbCIn32()`, `cbCLoad()`**, `cbCLoad32()`**
UL for .NET:	`CIn()`*, `CIn32()`, `CLoad()`**, `CLoad32()`** *Although `cbCIn()`/`CIn()` are valid for use with this counter, `cbCIn32()` or `CIn32()` may be more appropriate, since the values returned may be greater than the data types used by `cbCIn()` and `CIn()` can handle. **`cbCLoad()`, `cbCLoad32()`, `CLoad()` and `CLoad32()` only accept `Count`=0. These functions are used to reset the counter.
`CounterNum`:	1
`Count`	0 to 232-1 when reading the counter. The "Basic signed integers" guidelines on page 134 apply when using `cbCIn()` or `CIn()` for values greater than 32767, and when using `cbCIn32()` or `CIn32()` for values greater than 2147483647. 0 when loading the counter. `cbCLoad()` and `cbCLoad32()`/`CLoad()` and `CLoad32()` are only used to reset the counter for this module to 0. No other values are valid.
`RegNum`	LOADREG1

Miscellaneous functions and methods supported

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

Causes the USB LED on a Measurement Computing USB module to blink.

When you have several modules connected to the computer, use these functions to identify a particular module by making its LED blink.

USB-SSR Series

The USB-SSR24 and USB-SSR08 support the following UL and UL for .NET features.

Digital I/O

Port I/O functions, methods, and argument values supported

UL:	`cbDOut()`, `cbDIn()`
UL for .NET:	`DOut()`, `DIn()`

`PortNum`	**USB-SSR08**:
	`FIRSTPORTCL`, `FIRSTPORTCH`
	USB-SSR24:
	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`

`DataValue`	**USB-SSR08**: 0 to 15 for `FIRSTPORTCL` or `FIRSTPORTCH` **USB-SSR24**: 0 to 255 for `FIRSTPORTA` or `FIRSTPORTB` 0 to 15 for `FIRSTPORTCL` or `FIRSTPORTCH`

Bit I/O functions, methods, and argument values supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`FIRSTPORTA`
`BitNum`	**USB-SSR08**: 16 to 23 on `FIRSTPORTA` **USB-SSR24**: 0 to 23 on `FIRSTPORTA`

Miscellaneous

Miscellaneous functions and methods supported

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

Causes the USB LED on a Measurement Computing USB module to blink.

When you have several modules connected to the computer, use these functions to identify a particular module by making its LED blink.

Hardware considerations

Do not change state of switches while program is running

Do not change the state of any switches (labeled S1, S2, and S3) on a USB-SSR module while a program is running. UL stores the current state of each switch, and changing a switch setting while a program is running can cause unpredictable results.

Switch & Sense 8/8

The Switch & Sense 8/8 supports the following UL and UL for .NET features.

Digital I/O

***Port* I/O functions, methods, and argument values supported**

UL:	`cbDOut()`, `cbDIn()`
UL for .NET:	`DOut()`, `DIn()`
`PortNum`	`AUXPORT`
`DataValue`	0 to 255 for `AUXPORT`

***Bit* I/O functions, methods, and argument values supported**

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`AUXPORT`
`BitNum`	0 to 7 on `AUXPORT`

Miscellaneous

Miscellaneous functions and methods supported

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

Causes the USB LED on a Measurement Computing USB module to blink.

When you have several modules connected to the computer, use these functions to identify a particular module by making its LED blink.

DEMO-BOARD

The **DEMO-BOARD** is a software simulation of a data acquisition board that simulates analog input and digital I/O operations.

Analog Input

Analog input functions and methods supported

UL:	`cbAIn()`, `cbAInScan()`, `cbATrig()`, `cbFileAInScan()`
UL for .NET:	`AIn()`, `AInScan()`, `ATrig()`, `FileAInScan()`

Analog input argument values

`Options`	`BACKGROUND`, `CONTINUOUS`, `SINGLEIO`, `DMAIO`
`HighChan`	7 max
`Rate`	300000

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDIn()`, `cbDBitIn()`, `cbDInScan()`, `cbDOut()`, `cbDBitOut()`, `cbDOutScan()`, `cbDConfigPort()`
UL for .NET:	`DIn()`, `DBitIn()`, `DInScan()`, `DOut()`, `DBitOut()`, `DOutScan()`, `DConfigPort()`

Digital I/O argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `AUXPORT`
`DataValue`	0 to 255 using `FIRSTPORTA`, `FIRSTPORTB`, or `AUXPORT`
`BitNum`	0 to 15 using `FIRSTPORTA` 0 to 7 using `AUXPORT`

Using the Demo-Board

Analog input

The **DEMO-BOARD** simulates eight channels of 16-bit analog input. *Insta*Cal is used to configure the following waveforms on the analog input channels:

- sine wave
- square wave
- saw-tooth, ramp
- damped sine wave
- input from a data file

The data file is a streamer file, so any data that has been previously saved in a streamer file can be used as a source of demo data by the board. Data files are named `DEMO0.DAT` through `DEMO7.DAT`. When a data file is assigned to a channel, the library tries to extract data for that channel from the streamer file. If data for that channel does not exist, then the first (and possibly only) channel data in the streamer is extracted and used.

For example, `DEMO2.DAT` is assigned as the data source for channel 5 on the DEMO_BOARD. The library will try to extract data from the file that corresponds to channel 5. If `DEMO2.DAT` has scan data that corresponds to channels 0 through 15, then channel 5 data is extracted. If `DEMO2.DAT` only has data for a single channel, the data for that channel is used as the data source for channel 5.

Digital I/O

The **DEMO-BOARD** simulates the following:

- One eight-bit `AUXPORT` configurable digital input/output port. Each bit of the `AUXPORT` generates a square wave with a different period.
- Two eight-bit configurable digital I/O ports—`FIRSTPORTA`, `FIRSTPORTB`—which can be used for high speed scanning. `FIRSTPORTA` functions like `AUXPORT` in that it generates square waves. Each bit of `FIRSTPORTB` generates a pulse with a different frequency.

Digital Input Boards

Introduction

This section provides details on using digital input boards in conjunction with the Universal Library. Boards released after the printing of this document will be described in Readme files on the Universal Library disk.

To fully understand and maximize the performance of this and other digital input function calls, refer to the 82C55 data sheet in the *Documents* subdirectory of the installation (`C:\Program files\Measurement Computing\DAQ\Documents` by default), or from our web site at www.mccdaq.com/PDFmanuals/82C55A.pdf. Refer also to the 8536 data sheet (this data sheet file is not available in PDF format).

CIO- and PC104- DI Series

Digital I/O

Digital input functions and methods supported

UL:	`cbDIn`, `cbDBitIn()`
UL for .NET:	`DIn`, `DBitIn()`

Digital input argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL` and `FIRSTPORTCH`. For **DI48, DI96**, and **DI192**, the following argument values are also valid: `SECONDPORTA`, `SECONDPORTB`, `SECONDPORTCL`, `SECONDPORTCH` For **DI96**, and **DI192**, the following argument values are also valid: `THIRDPORTA`, `THIRDPORTB`, `THIRDPORTCL`, `THIRDPORTCH`, `FOURTHPORTA`, `FOURTHPORTB`, `FOURTHPORTCL`, `FOURTHPORTCH` For **DI192**, the following argument value is also valid: `FIFTHPORTA` through `EIGHTHPORTCH`
`DataValue`	0 to 255 for `PORTA` or `PORTB`, 0 to 15 for `PORTCL` or `PORTCH`
`BitNum`	0 to 23 for `FIRSTPORTA` For **DI48, DI96**, and **DI192**, the following argument values are also valid: 24 to 47 using `FIRSTPORTA` For **DI96**, and **DI192**, the following argument values are also valid: 48 to 95 using `FIRSTPORTA` For **DI192**, the following argument values are also valid: 96 to 191

CIO-DISO48

Digital I/O

Digital input functions and methods supported

UL:	`cbDIn`, `cbDBitIn()`
UL for .NET:	`DIn`, `DBitIn()`

Digital input argument values

`PortNum`	`FIRSTPORTA`, `SECONDPORTA`, `THIRDPORTA`, `FOURTHPORTA`, `FIFTHPORTA`, `SIXTHPORTA`
`DataValue`	0 to 255
`BitNum`	0 to 47 using `FIRSTPORTA`

Digital Output Boards

Introduction

This chapter provides details on using digital output boards in conjunction with the Universal Library. Boards released after the printing of this document will be described in Readme files on the Universal Library disk.

To fully understand and maximize the performance of this and other digital input function calls, refer to the 82C55 data sheet in the *Documents* subdirectory of the installation (`C:\Program files\Measurement Computing\DAQ\Documents` by default), or from our web site at www.mccdaq.com/PDFmanuals/82C55A.pdf. Refer also to the 8536 data sheet (this data sheet file is not available in PDF format).

CIO-RELAY Series

Digital I/O

Digital output functions and methods supported

UL:	`cbDOut`, `cbDBitOut()`
UL for .NET:	`DOut`, `DBitOut()`

Digital output argument values

`PortNum`	`FIRSTPORTA` For **CIO-RELAY16 & 16/M**, the following argument values are also valid: `FIRSTPORTB` For **CIO-RELAY24**, the following argument values are also valid: `SECONDPORTA` For **CIO-RELAY32**, the following argument values are also valid: `SECONDPORTB`
`DataValue`	0 to 255
`BitNum`	0 to 7 using `FIRSTPORTA` For **CIO-RELAY16 & 16/M**, the following argument values are also valid: 0 to 15 using `FIRSTPORTA` For **CIO-RELAY24**, the following argument values are also valid: 0 to 23 using `FIRSTPORTA` For **CIO-RELAY32**, the following argument values are also valid: 0 to 31 using `FIRSTPORTA`

USB-ERB Series

The USB-ERB08 and USB-ERB24 support the following UL and UL for .NET features.

Digital I/O

***Port* I/O functions, methods, and argument values supported**

UL:	`cbDOut()`, `cbDIn()`
UL for .NET:	`DOut()`, `DIn()`

`PortNum`	**USB-ERB08**:
	`FIRSTPORTCL`, `FIRSTPORTCH`
	USB-ERB24:
	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `FIRSTPORTCH`

`DataValue`	**USB-ERB08**: 0 to 15 for `FIRSTPORTCL` or `FIRSTPORTCH` **USB-ERB24**: 0 to 255 for `FIRSTPORTA` or `FIRSTPORTB` 0 to 15 for `FIRSTPORTCL` or `FIRSTPORTCH`

***Bit* I/O functions, methods, and argument values supported**

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`FIRSTPORTA`
`BitNum`	**USB-ERB08**: 16 to 23 on `FIRSTPORTA` **USB-ERB24**: 0 to 23 on `FIRSTPORTA`

Miscellaneous

Miscellaneous functions and methods supported

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

Causes the USB LED on a Measurement Computing USB module to blink.

When you have several modules connected to the computer, use these functions to identify a particular module by making its LED blink.

Do not change state of invert/non-invert switch (S1) while program is running

Do not change the state of the invert/non-invert switch (labeled S1) on a USB-ERB module while a program is running. UL stores the current state of this switch, and changing the switch setting while a program is running can cause unpredictable results.

CIO- and PC104-DO Series

Digital I/O

Digital output functions and methods supported

UL:	`cbDOut`, `cbDBitOut()`
UL for .NET:	`DOut`, `DBitOut()`

Digital output argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL` and `FIRSTPORTCH`.
	`For` **DO48H, DO48DD, DO96H** and **DO192H**, the following argument values are also valid: `SECONDPORTA`, `SECONDPORTB`, `SECONDPORTCL`, `SECONDPORTCH`
	For **DO96H** and **DO192H**, the following argument values are also valid: `THIRDPORTA`, `THIRDPORTB`, `THIRDPORTCL`, `THIRDPORTCH`, `FOURTHPORTA`, `FOURTHPORTB`, `FOURTHPORTCL`, `FOURTHPORTCH`
	For **DO192H**, the following argument values are also valid: `FIFTHPORTA` through `EIGHTHPORTCH`
`DataValue`	0 to 255 for `PORTA` or `PORTB`, 0 to 15 for `PORTCL` or `PORTCH`
`BitNum`	0 to 23 for `FIRSTPORTA`
	For **DO48H, DO48DD, DO96H** and **DO192H** the following argument values are also valid: 24 to 47 using `FIRSTPORTA`
	For **DO96H** and **DO192H**, the following argument values are also valid: 48 to 95 using `FIRSTPORTA`
	For **DO192H**, the following argument values are also valid: 96 to 191

Counter Boards

Introduction

This chapter provides details on using counter/timer boards in conjunction with the Universal Library. Boards released after the printing of this user's guide are explained in Readme files on the Universal Library installation disk.

Visual Basic signed integers

When reading or writing ports that are 16-bits wide, be aware of the following issue using signed integers (which is required when using Visual Basic):

On some boards, such as the **CIO-CTR10** count register or `AUXPORT` digital ports, the ports are 16-bits wide. When accessing the data at these ports, the digital values are arranged as a single 16-bit word. Using signed integers, values above 0111 1111 1111 1111 (32767 decimal) can be confusing. The next increment, 1000 0000 0000 0000 has a decimal value of -32768. Using signed integers, this is the value that is returned from a 16-bit counter at half of maximum count. The value for full count (just before the counter turns over) is -1. Keep this in mind if you are using Visual Basic, since Visual Basic does not supply unsigned integers (values from 0 to 65535) or unsigned longs (values from 0 to 4,294,967,295). Refer to "16-bit values using a signed integer data type" on page 16 for more information.

The Universal Library provides functions for the initialization and configuration of counter chips, and can configure a counter for any of the counter operations. However, counter configuration does not include counter-use, such as event counting and pulse width. Counter-use is accomplished by programs which use the counter functions. The Universal Library provides the `cbCFreqIn()` function for counter use, while the Universal Library for .NET provides the `CFreqIn()` method. Other functions and methods may be added for counter use to later revisions.

Read the counter chip's data sheet

To use a counter for any but the simplest counting function, you must read, understand, and employ the information contained in the chip manufacturer's data sheet. Technical support of the Universal Library does not include providing, interpreting, or explaining the counter chip data sheet.

To fully understand and maximize the performance of the counter/timer boards and their related function calls, review the following related data sheet(s):

Counter/Timer	Data Sheet
82C54	82C54.pdf is located in the Documents installation subdirectory, and is also available from our web site at www.mccdaq.com/PDFmanuals/82C54.pdf.
AM9513	9513A.pdf is located in the Documents installation subdirectory, and is also available from our web site at www.mccdaq.com/PDFmanuals/9513A.pdf.
Z8536	The data book for the Z8536 counter chip is included with the product that employs this chip.
LS7266	LS7266R1.pdf is located in the Documents installation subdirectory, and is also available from our web site at www.mccdaq.com/PDFmanuals/ls7266r1.pdf.

Counter chip variables

UL counter initialization and configuration functions include names for bit patterns, such as `ALEGATE`, which stands for `Active Low Enabled Gate N`. In any case where the UL has a name for a bit pattern, it is allowed to substitute the bit pattern as a numeric. This will work, but your programs will be harder to read and debug.

CTR Series

Counter I/O

Counter functions and methods supported

UL:	`cbC9513Config()`, `cbC9513Init()`, `cbCStoreOnInt()`, `cbCFreqIn()`, `cbCIn()`, `cbCLoad()`
UL for .NET:	`C9513Config()`, `C9513Init()`, `CStoreOnInt()`, `CFreqIn()`, `CIn()`, `CLoad()`

Counter argument values

`CounterNum`	1 to 5 (All boards in this series) **CTR10** & **CTR10HD** also support counters 6 through 10 **CTR20HD** also supports counters 11 through 20
`RegNum`	`LOADREG1 - 5`, `HOLDREG1 - 5`, `ALARM1CHIP1`, `ALARM2CHIP1` **CTR10** & **CTR10HD** also support `LOADREG6 - 10`, `HOLDREG6 - 10`, `ALARM1CHIP2`, `ALARM2CHIP2` **CTR20HD** also supports `LOADREG11 - 20`, `HOLDREG11 - 20`, `ALARM1CHIP3`, `ALARM2CHIP3`, `ALARM1CHIP4`, `ALARM2CHIP4`
`LoadValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)
`ChipNum`	1 (All boards in this series) **CTR10** & **CTR10HD** also support chip 2 **CTR20HD** also support chips 3 and 4
`FOutSource`	`CTRINPUT1 - 5`, `GATE1 - 5`, `FREQ1 - 5` These values refer to the sources on a particular 9513 chip, so are limited to the sources on that particular chip. For example, to set the source to the input for counter 6, use `CTRINPUT1` (the first counter on the second 9513 chip).
`CountSource`	`TCPREVCTR`, `CTRINPUT1 - 5`, `GATE1 - 5`, `FREQ1 - 5` These values refer to the sources on a particular 9513 chip, so are limited to the sources on that particular chip. For example, to set the source to the input for counter 6, use `CTRINPUT1` (the first counter on the second 9513 chip). Likewise for the `TCPREVCTR` value; when applied to the first counter on a chip (counter 6, for example) the "previous counter" is counter 5 on that chip (for this example, counter 10).

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`

Digital I/O argument values

`PortNum`	`AUXPORT*`
`DataValue`	**CTR05**: 0 to 255 **CTR10**: 0 to 65535. Refer to "Basic signed integers" on page 157.
`BitNum`	**CTR05**: 0 to 7; **CTR10**: 0 to 15 * `AUXPORT` is not configurable for these boards.

Event notification

Event notification functions and methods supported

PCI-CTR05, **PCI-CTR10** and **PCI-CTR20HD** only

UL:	`cbEnableEvent()`, `cbDisableEvent()`
UL for .NET:	`EnableEvent()`, `DisableEvent()`

Event notification argument values

`EventType`	`ON_EXTERNAL_INTERRUPT` (UL)/`OnExternalInterrupt` (UL for .NET)

Hardware considerations

Clock input frequency (PCI boards only)

The clock source for each of the four counters is configurable with *Insta*Cal:

PCI-CTR05, PCI-CTR10:	1 MHz, 1.67 MHz, 3.33 MHz, 5 MHz
PCI-CTR20HD:	1 MHz, 1.67 MHz, 3.33 MHz, 5 MHz, or External

Event Notification

`ON_EXTERNAL_INTERRUPT` cannot be used with `cbCStoreOnInt()` or `CStoreOnInt()`.

CTR Series boards that support event notification only support external rising edge interrupts.

INT32 Series

Counter I/O

Counter functions and methods supported

UL:	`cbC8536Config()`, `cbC8536Init()`, `cbCIn()`, `cbCLoad()`
UL for .NET:	`C8536Config()`, `C8536Init()`, `CIn()`, `CLoad()`

Counter argument values

`CounterNum`	1 to 6
`ChipNum`	1 or 2
`RegName`	`LOADREG1` through `LOADREG6`
`LoadValue`	Values up to 65,535 (2^{16}–1) can be used. Refer to "Basic signed integers" on page 157 for more information.

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDIn()`, `cbDOut()`, `cbDBitIn()`, `cbDBitOut()`, `cbDConfigPort()`
UL for .NET:	`DIn()`, `DOut()`, `DBitIn()`, `DBitOut()`, `DConfigPort()`

Digital I/O argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `FIRSTPORTCL`, `SECONDPORTA`, `SECONDPORTB` and `SECONDPORTCL`.
`DataValue`	0 to 255 using `PORTA` or `PORTB` 0 to 15 using `PORTCL`
`BitNum`	0 to 39 using `FIRSTPORTA`

Hardware considerations

Argument Value vs. configuration

These boards have two 8536 chips, which have both counter and digital I/O and interrupt vectoring capabilities. The numbers stated for digital I/O apply when both chips are configured for the maximum number of digital devices. The numbers stated for counter I/O apply when both chips are configured for the maximum number of counter devices.

PPIO-CTR06

Counter I/O

Counter functions and methods supported

UL:	`cbC8254Config()`, `cbCIn()`, `cbCLoad()`
UL for .NET:	`C8254Config()`, `CIn()`, `CLoad()`

Counter argument values

CounterNum	1 to 6

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDIn()`, `cbDOut()`, `cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DIn()`, `DOut()`, `DBitIn()`, `DBitOut()`

Digital I/O argument values

`PortNum`	`AUXPORT*`
`DataValue`	0 to 15, or 0 to 255, depending on jumper setting
`BitNum`	0 to 3, or 0 to 7, depending on jumper setting

* `AUXPORT` is not configurable for this board.

QUAD Series

Counter I/O

Counter functions and methods supported

UL:	`cbC7266Config()`, `cbCIn()`, `cbCIn32()`, `cbCLoad()`, `cbCLoad32()`, `cbCStatus()`
UL for .NET:	`C7266Config()`, `CIn()`, `CIn32()`, `CLoad()`, `CLoad32()`, `CStatus()`

Counter argument values

`CounterNum`	**PCM-QUAD02**, **CIO-QUAD02** 1 to 2 **CIO-QUAD04**, **PCI-QUAD04** 1 to 4

`RegName`	UL:
	`COUNT1`, `COUNT2`, `PRESET1`, `PRESET2`, `PRESCALER1`, `PRESCALER2`
	UL for .NET:
	`QuadCount1`, `QuadCount2`, `QuadPreset1`, `QuadPreset2`, `QuadPreScaler1`, `QuadPreScaler2`
	CIO-QUAD04, **PCI-QUAD04** also support:
	UL:
	`COUNT3`, `COUNT4`, `PRESET3`, `PRESET4`, `PRESCALER3`, `PRESCALER4`
	UL for .NET:
	`QuadCount3`, `QuadCount4`, `QuadPreset3`, `QuadPreset4`, `QuadPreScaler3`, `QuadPreScaler4`

`LoadValue`	When using `cbCLoad32()` or `CLoad32()` to load the `COUNT#` or `PRESET#` registers, values up to 16.78 million (2^{24}–1) can be loaded. Values using `cbCLoad()` and `CLoad()` are limited to 65,535 (2^{16}–1). Refer to "Basic signed integers" on page 157 for more information. When loading the `PRESCALER#` register, values can be from 0 to 255. (Digital Filter Clock frequency = 10 MHz/LoadValue + 1.)

Hardware considerations

Loading and Reading 24-bit values

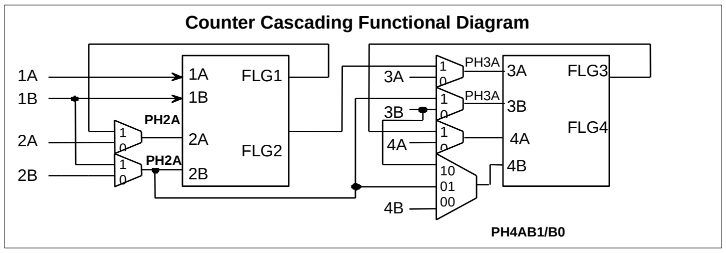
The **QUAD** series boards feature a 24-bit counter. For counts of less than 16-bits (65535), you can use the `cbCIn()` and `cbCLoad()` functions, or the `CIn()` and `CLoad()` methods. You can use the `cbCIn32()` and `cbCLoad()` functions, or the `CIn32()` and `CLoad32()` methods for any number supported by the LS7266 counter (24 bits = 16777216).

Cascading counters (PCI-QUAD04 only)

The **PCI-QUAD04** can be set up for cascading counters. By setting the appropriate registers, you can have (4) 24-bit counters, (2) 48-bit counters, (1) 24-bit and (1) 72-bit counters, or (1) 96-bit counter. The `OUTPUT` pins of a counter are directed to the next counter by setting the `FLG1` to `CARRY/BORROW` and the `FLG2` to `UP/DOWN`. Bits 3 and 4 of the IOR Register control are set to 1,0 to accomplish this.

You can set these bits by using the functions `cbC7266Config(BoardNum, CounterNum, Quadrature, CountingMode, DataEncoding, IndexMode, InvertIndex, FlagPins,` and `GateEnable)`. When using the Universal Library for .NET, use the `C7266Config()` method.
The constant `CARRYBORROW_UPDOWN` (value of 3) is used for the parameter `FlagPins`.

The IOR register cannot be read. However, you can read the values of the BADR2+9 register. The value for Base 2 can be determined by looking at the resources used by the board. The 8-bit region is BADR2. The BADR+9 register contains values for PhxA and PhxB, for x = 1 to 4 to identify counters. The diagram below indicates the routing of the FLG pins depending on the value of PhxA and PhxB. The actual values of the BADR2+9 register are shown below:



Register BADR2 + 9 D0-D6

	PH2A	PH2B	PH3A	PH3B	PH4A	PH4B1/PH4B0	Value
Case 1: (4) 24-bit counters (1/2/3/4)	0	0	0	0	0	0,0	00
Case 2: (2) 48-bit counters (1-2/3/4)	1	1	0	0	1	1,0	53
Case 3: (1) 24-bit, (1) 72-bit (1/2-3-4)	0	0	1	1	1	0,1	3C
Case 4: (1) 96-bit counter (1-2-3-4)	1	1	1	1	1	0,1	3F

Defaults to 0x00 (no inter-counter connections).

Examples

Case 1: (4) 24-bit counters (1/2/3/4)
```
cbC7266Config(0,1,0,0,2,0,0,1,0)
cbC7266Config(0,2,0,0,2,0,0,1,0)
cbC7266Config(0,3,0,0,2,0,0,1,0)
cbC7266Config(0,4,0,0,2,0,0,1,0)
```

Case 2: (2) 48-bit counters (1-2/3-4)
```
cbC7266Config(0,1,0,0,2,0,0,3,0)
cbC7266Config(0,2,0,0,2,0,0,1,0)
cbC7266Config(0,3,0,0,2,0,0,3,0)
cbC7266Config(0,4,0,0,2,0,0,1,0)
```

Case 3: (1) 24-bit & (1) 72-bit counter (1/2-3-4)
```
cbC7266Config(0,1,0,0,2,0,0,1,0)
cbC7266Config(0,2,0,0,2,0,0,3,0)
cbC7266Config(0,3,0,0,2,0,0,3,0)
cbC7266Config(0,4,0,0,2,0,0,1,0)
```

Case 4: (1) 96-bit counter (1-2-3-4)
```
cbC7266Config(0,1,0,0,2,0,0,3,0)
cbC7266Config(0,2,0,0,2,0,0,3,0)
cbC7266Config(0,3,0,0,2,0,0,3,0)
cbC7266Config(0,4,0,0,2,0,0,1,0)
```

The actual value of the BADR+9 register is not set until the `cbCLoad()/CLoad()` command is called.

Counter4 setting

Setting Counter4 to `CARRYBORROW-UPDOWN` is NOT VALID.

USB-4300 Series

The USB-4300 Series includes the USB-4301, USB-4302, USB-4303, and USB-4304 devices.

Counter I/O

Counter functions and methods supported

UL:	`cbC9513Config()`, `cbC9513Init()`, `cbCStoreOnInt()`, `cbCFreqIn()`,`cbCIn32()`, `cbCIn()`, `cbCLoad32()`, `cbCLoad()`
UL for .NET:	`C9513Config()`, `C9513Init()`, `CStoreOnInt()`, `CFreqIn()`, `CIn32()`, `CIn()`, `Cload32()`, `CLoad()`

Counter argument values

`CounterNum`	USB-4301 and USB-4302: 1 through 5 USB-4303 and USB-4304: 1 through 5, and 6 through 10
`RegNum`	USB-4301 and USB-4302: `LOADREG1 - 5`, `HOLDREG1 - 5`, `ALARM1CHIP1`, `ALARM2CHIP1` USB-4303 and USB-4304: `LOADREG1 - 10`, `HOLDREG1 - 10`, `ALARM1CHIP1`, `ALARM2CHIP1`, `ALARM1CHIP2`, `ALARM2CHIP2`
`LoadValue`	0 to 65535 (Refer to "16-bit values using a signed integer data type" on page 16 for information on 16-bit values using unsigned integers.)
`ChipNum`	USB-4301: 1 USB-4302: 1 USB-4303: 1, 2 USB-4304: 1, 2
`FOutSource`	`CTRINPUT1 - 5`, `GATE1 - 5`, `FREQ1 - 5` These values refer to the sources on a particular 9513 chip, so are limited to the sources on that particular chip. For example, to set the source to the input for counter 6, use `CTRINPUT1` (the first counter on the second 9513 chip).
`CountSource`	`TCPREVCTR`, `CTRINPUT1 - 5`, `GATE1 - 5`, `FREQ1 - 5` These values refer to the sources on a particular 9513 chip, so are limited to the sources on that particular chip. For example, to set the source to the input for counter 6, use `CTRINPUT1` (the first counter on the second 9513 chip). Likewise for the `TCPREVCTR` value: when applied to the first counter on a chip (for counter 6, the "previous counter" is counter 5 on that chip (for this example, counter 10).

Digital I/O

Port I/O functions and methods supported

UL:	`cbDIn()`, `cbDOut()`
UL for .NET:	`DIn()`, `DOut()`
`PortNum`	`AUXPORT*`
`DataValue`	0 to 255 * `AUXPORT` is not configurable for these boards.

Bit I/O functions and methods supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`

`PortType`	`AUXPORT*`
`BitNum`	0 to 7
	* `AUXPORT` is not configurable for these boards.

Event notification

Event notification functions and methods supported

UL:	`cbEnableEvent()`, `cbDisableEvent()`
UL for .NET:	`EnableEvent()`, `DisableEvent()`

Event notification argument values

`EventType`	`ON_EXTERNAL_INTERRUPT`
`EventParameter`	`LATCH_DI`, `LATCH_DO`

`LATCH_DI` can only be used with `cbDIn()` and `cbDBitIn()`. `LATCH_DO` can only be used with `cbDOut()` and `cbDBitOut()`.

Hardware considerations

Clock input frequency

The clock speed is configurable with *Insta*Cal for 1 MHz, 1.67 MHz, 3.33 MHz, or 5 MHz.

Event Notification

`ON_EXTERNAL_INTERRUPT` can't be used with `cbCStoreOnInt()` or `CStoreOnInt()`.

Interrupt Input pin

You can configure the interrupt input pin (**INT**) with *Insta*Cal to trigger off rising or falling edge inputs. You can program this pin to perform the following tasks:

- Send an event notification to the computer. The transfer rate is system-dependent.
- Latch digital input data.
- Latch digital output data.
- Save the current value of a counter. You can configure this option for each counter individually.

Digital bit latching

Digital input bit latching is supported by `cbDIn()` and `cbDBitIn()`. Digital output bit latching is supported by `cbDOut()` and `cbDBitOut()`.

- Use the `EventParam` option `LATCH_DI` with `cbDIn()` and `cbDBitIn()` to return the data that was latched in at the most recent interrupt edge. The current value of the digital inputs (0 or 1) is read and stored. The stored value is updated when an active edge occurs on the Interrupt Input pin.

  There is a latency period between when an active interrupt edge occurs on the INT pin and when the action triggered by that interrupt occurs. This latency can be as long as 100 µs, but typically varies from about 9 µs to about 40 µs between interrupts.

- Use the `EventParam` option `LATCH_DO` with `cbDOut()` and `cbDBitOut()` to latch out the data most recently written to the device. The digital outputs are not set to the value written until an active edge occurs on the Interrupt Input pin.

Expansion Boards

Introduction

This chapter provides details on using expansion (**EXP**) boards in conjunction with the Universal Library. Boards released after the printing of this user's guide are described in Readme files on the Universal Library disk.

Auto-detected expansion boards are automatically added to the *Insta*Cal configuration when *Insta*Cal is launched. The device properties are automatically adjusted to reflect the expansion properties. These types of expansion boards are not shown as a separate device in the device tree.

Manually configured expansion boards, such as the CIO-EXP series, are added to the *Insta*Cal configuration by selecting the compatible board on the main **InstaCal** form, and selecting the **Add Exp Board…** option from the **Install** menu. The expansion board will then be shown in the device tree as a branch attached to the device it was added to.

AI-EXP48

The AI-EXP48 expansion board can be used in combination with compatible parent boards, such as a USB-1616HS Series board.

The AI-EXP48 supports all of the analog input and temperature input capabilities of the parent board, but expands the channel count as follows:

Analog Input

Analog input argument values

`HighChan`	16 to 63 in single-ended mode, 8 to 31 in differential mode

Temperature Input

Temperature input argument values

`HighChan`	8 to 31

DAQ input

DAQ input argument values

`ChanArray`	`ANALOG`:	0 to 63 in single-ended mode, 0 to 31 in differential mode
	`CJC`:	6 to 11
	`TC`:	8 to 31

Hardware considerations

Associating CJC channels with TC channels

The TC channels must immediately follow their associated CJC channels in the channel array. For accurate thermocouple readings, associate CJC channels with the TC channels as listed in the following table:

CJC channels	TC channels
CJC6	TC8 through TC11
CJC7	TC12 through TC15
CJC8	TC16 through TC19
CJC9	TC20 through TC23
CJC10	TC24 through TC27
CJC11	TC28 through TC31

The parent board must be configured for differential inputs when using thermocouples

TC inputs are supported by differential mode configuration only.

CIO-EXP Series

Temperature Input

Temperature input functions and methods supported

UL:	`cbTIn()`, `cbTInScan()`
UL for .NET:	`TIn()`, `TInScan()`

Temperature input argument values

`Options`	`NOFILTER`
`Scale`	`CELSIUS`, `FAHRENHEIT`, `KELVIN`
`HighChan`	From 16 up to 255 for 16-channel boards, and from 64 up to 303 for 64-channel boards. The value depends on the number of boards connected and the application.

Hardware considerations

CIO-EXP boards are used only in combination with an A/D board. Channel numbers for accessing the expansion boards begin at 16 for 8-channel and 16-channel boards, and at 64 for 64-channel boards. To calculate the channel number for access to **CIO-EXP** channels, use the following formula:

```
Chan = (ADChan * 16) + (16 + MuxChan)
```

`MuxChan` is a number ranging from 0 to 15 that specifies the channel number on a particular bank of the expansion board. An **EXP32** has two banks, so the channel numbers for one **EXP32** connected to an A/D board would range from 16 to 47.

If all A/D channels are not used for **CIO-EXP** output, direct input to the A/D board is still available at these channels (using channel numbers below 16).

When **CIO-EXP** boards are used for **temperature input**, set the gain of the A/D board to a specific range. When using A/D boards with programmable gain, the range is set by the Universal Library. However, when using boards with switch-selectable gains, you must set the gain to a range that is dependent on the temperature sensor in use. Generally, thermocouple measurements require the A/D board to be set to 5 V bipolar, if available (or 10 V bipolar if not). RTD sensors require a setting of 10 V unipolar, if available. These checks are made when you configure the system for temperature measurement using *Insta*Cal.

MEGA-FIFO

Memory I/O

Memory I/O is only used in combination with a board which has DT-Connect.

Memory functions and methods supported

UL:	`cbMemSetDTMode()`, `cbMemReset()`, `cbMemRead()`, `cbMemWrite()`, `cbMemReadPretrig()`
UL for `.NET`:	`MemSetDTMode()`, `MemReset()`, `MemRead()`, `MemWrite()`, `MemReadPretrig()`

Some of these functions are integrated into the `cbAInScan()` function and `AInScan()` method. For example, if you use **MEGA-FIFO** with an A/D board and select the `EXTMEMORY` option, you would not have to call the `cbMemSetDTMode()` and `cbMemWrite` functions, or the `MemSetDTMode()` and `MemWrite()`methods.

`EXTMEMORY` option

`Continuous` mode can't be used with the `EXTMEMORY/ExtMemory` option.

MetraBus Boards

Introduction

This section provides details on using all **MetraBus** boards in conjunction with the Universal Library. Future releases will be described in Readme files on the Universal Library installation disk.

To use any **MetraBus** I/O board, a **MetraBus** interface board, such as the **ISA-MDB64**, **PCI-MDB64** or a **CPCI-MDB64**, is required for the Universal Library functions to operate correctly. The interface board and a **MetraBus** cable provide the interface between the PC bus (ISA-, PC104-, PCI-, or CPCI-) and the **MetraBus** I/O Boards.

The **MetraBus** system is made up of at least one controller board that communicates with real world interface boards via a data bus (ribbon cable). The implication is that there will always be two or more boards in the system.

MDB64 Series

This series makes up the controller portion of the **MetraBus** system. The Universal Library contains no function to communicate specifically with this board. The functions in the library are directed to the devices on the bus instead.

For example, if this board was installed in *Insta*Cal as board 0, and an **MII-32** was installed as board 1, the communication would be directed to board 1. If you wanted to read digital bits from this configuration, use the `cbDBitIn()` function or the `DBitIn()` method. The value of the `BoardNum` argument would be 1.

MIO and MII Digital I/O

All **MetraBus** boards require a cable and an interface board (such as an **ISA-, PC104-**, or **PCI- MDB64**) to interface to the host computer system.

Digital In

MII-32 Only

Digital input functions and methods supported

UL:	`cbDIn`, `cbDBitIn()`
UL for .NET:	`DIn`, `DBitIn()`

Digital input argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `SECONDPORTA`, `SECONDPORTB`
`DataValue`	0 to 255 for `PORTA` or `PORTB`
`BitNum`	0 to 31 for `FIRSTPORTA`

Digital Out

MIO-32 Only

Digital output functions and methods supported

UL:	`cbDOut`, `cbDBitOut()`, `cbDBitIn()`, `cbDIn()`
UL for .NET:	`DOut`, `DBitOut()`, `DBitIn()`, `DIn()`

Digital output argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `SECONDPORTA`, `SECONDPORTB`
`DataValue`	0 to 255 for `PORTA` or `PORTB`
`BitNum`	0 to 31 for `FIRSTPORTA`

Functions/methods for reading back the MIO-32 output state

Although the **MIO-32** is a digital output-only board, the state of the outputs can be read back using the UL functions `cbDIn()` and `cbDBitIn()`, or the UL for .NET methods `DIn()` and `DBitIn()`.

MEM Series Relay

All **MetraBus** boards require a cable and an interface board (such as an **ISA-, PC104-**, or **PCI- MDB64**) to interface to the host computer system.

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDOut()`, `cbDIn()`, `cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DOut()`, `DIn()`, `DBitIn()`, `DBitOut()`

Digital I/O argument values

`PortNum`	`FIRSTPORTA`
	`For` **MEM-32**, the following argument values are also valid:
	`FIRSTPORTB`, `SECONDPORTA`, `SECONDPORTB`

`DataValue`	0 to 255 for `PORTA` or `PORTB`
`BitNum`	0 to 7 for `FIRSTPORTA` `For` **MEM-32**, the following argument values are also valid: 0 to 31 for `FIRSTPORTA`

Functions/methods for reading back the MEM Series Relay output state

Although the **MEM Series Relay** is a digital output-only board, the state of the outputs can be read back using the UL functions `cbDIn()` and `cbDBitIn()`, or the UL for .NET methods `DIn()` and `DBitIn()`.

MSSR-24 SSR

All **MetraBus** boards require a cable and an interface board (such as an **ISA-, PC104-**, or **PCI- MDB64**) to interface to the host computer system.

Digital I/O

Digital I/O functions and methods supported

UL:	`cbDIn`, `cbDBitIn()`, `cbDOut`, `cbDBitOut()`
UL for .NET:	`DIn`, `DBitIn()`, `DOut`, `DBitOut()`

Digital I/O argument values

`PortNum`	`FIRSTPORTA`, `FIRSTPORTB`, `SECONDPORTA`
`DataValue`	0 to 255
`BitNum`	0 to 24 using `FIRSTPORTA`

Temperature Input Boards

Introduction

This chapter provides details on using temperature input boards in conjunction with the Universal Library and Universal Library for .NET. Boards released after the printing of this user's guide will be described in Readme files on the Universal Library disk.

For information on the CIO-EXP board series, refer to on page 167.

CIO-DAS-TEMP

Temperature input

Temperature input functions and methods supported

UL:	`cbTIn()`, `cbTInScan()`
UL for .NET:	`TIn()`, `TInScan()`

Temperature input argument values

`Options`	`NOFILTER`
`Scale`	`CELSIUS`, `FAHRENHEIT`, `KELVIN`
`HighChan`	0 to 31

Hardware considerations

Pacing Input

The rate of measurement is fixed at approximately 25 samples per second.

Selecting Thermocouples

J, K, E, T, R, S or B type thermocouples may be selected using *Insta*Cal.

DAS-TC Series

Temperature Input

Temperature input functions and methods supported

UL:	`cbTIn()`, `cbTInScan()`
UL for .NET:	`TIn()`, `TInScan()`

Temperature input argument values

`Options`	`NOFILTER`
`Scale`	`CELSIUS`, `FAHRENHEIT`, `KELVIN`
`HighChan`	0 to 15

Hardware considerations

Pacing input

The rate of measurement is fixed at approximately 25 samples per second.

Selecting thermocouples

J, K, E, T, R, S, N, or B type thermocouples may be selected using *Insta*Cal.

Open thermocouples

When using `cbTInScan()` or `TInScan()` with the **DAS-TC**, an open thermocouple error (`OPENCONNECTION`) on any of the channels will cause all data to be returned as –9999.0. This is a hardware limitation. If your application requires isolating channels with defective thermocouples attached and returning valid data for the remainder of the channels, use the `cbTIn()` function or `TIn()` method instead.

To read the voltage input of the thermocouple, select `VOLTS` for the `Scale` parameter in `cbTIn()` and `cbTInScan()`, or `TIn()` and `TInScan()`.

USB-TEMP Series, USB-TC Series

The USB-TEMP Series includes the USB-TEMP and USB-TEMP-AI devices. The USB-TC Series includes the USB-TC and USB-TC-AI devices.

Each series supports the following UL and UL for .NET features:

Temperature input

Temperature input functions and methods supported

UL:	`cbTIn()`, `cbTInScan()`
UL for .NET:	`TIn()`, `TInScan()`

Temperature input argument values

`Options`	`N/A`
`Scale`	`CELSIUS`, `FAHRENHEIT`, `KELVIN`
`HighChan`	USB-TEMP and USB-TC: 0 to 7
	USB-TEMP-AI and USB-TC-AI: 0 to 3

Voltage input (USB-TEMP-AI, USB-TC-AI)

Voltage input functions and methods supported

UL:	`cbVIn()`
UL for .NET:	`VIn()`

Voltage input argument values

`Options`	`N/A`
`HighChan`	0 to 3
`Range`	This board uses the Range set in *Insta*Cal, so the `Range` argument to this function is ignored.

Digital I/O

Configuration functions, methods, and argument values supported

UL:	`cbDConfigBit()`, `cbDConfigPort()`
UL for .NET:	`DConfigBit()`, `DConfigPort()`
`PortNum`	`AUXPORT`
`PortType`	`AUXPORT`

***Port* I/O functions, methods, and argument values supported**

UL:	`cbDIn()`,`cbDOut()`
UL for .NET:	`DOut()`, `DIn()`
`PortNum`	`AUXPORT`
`DataValue`	0 to 255 on `AUXPORT`

***Bit* I/O functions, methods, and argument values supported**

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`AUXPORT`

`BitNum`	0 to 7 on `AUXPORT`

Counter I/O (USB-TEMP-AI, USB-TC-AI)

Counter I/O functions and methods supported

UL:	`cbCIn()`*, `cbCIn32()`, `cbCLoad()`**, `cbCLoad32()`**
UL for .NET:	`CIn()`*, `CIn32()`, `CLoad()`**, `CLoad32()`**

*Although `cbCIn()` and `CIn()` are valid for use with this counter, `cbCIn32()` or `CIn32()` may be more appropriate, since the values returned may be greater than the data types used by `cbCIn()` and `CIn()` can handle.
**`cbCLoad()`, `cbCLoad32()`, `CLoad()` and `CLoad32()` only accept `Count`=0. These functions are used to reset the counter.

Counter I/O argument values

`CounterNum`	1
`Count`	2^{32}-1 when reading the counter. 0 when loading the counter. `cbCLoad()` and `cbCLoad32()` / `CLoad()` and `CLoad32()`are only used to reset the counter for this board to 0. No other values are valid. The "Basic signed integers" guidelines on page 134 apply when using `cbCIn()` or `CIn()` for values greater than 32767, and when using `cbCIn32()` or `CIn32()` for values greater than 2147483647.
`RegNum`	`LOADREG1`

Hardware considerations

Pacing readings

The internal update rate for measurement is a fixed value for these devices. If the UL reads the device faster than the internal update rate, readings "repeat." For example, if using `cbTIn()` in a loop to measure a rapidly changing temperature, readings do not change for several iterations of the loop, then "jump" when the update occurs internally.

Using single sensors with cbTInScan()

When using single sensors for RTD or thermistor sensors, you should ignore the data for channels that do not have sensors attached. It is best to use `cbTIn()` for these configurations, since you can select which channels to read. If you use `cbTInScan()`, however, data for all channels over the entire range of channels are returned. Since some channels are not populated in this configuration, you should filter out the data for channels without sensors.

Saving configuration settings

*Insta*Cal allows you to save configuration settings to a file or load a configuration from a previously saved file.

- Each USB-TEMP and USB-TEMP-AI channel can be configured to measure temperature data collected by one of five categories of temperature sensors: thermistors, thermocouples, RTDs, semiconductors, and *Disabled*.
- Each USB-TC and USB-TC-AI channel can be configured to measure temperature data collected by one of eight types of thermocouples.
- Each USB-TEMP-AI and USB-TC-AI voltage input channel can be configured for single-ended or differential mode and for one of four ranges - ±10 V, ±5 V, ±2.5 V, or ±1.25 V.

Recommended warm-up time

Allow the device to warm-up for 30 minutes before taking measurements. This warm-up time minimizes thermal drift and achieves the specified rated accuracy of measurements.

For RTD or thermistor measurements, this warm-up time is also required to stabilize the internal current reference.

Calibration

Any time the sensor category is changed in the configuration, a calibration is automatically performed by *Insta*Cal. If the device has not been warmed up when this occurs, you should re-calibrate after the specified warm-up time.

Error codes

- The UL returns *-9999* when a value is out of range or an open connection is detected.
- The UL returns *-9000* when the device is not ready. This usually occurs right after the device is powered up and calibration factors are being loaded.

Miscellaneous functions and methods supported

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

Causes the USB LED on a Measurement Computing USB module to blink.

When you have several modules connected to the computer, use these functions to identify a particular module by making its LED blink.

USB-5203, USB-5201

The USB-5203 and USB-5201 support the following UL and UL for .NET features.

Temperature input

Temperature input functions and methods supported

UL:	`cbTIn()`, `cbTInScan()`
UL for .NET:	`TIn()`, `TInScan()`

Temperature input argument values

`Options`	`N/A`
`Scale`	`CELSIUS`, `FAHRENHEIT`, `KELVIN`
`HighChan`	0 to 7

Digital I/O

Configuration functions, methods, and argument values supported

UL:	`cbDConfigBit()`, `cbDConfigPort()`
UL for .NET:	`DConfigBit()`, `DConfigPort()`
`PortNum`	`AUXPORT`
`PortType`	`AUXPORT`

Port I/O functions, methods, and argument values supported

UL:	`cbDOut()`, `cbDIn()`
UL for .NET:	`DOut()`, `DIn()`
`PortNum`	`AUXPORT`
`DataValue`	0 to 255 for `AUXPORT`

Bit I/O functions, methods, and argument values supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`AUXPORT`
`BitNum`	0 to 7 on `AUXPORT`

Data Logging

Data logger functions and methods supported

UL:	`cbLogConvertFile()`, `cbLogGetAIChannelCount()`, `cbLogGetAIInfo()`, `cbLogGetCJCInfo()`, `cbLogGetDIOInfo()`, `cbLogGetFileInfo()`, `cbLogGetFileName()`, `cbLogGetPreferences()`, `cbLogGetSampleInfo()`, `cbLogReadAIChannels()`, `cbLogReadCJCChannels()`, `cbLogReadDIOChannels()`, `cbLogReadTimeTags()`, `cbLogSetPreferences()`
UL for .NET:	`ConvertFile()`, `GetAIInfo()`,`GetAIChannelCount()`, `GetCJCInfo()`, `GetDIOInfo()`, `GetFileInfo()`, `GetFileName()`, `GetPreferences()`, `GetSampleInfo()`, `ReadAIChannels()`, `ReadCJCChannels()`, `ReadDIOChannels()`, `ReadTimeTags()`, `SetPreferences()` The `cbLogGetCJCInfo()` function and the `GetCJCInfo()` method return the number of CJC temperature channels logged in the binary file ("0" or "2".)

The `cbLogGetDIOInfo()` function and the `GetDIOInfo()` method return the number of digital I/O channels logged in the binary file ("0" to "8".)

Data logger argument values

Delimiter	Comma, Semicolon, Space, Tab
LoggerUnits	Temperature, Raw
Units	Celsius, Fahrenheit, Kelvin
TimeFormat	TwelveHour, TwentyFourHour
TimeZone	Local, GMT

Hardware considerations

Logging and storing measurement data

Temperature measurements can be stored onto a CompactFlash® memory card (64 MB CF card included with hardware). Each sample is stored on the card in a binary file. You set up your logging options through *Insta*Cal:

- temperature input channels to log
- channel format as raw data or temperature
- start mode to begin a logging session
- interval (sec.) between samples
- set up alarm conditions to trigger DIO bits

*Insta*Cal provides further options for copying, converting, and deleting the binary files. You can access log data stored on the memory card with a CompactFlash reader, or by transferring the files from Insta*Cal* to a computer for processing and conversion using the USB bus.

Note: A card reader is not required to access log data on a device installed with firmware 3.0 and later. A device with this firmware version appears in Windows Explorer as a removable drive from which you can directly access the log data.

External power required for data logging

Due to processing limitations, data logging to the memory card is not allowed when the device is connected to your computer's active USB bus. When operating as a data logger, disconnect the USB cable from the computer, and connect the external power supply shipped with the device.

Note: If you are using a self-powered hub, make sure it is attached to the PC’s USB port before connecting it to the USB-5201 or USB-5203. If a powered hub is connected to the device first, it may be detected by the device as a power supply and go into logging mode.

Configuring the DIO channels to generate alarms

The USB-5203 and USB-5201 both provide eight independent temperature alarms. Each alarm controls an associated digital I/O channel as an alarm output. The input to each alarm is one of the temperature input channels. Use *Insta*Cal to set up the temperature conditions to activate an alarm, and the output state of the channel (active high or low) when activated.

Digital channels that are configured as alarms will power up in an output state. When an alarm is activated, the associated DIO channel is driven to the output state defined by the alarm configuration.

The alarms function both in data logging mode and while attached to the USB port on a computer. The alarm configurations are stored in non-volatile memory on the device and are loaded on power up.

Pacing temperature readings

The internal update rate for temperature measurement is a fixed value for these devices. If the UL reads the device faster than the internal update rate, temperature readings "repeat." For example, if using `cbTIn()` in a loop to measure a rapidly changing temperature, readings do not change for several iterations of the loop, then "jump" when the update occurs internally.

Using single sensors with cbTInScan()

When using single sensors for RTD or thermistor sensors, you should ignore the data for channels that do not have sensors attached. It is best to use `cbTIn()` for these configurations, since you can select which channels to read. If you use `cbTInScan()`, however, data for all channels over the entire range of channels are returned. Since some channels are not populated in this configuration, you should filter out the data for channels without sensors.

Saving configuration settings

*Insta*Cal allows you to save USB-5203 and USB-5201 configuration settings to a file, or load a configuration from a previously saved file.

- Each USB-5203 channel can be configured to measure temperature data collected by one of five categories of temperature sensors: thermistors, thermocouples (one of eight types), RTDs, semiconductors, and *Disabled*.
- Each USB-5201 channel can be configured to measure temperature data collected by one of eight types of thermocouples.

Recommended warm-up time

Allow a warm-up time of 30 minutes before taking measurements. This warm-up time minimizes thermal drift and achieves the specified rated accuracy of measurements.

For RTD or thermistor measurements (USB-5203 only), this warm-up time is also required to stabilize the internal current reference.

Calibration

Any time the sensor category is changed in the configuration for the USB-5203, a calibration is automatically performed by *Insta*Cal. If the device has not been warmed up when this occurs, you should re-calibrate after the specified warm-up time.

Error codes

- The UL returns *-9999* when a value is out of range or an open connection is detected.
- The UL returns *-9000* when the device is not ready. This usually occurs right after the device is powered up and calibration factors are being loaded.

Miscellaneous functions and methods supported

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

Causes the LED on the side of the module to blink twice for visual identification.

When you have several modules connected to the computer, use these functions to identify a particular module by making its LED blink.

WEB-TEMP, WEB-TC

The WEB-TEMP and WEB-TC support the following UL and UL for .NET features.

Temperature input

Temperature input functions and methods supported

UL:	`cbTIn()`, `cbTInScan()`
UL for .NET:	`TIn()`, `TInScan()`

Temperature input argument values

`Options`	`N/A`
`Scale`	`CELSIUS`, `FAHRENHEIT`, `KELVIN`
`HighChan`	0 to 7

Digital I/O

Configuration functions, methods, and argument values supported

UL:	`cbDConfigBit()`, `cbDConfigPort()`
UL for .NET:	`DConfigBit()`, `DConfigPort()`
`PortNum`	`AUXPORT`
`PortType`	`AUXPORT`

Port I/O functions, methods, and argument values supported

UL:	`cbDIn()`, `cbDOut()`
UL for .NET:	`DIn()`, `DOut()`
`PortNum`	`AUXPORT`
`DataValue`	0 to 255 on `AUXPORT`

Bit I/O functions, methods, and argument values supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`AUXPORT`
`BitNum`	0 to 7 on `AUXPORT`

Configuration

Configuration functions and methods supported

UL:	`cbGetConfig()`, `cbSetConfig()`, `cbGetConfigString()`, `cbSetConfigString()`

Configuration argument values

ConfigItem:	`BINODEID`, `BINETIOTIMEOUT`, `BIHIDELOGINDLG`
Device Number	0
`maxConfigLen`	Up to 48

Miscellaneous

UL:	`cbDeviceLogin()`, `cbDeviceLogout()`, `cbFlashLED()`
UL for .NET:	`DeviceLogin()`, `DeviceLogout()`, `FlashLED()`

Hardware considerations

Web based

If the user name and password have been changed from the default, the user must log in with the new user name and password to change configuration settings. Only one user can be logged in at a time. The log in session times out after five minutes of inactivity. Log in is not required to view the current configuration in *Insta*Cal.

Hardware options are configurable on the web browser or with *Insta*Cal. If hardware options are changed on the web browser while *Insta*Cal is open, restart or refresh *Insta*Cal to update its configuration pages with the settings stored on the device. Network parameters and some configuration settings for resistance measurement are configurable with *Insta*Cal only.

Configuration options are stored in non-volatile memory in EEPROM, and are loaded on power up.

Network parameters

The following network parameters are configurable with *Insta*Cal. Configurable network options are enabled when you start *Insta*Cal if the default user name and password are still assigned. If a custom user name and password have been assigned, the configurable network options are enabled after you log in.

- **Identifier**: Text that identifies the WEB device. This value is optional, and is not set by default. You can enter up to 48 alpha-numeric characters. You can set this value in code using the Universal Library `ConfigItem` option `BINODEID` with `cbSetConfigString()`.
- **DHCP**: Enables automatic configuration of the IP address of the WEB device by a DHCP Server. When a DHCP-enabled server is available, an IP address is automatically assigned to the device when it is detected on the network. This value is set to *Enabled* by default. Disable this option when the server is not DHCP-enabled, or when you want to enter a static IP address.
- **IP**: The IP address that is currently stored on the device is displayed in the **Current Settings** frame in *Insta*Cal's Board Configuration dialog. By default, this address is set automatically when a DHCP server is available. If you are setting a static IP address manually, enter it in the **IP** text box on the **Default Settings** frame. Every device connected to the network must have a unique IP address. This value is set to 192.168.0.101 by default.
- **Subnet**: The Subnet Mask that is currently stored on the device is displayed in the **Current Settings** frame in *Insta*Cal's **Board Configuration** dialog. The Subnet Mask is the part of the IP address that denotes the local Subnet. By default, the Subnet Mask is set automatically when a DHCP server is available. If you are setting a static IP address manually, enter the Subnet Mask in the **Subnet** text box on the **Default Settings** frame.

  This value is set to 255.255.255.0 by default. The first three groups of numbers indicate the network number to which the device is connected, and the last group indicates the node number within the network that identifies the device.
- **Gateway**: The Gateway IP address that is currently stored on the device is displayed in the **Current Settings** frame in *Insta*Cal's Board Configuration dialog. By default, the Gateway IP address is set automatically when a DHCP server is available. If you are setting a static IP address manually, enter the Gateway in the **Gateway** text box on the **Default Settings** frame. This value is set to 192.168.0.1 by default. The Gateway parameter is used for communication between devices on different networks.
- **Server**: Enables or disables the device's web page server. This value is set to *Enabled* by default. When enabled, you can view the device's web page with a web browser. When disabled, you can only access the device with *Insta*Cal or the Universal Library. Disable when you want to restrict access to the device's web page. Changes to this setting take affect the next time you power up the device.
- **Change Login** button: Opens a dialog to change the user name and password used to log in to a device session. Once changed, log in is required to change configurable options on the device. The user name and password are not stored on the host computer, and must be entered each time you start the application. Refer to Logging in to a device session on page 186 for more information.

- **Login** button: This button is enabled when login is required.

*Insta*Cal's configuration page also lists the unique 64-bit physical (MAC) address assigned to the device. You cannot change this address.

Logging in to a device session

You must be logged in to a device session in order to change the configuration settings of a device or change the state of the digital outputs. A user name and password are required to log in if they are not set to the default values. For security, it is recommended that you change the login values from the defaults. The log in session times out after five minutes of inactivity.

The default user name is set to *webtemp* for the WEB-TEMP, and *webtc* for the WEB-TC. The default password is *mccdaq* for both devices. You can change these values in *Insta*Cal with the **Change Login** button after you are logged in to a device session. Each value can be up to eight alphanumeric characters.

Using *Insta*Cal, when the user name and password have been changed from the default values, the configuration page opens with configurable items disabled and the **Login** button enabled. Click the **Login** button and then enter the values. The `INVALIDLOGIN` error is returned if the login information is not valid. The `SESSIONINUSE` error is returned if you attempt to log in when a session is currently open by another user. Only one user can be logged in to a session at a time.

Similarly, applications written with the Universal Library will perform a background log in when required if the login parameters are set to the default values. If custom values have been set, you have the option to allow the default login dialog to pop up when required or to disable the default dialog and handle login in your code.

To disable the default login dialog when using the Universal Library, you can select the "**Show Login dialog prompt**" option in *Insta*Cal, or for a more permanent result, disable the default dialog using `cbSetConfig()` with the `BIHIDELOGINDLG` `ConfigItem` argument within your application code.

Factory default reset

To restore the network parameters (including the user name and password) to the factory default settings, press and hold the device's reset button for three seconds. You do not have to be logged in to restore the default network settings.

Manually adding a device to *Insta*Cal

If a device is not yet connected to the local network, or if it is connected remotely to a different LAN, *Insta*Cal will be unable to detect it. If autodetection fails, you can manually add the device to *Insta*Cal using the **Web** tab on the **Board Selection List** dialog, and specify the IP address and port to use in the broadcast.

The default IP address and port add a placeholder to the configuration of a WEB device detected on the network. The default IP address broadcasts to all devices detected on the local subnet. The default port lists the default port number that is used to interface with the UL.

Any instance of the device type responding to the broadcast will attach to the placeholder. You can specify the device to attach to the placeholder by clicking the **MAC** check box and entering the device's type and instance ID. Enter **C0** to locate a WEB-TC, or **C2** to locate a WEB-TEMP. Enter any value from **0x00000** to **0x2FFFE** (except 0x1FFFF) for the instance ID. The first three octets of a MAC address indicate the vendor ID and cannot be changed.

Configuring the DIO channels to generate alarms

The WEB-TEMP and WEB-TC provide eight independent temperature alarms. Each alarm controls an associated digital I/O channel as an alarm output. The input to each alarm is one of the temperature input channels. You set up the temperature conditions to activate an alarm, and the output state of the digital channel (active high or low) when activated. You can view the alarm status on the web browser.

Digital channels that are configured as alarms will power up in an output state. When an alarm is activated, the associated DIO channel is driven to the output state defined by the alarm configuration. The alarm configurations are stored in non-volatile memory on the device and are loaded on power up. Alarm settings can be configured using the device's web browser or *Insta*Cal.

Pacing temperature readings

The internal update rate for temperature measurement is a fixed value for these devices. If the UL reads the device faster than the internal update rate, temperature readings "repeat." For example, if using `cbTIn()` in a loop to measure a rapidly changing temperature, readings do not change for several iterations of the loop, then "jump" when the update occurs internally.

Using single sensors with cbTInScan() (WEB-TEMP only)

When using single sensors for RTD or thermistor sensors, you should ignore the data for channels that do not have sensors attached. It is best to use `cbTIn()` for these configurations, since you can select which channels to read. If you use `cbTInScan()`, however, data for all channels over the entire range of channels are returned. Since some channels are not populated in this configuration, filter out the data for channels without sensors.

Channel names

You can specify a custom name for each of the device channels with *Insta*Cal. Enter up to 10 alpha-numeric characters in the **Name** text box on each channel configuration page.

Saving configuration settings

*Insta*Cal allows you to save hardware configuration settings to a file, or load a configuration from a previously saved file.

Each WEB-TEMP channel can be configured to measure temperature data collected by one of five categories of temperature sensors: thermistors, thermocouples, RTDs, semiconductors, and *Disabled*. Each WEB-TC channel can be configured to measure temperature data collected by one of eight types of thermocouples.

Recommended warm-up time

Allow the WEB device to warm-up for 30 minutes before taking measurements. This warm-up time minimizes thermal drift and achieves the specified rated accuracy of measurements. For RTD or thermistor measurements, this warm-up time is also required to stabilize the internal current reference.

Calibration

You can manually calibrate a WEB device using *Insta*Cal or the web interface. Any time a sensor is changed using the WEB interface, a calibration is automatically performed. If the device has not been warmed up when this occurs, you should re-calibrate after the specified warm-up time.

Timeout errors

In some cases, there can be delays in obtaining the data from the WEB device, causing a `NOREMOTEACK` error to be generated. This can be caused by other users making configuration changes on the device, or by slow or busy network connections.

You can use the `ConfigItem` option `BINETIOTIMEOUT` with `cbSetConfig()` to set the time (in mS) to wait for a device to acknowledge a command or query made via the network connection.

FlashLED()

Call this function to flash the POWER/COMM LED on a WEB device. This is useful if you have multiple devices connected and you want to identify a particular device.

WLS Series

The WLS-IFC, WLS-TEMP, and WLS-TC support the following UL and UL for .NET features.

Temperature input (WLS-TEMP and WLS-TC)

Temperature input functions and methods supported

UL:	`cbTIn()`, `cbTInScan()`
UL for .NET:	`TIn()`, `TInScan()`

Temperature input argument values

`Options`	`N/A`
`Scale`	`CELSIUS`, `FAHRENHEIT`, `KELVIN`
`HighChan`	0 to 7

Digital I/O (WLS-TEMP and WLS-TC)

Configuration functions, methods, and argument values supported

UL:	`cbDConfigBit()`, `cbDConfigPort()`
UL for .NET:	`DConfigBit()`, `DConfigPort()`
`PortNum`	`AUXPORT`
`PortType`	`AUXPORT`

Port I/O functions, methods, and argument values supported

UL:	`cbDOut()`, `cbDIn()`
UL for .NET:	`DOut()`, `DIn()`
`PortNum`	`AUXPORT`
`DataValue`	0 to 255 for `AUXPORT`

Bit I/O functions, methods, and argument values supported

UL:	`cbDBitIn()`, `cbDBitOut()`
UL for .NET:	`DBitIn()`, `DBitOut()`
`PortType`	`AUXPORT`
`BitNum`	0 to 7 on `AUXPORT`

Configuration

Configuration functions and methods supported

UL:	`cbGetConfig()`, `cbSetConfig()`, `cbGetConfigString()`, `cbSetConfigString()`
UL for .NET:	`GetDeviceNotes()`, `SetDeviceNotes()`, `GetDeviceId()`, `SetDeviceId()`, `GetPANID()`, `SetPANID()`, `GetRFChannel()`, `SetRFChannel()`, `GetRSS()`

Configuration argument values

ConfigItem:	`BIRFCHANNEL`, `BIPANID`, `BINODEID`, `BIDEVNOTES`
	
	The following argument value is also valid for the WLS-TEMP and WLS-TC when they are operating as remote devices:
	
	`BIRSS`

Hardware considerations

Wireless operation

You can operate the WLS-TEMP and WLS-TC as remote devices that communicate with the computer through a USB-to-wireless interface device, such as the WLS-IFC. The interface device can communicate with multiple remote WLS-Series devices over a wireless link.

Network parameters (wireless operation)

Use *Insta*Cal to configure the network parameters required for wireless communication. Configuration options are stored in non-volatile memory in EEPROM, and are loaded on power up.

Network parameters can only be modified when the device is connected locally to the computer through the USB port. After configuring the network settings for a remote device, unplug from the computer and move the device to its remote location.

The following network parameters are programmable with *Insta*Cal:

- **Identifier**: Text that identifies the WLS Series device. This value is optional, and is not set by default. You can enter up to 20 alpha-numeric characters.

  You can set the text identifier value using the `ConfigItem` option `BINODEID` with `cbSetConfigString()` or `SetDeviceId()` while the device is connected locally to the computer through the USB port, or when the device is operating remotely.

- **PAN** (hex): The personal area network ID assigned to the device. This value is set to 1000 hex by default (4096 decimal).

  Most users do not need to change this value. However, you may want to change the PAN value in the following situations:

  - You have multiple WLS Series devices and do not want to allow communication between all of them. Set the PAN ID to the same value on each device that you want to communicate.

  - If other WLS Series devices are operating in the vicinity, you can avoid accidental changes to your device settings by changing the default PAN value.

  To change the PAN ID, enter a 16-bit hexadecimal value between 0 and FFFE. (Hexadecimal values consist of numbers between 0 and 9 and letters between A and F. In this case, up to four characters could be entered.)

  You can set the PAN value using the `ConfigItem` option `BIPANID` with `cbSetConfig()` when the device is connected locally to the computer through the USB port.

- CH: The IEEE 802.15.4 radio frequency (RF) channel number assigned to the device. This is the channel number used to transmit and receive data over the wireless link.

  The table below lists each channel available along with its corresponding transmission frequency.

RF Channel	Transmission Frequency (GHz)	RF Channel	Transmission Frequency (GHz)
12	2.410	18	2.440
13	2.415	19	2.445
14	2.420	20	2.450
15	2.425	21	2.455
16	2.430	22	2.460
17	2.435	23	2.465

  The channel number is set to *16* by default. Select a different channel number if another group of WLS Series devices is already transmitting on that channel, or if the signal is spotty or intermittent, indicating noise on the channel. If you change the channel for one device, remember to also change the channel number on all other devices with which you want to communicate.

The level of noise per channel is system-dependent, and depends on the number of transmitters in the local vicinity, including wireless telephones, video monitors, and so on.

You can set the RF channel using the `ConfigItem` option `BIRFCHANNEL` with `cbSetConfig()` while the device is connected locally to the computer through the USB port.

- **AES Key**: The value used to encrypt a message (optional).

  This value is disabled by default. To enable encryption, click the *AES Key* button and enter up to 16 alpha-numeric characters in the text box. This value is write-only; it cannot be read back.

  Unless you suspect that there are other users of WLS Series devices in the area, there should be no need to enable encryption. However, if you suspect that there are other WLS Series devices in the area, and you need to secure the devices from being accessed by other users, enable this feature.

  Note that enabling encryption does NOT secure the device from access through a local USB connection. A remote device configured for encryption can be connected locally through the USB port to access other remote WLS Series devices with the same settings; you may need to physically secure the remote devices to prevent tampering of the of device's network.

Set the PAN ID, RF channel, and AES key to the same value for each device that you want to communicate

Only devices with matching parameter settings for PAN ID, RF channel, and AES encryption (if set) can communicate with each other.

*Insta*Cal's configuration page also lists the unique 64-bit address assigned to the device. You cannot change this address.

Use the **Device Notes** tab to enter up to 239 ASCII characters of additional text — for example, what the device is measuring, and which device it is communicating with. You can set the text to store in the device's memory using the `ConfigItem` option `BIDEVNOTES` with `cbSetConfigString()`.

Received Signal Strength (wireless operations)

When a WLS Series device is operating remotely, *Insta*Cal's configuration page includes a bar graph. The bar graph indicates the strength of the signal received by the remote device from the wireless interface module, and the fade margin of signals received by a device (refer to the following table.)

Active bars	fade margin	Rss (dBm)
0 – Weak signal	< 10 dBm	-82 dBm > rss
1 – Moderate signal	≥ 10 dBm	-72 dBm > rss >= -82 dBm
2 – Strong signal	≥ 20 dBm	-62 dBm > rss >= -72 dBm
3 – Very strong signal	≥ 30 dBm	rss > -62 dBm

The number of bars corresponds to the number of LEDs that are lit on the remote device. The bar graph display updates every two seconds on the *Insta*Cal form.

If the signal is not strong enough for communication between the interface device and the remote device, no bars or LEDs show, and a `NOREMOTEACK` error is returned. If this occurs, try moving or re-orienting the device to increase the strength of the signal

You can retrieve the value in dBm of the signal strength received by a remote device using the `ConfigItem` option `BIRSS` with `cbGetConfig()`.

External power required for wireless operations

An external power supply is required to power remote devices. For wireless operations, connect the device's USB cable to the AC-to-USB power adapter that shipped with the device.

Always connect an external hub to its power supply

If you are using a hybrid hub — one that can operate in either self-powered or bus-powered mode — always connect it to its external power supply.

If you use a hub of this type without connecting to external power, communication errors may occur that could result in corrupt configuration information on the wireless device. You can restore the factory default configuration settings with *Insta*Cal.

Factory default reset

To restore factory default configuration settings, click on the **Reset Defaults** button on *Insta*Cal's configuration page. The device must be connected locally to the computer's USB port to restore default settings.

Configuring the DIO channels to generate alarms (WLS-TEMP and WLS-TC)

The WLS-TEMP and WLS-TC both provide eight independent temperature alarms. Each alarm controls an associated digital I/O channel as an alarm output. The input to each alarm is one of the temperature input channels. Use *Insta*Cal to set up the temperature conditions to activate an alarm, and the output state of the channel (active high or low) when activated.

Digital channels that are configured as alarms will power up in an output state. When an alarm is activated, the associated DIO channel is driven to the output state defined by the alarm configuration. The alarms function both in wireless mode and while attached to the USB port on a computer. The alarm configurations are stored in non-volatile memory on the device and are loaded on power up.

Alarm settings can be configured when the device is connected locally to the computer through the USB port, or when the device is operated remotely through a wireless interface.

Pacing temperature readings

The internal update rate for temperature measurement is a fixed value for these devices. If the UL reads the device faster than the internal update rate, temperature readings "repeat." For example, if using `cbTIn()` in a loop to measure a rapidly changing temperature, readings do not change for several iterations of the loop, then "jump" when the update occurs internally.

Using single sensors with cbTInScan()

When using single sensors for RTD or thermistor sensors, you should ignore the data for channels that do not have sensors attached. It is best to use `cbTIn()` for these configurations, since you can select which channels to read. If you use `cbTInScan()`, however, data for all channels over the entire range of channels are returned. Since some channels are not populated in this configuration, you should filter out the data for channels without sensors.

Saving configuration settings (WLS-TEMP and WLS-TC)

*Insta*Cal allows you to save configuration settings to a file, or to load a configuration from a previously saved file.

- Each WLS-TEMP channel can be configured to measure temperature data collected by one of five categories of temperature sensors: thermistors, thermocouples, RTDs, semiconductors, and *Disabled*.
- Each WLS-TC channel can be configured to measure temperature data collected by one of eight types of thermocouples.

Recommended warm-up time

Allow the WLS-TEMP and WLS-TC to warm-up for 30 minutes before taking measurements. This warm-up time minimizes thermal drift and achieves the specified rated accuracy of measurements.

For RTD or thermistor measurements, this warm-up time is also required to stabilize the internal current reference.

Calibration

Any time the sensor category is changed in the configuration for the WLS-TEMP, a calibration is automatically performed by *Insta*Cal. If the device has not been warmed up when this occurs, you should re-calibrate after the specified warm-up time.

Error codes

- The UL returns *-9999* when a value is out of range or an open connection is detected.
- The UL returns *-9000* when the device is not ready. This usually occurs right after the device is powered up and calibration factors are being loaded.
- With wireless operations, the UL returns `NOREMOTEACK` when the signal is not strong enough for communication between the interface device and the remote device.

Miscellaneous functions and methods supported

UL:	`cbFlashLED()`
UL for .NET:	`FlashLED()`

Causes the USB LED on a Measurement Computing USB module to blink. When you have several modules connected to the computer, use these functions to identify a particular module by making its LED blink.

Other Hardware

Introduction

This chapter provides details on using communications boards in conjunction with the Universal Library and Universal Library for .NET. Boards released after the printing of this user's guide will be described in Readme files on the Universal Library disk.

COM422 Series

No library functions are supported for these boards, but *Insta*Cal can be used to configure the serial protocol in conjunction with the `Set422.exe` utility. All other serial communications are handled by Windows standard serial communications handlers.

COM485 Series

The **COM485** Series board supports the UL function `cbRS485()` and the UL for .NET method `RS485()` for controlling the transmit and receive enable register. All other serial communications are handled by Windows standard serial communications handlers.

Appendix – Measurement Computing Device IDs

This appendix lists the device ID associated with each Measurement Computing hardware type. This information is returned by the `BoardName` and `BoardNum` arguments.

Board Name	Device ID	Board Name	Device ID
PCI-DAS1602/16	1	PC-CARD-DAS16/16	56
		PC-CARD-DAS16/16-AO	57
CIO-DAS6402/12	8	PC-CARD-DAS16/12	58
CIO-DAS16/M1/16	9	PC-CARD-DAS16/12-AO	59
CIO-DAS6402/16	10	PC-CARD-DAS16/330	60
PCI-DIO48H	11	PC-CARD-D24/CTR3	61
PCI-PDISO8	12	PC-CARD-DIO48	62
PCI-PDISO16	13	PCI-COM232	63
CPCI-GPIB	14	PCI-COM232/2	64
PCI-DAS1200	15	PCI-COM232/4	65
PCI-DAS1602/12	16	PCI-COM422	66
CIO-RELAY16M	17	PCI-COM422/2	67
CIO-PDMA32	18	PCI-COM485	68
CIO-DAC04/16-HS	19	PCI-COM485/2	69
PCI-DIO24H	20	ISA-MDB64	70
PCI-DIO24H/CTR3	21	MII-32	71
PCI-DIO48H/CTR15	22	MIO-32	72
PCI-DIO96H	23	MEM-8	73
PCI-CTR05	24	MEM-32	74
PCI-DAS1200Jr	25	PCI-MDB64	75
PCI-DAS1001	26	PCI-DAS1000	76
PCI-DAS1002	27	PCI-QUAD04	77
PCI-DAS1602JR_16	28	MSSR-24	78
PCI-DAS6402/16	29	PC104-MDB64	79
PCI-DAS6402/12	30	MAI-16	80
PCI-DAS16/M1	31		
PCI-DDA02/12	32	PCI-DAS4020/12	82
PCI-DDA04/12	33	PCIM-DDA06/16	83
PCI-DDA08/12	34	PCI-DIO96	84
PCI-DDA02/16	35	CPCI-DIO24H	85
PCI-DDA04/16	36	PCIM-DAS1602/16	86
PCI-DDA08/16	37	PCI-DAS3202/16	87
PCI-DAC04/12HS	38	PC104-AC5	88
PCI-DAC04/16HS	39	PCI-QUAD-AC5	89
PCI-DIO24	40	CPCI-DIO96H	90
PCI-DAS08	41	CPCI-DIO48H	91
CIO-RELAY24	42	PC-CARD-DAC08	92
CIO-RELAY32	43	PCI-DAS6023	93
PCI-INT32	44	PCI-DAS6025	94
DEMO-BOARD	45	PCI-DAS6030	95
CIO-DAS-TC	46	PCI-DAS6031	96
CIO-QUAD02	47	PCI-DAS6032	97
CIO-QUAD04	48	PCI-DAS6033	98
PCM-QUAD02	49	PCI-DAS6034	99
PCI-DAS64	50	PCI-DAS6035	100
PCI-DUAL-AC5	51	PCI-DAS6040	101
PCI-DAS-TC	52	PCI-DAS6052	102
PCI-DAS64/M1/16	53	PCI-DAS6070	103
PCI-DAS64/M2/16	54	PCI-DAS6071	104
PCI-DAS64/M3/16	55		

Board Name	**Device ID**	**Board Name**	**Device ID**
PCI-CTR10	110	USB-4301	174
PCI-DAS6036	111	USB-5201 (Rev. 3 fw and later)	175
PCI-DAC6702	112	USB-5203 (Rev. 3 fw and later)	176
PCI-DAC6703	113	USB-2523	177
		USB-2527	178
PCI-CTR20HD	116	USB-2533	179
miniLAB 1008	117	USB-2537	180
PMD-1024LS	118	WLS-IFC	181
PCI-DIO24/LP	119	WLS-TC	182
PCI-DAS6013	120	WLS-TEMP	183
PCI-DAS6014	121	USB-4302	184
USB-1208LS, PMD-1208LS	122	USB-4303	185
PCIM-DAS16JR/16	123	USB-4304	186
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E-PDISO16	137	CIO-DAS16	257
USB-ERB24	138	CIO-DAS16/F	258
USB-ERB08	139	CIO-DAS16/Jr	259
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USB-TEMP	141	CIO-DAS16/330i	261
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USB-DIO96H	146	CIO-DAS16/Jr16	265
USB-DIO24/37	147		
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USB-DIO96H/50	149		
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USB-5201 (< Rev. 3 fw)	152	CIO-EXP-GP	771
USB-1608HS-2AO	153	CIO-EXP-RTD	772
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USB-3106	159	CIO-DIO96	1028
		CIO-DIO192	1029
USB-1408FS	161	CIO-DIO24/CTR3	1030
USB-3110	162	CIO-DIO48H	1031
USB-3112	163	CIO-DUAL-AC5	1032
USB-3114	164	CIO-DI48	1033
PCI-2511	165	CIO-DO48H	1034
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CIO-DO24DD	1039
CIO-DO48DD	1040
PC104-DIO48	1041
PC104-DI48	1042
PC104-DO48H	1043
CIO-PDMA16	1281
CIO-DAC02	1537
CIO-DAC08	1538
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CIO-DAC08I	1541
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CIO-DDA06/12	1793
CIO-DDA06/16	1794
CIO-DDA06/Jr	1795
CIO-DAC02/16	1796
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CIO-DAC16/16	1798
CIO-DDA06Jr/16	1799
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CIO-CTR10	2050
CIO-CTR10-HD	2051
CIO-CTR20-HD	2052
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CIO-PDISO8	2305
CIO-PDISO16	2306
PC104-PDISO8	2307
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CIO-DAS08	3073
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CIO-DAS08PGH	3075
CIO-DAS08/AOL	3076
CIO-DAS08/AOH	3077
CIO-DAS08PGM	3078
CIO-DAS08/AOM	3079
CIO-DAS08/Jr	3080
PC104-DAS08	3081
CIO-DAS08Jr/16	3082
CIO-DAS48PGA	3329
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CIO-DAS1602/12	3586
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CIO-RELAY16/M	4099
CIO-DAS-TEMP	4353
CIO-DISO48	8193
CIO-INT32	12289
PCM-DAS08	16385
PCM-D24/CTR3	16386
PCM-DAC02	16387
PCM-COM422	16388
PCM-COM485	16389
PCM-DAS16D/12	16390
PCM-DAS16S/12	16391
PCM-DAS16D/16	16392
PCM-DAS16S/16	16393
PCM-DAS16S/330	16394
PCM-DAS16D/12AO	16395
PCM-DAC08	16401
CIO-COM422	20481
CIO-COM485	20482
CIO-DUAL422	20483
CIO-DAS800	24577
CIO-DAS801	24578
CIO-DAS802	24579
CIO-DAS802/16	24580

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