DATA TRANSLATION®

A MEASUREMENT COMPUTING COMPANY

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# DataAcq SDK User's Manual

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# About this Manual

This manual describes how to get started using the DataAcq SDK™ (Software Development Kit) to develop application programs for data acquisition devices that conform to the DT-Open Layers™ standard.

## Intended Audience

This document is intended for engineers, scientists, technicians, OEMs, system integrators, or others responsible for developing application programs using Microsoft® Developer's Studio (version 6.0 and higher) to perform data acquisition operations.

It is assumed that you are a proficient programmer, that you are experienced programming in the Microsoft® Windows® XP, or Windows Vista®, Windows 7, or Windows 8 operating environment on the PC or compatible computer platform, and that you have familiarity with data acquisition principles and the requirements of your application.

## What You Should Learn from this Manual

This manual summarizes the functions provided by the DataAcq SDK, and describes how to use the functions to develop a data acquisition program. Using this manual, you should be able to successfully install the DataAcq SDK and get started writing an application program for data acquisition.

This manual is intended to be used with the online help for the DataAcq SDK, which you can find in the same program group as the DataAcq SDK software. The online help for the DataAcq SDK contains all of the specific reference information for each of the functions, error codes, and Windows messages.

## Organization of this Manual

This manual is organized as follows:

- Chapter 1, "Getting Started," tells how to install the DataAcq SDK.
- Chapter 2, "Function Summary," summarizes the functions provided in the DataAcq SDK.
- Chapter 3, "Using the DataAcq SDK," describes the operations that you can perform using the DataAcq SDK.
- Chapter 4, "Programming Flowcharts," provides programming flowcharts for using the functions provided in the DataAcq SDK.
- Chapter 5, "Product Support," describes how to get help if you have trouble using the DataAcq SDK.
- Appendix A, "Sample Code," provides code fragments that illustrate the use of the functions in the DataAcq SDK.
- An index completes this manual.

## Conventions Used in this Manual

The following conventions are used in this manual:

- Notes provide useful information that requires special emphasis, cautions provide information to help you avoid losing data or damaging your equipment, and warnings provide information to help you avoid catastrophic damage to yourself or your equipment.
- Items that you select or type are shown in **bold**. Function names also appear in bold.
- Code fragments are shown in `courier font.`

## Related Information

Refer to the following documentation for more information on using the DataAcq SDK:

- DataAcq SDK Online Help. This Windows help file is located in the same program group as the DataAcq SDK software and contains all of the specific reference information for each of the functions, error codes, and Windows messages provided by the DataAcq SDK. Refer to page 15 for information on how to open this help file.
- Device-specific manuals that describe how to get started using your device, the features of the device, and the capabilities supported by the driver for the device. These manuals are on your Data Acquisition OMNI CD™ CD.
- Windows XP, Windows Vista, Windows 7, or Windows 8 documentation.
- For C programmers, refer to *Microsoft C Reference*, Document Number LN06515-1189, Microsoft Corporation, and *The C Programming Language*, Brian W. Kernighan and Dennis Ritchie, Prentice Hall, 1988, 1987 Bell Telephone Laboratories, Inc, ISBN 0-13-109950-7.

## Where to Get Help

Should you run into problems installing or using the DataAcq SDK, our Technical Support Department is available to provide prompt, technical assistance. Refer to Chapter 5 for more information. If you are outside the U.S. or Canada, call your local distributor; see our web site (www.mccdaq.com) for the name and telephone number of your nearest distributor.

# 1

# Getting Started

## What is the DataAcq SDK?

The DataAcq SDK is a DLL (Dynamic Linked Library) that supports Data Translation's most popular data acquisition devices under Microsoft Windows XP (32-bit), Windows Vista (32-bit and 64-bit), Windows 7 (32-bit and 64-bit), and Windows 8 (32-bit and 64-bit).

The DataAcq SDK functions are fully compatible with DT-Open Layers™, which is a set of standards for developing integrated, modular application programs under Windows.

Because DT-Open Layers is modular and uses Windows DLLs, you can add support for a new data acquisition device at any time. Just add the new DT-Open Layers device driver, modify your code to incorporate the features of the new device, and then recompile the code. All calls to DataAcq SDK functions currently in your application program can remain untouched.

The list of supported data acquisition devices is constantly expanding. For the most up-to-date information, refer to the Data Translation web site (www.mccdaq.com).

# Quick Start

The following is an overview of the tasks required to install and use the DataAcq SDK; the following sections describe these steps in more detail:

1. Make sure that your system meets the requirements for installing the DataAcq SDK. For more information, refer to the next section.
2. Install the DataAcq SDK.
3. Create your 32-bit or 64-bit application program. For more information, refer to the Microsoft Developer's Studio documentation and to the sample code provided in Appendix A starting on page 169.

If you have problems installing or using the DataAcq SDK, refer to page 15 for information on opening the online help, or refer to Chapter 5 starting on page 167 for information on contacting the Data Translation Technical Support Department.

## What You Need

To use the DataAcq SDK, you need the following:

- Pentium-based computer. For Windows XP, 233 MHz or higher with Service Pack 2.
- Windows XP, Windows Vista, Windows 7, or Windows 8
- Minimum RAM requirements depend on the operating system you are using; consult your operating system documentation for details
- CD-ROM drive
- One or more of the supported Data Translation data acquisition devices
- Any language that has the ability to call DLLs and receive callbacks

## Installing the Software

The DataAcq SDK is installed automatically when you install the device driver for the module. Refer to your board manual for more information.

## Creating 32-Bit and 64-Bit Application Programs Using the DataAcq SDK

Two platform-specific versions of the DataAcq SDK native libraries are provided: one version supports applications that target x86 platforms, and the other version supports applications that target x64 platforms.

Libraries oldaapi32.lib, olmem32.lib, and graph32.lib target x86 platforms and are located in Program Files\Data Translation\Win32\SDK\Lib.

Libraries oldaapi64.lib, olmem64.lib, and graph64.lib target x64 platforms and are located in Program Files (x86)\Data Translation\Win32\SDK\Lib64.

## Creating 32-Bit Native Windows Applications

To build 32-bit native Windows applications, reference the Win32 import libraries (oldaapi32.lib and olmem32.lib). The libraries are located under Program Files\Data Translation\Win32\SDK\Lib.

The 32-bit native Windows applications will run under x86 and x64 platforms. Note that 32-bit applications will run under the WOW64 emulator on x64 platforms.

## Creating 64-Bit Native Windows Applications

To build 64-bit native Windows applications, reference the Win64 import libraries (oldaapi64.lib and olmem64.lib). The libraries are located under Program Files (x86)\Data Translation\Win32\SDK\Lib64.

The 64-bit native Windows applications will run under x64 platforms only.

# Using the DataAcq SDK Online Help

The *DataAcq SDK User's Manual* is intended to be used with the online help for the DataAcq SDK. The online help contains all of the specific reference information for each of the functions, error codes, and Windows messages not included in this manual.

To open the online help file, select the following from the Windows Task Bar: **Start |Programs | Data Translation, Inc |DT-Open Layers for Win32 |SDK |Data Acquisition SDK Help** from the Windows Start menu.

# About the Example Programs

To help you understand more about using the functions of the DataAcq SDK in an actual program, the DataAcq SDK provides a C example program (CEXMPL32.EXE). This example program allows you to configure any of the subsystems on the data acquisition device. The source code is located in the following directory: C:\Program Files\Data Translation\Win32\ SDK\ Examples\CExample. Resource files are also provided.

Additionally, the DataAcq SDK provides the following simple example programs. These programs are designed to use minimum Windows user interface code, while demonstrating the functions of the DataAcq SDK. Source code and resource files are provided for each of these programs:

**Note:** These examples are provided as 32-bit applications. You can rebuild them as 64-bit applications, if desired, by referencing the Win64 import libraries (oldaapi64.lib and olmem64.lib). The libraries are located under Program Files (x86)\Data Translation\Win32\SDK\Lib64. Refer to page 14 for more information.

- **ContAdc** – Opens the first available DT-Open Layers device, opens and configures an A/D subsystem, and performs continuous operations. Displays results in a dialog box.
- **ContDac** – Opens the first available DT-Open Layers device, opens and configures a D/A subsystem, and performs continuous operations outputting a square wave. Displays results in a dialog box.
- **DtConsole** – Opens the first available DT-Open Layers device, opens and configures an A/D subsystem, and performs a continuous A/D operation on a console screen.
- **IepContAdc** – Opens the first available DT-Open Layers device, opens and configures an A/D subsystem, configures a channel to use AC coupling and an internal excitation current source for an IEPE input, and performs a continuous A/D operation. Displays results in a dialog box.
- **GenerateFreq** – Opens the first available DT-Open Layers device, opens and configures a C/T subsystem, and continuously outputs a pulse. Displays results in a dialog box.
- **MeasureFreq** – Opens the first available DT-Open Layers device, opens and configures a C/T subsystem, and continuously measures a pulse. Displays results in a dialog box.
- **SvAdc** – Opens the first available DT-Open Layers device, opens and configures an A/D subsystem, and performs a single-value operation. Displays results in a message box.
- **SvDac** – Opens the first available DT-Open Layers device, opens and configures a D/A subsystem, and performs a single-value operation with maximum positive and maximum negative range. Displays results in a message box.
- **SvDin** – Opens the first available DT-Open Layers device, opens and configures a DIN subsystem, and performs a single-value operation. Displays results in a message box.
- **SvDout** – Opens the first available DT-Open Layers device, opens and configures a DOUT subsystem, and performs a single-value operation. Displays results in a message box.

- **ThermoAdc –** Opens the first available DT-Open Layers device, opens and configures an A/D subsystem, and performs a thermocouple measurement. Displays results in a dialog box.
- **VBTempPoint –** Written in Visual Basic, this program continuously displays the values of all 48 analog input channels of the TEMPpoint temperature instrument.

Each example program provided in the DataAcq SDK comes with the workspace and project files for use in the integrated development environment provided by the Microsoft Developer's Studio. No special switches are necessary beyond instructing the IDE to create a Windows EXE or DLL.

**Note:** The DataAcq SDK installation program automatically includes an environment variable (DA_SDK). All the example programs use this environment variable; therefore, you can build the example programs without adding any include or library files to your projects.

## About the Library Function Calling Conventions

The DataAcq SDK functions adhere to the Microsoft Pascal calling conventions. You can find prototypes for these functions in the include files OLDAAPI.H and OLMEM.H. We recommend that you follow these calling conventions for proper operation.

DataAcq SDK functions return an ECODE value, which is an unsigned long value indicating the status of the requested function. Check the return status value for an error condition using the symbolic constants defined in the include files. This practice is illustrated in the C example program (CEXMPL32.EXE).

**Note:** For detailed information on the error codes, refer to the DataAcq SDK online help.

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# Function Summary

# Data Acquisition Functions

The following groups of data acquisition functions are available:

- Information functions
- Initialization and termination functions
- Configuration functions
- Operation functions
- Data conversion functions

These functions are briefly described in the following subsections.

**Note:** For specific information about each of these functions, refer to the DataAcq SDK online help. See page 15 for information on opening the online help file.

## Information Functions

To determine the capabilities of your installed devices, subsystems on each device, and software, use the Information functions listed in Table 1.

**Table 1: Information Functions**

| Query about | Function | Description |
|---|---|---|
| Devices | **olDaEnumBoards** | Lists all currently installed DT-Open Layers data acquisition devices, drivers, and driver parameters. |
| | **olDaEnumBoardsEx** | Lists all currently-installed DT-Open Layers DataAcq devices and returns registry information for each device. |
| | **olGetBoardInfo** | Gets the driver name, model name, and instance number of the specified board, based on its board name. |
| | **olDaGetDeviceName** | Gets the full name of the specified device (this name is set by the driver as part of the installation procedure). |
| Subsystems | **olDaEnumSubSystems** | Lists the names, types, and element number for each subsystem supported by the specified device. |
| | **olDaGetDevCaps** | Returns the number of elements available for the specified subsystem on the specified device. |
| | **olDaGetSSCaps** | Returns information about whether the specified subsystem capability is supported and/or the number of capabilities supported. Refer to Table 2 for a list of possible capabilities and return values. |

Table 1: Information Functions (cont.)

| Query about | Function | Description |
|---|---|---|
| Subsystems (cont.) | **olDaGetSSCapsEx** | Returns information about extended subsystem capabilities. Refer to Table 3 for a list of possible capabilities and return values. |
| | **olDaEnumSSCaps** | Lists the possible settings for the specified subsystem capabilities, including filters, ranges, gains, resolution, and threshold channels for the start and reference trigger. |
| | **olDaGetDASSInfo** | Returns the subsystem type and element number of the specified subsystem with the specified device handle. |
| | **olDaIsRunning** | This function returns a Boolean value indicating whether the specified subsystem is currently running. |
| | **olDaGetQueueSize** | Returns the size of the specified queue (ready, done or inprocess) for the specified subsystem. The size indicates the number of buffers on the specified queue. |
| | **olDaEnumSSList** | Lists all subsystems on the simultaneous start list. |
| Software | **olDaGetDriverVersion** | Returns the device driver version number. |
| | **olDaGetVersion** | Returns the software version of the DataAcq SDK. |
| | **olDaGetErrorString** | Returns the string that corresponds to a device error code value. |
| Channels | **olDaEnumChannelCaps** | Enumerates the capabilities of a specified channel. |
| | **olDaGetChannelCaps** | Returns whether the capability is supported for the specified channel. |

## *Subsystem Capability Queries*

Table 2 lists the subsystem capabilities that you can query using the **olDaGetSSCaps** function; this function returns values as integers.

Table 3 lists the subsystem capabilities that you can query using the **olDaGetSSCapsEx** function; this function returns values as floating-point numbers.

Note that capabilities may be added as new devices are developed; for the most recent set of capabilities, refer to the DataAcq SDK online help.

**Table 2: Capabilities to Query with olDaGetSSCaps**

| Query about | Capability | Function Returns |
|---|---|---|
| Data Flow Mode | OLSSC_SUP_SINGLEVALUE | Nonzero if subsystem supports single-value operations. |
| | OLSSC_SUP_CONTINUOUS | Nonzero if subsystem supports continuous post-trigger operations. |
| | OLSSC_SUP_CONTINUOUS_PRETRIG | Nonzero if subsystem supports continuous pre-trigger operations. |
| | OLSSC_SUP_CONTINUOUS_ABOUTTRIG | Nonzero if subsystem supports continuous about-trigger (both pre- and post-trigger) operations. |
| Simultaneous Operations | OLSSC_SUP_SIMULTANEOUS_START | Nonzero if subsystem can be started simultaneously with another subsystem on the device. |
| Synchronization Operations | OLSSC_SUP_SYNCHRONIZATION | Non-zero if subsystem supports programmable synchronization modes. |
| Pausing Operations | OLSSC_SUP_PAUSE | Nonzero if subsystem supports pausing during continuous operation. |
| Windows Messaging | OLSSC_SUP_POSTMESSAGE | Nonzero if subsystem supports asynchronous operations. |
| Buffering | OLSSC_SUP_BUFFERING | Nonzero if subsystem supports buffering. |
| | OLSSC_SUP_WRPSINGLE | Nonzero if subsystem supports single-buffer wrap mode. |
| | OLSSC_SUP_WRPMULTIPLE | Nonzero if subsystem supports multiple-buffer wrap mode. |
| | OLSSC_SUP_INPROCESSFLUSH | Nonzero if subsystem supports transferring data from a buffer on a subsystem's inprocess queue. |
| | OLSSC_SUP_WAVEFORM_MODE | Nonzero if subsystem supports waveform generation. |
| | OLSSC_SUP_WRPWAVEFORM_ONLY | Nonzero if the subsystem supports waveform-based operations using the onboard FIFO only. If this capability is nonzero, the buffer wrap mode must be set to single. In addition, the buffer size must be less than or equal to the FIFO size. |
| DMA | OLSSC_NUMDMACHANS | Number of DMA channels supported. |
| | OLSSC_SUP_GAPFREE_NODMA | Nonzero if subsystem supports gap-free continuous operation with no DMA. |
| | OLSSC_SUP_GAPFREE_SINGLEDMA | Nonzero if subsystem supports gap-free continuous operation with a single DMA channel. |
| | OLSSC_SUP_GAPFREE_DUALDMA | Nonzero if subsystem supports gap-free continuous operation with two DMA channels. |

Table 2: Capabilities to Query with olDaGetSSCaps (cont.)

| Query about | Capability | Function Returns |
|---|---|---|
| Triggered Scan Mode | OLSSC_SUP_TRIGSCAN | Nonzero if subsystem supports triggered scans. |
| | OLSSC_MAXMULTISCAN | Maximum number of scans per trigger or retrigger supported by the subsystem. |
| | OLSS_SUP_RETRIGGER_SCAN_PER_TRIGGER | Nonzero if subsystem supports scan-per-trigger triggered scan mode (retrigger is the same as the initial trigger source). |
| | OLSS_SUP_RETRIGGER_INTERNAL | Nonzero if subsystem supports internal retriggered scan mode. (retrigger source is on the device; initial trigger is any available trigger source). |
| | OLSSC_SUP_RETRIGGER_EXTRA | Nonzero if subsystem supports retrigger-extra triggered scan mode (retrigger can be any supported trigger source; initial trigger is any available trigger source). |
| Channel-Gain List | OLSSC_CGLDEPTH | Number of entries in channel-gain list. |
| | OLSSC_SUP_RANDOM_CGL | Nonzero if subsystem supports random channel-gain list setup. |
| | OLSSC_SUP_SEQUENTIAL_CGL | Nonzero if subsystem supports sequential channel-gain list setup. |
| | OLSSC_SUP_ZEROSEQUENTIAL_CGL | Nonzero if subsystem supports sequential channel-gain list setup starting with channel zero. |
| | OLSSC_SUP_SIMULTANEOUS_SH | Nonzero if subsystem supports simultaneous operations. |
| | OLSSC_SUP_CHANNELLIST_INHIBIT | Nonzero if subsystem supports channel-gain list entry inhibition. |
| Gain | OLSSC_SUP_PROGRAMGAIN | Nonzero if subsystem supports programmable gain. |
| | OLSSC_NUMGAINS | Number of gain selections. |
| | OLSSC_NONCONTIGUOUS_CHANNELNUM | Number of random-order entries allowed in the channel-gain list. |
| | OLSSC_SUP_SINGLEVALUE_AUTORANGE | Nonzero if subsystem supports autoranging operations. |
| Synchronous Digital I/O | OLSSC_SUP_SYNCHRONOUS_DIGITALIO | Nonzero if subsystem supports synchronous digital output operations. |
| | OLSSC_MAXDIGITALIOLIST_VALUE | Maximum value for synchronous digital output channel list entry. |

Table 2: Capabilities to Query with olDaGetSSCaps (cont.)

| Query about | Capability | Function Returns |
|---|---|---|
| I/O Channels | OLSSC_NUMCHANNELS | Number of I/O channels. |
| | OLSSC_SUP_EXP2896 | Nonzero if subsystem supports channel expansion with DT2896. |
| | OLSSC_SUP_EXP727 | Nonzero if subsystem supports channel expansion with DT727. |
| Channel Type | OLSSC_SUP_SINGLEENDED | Nonzero if subsystem supports single-ended inputs. |
| | OLSSC_MAXSECHANS | Number of single-ended channels. |
| | OLSSC_SUP_DIFFERENTIAL | Nonzero if subsystem supports differential inputs. |
| | OLSSC_MAXDICHANS | Number of differential channels. |
| Filters | OLSSC_SUP_FILTERPERCHAN | Nonzero if subsystem supports filtering per channel. |
| | OLSSC_NUMFILTERS | Number of filter selections. |
| | OLSSC_SUP_DATA_FILTERS | Nonzero if subsystem supports programmable filter types. |
| Ranges | OLSSC_NUMRANGES | Number of range selections. |
| | OLSSC_SUP_RANGEPERCHANNEL | Nonzero if subsystem supports different range settings for each channel. |
| | OLSSC_SUP_CURRENT_OUTPUTS | Non-zero if subsystem supports current outputs. |
| Resolution | OLSSC_SUP_SWRESOLUTION | Nonzero if subsystem supports software-programmable resolution. |
| | OLSSC_NUMRESOLUTIONS | Number of different resolutions that you can program for the subsystem. |
| Data Encoding | OLSSC_SUP_BINARY | Nonzero if subsystem supports binary encoding. |
| | OLSSC_SUP_2SCOMP | Nonzero if subsystem supports twos complement encoding. |
| | OLSSC_RETURNS_FLOATS | Non-zero if the subsystem returns floating-point rather than integer values. |

Table 2: Capabilities to Query with olDaGetSSCaps (cont.)

| Query about | Capability | Function Returns |
|---|---|---|
| Triggers | OLSSC_SUP_SOFTTRIG | Nonzero if subsystem supports an internal software trigger for the start trigger. |
| | OLSSC_SUP_EXTERNTRIG | Nonzero if subsystem supports an external digital (TTL) trigger for the start trigger. |
| | OLSSC_SUP_SV_POS_EXTERN_TTLTRIG | Nonzero if subsystem supports a positive, external digital (TTL) trigger for a single-value operation. |
| | OLSSC_SUP_SV_NEG_EXTERN_TTLTRIG | Nonzero if subsystem supports a negative, external digital (TTL) trigger for a single-value operation. |
| | OLSSC_SUP_THRESHTRIGPOS | Nonzero if subsystem supports a positive analog threshold trigger for a start trigger. |
| | OLSSC_SUP_THRESHTRIGNEG | Nonzero if subsystem supports a negative analog threshold trigger for a start trigger. |
| | OLSSC_SUP_ANALOGEVENTTRIG | Nonzero if subsystem supports analog event trigger. |
| | OLSSC_SUP_DIGITALEVENTTRIG | Nonzero if subsystem supports digital event trigger. |
| | OLSSC_SUP_TIMEREVENTTRIG | Nonzero if subsystem supports timer event trigger. |
| | OLSSC_NUMEXTRATRIGGERS | Number of extra trigger sources supported. |
| | OLSSC_SUP_EXTERNTTLPOS_ REFERENCE_TRIG | Nonzero if subsystem supports a positive, external digital (TTL) trigger for a reference trigger. |
| | OLSSC_SUP_EXTERNTTLNEG_ REFERENCE_TRIG | Nonzero if subsystem supports a negative, external digital (TTL) trigger for a reference trigger. |
| | OLSSC_SUP_THRESHPOS_ REFERENCE_TRIG | Nonzero if subsystem supports a positive threshold trigger for the reference trigger. |
| | OLSSC_SUP_THRESHNEG_ REFERENCE_TRIG | Nonzero if subsystem supports a negative threshold trigger for the reference trigger. |
| | OLSSC_SUP_SYNCBUS_REFERNCE_ TRIG | Nonzero if subsystem supports a Sync Bus trigger for the reference trigger. |
| | OLSSC_SUP_POST_REFERENCE_TRIG_ SCANCOUNT | Non-zero if subsystem supports specifying the number of samples to acquire after the reference trigger. |

**Table 2: Capabilities to Query with olDaGetSSCaps (cont.)**

| Query about | Capability | Function Returns |
|---|---|---|
| Clocks | OLSSC_SUP_INTCLOCK | Nonzero if subsystem supports internal clock. |
| | OLSSC_SUP_EXTCLOCK | Nonzero if subsystem supports external clock. |
| | OLSSC_NUMEXTRACLOCKS | Number of extra clock sources. |
| | OLSSC_SUP_SIMULTANEOUS_ CLOCKING | Non-zero if subsystem supports simultaneous clocking of all channels. |
| Multiple Sensor Support | OLSSC_SUP_MULTISENSOR | Non-zero if the subsystem supports multiple sensor types for each channel; otherwise, returns False. |
| Current | OLSSC_SUP_CURRENT | Non-zero if the subsystem supports current measurements; otherwise, returns False. |
| Resistance | OLSSC_SUP_RESISTANCE | Non-zero if the subsystem supports resistance measurements; otherwise, returns False. |
| IEPE | OLSSC_SUP_IEPE | Non-zero is subsystem supports IEPE (accelerometer) inputs. |
| | OLSSC_SUP_AC_COUPLING | Non-zero if subsystem supports programmable AC coupling for an IEPE input. |
| | OLSSC_SUP_DC_COUPLING | Non-zero if subsystem supports programmable DC coupling for an IEPE input. |
| Excitation Current Source | OLSSC_SUP_INTERNAL_EXCITATION_ CURRENT_SOURCE | Non-zero if subsystem supports a programmable internal excitation current source for an IEPE input. |
| | OLSSC_SUP_EXTERNAL_EXCITATION_ CURRENT_SOURCE | Non-zero if subsystem supports a programmable external excitation current source for an IEPE input. |
| | OLSSC_NUM_EXCITATION_CURRENT_ VALUES | Number of different values for the internal excitation current source that can be programmed for the subsystem. |

Table 2: Capabilities to Query with olDaGetSSCaps (cont.)

| Query about | Capability | Function Returns |
|---|---|---|
| RTDs and Thermocouples | OLSSC_SUP_RTDS | Non-zero if subsystem supports RTD inputs. |
| | OLSSC_RETURNS_OHMS | Non-zero if the subsystem can return resistance values, in Ohms. |
| | OLSSC_SUP_THERMOCOUPLES | Non-zero if subsystem supports thermocouple inputs. |
| | OLSSC_SUP_TEMPERATURE_DATA_IN_STREAM | (Has meaning only if OLSSC_SUP_RTDS or OLSSC_SUP_THERMOCOUPLES is non-zero.) Non-zero if the device performs correction and linearization in the hardware and returns temperature values in the data stream. If zero, the device returns only raw counts and the application must perform all linearization and correction. |
| | OLSSC_SUP_INTERLEAVED_CJC_IN_STREAM | (Has meaning only if OLSSC_SUP_TEMPERATURE_DATA_IN_STREAM is non-zero.) Non-zero if the device can optionally interleave CJC data with A/D data in the data stream. |
| | OLSSC_SUP_CJC_SOURCE_CHANNEL | (Has meaning only if OLSSC_SUP_TEMPERATURE_DATA_IN_STREAM is 0.) Non-zero if one of the analog input channels on the device is used as the CJC input. |
| | OLSSC_SUP_CJC_SOURCE_INTERNAL | (Has meaning only if OLSSC_SUP_TEMPERATURE_DATA_IN_STREAM is non-zero.) Non-zero if the CJC is measured internally on the device rather than using one of the analog input channels as the CJC input. |
| Thermistors | OLSSC_SUP_THERMISTOR | Non-zero if the subsystem supports thermistor inputs; otherwise, returns False. |
| Strain Gages and Bridge-Based Sensors | OLSSC_SUP_STRAIN_GAGE | Non-zero if subsystem supports strain gage inputs. |
| | OLSSC_SUP_BRIDGEBASEDSENSORS | Non-zero if subsystem supports bridge-based sensor inputs. |
| | OLSSC_SUP_SHUNT_CALIBRATION | Non-zero if subsystem supports shunt calibration for strain gage and bridge-based sensors. |
| | OLSSC_SUP_REMOTE_SENSE | Non-zero if subsystem supports remote sensing for strain gage and bridge-based sensors. |
| | OLSSC_SUP_INTERNAL_EXCITATION_VOLTAGE_SOURCE | Non-zero if subsystem supports a programmable internal excitation voltage source for strain gage and bridge-based sensors. |

Table 2: Capabilities to Query with olDaGetSSCaps (cont.)

| Query about | Capability | Function Returns |
|---|---|---|
| Strain Gages and Bridge-Based Sensors (cont.) | OLSSC_SUP_EXTERNAL_EXCITATION_ VOLTAGE_SOURCE | Non-zero if subsystem supports a programmable external excitation voltage source for strain gage and bridge-based sensors. |
| Mute and UnMute | OLSSC_SUP_MUTE | Non-zero if subsystem supports the ability to mute and unmute the output voltage. |
| Counter/Timer Modes | OLSSC_SUP_CASCADING | Nonzero if subsystem supports cascading. |
| | OLSSC_SUP_CTMODE_COUNT | Nonzero if subsystem supports event counting mode. |
| | OLSSC_SUP_CTMODE_RATE | Nonzero if subsystem supports rate generation (continuous pulse output) mode. |
| | OLSSC_SUP_CTMODE_ONESHOT | Nonzero if subsystem supports (single) one-shot mode. |
| | OLSSC_SUP_CTMODE_ONESHOT_RPT | Nonzero if subsystem supports repetitive one-shot mode. |
| | OLSSC_SUP_CTMODE_UP_DOWN | Nonzero if subsystem supports up/down counting mode. |
| | OLSSC_SUP_CTMODE_MEASURE | Returns a value indicating how edge-to-edge measurement mode is supported (see page 100 for more information). |
| | OLSSC_SUP_CTMODE_CONT_MEASURE | Returns a value indicating how continuous edge-to-edge measurement mode is supported (see page 100 for more information). |
| | OLSSC_SUP_QUADRATURE_DECODER | Nonzero if subsystem supports taking input from quadrature encoders. |
| Counter/Timer Pulse Output Types | OLSSC_FIXED_PULSE_WIDTH | Nonzero if subsystem supports fixed output pulse widths. |
| | OLSSC_SUP_PLS_HIGH2LOW | Nonzero if subsystem supports high-to-low output pulses. |
| | OLSSC_SUP_PLS_LOW2HIGH | Nonzero if subsystem supports low-to-high output pulses |

### Table 2: Capabilities to Query with olDaGetSSCaps (cont.)

| Query about | Capability | Function Returns |
|---|---|---|
| Counter/Timer Gates | OLSSC_SUP_GATE_NONE | Nonzero if subsystem supports an internal (software) gate type. |
| | OLSSC_SUP_GATE_HIGH_LEVEL | Nonzero if subsystem supports high-level gate type. |
| | OLSSC_SUP_GATE_LOW_LEVEL | Nonzero if subsystem supports low-level gate type. |
| | OLSSC_SUP_GATE_HIGH_EDGE | Nonzero if subsystem supports high-edge gate type. |
| | OLSSC_SUP_GATE_LOW_EDGE | Nonzero if subsystem supports low-edge gate type. |
| | OLSSC_SUP_GATE_LEVEL | Nonzero if subsystem supports level change gate type. |
| | OLSSC_SUP_GATE_HIGH_LEVEL_ DEBOUNCE | Nonzero if subsystem supports high-level gate type with input debounce. |
| | OLSSC_SUP_GATE_LOW_LEVEL_ DEBOUNCE | Nonzero if subsystem supports low-level gate type with input debounce. |
| | OLSSC_SUP_GATE_HIGH_EDGE_ DEBOUNCE | Nonzero if subsystem supports high-edge gate type with input debounce. |
| | OLSSC_SUP_GATE_LOW_EDGE_ DEBOUNCE | Nonzero if subsystem supports low-edge gate type with input debounce. |
| | OLSSC_SUP_GATE_LEVEL_DEBOUNCE | Nonzero if subsystem supports level change gate type with input debounce. |
| Tachometer | OLSSC_SUP_PLS_HIGH2LOW | Nonzero if subsystem supports high-to-low (falling) tachometer edges. |
| | OLSSC_SUP_PLS_LOW2HIGH | Nonzero if subsystem supports low-to-high (rising) tachometer edges. |
| | OLSSC_SUP_STALE_DATA_FLAG | Nonzero if subsystem supports the stale data flag. |
| Interrupt | OLSSC_SUP_INTERRUPT | Nonzero if subsystem supports interrupt-driven I/O. |
| FIFOs | OLSSC_SUP_FIFO | Nonzero if subsystem has a FIFO in the data path. |
| | OLSSC_FIFO_SIZE_IN_K | Size of the output FIFO, in kilobytes. |
| Processors | OLSSC_SUP_PROCESSOR | Nonzero if subsystem has a processor on device. |
| Software Calibration | OLSSC_SUP_SWCAL | Nonzero if subsystem supports software calibration. |
| | OLSSC_SUP_AUTOCAL | Nonzero if subsystem supports self-calibration. |

**Table 3: Capabilities to Query with olDaGetSSCapsEx**

| Query about | Capability | Function Returns |
|---|---|---|
| Triggered Scan Mode | OLSSCE_MAXRETRIGGER | Maximum retrigger frequency supported by the subsystem. |
| | OLSSCE_MINRETRIGGER | Minimum retrigger frequency supported by the subsystem. |
| Clocks | OLSSCE_BASECLOCK | Base clock frequency supported by the subsystem. |
| | OLSSCE_MAXCLOCKDIVIDER | Maximum external clock divider supported by the subsystem. |
| | OLSSCE_MINCLOCKDIVIDER | Minimum external clock divider supported by the subsystem. |
| | OLSSCE_MAXTHROUGHPUT | Maximum throughput supported by the subsystem. |
| | OLSSCE_MINTHROUGHPUT | Minimum throughput supported by the subsystem. |
| Thermocouples | OLSSCE_CJC_MILLIVOLTS_PER_ DEGREE_C | (Has meaning only if OLSSC_SUP_ THERMOCOUPLES is non-zero.) Number of millivolts per degree C for the CJC input. |
| Excitation Voltage | OLSSC_MIN_EXCITATION_VOLTAGE | The minimum value for the internal excitation voltage source that can be programmed for the subsystem. |
| | OLSSC_MAX_EXCITATION_VOLTAGE | The maximum value for the internal excitation voltage source that can be programmed for the subsystem. |

## Initialization and Termination Functions

Once you have identified the available devices, use the Initialization functions described in Table 4.

**Table 4: Initialization Functions**

| Function | Description |
|---|---|
| **olDaInitialize** | Provides the means for the software to associate specific requests with a particular device; it must be called before any other function. This function loads a specified device's software support and provides a “device handle” value. This value is used to identify the device, and must be supplied as an argument in all subsequent function calls that reference the device. |
| **olDaGetDASS** | Allocates a subsystem for use by returning a handle to the subsystem. |

When you are finished with your program, use the Termination functions listed in Table 5.

Table 5: Termination Functions

| Function | Description |
|---|---|
| **olDaReleaseDASS** | Releases the specified subsystem and relinquishes all resources associated with it. |
| **olDaTerminate** | Ends a session between your application and the specified device. The device is returned to an inactive state and all resources are returned to the system. |

## Configuration Functions

Once you have initialized a subsystem and determined what its capabilities are, set or get the value of the subsystem's parameters by calling the Configuration functions listed in Table 6.

Table 6: Configuration Functions

| Feature | Function | Description |
|---|---|---|
| Data Flow Mode | **olDaSetDataFlow** | Sets the data flow mode. |
| | **olDaGetDataFlow** | Gets the data flow mode. |
| Windows Messaging | **olDaSetNotificationProcedure** | Specifies the notification procedure to call for information messages from the subsystem. |
| | **olDaGetNotificationProcedure** | Gets the address of the notification procedure. |
| | **olDaSetWndHandle** | Sets the window to which information messages are sent. |
| | **olDaGetWndHandle** | Gets the window handle. |
| Buffer Wrap Mode | **olDaSetWrapMode** | Sets the buffer processing wrap mode. |
| | **olDaGetWrapMode** | Gets the buffer processing wrap mode. |
| DMA | **olDaSetDmaUsage** | Sets the number of DMA channels to be used. |
| | **olDaGetDmaUsage** | Gets the number of DMA channels to be used. |

Table 6: Configuration Functions (cont.)

| Feature | Function | Description |
|---|---|---|
| Triggered Scans | **olDaSetTriggeredScanUsage** | Enables or disables triggered scan mode. |
| | **olDaGetTriggeredScanUsage** | Gets the triggered scan mode setting. |
| | **olDaSetMultiscanCount** | Sets the number of times to scan per trigger/retrigger. |
| | **olDaGetMultiscanCount** | Gets the number of times to scan per trigger/retrigger. |
| | **olDaSetRetriggerMode** | Sets the retrigger mode. |
| | **olDaGetRetriggerMode** | Gets the retrigger mode. |
| | **olDaSetRetriggerFrequency** | Sets the frequency of the internal retrigger when using internal retrigger mode. |
| | **olDaGetRetriggerFrequency** | Gets the frequency of the internal retrigger when using internal retrigger mode. |
| Channel-Gain List | **olDaSetChannelListSize** | Sets the size of the channel-gain list. |
| | **olDaGetChannelListSize** | Gets the size of the channel-gain list. |
| | **olDaSetChannelListEntry** | Sets the channel number of a channel-gain list entry. |
| | **olDaGetChannelListEntry** | Gets the channel number of a channel-gain list entry. |
| | **olDaSetGainListEntry** | Sets a gain value for a channel-gain list entry. |
| | **olDaGetGainListEntry** | Gets the gain value of a channel-gain list entry. |
| | **olDaSetChannelListEntryInhibit** | Enables/disables channel entry inhibition for a channel-gain list entry. |
| | **olDaGetChannelListEntryInhibit** | Gets the channel entry inhibition setting of a channel-gain list entry. |
| | **olDaSetDigitalIOListEntry** | Sets the digital value to output for the channel-gain list entry. |
| | **olDaGetDigitalIOListEntry** | Gets the digital value to output for the channel-gain list entry. |
| SynchronousDigital I/O | **olDaSetSynchronousDigitalIOUsage** | Enables or disables synchronous digital I/O operations. |
| | **olDaGetSynchronousDigitalIOUsage** | Gets the synchronous digital I/O setting. |
| Channel Type | **olDaSetChannelType** | Sets the channel configuration type of a channel. |
| | **olDaGetChannelType** | Gets the channel configuration type of a channel. |

Table 6: Configuration Functions (cont.)

| Feature | Function | Description |
|---|---|---|
| Filters | **olDaSetChannelFilter** | Sets the filter cut-off frequency for a channel. |
| | **olDaGetChannelFilter** | Gets the filter cut-off frequency for a channel. |
| | **olDaSetDataFilterType** | Sets the filter type for a subsystem that supports programmable filter types. |
| | **olDaGetDataFilterType** | Gets the filter type for a subsystems that support programmable filters. |
| Ranges | **olDaSetRange** | Sets the voltage range for a subsystem. |
| | **olDaGetRange** | Gets the voltage range for a subsystem. |
| | **olDaSetChannelRange** | Sets the voltage range for a channel. |
| | **olDaGetChannelRange** | Gets the voltage range for a channel. |
| Resolution | **olDaSetResolution** | Sets the number of bits of resolution. |
| | **olDaGetResolution** | Gets the number of bits of resolution. |
| Data Encoding | **olDaSetEncoding** | Sets the data encoding type. |
| | **olDaGetEncoding** | Gets the data encoding type. |
| Triggers | **olDaSetTrigger** | Sets the trigger source used for the start trigger. |
| | **olDaGetTrigger** | Gets the trigger source used for the start trigger. |
| | **olDaSetTriggerThresholdChannel** | Sets the number of the channel that is monitored for the start trigger event (OL_TRG_THRESHPOS or OL_TRG_THRESHNEG). |
| | **olDaGetTriggerThresholdChannel** | Gets the number of the channel that is monitored for the start trigger event (OL_TRG_THRESHPOS or OL_TRG_THRESHNEG). |
| | **olDaSetTriggerThresholdLevel** | Sets the threshold level for the start threshold trigger. |
| | **olDaGetTriggerThresholdLevel** | Gets the threshold level for the start threshold trigger. |
| | **olDaSetReferenceTrigger** | Sets the trigger source used for the reference trigger. |
| | **olDaGetReferenceTrigger** | Gets the trigger source used for the reference trigger. |

**Table 6: Configuration Functions (cont.)**

| Feature | Function | Description |
|---|---|---|
| Triggers (cont.) | **olDaSetReferenceTriggerThresholdChannel** | Sets the number of the channel that is monitored for the reference trigger event (OL_REFERENCE_TRG_THRESHPOS or OL_REFERENCE_TRG_THRESHNEG). |
| | **olDaGetReferenceTriggerThresholdChannel** | Gets the number of the channel that is monitored for the reference trigger event (OL_REFERENCE_TRG_THRESHPOS or OL_REFERENCE_TRG_THRESHNEG). |
| | **olDaSetReferenceTriggerThresholdLevel** | Sets the threshold level for the reference threshold trigger. |
| | **olDaGetReferenceTriggerThresholdLevel** | Gets the threshold level for the reference threshold trigger. |
| | **olDaSetReferenceTriggerPostScanCount** | Sets the number of samples per channel to acquire after the reference trigger event occurs. |
| | **olDaGetReferenceTriggerPostScanCount** | Gets the number of samples per channel to acquire after the reference trigger event occurs. |
| | **olDaSetPretriggerSource** | Sets the pre-trigger source. |
| | **olDaGetPretriggerSource** | Gets the pre-trigger source. |
| | **olDaSetRetrigger** | Sets the retrigger source for retrigger-extra retrigger mode. |
| | **olDaGetRetrigger** | Gets the retrigger source for retrigger-extra retrigger mode. |
| Clocks | **olDaSetClockSource** | Sets the clock source. |
| | **olDaGetClockSource** | Gets the clock source. |
| | **olDaSetClockFrequency** | Sets the frequency of the internal clock or a counter/timer’s output frequency. |
| | **olDaGetClockFrequency** | Gets the frequency of the internal clock or a counter/timer’s output frequency. |
| | **olDaSetExternalClockDivider** | Sets the input divider value of the external clock. |
| | **olDaGetExternalClockDivider** | Gets the input divider value of the external clock. |
| Multiple Sensor Types | **olDaSetMultiSensorType** | Sets the measurement type for the specified channel. |
| | **olDaGetMultiSensorType** | Gets the measurement type for the specified channel. |

Table 6: Configuration Functions (cont.)

| Feature | Function | Description |
|---|---|---|
| IEPE Support | **olDaSetCouplingType** | Sets the coupling type to use or the specified channel. |
| | **olDaGetCouplingType** | Gets the coupling type that is used by the specified channel. |
| | **olDaSetExcitationCurrentSource** | Sets the excitation current source for the specified channel. |
| | **olDaGetExcitationCurrentSource** | Gets the excitation current source that is used by the specified channel. |
| | **olDaSetExcitationCurrentValue** | Sets the value of the internal excitation current source to use for the specified channel. |
| | **olDaGetExcitationCurrentValue** | Gets the value of the internal excitation current source that is used by the specified channel. |
| Strain Gage and Bridge-Based Sensor Support | **olDaSetStrainBridgeConfiguration** | Sets the configuration of the strain gage for the channel. |
| | **olDaGetStrainBridgeConfiguraiton** | Gets the configuration of the strain gage for the channel. |
| | **olDaSetBridgeConfiguration** | Sets the configuration of the bridge-based sensor for the channel. |
| | **olDaGetBridgeConfiguraiton** | Gets the configuration of the bridge-based sensor for the channel. |
| | **olDaSetStrainExcitationVoltage Source** | Sets the excitation voltage source for the subsystem. |
| | **olDaGetStrainExcitationVoltage Source** | Gets the excitation voltage source for the subsystem. |
| | **olDaSetStrainExcitationVoltage** | Sets the value of the internal excitation voltage source to use for the subsystem. |
| | **olDaGetStrainExcitationVoltage** | Gets the value of the internal excitation voltage source to use for the subsystem. |
| | **olDaSetStrainShuntResistor** | Specifies whether the shunt resistor for the channel is enabled or disabled. |
| | **olDaGetStrainShuntResistor** | Returns whether the shunt resistor for the channel is enabled or disabled. |
| RTDs | **olDaSetRtdType** | Sets the type of RTD to use for the input channel of the specified subsystem. |
| | **olDaGetRtdType** | Gets the currently configured RTD type for the input channel of the specified subsystem. |
| | **olDaSetRtdR0** | Sets the nominal resistance of the RTD, in ohms at 0 degrees C, for the specified channel. |
| | **olDaGetRtdR0** | Gets the nominal resistance of the RTD, in ohms at 0 degrees C, for the specified channel. |

Table 6: Configuration Functions (cont.)

| Feature | Function | Description |
|---|---|---|
| RTDs (cont.) | **olDaSetRtdA** | Sets the A coefficient for the RTD that is connected to the specified channel. |
| | **olDaGetRtdA** | Gets the A coefficient for the RTD that is connected to the specified channel. |
| | **olDaSetRtdB** | Sets the B coefficient for the RTD that is connected to the specified channel. |
| | **olDaGetRtdB** | Gets the B coefficient for the RTD that is connected to the specified channel. |
| | **olDaSetRtdC** | Sets the C coefficient for the RTD that is connected to the specified channel. |
| | **olDaGetRtdC** | Gets the C coefficient for the RTD that is connected to the specified channel. |
| Thermocouples | **olDaSetThermocoupleType** | Sets the type of thermocouple to use for the input channel of the specified subsystem. |
| | **olDaGetThermocoupleType** | Gets the currently configured thermocouple type for the input channel of the specified subsystem. |
| | **olDaSetReturnCjcTemperature InStream** | Enables or disables the specified subsystem from returning CJC values in the data stream. |
| | **olDaGetReturnCjcTemperature InStream** | Returns whether the specified subsystem has been enabled or disabled from returning CJC values in the data stream. |
| Thermistors | **olDaSetThermistorA** | Sets the A coefficient for the thermistor that is connected to the specified channel. |
| | **olDaGetThermistorA** | Gets the A coefficient for the thermistor that is connected to the specified channel. |
| | **olDaSetThermistorB** | Sets the B coefficient for the thermistor that is connected to the specified channel. |
| | **olDaGetThermistorB** | Gets the B coefficient for the thermistor that is connected to the specified channel. |
| | **olDaSetThermistorC** | Sets the C coefficient for the thermistor that is connected to the specified channel. |
| | **olDaGetThermistorC** | Gets the C coefficient for the thermistor that is connected to the specified channel. |
| Sensor Wiring Configuration | **olDaSetSensorWiringConfiguration** | Sets the wiring configuration (two-wire, three-wire, or four-wire) for the specified channel. |
| | **olDaGetSensorWiringConfiguration** | Gets the wiring configuration (two-wire, three-wire, or four-wire) for the specified channel. |

**Table 6: Configuration Functions (cont.)**

| Feature | Function | Description |
|---|---|---|
| Input Termination Resistor | **olDaSetInputTerminationEnabled** | Sets the state of the input termination resistor for the specified channel. |
| | **olDaGetInputTerminationEnabled** | Gets the state of the input termination resistor for the specified channel. |
| Sync Mode | **olDaSetSyncMode** | Sets the synchronization mode for devices that provide a synchronization connector. |
| | **olDaGetSyncMode** | Gets the synchronization mode for devices that provide a synchronization connector. |
| Counter/Timers | **olDaSetCTMode** | Sets the counter/timer mode. |
| | **olDaGetCTMode** | Gets the counter/timer mode. |
| | **olDaSetCascadeMode** | Sets the counter/timer cascade mode. |
| | **olDaGetCascadeMode** | Gets the counter/timer cascade mode. |
| | **olDaSetGateType** | Sets the gate type for the counter/timer mode. |
| | **olDaGetGateType** | Gets the gate type for the counter/timer mode. |
| | **olDaSetPulseType** | Sets the pulse type for the counter/timer mode. |
| | **olDaGetPulseType** | Gets the pulse type for the counter/timer mode. |
| | **olDaSetPulseWidth** | Sets the pulse output width for the counter/timer mode. |
| | **olDaGetPulseWidth** | Gets the pulse width for the counter/timer mode. |
| | **olDaSetMeasureStartEdge** | Sets the start edge for edge-to-edge measurement operations. |
| | **olDaGetMeasureStartEdge** | Gets the start edge for edge-to-edge measurement operations. |
| | **olDaSetMeasureStopEdge** | Sets the stop edge for edge-to-edge measurement operations. |
| | **olDaGetMeasureStopEdge** | Gets the stop edge for edge-to-edge measurement operations. |
| | **olDaSetQuadDecoder** | Sets various aspects of a quadrature decoder. |

**Table 6: Configuration Functions (cont.)**

| Feature | Function | Description |
|---|---|---|
| Tachometer | **olDaSetEdgeType** | Sets the edge type (Falling or Rising) for the tachometer subsystem. |
| | **olDaGetEdgeType** | Gets the edge type (Falling or Rising) for the tachometer subsystem. |
| | **olDaSetStaleDataFlagEnabled** | Sets the flag indicating whether or not the value of the tachometer is new.<br>If StaleDataFlagEnabled is True, the most significant bit (MSB) of the value is set to 0 to indicate new data; reading the value before the measurement is complete returns an MSB of 1.<br>If the StaleDataFlagEnabled is False, the MSB is always set to 0. |
| | **olDaGetStaleDataFlagEnabled** | Gets the flag indicating whether or not the value of the tachometer is new.<br>If StaleDataFlagEnabled is True, the most significant bit (MSB) of the value is set to 0 to indicate new data; reading the value before the measurement is complete returns an MSB of 1.<br>If the StaleDataFlagEnabled is False, the MSB is always set to 0. |

## Operation Functions

Once you have set the parameters of a subsystem, use the Operation functions listed in Table 7.

**Table 7: Operation Functions**

| Operation | Function | Description |
|---|---|---|
| Single-Value Operations | **olDaGetSingleValue** | Reads a single input value from the specified channel of a subsystem (using a specified gain), and returns the data as a 32-bit integer (long). |
| | **olDaGetSingleValues** | For subsystems that support simultaneous operations, reads a single input value from all of the input channels of the specified subsystem (using a specified gain), and returns the data as 32-bit integers (longs). |
| | **olDaGetSingleFloat** | Reads a single input value from the specified channel of a subsystem (using a specified gain) and returns the data as a floating-point value. |
| | **olDaGetSingleFloats** | For subsystems that support simultaneous operations, reads a single input value from all of the input channels of the specified subsystem (using the specified gain), and returns the data as floating-point values. |
| | **olDaGetCjcTemperature** | Reads the CJC temperature of an input channel on the specified subsystem, and returns the temperature, in degrees C, as a floating-point value. |
| | **olDaGetCjcTemperatures** | For subsystems that support simultaneous operations, this function reads the CJC temperature of each input channel on the specified subsystem, and returns the temperatures, in degrees C, as floating-point values. |
| | **olDaGetSingleValueEx** | Determines the appropriate gain for the range (called autoranging), if desired, reads a single input value from the specified subsystem channel, and returns the value as both a code and a voltage. |
| | **olDaPutSingleValue** | Writes a single output value to the specified channel of a subsystem. |
| | **olDaPutSingleValues** | For subsystems that support simultaneous operations, writes a single value to each output channel of the specified subsystem. |
| Configure Operation | **olDaConfig** | After setting up a specified subsystem using the configuration functions, configures the subsystem with new parameter values. |

Table 7: Operation Functions (cont.)

| Operation | Function | Description |
|---|---|---|
| Start/Stop Operations | **olDaStart** | Starts the operation for which the subsystem has been configured. |
| | **olDaPause** | Pauses a continuous operation on the subsystem. |
| | **olDaContinue** | Continues the previously paused operation on the subsystem. |
| | **olDaStop** | Stops the operation and returns the subsystem to the ready state. |
| | **olDaAbor** | Stops the subsystem's operation immediately. |
| | **olDaReset** | Causes the operation to terminate immediately, and re-initializes the subsystem. |
| Mute and Unmute Operations | **olDaMute** | Attenuates the output voltage of the subsystem to 0 V over a hardware-dependent number of samples. |
| | **olDaUnMute** | Returns the output voltage of the subsystem to its current level over a hardware-dependent number of samples. |
| Calibration Operations | **olDaAutoCalibrate** | Initiates the internal self-calibration process of the specified subsystem, if supported by the device. |
| Buffer Operations | **olDaGetBuffer** | Gets a completed buffer from the done queue of the specified subsystem. |
| | **olDaPutBuffer** | Assigns a data buffer for the subsystem to the ready queue. |
| | **olDaFlushBuffers** | Transfers all data buffers held by the subsystem to the done queue. |
| | **olDaFlushFromBufferInprocess** | Copies all valid samples, up to a given number of samples, from the inprocess buffer to a specified buffer. It also sets the logical size of the buffer with flushed data to the number of samples copied and places the inprocess buffer on the done queue when it has been filled with the remaining samples. |
| Counter/Timer Operations | **olDaReadEvents** | Gets the number of events that have been counted since the subsystem was started with **olDaStart**. |
| | **olDaMeasureFrequency** | Measures the frequency of the input clock source for the selected counter/timer. |

Table 7: Operation Functions (cont.)

| Operation | Function | Description |
|---|---|---|
| Simultaneous Operations | **olDaGetSSList** | Gets a handle to a simultaneous start list. |
| | **olDaPutDassToSSList** | Puts the specified subsystem on the simultaneous start list. |
| | **olDaSimultaneousPreStart** | Simultaneously prestarts (performs setup operations on) all subsystems on the specified simultaneous start list. |
| | **olDaSimultaneousStart** | Simultaneously starts all subsystems on the specified simultaneous start list. |
| | **olDaReleaseSSList** | Releases the specified simultaneous start list and relinquishes all resources associated with it. |

## Data Conversion Functions

Once you have acquired data, you can use the functions listed in Table 8 to convert the data, if desired.

Table 8: Data Conversion Functions

| Function | Description |
|---|---|
| **olDaCodeToVolts** | Converts a code value to voltage value, using the range, gain, resolution, and encoding you specify. |
| **olDaVoltsToCode** | Converts a voltage value to code value, using the range, gain, resolution, and encoding you specify. |
| **olDaVoltsToStrain** | Converts a raw A/D count value to a strain value based on the specified configuration. |
| **olDaVoltsToBridgeBasedSensor** | Converts a raw A/D count value to a value for a bridge-based sensor based on the specified configuration. |

# Data Management Functions

Data management functions link the various layers of the DT-Open Layers architecture together. The fundamental data object in the DataAcq SDK is a buffer. All functions that create, manipulate, and delete buffers are encapsulated in the data management portion of the DataAcq SDK.

The following groups of data management functions are available:

- Buffer management functions
- List management functions

The following subsections summarize these functions.

**Note:** For specific information about each of these functions, refer to the DataAcq SDK online help. See page 15 for information on launching the online help file.

## Buffer Management Functions

The Buffer Management functions, listed in Table 9, are a set of object-oriented tools intended for both application and system programmers. When a buffer object is created, a buffer handle (HBUF) is returned. This handle is used in all subsequent buffer manipulation.

**Table 9: Buffer Management Functions**

| Function | Description |
|---|---|
| **olDmAllocBuffer** | Creates a buffer object of a specified number of samples, where each sample is 2 bytes. |
| **olDmCallocBuffer** | Creates a buffer object of a specified number of samples of a specified size. |
| **olDmCopyBuffer** | Copies data from the buffer to the specified array. |
| **olDmCopyFromBuffer** | Copies data from the buffer to the specified array. |
| **olDmCopyToBuffer** | Copies data from the specified array to the buffer. |
| **olDmFreeBuffer** | Deletes a buffer object. |
| **olDmGetBufferPtr** | Gets a pointer to the buffer data. |
| **olDmGetBufferSize** | Gets the physical buffer size (in bytes). |
| **olDmGetDataBits** | Gets the number of valid data bits. |
| **olDmSetDataBits** | Sets the number of valid data bits. |
| **olDmSetDataWidth** | Sets the width of each data sample. |
| **olDmGetDataWidth** | Gets the width of each data sample. |

Table 9: Buffer Management Functions (cont.)

| Function | Description |
|---|---|
| **olDmGetErrorString** | Gets the string corresponding to a data management error code value. |
| **olDmGetMaxSamples** | Gets the physical size of the buffer (in samples). |
| **olDmGetTimeDateStamp** | Gets the time and date of the buffer's data. |
| **olDmSetValidSamples** | Sets the number of valid samples in the buffer. |
| **olDmGetValidSamples** | Gets the number of valid samples. |
| **olDmGetVersion** | Gets the version of the data management library. |
| **olDmMallocBuffer** | Creates a buffer object of a specified number of bytes. |
| **olDmReAllocBuffer** | Reallocates a buffer object (alloc() interface). |
| **olDmReCallocBuffer** | Reallocates a buffer object (calloc() interface). |
| **olDmReMallocBuffer** | Reallocates a buffer object (malloc() interface). |

## Buffer List Management Functions

Buffer List Management functions, described in Table 10, provide a straightforward mechanism for handling buffer lists, called *queues,* that the software creates internally as well as other lists that you might want to create. You are not required to use these functions; however, you may find them helpful in your application.

Buffer List Management functions are particularly useful when dealing with a device that acquires or outputs continuous data. Refer to Chapter 5 for more information on queues and other lists.

Table 10: Buffer List Management Functions

| Function | Description |
|---|---|
| **olDmCreateList** | Creates a user-defined list object. |
| **olDmEnumBuffers** | Enumerates all buffers on a queue or on a list you created. |
| **olDmEnumLists** | Enumerates all queues or lists. |
| **olDmFreeList** | Deletes a user-defined list. |
| **olDmGetBufferFromList** | Removes a buffer from the start of a queue or user-defined list. |
| **olDmGetListCount** | Gets the number of buffers on a queue or user-defined list. |
| **olDmGetListHandle** | Finds the queue or user-defined list that a buffer is on. |

Table 10: Buffer List Management Functions (cont.)

| Function | Description |
|---|---|
| **olDmGetListIds** | Gets a description of the queue or list. |
| **olDmPeekBufferFromList** | Gets the handle of the first buffer in the queue or list but does not remove the buffer from the queue or list. |
| **olDmPutBufferToList** | Adds a buffer to the end of a queue or list. |

3

# Using the DataAcq SDK

This chapter provides conceptual information to describe the following operations provided by the DataAcq SDK:

- System operations, described starting on page 47
- Analog and digital I/O operations, described starting on page 50
- Counter/timer operations, described starting on page 94
- Simultaneous startup, described starting on page 126

Use this information with the reference information provided in the DataAcq SDK online help when programming your data acquisition devices; refer to page 15 for more information on launching this help file.

# *System Operations*

The DataAcq SDK provides functions for the following general system operations:

- Initializing a device
- Specifying a subsystem
- Configuring a subsystem
- Calibrating a subsystem
- Handling errors
- Handling messages
- Releasing a subsystem and driver

The following subsections describe these operations in more detail.

## Initializing a Device

To perform a data acquisition operation, your application program must initialize the device driver for the device you are using with the **olDaInitialize** function. This function returns a device handle, called HDEV. You need one device handle for each device. Device handles allow you to access more than one device in your system.

If you are unsure of the DT-Open Layers devices in your system, use the **olDaEnumBoards** function, which lists the device name, device driver name, and system resources used by each DT-Open Layers device in your system, or the **olDaGetBoardInfo** function, which returns the driver name, model name, and instance number of the specified board, based on its board name.

Once you have initialized a device, you can specify a subsystem, as described in the next section.

## Specifying a Subsystem

The DataAcq SDK allows you to define the following subsystems:

- Analog input (A/D subsystem)
- Analog output (D/A subsystem)
- Digital input (DIN subsystem)
- Digital output (DOUT subsystem)
- Counter/timer (C/T subsystem)
- Tachometer (TACH subsystem)

A device can have multiple elements of the same subsystem type. Each of these elements is a subsystem of its own and is identified by a subsystem type and element number. Element numbering is zero-based; that is, the first instance of the subsystem is called element 0, the second instance of the subsystem is called element 1, and so on. For example if two digital I/O ports are on your device, two DIN or DOUT subsystems are available, differentiated as element 0 and element 1.

Once you have initialized the device driver for the specified device, you must specify the subsystem/element on the specified device using the **olDaGetDASS** function. This function returns a subsystem handle, called HDASS. To access a subsystem, you need one subsystem handle for each subsystem. Subsystem handles allow you to access more than one subsystem on a device.

If you are unsure of the subsystems on a device, use the **olDaEnumSubSystems** or **olDaGetDevCaps** function. **olDaEnumSubSystems** lists the names, types, and number of elements for all subsystems supported by the specified device. **olDaGetDevCaps** returns the number of elements for a specified subsystem type on a specified device.

**Note:** You can call any function that contains HDASS as a parameter for any subsystem. In some cases, however, the subsystem may not support the particular capability. If this occurs, the subsystem returns an error code indicating that it does not support that function.

Once you have specified a subsystem/element, you can configure the subsystem and perform a data acquisition operation, as described in the following section.

## Configuring a Subsystem

You configure a subsystem by setting its parameters or capabilities. For more information on the capabilities you can query and specify, refer to the following:

- For analog and digital I/O operations, refer to page 50
- For the counter/timer operations, refer to page 94
- For tachometer operations, refer to page 119
- For quadrature decoder operations, refer to page 123
- For simultaneous operations, refer to page 126

Once you have set up the parameters appropriately for the operation you want to perform, call the **olDaConfig** function to configure the parameters before performing the operation.

## Calibrating a Subsystem

Some devices provide an self-calibrating feature, where a specified subsystem performs an auto-zero function. To determine if the specified subsystem supports this capability, call the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_AUTOCAL. If this function returns a nonzero value, the capability is supported.

To calibrate the subsystem, call the **olDaAutoCalibrate** function. Note that the subsystem must be stopped before calling this function, or an error is returned.

## Handling Errors

An error code is returned by each function in the DataAcq SDK. An error code of 0 indicates that the function executed successfully (no error). Any other error code indicates that an error occurred. Your application program should check the value returned by each function and perform the appropriate action if an error occurs.

Refer to the DataAcq SDK online help for detailed information on the returned error codes and how to proceed should they occur.

## Handling Messages

The data acquisition device notifies your application of buffer movement and other events by generating messages.

To determine if the subsystem can post messages, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_POSTMESSAGE. If this function returns a nonzero value, the capability is supported.

Specify the window to receive messages using the **olDaSetWndHandle** function or the procedure to handle these messages using the **olDaSetNotificationProcedure** function.

**Note:** The lParam parameter specified in this call is included in all messages, except in the case of an OLDA_WM_IO_COMPLETE, OLDA_WM_EVENT_DONE, or OLDA_WM_MEASURE_DONE message where the value of lParam is device-dependent. Refer to page 89 for more information on these messages.

Refer to the DataAcq SDK online help for more information on the messages that can be generated and how to proceed should they occur.

## Releasing the Subsystem and the Driver

When you are finished performing data acquisition operations, release the simultaneous start list, if used, using the **olDaReleaseSSList** function. Then, release each subsystem using the **olDaReleaseDASS** function. Release the driver and terminate the session using the **olDaTerminate** function.

# Analog and Digital I/O Operations

The DataAcq SDK defines the following capabilities that you can query and/or specify for analog and/or digital I/O operations:

- Channels (including channel type, channel list, channel inhibit list, and synchronous digital I/O list)
- Multisensor inputs
- Voltage inputs
- Current measurements
- Resistance measurements
- IEPE sensor inputs
- Thermocouple inputs
- RTD inputs
- Thermistor inputs
- Strain gage and bridge-based sensor inputs
- Data encoding
- Resolution
- Ranges
- Gains
- Filters
- Data flow modes
- Triggered scan mode
- Interrupts
- Clock sources
- Trigger sources
- Post trigger count
- Synchronization mode
- Buffers
- DMA resources

The following subsections describe these capabilities in more detail.

## Channels

Each subsystem (or element of a subsystem type) can have multiple channels. To determine how many channels the subsystem supports, use the **olDaGetSSCaps** function, specifying the OLSSC_NUMCHANNELS capability.

Some subsystems on the DT2896 and DT727 devices also provide channel expansion. To determine if the subsystem supports channel expansion, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_EXP2896 capability (for the DT2896) or the OLSSC_SUP_EXP727 capability (for the DT727). If this function returns a nonzero value, the capability is supported.

### Specifying the Channel Type

The DataAcq SDK supports the following channel types:

- **Single-ended** – Use this configuration when you want to measure high-level signals, noise is insignificant, the source of the input is close to the device, and all the input signals are referred to the same common ground.

  To determine if the subsystem supports the single-ended channel type, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_SINGLEENDED capability. If this function returns a nonzero value, the capability is supported.

  To determine how many single-ended channels are supported by the subsystem, use the **olDaGetSSCaps** function, specifying the OLSSC_MAXSECHANS capability.

  Specify the channel type as single-ended for each channel using the **olDaSetChannelType** function.

- **Differential** – Use this configuration when you want to measure low-level signals (less than 1 V), you are using an A/D converter with high resolution (greater than 12 bits), noise is a significant part of the signal, or common-mode voltage exists.

  To determine if the subsystem supports the differential channel type, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_DIFFERENTIAL capability. If this function returns a nonzero value, the capability is supported.

  To determine how many differential channels are supported by the subsystem, use the **olDaGetSSCaps** function, specifying the OLSSC_MAXDICHANS capability.

  Specify the channel type as differential for each channel using the **olDaSetChannelType** function.

**Note:** For pseudo-differential analog inputs, specify the single-ended channel type; in this case, how you wire these signals determines the configuration. This option provides less noise rejection than the differential configuration, but twice as many analog input channels.

For older model devices, this setting is jumper-selectable and must be specified in the driver configuration dialog.

The channel list is not used to set the channel type.

The following subsections describe how to specify channels.

## Specifying a Single Channel

The simplest way to acquire data from or output data to a single channel is to specify the channel for a single-value operation; refer to page 69 for more information on single-value operations.

You can also specify a single channel using a channel list, described in the next section.

## Specifying One or More Channels

You acquire data from or output data to one or more channels using a channel list.

The DataAcq SDK provides features that allow you to group the channels in the list sequentially (either starting with 0 or with any other analog input channel) or randomly. In addition, the DataAcq SDK allows you to specify a single channel or the same channel more than once in the list. Your device, however, may limit the order in which you can enter a channel in the channel list.

To determine how the channels can be ordered in the channel list for your subsystem, use the **olDaGetSSCaps** function, specifying the OLSSC_RANDOM_CGL capability. If this function returns a nonzero value, the capability is supported; you can order the channels in the channel list in any order, starting with any channel.

If this capability is not supported, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_SEQUENTIAL_CGL capability. If this function returns a nonzero value, the capability is supported; you must order the channels in the channel list in sequential order, starting with any channel.

If this capability is not supported, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_ZEROSEQUENTIAL_CGL capability. If this function returns a nonzero value, the capability is supported; you must order the channels in the channel list in sequential order, starting with channel 0.

To determine if the subsystem supports simultaneous sample-and-hold mode use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_SIMULTANEOUS_SH capability. If this function returns a nonzero value, the capability is supported. You must enter at least two channels in the channel list. Generally, the first channel is the sample channel and the remaining channels are the hold channels.

The following subsections describe how to specify channels in a channel list.

### Specifying the Channel List Size

To determine the maximum size of the channel list for the subsystem, use the **olDaGetSSCaps** function, specifying the OLSSC_CGLDEPTH capability.

Use the **olDaSetChannelListSize** function to specify the size of the channel list.

**Note:** The OLSSC_CGLDEPTH capability specifies the maximum size of the channel list, channel inhibit list, synchronous digital I/O list, and gain list.

### Specifying the Channels in the Channel List

Use the **olDaSetChannelListEntry** function to specify the channels in the channel list in the order you want to sample them or output data from them. (For simultaneous sampling modules, order does not matter, and you cannot enter a particular channel more than once.)

The channels are sampled or output in order from the first entry to the last entry in the channel list. Channel numbering is zero-based; that is, the first entry in the channel list is entry 0, the second entry is entry 1, and so on.

For example, if you want to sample channel 4 twice as frequently as channels 5 and 6, you could program the channel list as follows:

| Channel-List Entry | Channel | Description |
|---|---|---|
| 0 | 4 | Sample channel 4. |
| 1 | 5 | Sample channel 5. |
| 2 | 4 | Sample channel 4 again. |
| 3 | 6 | Sample channel 6. |

In this example, channel 4 is sampled first, followed by channel 5, channel 4 again, and then channel 6.

### Inhibiting Channels in the Channel List

If supported, you can set up a channel-inhibit list; this feature is useful if you want to discard values acquired from specific channels, as is typical in simultaneous sample-and-hold applications.

To determine if a subsystem supports a channel-inhibit list, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_CHANNELLIST_INHIBIT capability. If this function returns a nonzero value, the capability is supported.

Using the **olDaSetChannelListEntryInhibit** function, you can enable or disable inhibition for each entry in the channel list. If enabled, the acquired value is discarded after the channel entry is sampled; if disabled, the acquired value is stored after the channel entry is sampled.

In the following example, the values acquired from channels 11 and 9 are discarded and the values acquired from channels 10 and 8 are stored.

| Channel-List Entry | Channel | Channel Inhibit Value | Description |
|---|---|---|---|
| 0 | 11 | True | Sample channel 11 and discard the value. |
| 1 | 10 | False | Sample channel 10 and store the value. |
| 2 | 9 | True | Sample channel 9 and discard the value. |
| 3 | 8 | False | Sample channel 8 and store the value. |

### Specifying Synchronous Digital I/O Values in the Channel List

If supported, you can set up a synchronous digital I/O list; this feature is useful if you want to write a digital output value to dynamic digital output channels when an analog input channel is sampled.

To determine if the subsystem supports synchronous (dynamic) digital output operations, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_SYNCHRONOUS_DIGITALIO capability. If this function returns a nonzero value, the capability is supported.

Use the **olDaSetSynchronousDigitalIOUsage** function to enable or disable synchronous (dynamic) digital output operation for a specified subsystem.

Once you enable a synchronous digital output operation, specify the values to write to the synchronous (dynamic) digital output channels using the **olDaSetDigitalIOListEntry** function for each entry in the channel list.

To determine the maximum digital output value that you can specify, use the **olDaGetSSCaps** function, specifying the OLSSC_MAXDIGITALIOLIST_VALUE capability.

As each entry in the channel list is scanned, the corresponding value in the synchronous digital I/O list is output to the dynamic digital output channels.

In the following example, when channel 7 is sampled, a value of 1 is output to the dynamic digital output channels. When channel 5 is sampled, a value of 1 is output to the dynamic digital output channels. When channels 6 and 4 are sampled, a value of 0 is output to the dynamic digital output channels.

| Channel-List Entry | Channel | Synchronous Digital I/O Value | Description |
|---|---|---|---|
| 0 | 7 | 1 | Sample channel 7 and output a value of 1 to the dynamic digital output channels. |
| 1 | 5 | 1 | Sample channel 5 and output a value of 1 to the dynamic digital output channels. |
| 2 | 6 | 0 | Sample channel 6 and output a value of 0 to the dynamic digital output channels. |
| 3 | 4 | 0 | Sample channel 4 and output a value of 0 to the dynamic digital output channels. |

If your device had two dynamic digital output channels and a value of 1 is output (01 in binary format), a value of 1 is written to dynamic digital output channel 0 and a value of 0 is written to dynamic digital output channel 1. Similarly, if a value of 2 is output (10 in binary format), a value of 0 is written to dynamic digital output channel 0 and a value of 1 is written to dynamic digital output channel 1.

**Note:** If you are controlling sample-and-hold devices with these channels, you may need to program the first channel at the sample logic level and the following channels at the hold logic level; see your device/device driver documentation for details.

## MultiSensor Inputs

Some subsystems support multiple sensor types for each channel. To determine if the subsystem supports multiple sensor inputs, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_MULTISENSOR.

To determine which sensor types are supported for a given channel, query the channel using the **olDaEnumChannelCaps** function with the OL_ENUM_CHANNEL_SUPPORTED_MULTISENSOR_TYPES capability. All the supported sensor types are returned for the channel. The following sensor types may be supported:

- VOLTAGEIN
- VOLTAGEOUT
- DIGITALINPUT
- DIGITALOUTPUT
- QUADRATUREDECODER
- COUNTERTIMER
- TACHOMETER

- CURRENT_
- THERMOCOUPLE
- RTD
- STRAINGAGE
- ACCELEROMETER
- BRIDGE
- THERMISTOR
- RESISTANCE

Use the **olDaSetMultiSensorType** function to specify the sensor or measurement type to use for the specified channel.

You can determine which sensor type was configured for the specified channel using the **olDaGetMultiSensorType** function.

## Voltage Inputs

Some voltage input channels support a bias return termination resistor. To determine if the channel supports input termination, use the **olDaGetChannelCaps** function, specifying the capability OLCHANNELCAP_SUP_INPUT_TERMINATION.

The bias return termination resistor is typically enabled for floating and grounded voltage sources. It is typically disabled for voltage sources with grounded references. Refer to the documentation for your device for wiring information.

You can enable or disable the bias return termination resistor for a given channel using the **olDaSetInputTerminationEnabled** function. You can return the configuration of the input termination resistor for a given channel using the **olDaGetInputTerminationEnabled** function.

## Current Measurements

To determine if your analog input subsystem supports current measurements, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_CURRENT.

Some current channels support a bias return termination resistor. To determine if the channel supports input termination, use the **olDaGetChannelCaps** function, specifying the capability OLCHANNELCAP_SUP_INPUT_TERMINATION.

The bias return termination resistor is typically enabled for floating and grounded current sources. It is typically disabled for current sources with grounded references. Refer to the documentation for your device for wiring information.

You can enable or disable the bias return termination resistor for a given channel using the **olDaSetInputTerminationEnabled** function. You can return the configuration of the input termination resistor for a given channel using the **olDaGetInputTerminationEnabled** function.

## Resistance Measurements

To determine if your analog input subsystem supports resistance measurements, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_RESISTANCE.

You can set the following parameters for resistance measurements:

- Sensor Wiring
- Excitation current source

### Sensor Wiring

Verify how the resistance measurement is wired to the analog input channel, and then use the **olDaSetSensorWiringConfiguration** function to specify the wiring configuration that is used (two-wire, three-wire, or four-wire). Ensure that the software configuration matches the hardware configuration.

Use the **olDaGetSensorWiringConfiguration** function to return the configured wiring configuration for a specified channel.

### Excitation Current Sources and Values

To determine if the analog input channel supports an internal excitation current source, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_INTERNAL_EXCITATION_CURRENT_SOURCE. To determine if the analog input channel supports an external excitation current source, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_EXTERNAL_EXCITATION_CURRENT_SOURCE.

To set the excitation current source for the channel, use the **olDaSetExcitationCurrentSource** function.

If you specify an internal excitation current source, you can set the value of the current source using the **olDaSetExcitationCurrentValue** function. If the specified value is not supported by the device, an error is reported.

To determine how many values the subsystem supports for the internal excitation current source, use the OLSSC_NUM_EXCITATION_CURRENT_VALUES capability with the **olDaGetSSCaps** function.

To determine the actual values that are available for the internal excitation current source, query the subsystem using the **olDaEnumSSCaps** function with the OL_ENUM_EXCITATION_CURRENT_VALUES capability.

## IEPE Inputs

To determine if your analog input subsystem supports IEPE (accelerometer) inputs, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_IEPE.

You can set the following parameters for IEPE inputs:

- Coupling type
- Excitation current source

### *Coupling Type*

To determine if AC coupling is supported by a specified analog input channel, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_AC_COUPLING.

To determine if DC coupling is supported by the analog input channel, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_DC_COUPLING.

To set the coupling type for the channel, use the **olDaSetCouplingType** function.

### *Excitation Current Sources and Values*

To determine if the analog input channel supports an internal excitation current source, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_INTERNAL_EXCITATION_CURRENT_SOURCE. To determine if the analog input channel supports an external excitation current source, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_EXTERNAL_EXCITATION_CURRENT_SOURCE.

To set the excitation current source for the channel, use the **olDaSetExcitationCurrentSource** function.

If you specify an internal excitation current source, you can set the value of the current source using the **olDaSetExcitationCurrentValue** function. If the specified value is not supported by the device, an error is reported.

To determine how many values the subsystem supports for the internal excitation current source, use the OLSSC_NUM_EXCITATION_CURRENT_VALUES capability with the **olDaGetSSCaps** function.

To determine the actual values that are available for the internal excitation current source, query the subsystem using the **olDaEnumSSCaps** function with the OL_ENUM_EXCITATION_CURRENT_VALUES capability.

## Thermocouples

Some A/D subsystems support thermocouple inputs. To determine if your subsystem supports thermocouple inputs, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_THERMOCOUPLES capability.

### Thermocouple Input Types

If the subsystem supports thermocouple inputs, specify the type of thermocouple that is connected to the input channel using the **olDaSetThermocoupleType** function. The following thermocouple types are defined:

- OL_THERMOCOUPLE_TYPE_NONE – Specifies voltage rather than temperature
- OL_THERMOCOUPLE_TYPE_J – Specifies a J thermocouple type
- OL_THERMOCOUPLE_TYPE_K – Specifies a K thermocouple type
- OL_THERMOCOUPLE_TYPE_B – Specifies a B thermocouple type
- OL_THERMOCOUPLE_TYPE_E – Specifies a E thermocouple type
- OL_THERMOCOUPLE_TYPE_N – Specifies a N thermocouple type
- OL_THERMOCOUPLE_TYPE_R – Specifies a R thermocouple type
- OL_THERMOCOUPLE_TYPE_S – Specifies a S thermocouple type
- OL_THERMOCOUPLE_TYPE_T – Specifies a T thermocouple type

If the thermocouple type is set to OL_THERMOCOUPLE_TYPE_NONE, data is returned in voltage rather than temperature. If the thermocouple type is set for any of the other defined thermocouple types, the data is returned in degrees C.

On some devices, thermocouple data is returned as integer values. On other devices, thermocouple data is returned as floating-point values (4 bytes). To determine if your subsystem returns floating-point values, use the **olDaGetSSCaps** function, specifying the capability OLSSC_RETURNSFLOATS.

**Notes:** If a channel that was configured for a thermocouple input has an open thermocouple or no thermocouple connected to it, the value SENSOR_IS_OPEN (99999 decimal) is returned. This value is returned anytime a voltage greater than 100 mV is measure on the input, since this value is greater than any legitimate thermocouple voltage.

If the channel was configured for a voltage input (not a thermocouple type), the SENSOR_IS_OPEN value is not returned. Instead, the voltage value is returned. If no input is connected to the channel, the software returns a value of approximately 0.7 V due to the open thermocouple detection pull-up circuit.

If the input voltage is less than the legal voltage range for the selected thermocouple type, the software returns the value TEMP_OUT_OF_RANGE_LOW (–88888 decimal). If the input voltage is greater than the legal voltage range for the selected thermocouple type, the software returns the value TEMP_OUT_OF_RANGE_HIGH (88888 decimal).

## Thermocouple Correction and Linearization

Some devices do thermocouple correction and linearization in hardware based on the value of an internal CJC (cold junction compensation) channel. Every sample in the data stream corresponds to a single (typically, floating-point) value that represents either the temperature (in degrees C) or the voltage of the input channel, based on its thermocouple type.

Other devices return A/D input values in raw counts and the application program is responsible for correcting and linearizing the data based on the value of the CJC channel.

To determine if your subsystem does thermocouple correction and linearization in hardware, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_TEMPERATURE_DATA_IN_STREAM. If this query returns a nonzero value, correction and linearization is done in hardware. If this query returns a value of 0, your application program is responsible for correcting and linearizing thermocouple values.

Use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_CJC_SOURCE_INTERNAL, to determine whether the CJC value is measured internally on the device (rather than using one of the analog input channels).

To determine if one of the analog input channels is used as the CJC channel, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_CJC_SOURCE_CHANNEL.

**Notes:** Some devices that support correcting and linearizing thermocouple data in hardware also provide the option of returning CJC values in the data stream. This option is seldom used, but is provided if you want to linearize thermocouple values in your application (rather than in hardware) when using continuous operations.

To determine if the subsystem supports interleaving CJC values with A/D values in the data stream, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_INTERLEAVED_CJC_IN_STREAM.

By default, the subsystem is disabled from returning CJC values in the data stream. To enable the subsystem to return CJC values in the data stream, use the **olDaSetReturnCjcTemperatureInStream** function. When enabled, two (typically floating-point) values are returned in the data stream: the first value represents the temperature or voltage of the input channel (based on the thermocouple type of the input), and the second value represents the CJC temperature, in degrees C. Generally, in this configuration, a thermocouple type of OL_THERMOCOUPLE_TYPE_NONE is specified for each channel to allow direct linearization of voltage values into temperature. If you return CJC values in the data stream, ensure that you allocate a buffer that is twice as large to accommodate the CJC values (buffer size = number of channels x 2 x the number of samples).

## RTD Inputs

Some A/D subsystems support RTD inputs. To determine if your subsystem supports RTD inputs, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_RTDS capability.

In an RTD measurement, the measurement device reads the voltage drop across the RTD as the resistance changes and converts the voltage to the appropriate temperature using the Callendar-Van Dusen transfer function:

$$R_T = R_0[1 + AT + BT^2 + CT^3(T - 100)]$$

where,

- $R_T$ is the resistance at temperature.
- $R_0$ is the resistance at 0° C.
- A, B, and C are the Callendar-Van Dusen coefficients for a particular RTD type. (The value of C is 0 for temperatures above 0° C.)

For channels that support RTD inputs, you must specify the type of RTD that is connected to the input channel using the **olDaSetRtdType** function. To specify the R0 coefficient, use the **olDaSetRtdR0** function. To specify the A coefficient, use the **olDaSetRtdA** function. To specify the B coefficient, use the **olDaSetRtdB** function. To specify the C coefficient, use the **olDaSetRtdC** function.

Table 11 lists the values that are supported for these parameters:

**Table 11: Values Supported for RTD Parameters**

| Values for the RTD Type | Values for the R0 Coefficient ( Ω) | Values for the A Coefficient | Values for the B Coefficient | Values for the C Coefficient |
|---|---|---|---|---|
| Pt3850[a]<br>(the default) | 100 (the default), 500, or 1000 | $3.9083 \times 10^{-3}$ | $-5.775 \times 10^{-7}$ | $-4.183 \times 10^{-12}$ |
| Pt3920[b] | 98.129 | $3.9787 \times 10^{-3}$ | $-5.869 \times 10^{-7}$ | $-4.167 \times 10^{-12}$ |
| Pt3911[c] | 100 | $3.9692 \times 10^{-3}$ | $-5.8495 \times 10^{-7}$ | $-4.233 \times 10^{-12}$ |
| Pt3750[d] | 1000 | $3.81 \times 10^{-3}$ | $-6.02 \times 10^{-7}$ | $-6.0 \times 10^{-12}$ |
| Pt3916[e] | 100 | $3.9739 \times 10^{-3}$ | $-5.870 \times 10^{-7}$ | $-4.4 \times 10^{-12}$ |
| Pt3928[f] | 100 | $3.9888 \times 10^{-3}$ | $-5.915 \times 10^{-7}$ | $-3.85 \times 10^{-12}$ |
| Custom | User-defined | User-defined | User-defined | User-defined |

a. Uses a Temperature Coefficient of Resistance (TCR) value of 0.003850 Ω / Ω /° C as specified in the DIN/IEC 60751 ASTM-E1137 standard.
b. Uses a TCR value of 0.003920 Ω / Ω /° C as specified in the SAMA RC21-4-1966 standard.
c. Uses a TCR value of 0.003911 Ω / Ω /° C as specified in the US Industrial Standard standard.
d. Uses a TCR value of 0.003750 Ω / Ω /° C as specified in the Low Cost standard.
e. Uses a TCR value of 0.003916 Ω / Ω /° C as specified in the Japanese JISC 1604-1989 standard.
f. Uses a TCR value of 0.003928 Ω / Ω /° C as specified in the ITS-90 standard.

If you specify a value of Pt3850 for the RTD type, you must also specify R0 value, unless you are using a 100 Ω RTD (the default value). If you specify a value of Custom for the RTD type, you must specify the values for R0, A, B, and C coefficients. Otherwise, the software automatically sets the appropriate value for R0, A, B, and C based on the selected RTD type. You can determine the configured settings for an RTD input using the **DaGetRtdType**, **olDaGetRtdR0**, **olDaGetRtdA**, **olDaGetRtdB**, and **olDaGetRtdC** functions.

Use the **olDaSetSensorWiringConfiguration** function to specify the wiring configuration (two-wire, three-wire, or four-wire) for the RTD input. Ensure that the software configuration matches the hardware configuration. You can use the **olDaGetSensorWiringConfiguration** function to return the configured wiring configuration for a specified channel.

RTD data is returned as floating-point values (4 bytes). To determine if your subsystem returns floating-point values, use the **olDaGetSSCaps** function, specifying the capability OLSSC_RETURNSFLOATS.

**Notes:** If the input voltage is less than the legal voltage range for the selected RTD type, the software returns the value TEMP_OUT_OF_RANGE_LOW (–88888 decimal). If the input voltage is greater than the legal voltage range for the selected RTD type, the software returns the value TEMP_OUT_OF_RANGE_HIGH (88888 decimal). If the device detects an open circuit on the input (no connection to the Current and Return wires of a 4-wire RTD connection), the software returns the value OPEN_SENSOR (99999.0 decimal).

## Thermistor Inputs

To determine if your subsystem supports thermistor inputs, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_THERMISTOR capability.

The resistance of NTC thermistors increases with decreasing temperature. The resistance to temperature relationship is characterized by the Steinhart-Hart equation:

$$\frac{1}{T} = A + BlnR + Cln(R)^3$$

where,

- T is the temperature, in degrees Kelvin.
- R is the resistance at T, in ohms.
- A, B, and C are the Steinhart-Hart coefficients for a particular thermistor type and value, and are supplied by the thermistor manufacturer.

For channels that support thermistors, you must specify the A coefficient using the **olDaSetThermistorA** function, the B coefficient using the **olDaSetThermistorB** function, and the C coefficient using the **olDaSetThermistorC** function.

You can determine the configured settings for a thermistor input using the **olDaGetThermistorA**, **olDaGetThermistorB**, and **olDaGetThermistorC** functions.

Use the **olDaSetSensorWiringConfiguration** function to specify the wiring configuration (two-wire, three-wire, or four-wire) for the thermistor input. Ensure that the software configuration matches the hardware configuration. You can use the **olDaGetSensorWiringConfiguration** function to return the configured wiring configuration for a specified channel.

Thermistor data is returned as floating-point values (4 bytes). To determine if your subsystem returns floating-point values, use the **olDaGetSSCaps** function, specifying the capability OLSSC_RETURNSFLOATS.

## Strain Gage and Bridge-Based Sensor Inputs

Some A/D subsystems support strain gage inputs. To determine if your subsystem supports strain gage inputs, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_STRAIN_GAGE capability.

To determine if your analog input subsystem supports bridge-based sensors, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_BRIDGEBASEDSENSORS.

Once you acquire a voltage value from a channel that was configured for a strain gage input, you can convert the value to strain using the **olDaVoltsToStrain** function or to a bridge-based sensor value using the **olDaVoltsToBridgeBasedSensor** function.

These functions take a number of parameters specific to the sensor type, such as the gage type, gage resistance, transducer capacity, and so on.

### *Excitation Voltage*

If your subsystem supports strain gage or bridge-based sensors, you can determine if your A/D subsystem supports an external excitation voltage source by using the **olDaGetSSCaps** function, specifying the OLSSC_SUP_EXTERNAL_EXCITATION_VOLTAGE_SOURCE capability. To determine if your A/D subsystem supports an internal excitation voltage source, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_INTERNAL_EXCITATION_VOLTAGE_SOURCE capability. You can specify whether the subsystem uses the internal excitation voltage source on the device or an external excitation voltage source using the **olDaSetStrainExcitationVoltageSource** function.

If the subsystem supports an internal excitation voltage source, you can determine the minimum value that you can program for the internal excitation voltage source by using the **olDaGetSSCapsEx** function, specifying the OLSSCE_MIN_EXCITATION_VOLTAGE capability. To determine the maximum value that you can program for the internal excitation voltage source, use the **olDaGetSSCapsEx** function, specifying the OLSSCE_MAX_EXCITATION_VOLTAGE capability. You can specify the value of the excitation voltage source using the **olDaSetStrainExcitationVoltage** function.

### Strain Gage Type

If the subsystem supports strain gage inputs, you can specify the configuration of the strain gage for each input channel using the **olDaSetStrainBridgeConfiguration** function. The following types are defined:

- FULL_BRIDGE_BENDING
- FULL_BRIDGE_BENDING_POISSON
- FULL_BRIDGE_AXIAL
- HALF_BRIDGE_POISSON
- HALF_BRIDGE_BENDING
- QUARTER_BRIDGE
- QUARTER_BRIDGETEMPCOMPENSATION

You can return the strain gage type that is configured for the channel using the **olDaGetStrainBridgeConfiguration** function.

### Bridge-Based Sensor Type

If the subsystem supports bridge-based sensors, you can specify the configuration of the bridge-based sensor or general-purpose bridge for each input channel using the **olDaSetBridgeConfiguration** function. The following types are defined:

- FULL_BRIDGE
- HALF_BRIDGE
- QUARTER_BRIDGE

You can return the bridge type that is configured for the channel using the **olDaGetBridgeConfiguration** function.

### Shunt Calibration

You can determine if your A/D subsystem supports shunt calibration by using the **olDaGetSSCaps** function, specifying the OLSSC_SUP_SHUNT_CALIBRATION capability. You can use shunt calibration to correct span errors in the measurement path.

If you want to use the internal shunt resistor provided by the device, ensure that the internal RSHUNT+ and RSHUNT– lines are connected across the gage and that no strain is applied to the specimen. Then, enable the shunt resistor for the specified analog input channel by setting the state of the resistor to TRUE using the **olDaSetStrainShuntResistor** function. (Be sure to set this value back to False when the shunt calibration procedure is complete.)

Once the internal shunt resistor is enabled or you have connected your own shunt resistor to the bridge, read the value of the bridge, and then divide the expected value of the bridge by the actual value that you read. Internally, the software multiplies the channel measurement with this value to adjust the gain of the device.

### TEDS

If your strain gage provides a TEDS (Transducer Electronic Data Sheet) interface, you can read the TEDS data from the strain gage directly using the **olDaReadStrainGageHardwareTeds** function or from a data file for the strain gage using the **olDaReadStrainGageVirtualTeds** function.

If you are using a bridge-based sensor or transducer, such as a load cell, that provides a TEDS interface, you can read the TEDS data from the sensor directly using the **olDaReadBridgeSensorHardwareTeds** function or from a data file for the bridge-based sensor using the **olDaReadBridgeSensorVirtualTeds** function.

**Note:** The TEDS information is read-only. These functions help you determine the appropriate settings for your sensor.

## Data Encoding

For A/D and D/A subsystems only, the DataAcq SDK defines two data encoding types: binary and twos complement.

To determine the data encoding types supported by the subsystem, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_BINARY for binary data encoding or OLSSC_SUP_2SCOMP for twos complement data encoding. If this function returns a nonzero value, the capability is supported. Use the **olDaSetEncoding** function to specify the data encoding type.

## Resolution

To determine if the subsystem supports software-programmable resolution, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_SWRESOLUTION. If this function returns a nonzero value, the capability is supported.

To determine the number of resolution settings supported by the subsystem, use the **olDaGetSSCaps** function, specifying the capability OLSSC_NUMRESOLUTION. To list the actual bits of resolution supported, use the **olDaEnumSSCaps** function, specifying the OL_ENUM_RESOLUTION capability.

Use the **olDaSetResolution** function to specify the number of bits of resolution to use for the subsystem.

## Ranges

The range capability applies to A/D and D/A subsystems only.

**Note:** Some D/A subsystems support both voltage and current output channels. To determine whether your subsystem supports current output channels, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_CURRENT_OUTPUT capability. If this function returns a nonzero value, current output channels are supported.

Depending on your subsystem, you can set the range for the entire subsystem or the range for each channel; the range is typically specified in voltage. (If you are using a current output channel, determine how the voltage range maps to your current output range and write the appropriate voltage to the output channel.)

To determine if the subsystem supports the range-per-channel capability, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_RANGEPERCHANNEL capability. If this function returns a nonzero value, the capability is supported.

To determine how many ranges the subsystem supports, use the **olDaGetSSCaps** function, specifying the OLSSC_NUMRANGES capability.

To list the minimum and maximum ranges supported by the subsystem, use the **olDaEnumSSCaps** function, specifying the OL_ENUM_RANGES capability.

Use **olDaSetRange** to specify the range for a subsystem. If your subsystem supports the range-per-channel capability, use **olDaSetChannelRange** to specify the range for each channel.

**Notes:** The channel list is not used to set the range for a channel.

For older device models, the range is jumper-selectable and must be specified in the driver configuration dialog.

## Gains

The range divided by the gain determines the effective range for the entry in the channel list. For example, if your device provides a range of ±10 V and you want to measure a ±1.5 V signal, specify a range of ±10 V and a gain of 4; the effective input range for this channel is then ±2.5 V (10/4), which provides the best sampling accuracy for that channel.

The way you specify gain depends on how you specified the channels, as described in the following subsections.

**Note:** If your device supports autoranging for single-value operations, the device can determine the appropriate gain for your range rather than you having to specify it. Refer to page 69 for more information on autoranging.

### *Specifying the Gain for a Single Channel*

The simplest way to specify gain for a single channel is to specify the gain in a single-value operation; refer to page 69 for more information on single-value operations.

You can also specify the gain for a single channel using a gain list, described in the next section.

### *Specifying the Gain for One or More Channels*

You can specify the gain for one or more channels using a gain list. The gain list parallels the channel list. (The two lists together are often referred to as the channel-gain list or CGL.)

To determine if the subsystem supports programmable gain, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_PROGRAMGAIN capability. If this function returns a nonzero value, the capability is supported.

To determine how many gains the subsystem supports, use the **olDaGetSSCaps** function, specifying the OLSSC_NUMGAINS capability.

To list the gains supported by the subsystem, use the **olDaEnumSSCaps** function, specifying the OL_ENUM_GAINS capability.

Specify the gain for each entry in the channel list using the **olDaSetGainListEntry** function.

In the following example, a gain of 2 is applied to channel 5, a gain of 4 is applied to channel 6, and a gain of 1 is applied to channel 7.

| Channel-List Entry | Channel | Gain | Description |
|---|---|---|---|
| 0 | 5 | 2 | Sample channel 5 using a gain of 2. |
| 1 | 6 | 4 | Sample channel 6 using a gain of 4. |
| 2 | 7 | 1 | Sample channel 7 using a gain of 1. |

**Note:** If your subsystem does not support programmable gain, enter a value of 1 for all entries.

If your subsystem does not support the gain-per-channel capability, set all entries in the gain list to the same value.

# Filters

Some subsystems support a filter per channel, while others may support programmable filter types. These capabilities are described in the following subsections.

## FIlter Per Channel

This capability applies to A/D and D/A subsystems only.

Depending on your subsystem, you can specify a filter for each channel. To determine if the subsystem supports a filter for each channel, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_FILTERPERCHAN capability. If this function returns a nonzero value, the capability is supported.

To determine how many filters the subsystem supports, use the **olDaGetSSCaps** function, specifying the OLSSC_NUMFILTERS capability.

To list the cut-off frequency of all filters supported by the subsystem, use the **olDaEnumSSCaps** function, specifying the OL_ENUM_FILTERS capability.

If the subsystem supports filtering per channel, specify the filter for each channel using the **olDaSetChannelFilter** function. The filter is equal to or greater than a cut-off frequency that you supply.

**Notes:** The channel list is not used to set the filter for a channel.

If the subsystem supports more than one filter but does not support a filter per channel, the filter specified for channel 0 is used for all channels.

## Filter Types

This capability applies to A/D subsystems only that support temperature measurements and programmable filter types. To determine if the subsystem supports programmable filter types, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_DATA_FILTERS capability. If this function returns a nonzero value, the capability is supported.

If the subsystem supports programmable filter types, specify the filter for each channel using the **olDaSetDataFilterType** function. The following filter types are available:

- OL_DATA_FILTER_RAW – No filter. Provides fast response times, but the data may be difficult to interpret. Use when you want to filter the data yourself.

  This filter type returns the data exactly as it comes out of the Delta-Sigma A/D converters. Note that Delta-Sigma converters provide substantial digital filtering above the Nyquist frequency.

  Generally, the only time it is desirable to use this filter type is if you are using fast responding inputs, sampling them at higher speeds (> 1 Hz), and need as much response speed as possible.

- OL_DATA_FILTER_MOVING_AVERAGE – Provides a compromise of filter functionality and response time. This filter can be used in any application.

  This low-pass filter takes the previous 16 samples, adds them together, and divides by 16.

You can return the currently configured filter type using the **olDaGetDataFilterType** function.

**Note:** In previous versions of the DataAcq SDK, these functions were called **olDaSetTempFilterType** and **olDaGetTempFilterType**, the capability was called OLSSC_SUP_TEMP_FILTERS, and the constants were called OL_TEMP_FILTER_RAW and OL_TEMP_FILTER_MOVING_AVERAGE. These function remain as supported, deprecated functions within the Win32 library.

## Data Flow Modes

The DataAcq SDK defines the following data flow modes for A/D, D/A, DIN, and DOUT subsystems:

- Single value
- Continuous

The following subsections describe these data flow modes in detail.

### *Single-Value Operations*

Single-value operations are the simplest to use but offer the least flexibility and efficiency. In a single-value operation, a single data value is read or written at a time. The result is returned immediately. You cannot specify a channel-gain list, clock source, trigger source, DMA channel, or buffer for a single-value operation. Single-value operations stop automatically when finished; you cannot stop a single-value operation manually.

To determine if the subsystem supports single-value operations, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_SINGLEVALUE. If this function returns a nonzero value, the capability is supported.

Specify the operation mode as OL_DF_SINGLEVALUE using the **olDaSetDataFlow** function.

#### Typical Single-Value Operations

Use one of the following functions to read a single value from or write a single-value to a specified channel; the device performs the operation immediately:

- **olDaGetSingleValue** – Acquires a count value from a single input channel using a specified gain, and returns the data as a 32-bit integer.

  If you later want to convert the count value to engineering units, you can use the **olDaCodeToVolts** function. Similarly, if you want to convert the engineering units to counts, you can use the **olDaVoltsToCode** function.

- **olDaGetSingleFloat** – Typically used with RTD or thermocouple inputs, acquires a single voltage or temperature value (depending on the RTD or thermocouple type) from a single input channel, and returns the data as a floating-point value. Refer to page 61 for more information on RTDs; refer to page 58 for more information on thermocouples.
- **olDaGetCjcTemperature** – If you want to correct and linearize thermocouple values in the application rather than in hardware, this function acquires the CJC temperature for a specified input channel, and returns the data as a floating-point value. Refer to page 58 for more information on thermocouple and CJC values.
- **olDaGetSingleValueEx** – Some devices support autoranging for single-value analog input operations, where the device determines the best gain for the specified range. If autoranging is supported, this function allows you to specify the range and analog input channel; the driver then acquires the value from the specified channel using the best gain for the range, and returns the result immediately in both counts and engineering units (such as voltage).

  To determine if the subsystem supports autoranging for single-value operations, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_SINGLEVALUE_AUTORANGE. If this function returns a nonzero value, the capability is supported.
- **olDaPutSingleValue** function – Outputs a single count value to a single output channel using the specified gain.

### Simultaneous Single-Value Operations

Some devices support simultaneous single-value operations, allowing you to read a single value from each input channel of an A/D subsystem or to write a single value to each output channel of a D/A subsystem. To determine if your device supports simultaneous operations, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_SIMULTANEOUS_SH. If this function returns a nonzero value, the capability is supported.

Use one of the following functions to read a single value from or write a single value to all the channels of the subsystem simultaneously; the device performs the operation immediately:

- **olDaGetSingleValues** – Acquires a single count value from each of the channels of the subsystem simultaneously and returns the data as 32-bit integers.
- **olDaGetSingleFloats** – Typically used with RTD or thermocouple inputs, acquires a single voltage or temperature value (depending on the RTD or thermocouple type) from each of the input channels of the subsystem simultaneously, and returns the data as floating-point values. Refer to page 61 for more information on RTDs; refer to page 58 for more information on thermocouples.
- **olDaGetCjcTemperatures** – If you want to correct and linearize thermocouple values in the application rather than in hardware, this function acquires a single CJC temperature from each of the input channels supported by the subsystem, and returns them as floating-point values. Refer to page 58 for more information on thermocouples and CJC values.
- **olDaPutSingleValues** function – Outputs a single count value to each of the channels of the subsystem simultaneously, using the specified gain. If you do not want to update a particular output channel, specify the constant DONT_UPDATE for the channel value; in this case, the channel maintains the last value that was written to it.

### Continuous Operations

For a continuous operation, you can specify any supported subsystem capability, such as a channel-gain list, clock source, trigger source, buffer, and so on, and then configure the subsystem using the **olDaConfig** function.

Call the **olDaStart** function to start a continuous operation.

To stop a continuous operation, perform either an orderly stop using the **olDaStop** function or an abrupt stop using the **olDaAbort** or **olDaReset** function.

In an orderly stop (**olDaStop**), the device finishes acquiring the specified number of samples, stops all subsequent acquisition, and transfers the acquired data to a buffer on the done queue; all subsequent triggers or retriggers are ignored. (Refer to page 86 for more information on buffers and queues.)

In an abrupt stop (**olDaAbort**), the device stops acquiring samples immediately; the acquired data is transferred to a buffer and put on the done queue; however, the buffer may not be completely filled. All subsequent triggers or retriggers are ignored.

**Note:** **olDaStop** always waits for the current buffer to be filled before stopping the subsystem. Therefore, if you are using an external trigger or a threshold trigger and the trigger is never received, do not call **olDaStop** as the subsystem will not be stopped if it is waiting for a trigger. Instead, call **olDaAbort**, which stops the subsystem immediately.

The **olDaReset** function reinitializes the subsystem after stopping it abruptly.

For analog output operations, you can also stop the operation by not sending new data to the device. The operation stops when no more data is available.

If your device supports it, you can mute the output, which attenuates the output voltage to 0 V by using **olDaMute**. This does not stop the analog output operation; instead, the analog output voltage is reduced to 0 V over a hardware-dependent number of samples. You can unmute the output voltage to its current level by using **olDaUnMute**. To determine if muting and unmuting are supported by your device, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_MUTE capability. If this function returns a nonzero value, the capability is supported.

Some subsystems also allow you to pause the operation using the **olDaPause** function and to resume the paused operation using the **olDaContinue** function. To determine if pausing is supported, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_PAUSE capability. If this function returns a nonzero value, the capability is supported.

**Note:** To determine whether a subsystem is currently running, use the **olDaIsRunning** function. If TRUE is returned, the subsystem is currently running; if FALSE is returned, the subsystem is not currently running.

The following continuous modes are supported by the DataAcq SDK:

- Continuous pre- and post-trigger operations that use a start and reference trigger
- Continuous post-trigger operations (does not use a reference trigger)
- Continuous pre-trigger operations (does not use a reference trigger)
- Continuous about-trigger operations (does not use a reference trigger)

These modes are described in the following subsections.

#### Continuous Pre- and Post-Trigger Mode Using a Start and Reference Trigger

Use this mode when you want to acquire pre-trigger data from multiple analog input channels continuously when a specified trigger occurs and, when a reference trigger occurs, acquire a specified number of post-trigger samples.

Refer to the documentation for your device to determine if a reference trigger is supported.

To determine if the subsystem supports continuous operations, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_CONTINUOUS. If this function returns a nonzero value, the capability is supported. Using the **olDaSetDataFlow** function, specify the operation mode as OL_DF_CONTINUOUS.

Use the **olDaSetTrigger** function to specify the trigger source that starts acquisition of pre-trigger data. Use the **olDaSetReferenceTrigger** function to specify the trigger source that stops pre-trigger acquisition and starts post-trigger acquisition. Refer to page 81 for more information on supported trigger sources.

If the trigger source for the start trigger is a threshold trigger, specify the channel to use for the threshold trigger using the **olDaSetTriggerThresholdChannel** function, and specify the voltage value for the threshold level using the **olDaSetTriggerThresholdLevel** function. Refer to page 82 for more information.

If the trigger source for the reference trigger is a threshold trigger, specify the channel to use for the threshold trigger using the **olDaSetReferenceTriggerThresholdChannel** function, and specify the voltage value for the threshold level using the **olDaSetReferenceTriggerThresholdLevel** function. Refer to page 82 for more information.

Specify the number of samples to acquire after the reference trigger occurs using the **olDaSetReferenceTriggerPostScanCount** property. Refer to page 85 for more information on the post-trigger scan count.

Pre-trigger acquisition begins when the start trigger is detected. When the reference trigger occurs, pre-trigger acquisition stops and post-trigger acquisition begins until the number of samples specified by **olDaSetReferenceTriggerPostScanCount** has been acquired. At that point, you will get the last buffer that has valid samples; the remainder of the buffers are cancelled.

Figure 1 illustrates continuous scan mode (using a start and reference trigger) on a simultaneous board using a channel list of five entries: channel 0 through channel 4. In this example, pre-trigger analog input data is acquired for each channel simultaneously when the start trigger is detected. When the reference trigger occurs, the specified number of post-trigger samples (3, in this example) are acquired simultaneously for each channel.

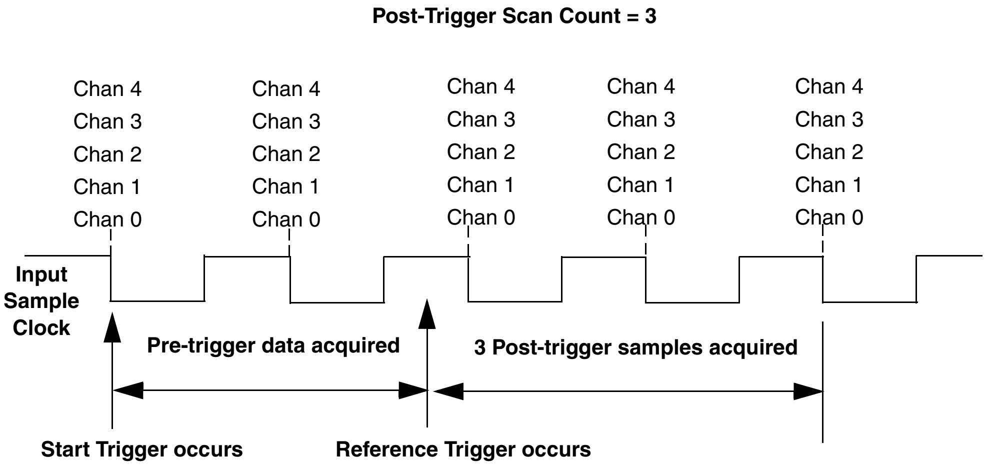


**Figure 1: Continuous Pre- and Post-Trigger Operations Using a Start and Reference Trigger**

### Continuous Post-Trigger Mode

**Note:** This mode does not support use of a reference trigger. To use a reference trigger, refer to page 72.

Use continuous post-trigger when you want to acquire or output data continuously when a trigger occurs.

To determine if the subsystem supports continuous (post-trigger) operations, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_CONTINUOUS. If this function returns a nonzero value, the capability is supported.

For continuous (post-trigger) mode, specify the operation mode as OL_DF_CONTINUOUS using the **olDaSetDataFlow** function.

Use the **olDaSetTrigger** function to specify the trigger source that starts the operation. Refer to page 81 for more information on supported trigger sources.

When the post-trigger event is detected, the device cycles through the channel list, acquiring and/or outputting the value for each entry in the channel list; this process is defined as a scan. The device then wraps to the start of the channel list and repeats the process continuously until either the allocated buffers are filled or you stop the operation. Refer to page 52 for more information on channel lists; refer to page 86 for more information on buffers.

Figure 2 illustrates continuous post-trigger mode using a channel list of three entries: channel 0, channel 1, and channel 2. In this example, post-trigger analog input data is acquired on each clock pulse of the A/D sample clock; refer to page 79 for more information on clock sources. The device wraps to the beginning of the channel list and repeats continuously.

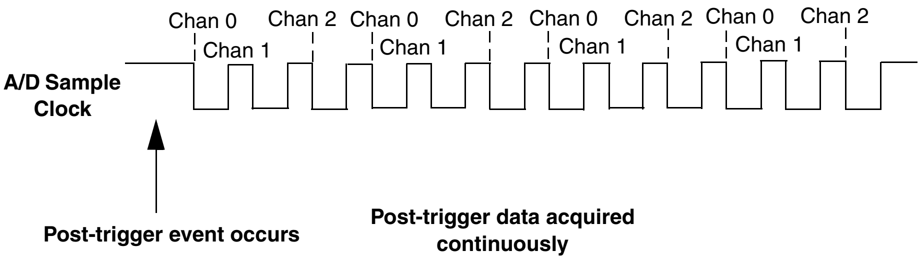


**Figure 2: Continuous Post-Trigger Mode**

### Continuous Pre-Trigger Mode (Legacy Devices)

**Note:** This mode does not support use of a reference trigger. To use a reference trigger, refer to page 72.

Some older, legacy, devices support pre-trigger mode. Use continuous pre-trigger mode when you want to acquire data before a specific external event occurs.

To determine if the subsystem supports continuous pre-trigger mode, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_CONTINUOUS_PRETRIG capability. If this function returns a nonzero value, the capability is supported.

Specify the operation mode as OL_DF_CONTINUOUS_PRETRIG using the **olDaSetDataFlow** function.

Pre-trigger acquisition starts when the device detects the pre-trigger source and stops when the device detects an external post-trigger source, indicating that the first post-trigger sample was acquired (this sample is ignored).

Use the **olDaSetPretriggerSource** function to specify the trigger source that starts the pre-trigger operation (generally this is a software trigger). Specify the post-trigger source that stops the operation using **olDaSetTrigger**. Refer to page 81 and to your device/driver documentation for supported pre-trigger and post-trigger sources.

Figure 3 illustrates continuous pre-trigger mode using a channel list of three entries: channel 0, channel 1, and channel 2. In this example, pre-trigger analog input data is acquired on each clock pulse of the A/D sample clock; refer to page 79 for more information on clock sources. The device wraps to the beginning of the channel list and the acquisition repeats continuously until the post-trigger event occurs. When the post-trigger event occurs, acquisition stops.

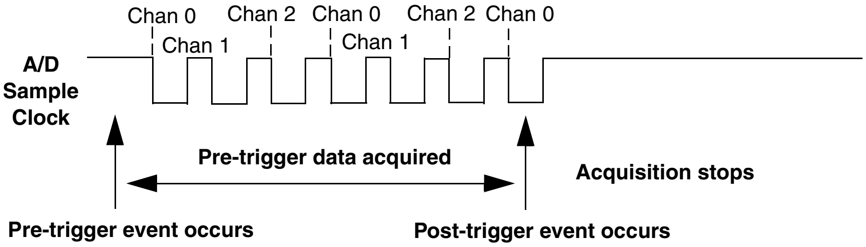


**Figure 3: Continuous Pre-Trigger Mode**

### Continuous About-Trigger Mode (Legacy Devices)

**Note:** This mode does not support use of a reference trigger. To use a reference trigger, refer to page 72.

Some older, legacy, devices support about-trigger mode. Use continuous about-trigger mode when you want to acquire data both before and after a specific external event occurs. This operation is equivalent to doing both a pre-trigger and a post-trigger acquisition.

To determine if the subsystem supports continuous about-trigger mode, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_CONTINUOUS_ABOUTTRIG capability. If this function returns a nonzero value, the capability is supported.

Specify the operation mode as OL_DF_CONTINUOUS_ABOUTTRIG using the **olDaSetDataFlow** function.

The about-trigger acquisition starts when the device detects the pre-trigger source. When it detects an external post-trigger source, the device stops acquiring pre-trigger data and starts acquiring post-trigger data.

Use the **olDaSetPretriggerSource** function to specify the pre-trigger source that starts the pre-trigger operation (this is generally a software trigger) and **olDaSetTrigger** to specify the trigger source that stops the pre-trigger acquisition and starts the post-trigger acquisition.

Refer to page 81 and to your device/driver documentation for supported pre-trigger and post-trigger sources.

The about-trigger operation stops when the specified number of post-trigger samples has been acquired or when you stop the operation.

Figure 4 illustrates continuous about-trigger mode using a channel list of three entries: channel 0, channel 1, and channel 2. In this example, pre-trigger analog input data is acquired on each clock pulse of the A/D sample clock. The device wraps to the beginning of the channel list and the acquisition repeats continuously until the post-trigger event occurs. When the post-trigger event occurs, post-trigger acquisition begins on each clock pulse of the A/D sample clock; refer to page 79 for more information on clock sources. The device wraps to the beginning of the channel list and acquires post-trigger data continuously.

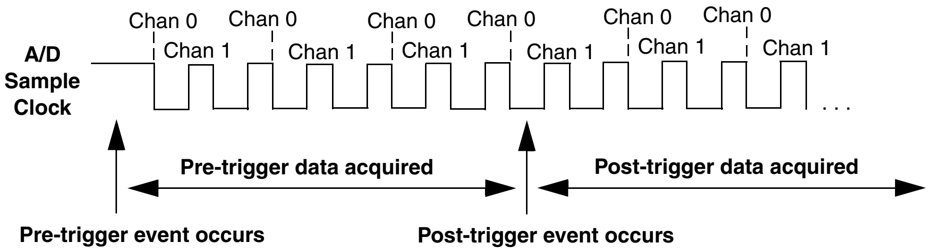


**Figure 4: Continuous About-Trigger Mode**

## Triggered Scan Mode

In triggered scan mode, the device scans the entries in a channel-gain list a specified number of times when it detects the specified trigger source, acquiring the data for each entry that is scanned.

To determine if the subsystem supports triggered scan mode, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_TRIGSCAN capability. If this function returns a nonzero value, the capability is supported. Note that you cannot use triggered scan mode with single-value operations.

To enable (or disable) triggered scan mode, use the **olDaSetTriggeredScanUsage** function.

To determine the maximum number of times that the device can scan the channel-gain list per trigger, use the **olDaGetSSCaps** function, specifying the OLSSC_MAXMULTISCAN capability.

Use the **olDaSetMultiscanCount** function to specify the number of times to scan the channel-gain list per trigger.

The DataAcq SDK defines the following retrigger modes for a triggered scan; these retrigger modes are described in the following subsections:

- Scan-per-trigger
- Internal retrigger
- Retrigger extra

**Note:** If your device driver supports it, retrigger extra is the preferred triggered scan mode.

## Scan-Per-Trigger Mode

Use scan-per-trigger mode if you want to accurately control the period between conversions of individual channels and retrigger the scan based on an internal or external event. In this mode, the retrigger source is the same as the initial trigger source.

To determine if the subsystem supports scan-per-trigger mode, use the **olDaGetSSCaps** function, specifying the OLSS_SUP_RETRIGGER_SCAN_PER_TRIGGER capability. If this function returns a nonzero value, the capability is supported.

Specify the retrigger mode as scan-per-trigger using the **olDaSetRetriggerMode** function.

When it detects an initial trigger (post-trigger mode only), the device scans the channel-gain list a specified number of times (determined by the **olDaSetMultiscanCount** function), then stops. When the external retrigger occurs, the process repeats.

The conversion rate of each channel in the scan is determined by the frequency of the A/D sample clock; refer to page 79 for more information on clock sources. The conversion rate of each scan is determined by the period between retriggers; therefore, it cannot be accurately controlled. The device ignores external triggers that occur while it is acquiring data. Only retrigger events that occur when the device is waiting for a trigger are detected and acted on. Some devices may generate an OLDA_WM_TRIGGER_ERROR message.

## Internal Retrigger Mode

Use internal retrigger mode if you want to accurately control both the period between conversions of individual channels in a scan and the period between each scan.

To determine if the subsystem supports internal retrigger mode, use the **olDaGetSSCaps** function, specifying the OLSS_SUP_RETRIGGER_INTERNAL capability. If this function returns a nonzero value, the capability is supported.

Specify the retrigger mode as internal using the **olDaSetRetriggerMode** function.

The conversion rate of each channel in the scan is determined by the frequency of the A/D sample clock; refer to page 79 for more information on clock sources. The conversion rate between scans is determined by the frequency of the internal retrigger clock on the device. You specify the frequency on the internal retrigger clock using the **olDaSetRetriggerFrequency** function.

When it detects an initial trigger (pre-trigger source or post-trigger source), the device scans the channel-gain list a specified number of times (determined by the **olDaSetMultiscanCount** function), then stops. When the internal retrigger occurs, determined by the frequency of the internal retrigger clock, the process repeats.

We recommend that you set the retrigger frequency as follows:

$$\text{Min. Retrigger Period} = \frac{\text{\# of CGL entries x \# of CGLs per trigger}}{\text{A/D sample clock frequency}} + 2\ \mu\text{s}$$

$$\text{Max. Retrigger Frequency} = \frac{1}{\text{Min. Retrigger Period}}$$

For example, if you are using 512 channels in the channel-gain list (CGL), scanning the channel-gain list 256 times every trigger or retrigger, and using an A/D sample clock with a frequency of 1 MHz, set the maximum retrigger frequency to 7.62 Hz, since

$$7.62\ \text{Hz} = \frac{1}{\frac{(512 * 256)}{1\ \text{MHz}} + 2\ \mu\text{s}}$$

## Retrigger Extra Mode

Use retrigger extra mode if you want to accurately control the period between conversions of individual channels and retrigger the scan on a specified retrigger source; the retrigger source can be any of the supported trigger sources.

To determine if the subsystem supports retrigger extra mode, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_RETRIGGER_EXTRA capability. If this function returns a nonzero value, the capability is supported.

Specify the retrigger mode as retrigger extra using the **olDaSetRetriggerMode** function.

Use the **olDaSetRetrigger** function to specify the retrigger source. Refer to page 81 and to your device/device driver documentation for supported retrigger sources.

The conversion rate of each channel in the scan is determined by the frequency of the A/D sample clock; refer to page 79 for more information on clock sources. The conversion rate of each scan is determined by the period between retriggers.

If you are using an internal retrigger, specify the period between retriggers using **olDaSetRetriggerFrequency** (see page 77). If you are using an external retrigger, the period between retriggers cannot be accurately controlled. The device ignores external triggers that occur while it is acquiring data. Only retrigger events that occur when the device is waiting for a trigger are detected and acted on. Some devices may generate an OLDA_WM_TRIGGER_ERROR message.

## Interrupts

Some devices can generate an interrupt when an event occurs, such as when a digital input line changes state (also known as interrupt-on-change). Interrupts are useful when you want to monitor critical signals or when you want to signal the host computer to transfer data to or from the device. You enable interrupts when you configure the driver for the device using the Open Layers Control Panel applet; refer to your device documentation for details.

To determine if your subsystem supports interrupts, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_INTERRUPT. If this function returns a nonzero value, the capability is supported.

To monitor interrupt-on-change events on a digital input port, use software to set up the subsystem for a continuous digital input operation and start the operation; refer to page 134 for more information.

**Note:** Single-value operations do not support interrupt-on-change.

An event done message (OLDA_WM_EVENT_DONE) is generated whenever an interrupt-on-change event is detected.

Use the **olDaSetWndHandle** or **olDaSetNotificationProcedure** function to handle event done messages; you can read the *IParam* parameter of these functions to determine which digital line(s) changed state.

**Note:** For Data Translation PCI boards that support interrupt-on-change, the low word of *lParam* contains the DIO lines (bits) that caused the event and the high word of *lParam* contains the status of the digital input port when the interrupt occurred.

For Data Translation USB modules that support interrupt-on-change, the meaning of *lParam* depends on the module you are using.

Refer to your device documentation for more information.

## Clock Sources

The DataAcq SDK defines internal, external, and extra clock sources, described in the following subsections. Note that you cannot specify a clock source for single-value operations.

**Note:** Some subsystems allow you to read or update multiple channels on a single clock pulse. You can determine whether multiple channels are read or updated on a single clock pulse by using the query OLSSC_SUP_SIMULTANEOUS_CLOCKING.

### Internal Clock Source

The internal clock is the clock source on the device that paces data acquisition or output for each entry in the channel-gain list.

To determine if the subsystem supports an internal clock, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_INTCLOCK capability. If this function returns a nonzero value, the capability is supported.

Specify the clock source as internal using the **olDaSetClockSource** function. Then, use the **olDaSetClockFrequency** function to specify the frequency at which to pace the operation.

To determine the maximum frequency that the subsystem supports, use the **olDaGetSSCapsEx** function, specifying the OLSSCE_MAXTHROUGHPUT capability. To determine the minimum frequency that the subsystem supports, use the **olDaGetSSCapsEx** function, specifying the OLSSCE_MINTHROUGHPUT capability.

**Note:** According to sampling theory (Nyquist Theorem), you should specify a frequency for an A/D signal that is at least twice as fast as the input's highest frequency component. For example, to accurately sample a 20 kHz signal, specify a sampling frequency of at least 40 kHz. Doing so avoids an error condition called *aliasing*, in which high frequency input components erroneously appear as lower frequencies after sampling.

### External Clock Source

The external clock is a clock source attached to the device that paces data acquisition or output for each entry in the channel-gain list. This clock source is useful when you want to pace at rates not available with the internal clock or if you want to pace at uneven intervals.

To determine if the subsystem supports an external clock, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_EXTCLOCK capability. If this function returns a nonzero value, the capability is supported.

Specify the clock source as external using the **olDaSetClockSource** function. Then, use the **olDaSetExternalClockDivider** to specify the clock divider used to determine the frequency at which to pace the operation; the clock input source divided by the clock divider determines the frequency of the clock signal.

To determine the maximum clock divider that the subsystem supports, use the **olDaGetSSCapsEx** function, specifying the OLSSCE_MAXCLOCKDIVIDER capability. To determine the minimum clock divider that the subsystem supports, use the **olDaGetSSCapsEx** function, specifying the OLSSCE_MINCLOCKDIVIDER capability.

### Extra Clock Source

Your device driver may define extra clock sources that you can use to pace acquisition or output operations.

To determine how many extra clock sources are supported by your subsystem, use the **olDaGetSSCaps** function, specifying the OLSSC_NUMEXTRACLOCKS capability. Refer to your device/driver documentation for a description of the extra clock sources.

The extra clock sources may be internal or external. Refer to the previous sections for information on how to specify internal and external clocks and their frequencies or clock dividers.

## Trigger Source

The DataAcq SDK defines the following trigger sources:

- Software (internal) trigger
- External digital (TTL) trigger
- External analog threshold (positive) trigger
- External analog threshold (negative) trigger
- Analog event trigger
- Digital event trigger
- Timer event trigger
- Extra trigger

For devices that support a start trigger and reference trigger for performing continuous pre-and post-trigger analog input operations, specify the start trigger type using the **olDaSetTrigger** function, and specify the reference trigger type using the **olDaSetReferenceTrigger** function.

For devices that support continuous post-trigger and about-trigger operations without using a reference trigger, specify the post-trigger source using the **olDaSetTrigger** function; refer to page 73 for more information on post-trigger operations and page 75 for more information on about-trigger operations.

For devices that support a pre-trigger source without using a reference trigger, use the **olDaSetPretriggerSource** function; see page 74 for more information. To specify a retrigger source, use the **olDaSetRetrigger** function; see page 78 for more information.

The following subsections describe these trigger sources. Note that you cannot specify a trigger source for single-value operations.

### Software (Internal) Trigger Source

A software trigger occurs when you start the operation; internally, the computer writes to the device to begin the operation.

To determine if the subsystem supports a software trigger for a start trigger, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_SOFTTRIG. If this function returns a nonzero value, the capability is supported.

### External Digital (TTL) Trigger Source

An external digital trigger is a digital (TTL) signal attached to the device.

To determine if the subsystem supports an external digital trigger for a start trigger, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_EXTERNTRIG. If this function returns a nonzero value, the capability is supported.

To determine if the subsystem supports a positive external digital trigger for a reference trigger, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_EXTERNTTLPOS_REFERENCE_TRIG. If this function returns a nonzero value, the capability is supported.

To determine if the subsystem supports a negative external digital trigger for a reference trigger, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_EXTERNTTLNEG_REFERENCE_TRIG. If this function returns a nonzero value, the capability is supported.

To determine if the subsystem supports a positive, external digital trigger for a single-value operation, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_SV_POS_EXTERN_TTLTRIG. If this function returns a nonzero value, the capability is supported.

To determine if the subsystem supports a negative, external digital trigger for a single-value operation, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_SV_NEG_EXTERN_TTLTRIG. If this function returns a nonzero value, the capability is supported.

### External Analog Threshold (Positive) Trigger Source

An external analog threshold (positive) trigger is generally either an analog signal from an analog input channel or an external analog signal attached to the device. An analog trigger occurs when the device detects a transition from a negative to positive value that crosses a threshold value. The threshold level is generally set using a D/A subsystem on the device.

To determine if the subsystem supports analog threshold triggering (positive polarity) for a start trigger, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_THRESHTRIGPOS. If this function returns a nonzero value, the capability is supported.

To determine if the subsystem supports analog threshold triggering (positive polarity) for a reference trigger, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_THRESHPOS_REFERENCE_TRIG. If this function returns a nonzero value, the capability is supported.

To list the actual channel numbers that support a threshold channel, use the **olDaEnumSSCaps** function, specifying the capability OL_ENUM_THRESHOLD_START_TRIGGER_CHANNELS for the start trigger or OL_ENUM_THRESHOLD_REFERENCE_TRIGGER_CHANNELS for the reference trigger.

To set the channel that you want to use for the threshold trigger for the start trigger, use the **olDaSetTriggerThresholdChannel** function. To set the channel that you want to use for the threshold trigger for the reference trigger, use the **olDaSetReferenceTriggerThresholdChannel** function. By default, channel 0 is used for the threshold channel.

To return the channel that is currently set for the start threshold trigger, use the **olDaGetTriggerThresholdChannel** function. To return the channel that is currently set for the stop threshold trigger, use the **olDaGetReferenceTriggerThresholdChannel** function.

On some devices, the threshold level is set using an analog output subsystem on the device. On other devices, you set the threshold level for the start trigger using the **olDaSetTriggerThresholdLevel** function, and for the reference trigger using the **olDaSetReferenceTriggerThresholdLevel** function. By default, the trigger threshold value is in voltage unless specified otherwise for the device; see the user’s manual for your device for valid threshold value settings.

**Note:** The threshold level set by the **olDaSetTriggerThresholdLevel** or **olDaSetReferenceTriggerThresholdLevel f**unction depends on the voltage range and the gain of the subsystem. For example, if the voltage range of the analog input subsystem is ±10 V, and the specified gain is 1, specify a threshold voltage level within ±10 V. Likewise, if the voltage range of the analog input subsystem is ±10 V, and the specified gain is 10, specify a threshold voltage level within ±1 V. Refer to your device documentation for details on how to specify the threshold value for your device.

To return the currently set threshold level for the start trigger, use the **olDaGetTriggerThresholdLevel** function. To return the currently set threshold level for the reference trigger, use the **olDaGetReferenceTriggerThresholdLevel** function.

### External Analog Threshold (Negative) Trigger Source

An external analog threshold (negative) trigger is generally either an analog signal from an analog input channel or an external analog signal attached to the device. An analog trigger event occurs when the device detects a transition from a positive to negative value that crosses a threshold value. The threshold level is generally set using a D/A subsystem on the device.

To determine if the subsystem supports analog threshold triggering (negative polarity) for a start trigger, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_THRESHTRIGNEG. If this function returns a nonzero value, the capability is supported.

To determine if the subsystem supports analog threshold triggering (negative polarity) for a reference trigger, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_THRESHNEG_REFERENCE_TRIG. If this function returns a nonzero value, the capability is supported.

To list the actual channel numbers that support a threshold channel, use the **olDaEnumSSCaps** function, specifying the capability OL_ENUM_THRESHOLD_START_TRIGGER_CHANNELS for the start trigger or OL_ENUM_THRESHOLD_REFERENCE_TRIGGER_CHANNELS for the reference trigger.

To set the channel that you want to use for the threshold trigger for the start trigger, use the **olDaSetTriggerThresholdChannel** function. To set the channel that you want to use for the threshold trigger for the reference trigger, use the **olDaSetReferenceTriggerThresholdChannel** function. By default, channel 0 is used for the threshold channel.

To return the channel that is currently set for the start threshold trigger, use the **olDaGetTriggerThresholdChannel** function. To return the channel that is currently set for the stop threshold trigger, use the **olDaGetReferenceTriggerThresholdChannel** function.

On some devices, the threshold level is set using an analog output subsystem on the device. On other devices, you set the threshold level for the start trigger using the **olDaSetTriggerThresholdLevel** function, and for the reference trigger using the **olDaSetReferenceTriggerThresholdLevel** function. By default, the trigger threshold value is in voltage unless specified otherwise for the device; see the user's manual for your device for valid threshold value settings.

**Note:** The threshold level set by the **olDaSetTriggerThresholdLevel** or **olDaSetReferenceTriggerThresholdLevel f**unction depends on the voltage range and gain of the subsystem. For example, if the voltage range of the analog input subsystem is ±10 V, and the specified gain is 1, specify a threshold voltage level within ±10 V. Likewise, if the voltage range of the analog input subsystem is ±10 V, and the specified gain is 10, specify a threshold voltage level within ±1 V. Refer to your device documentation for details on how to specify the threshold value for your device.

To return the currently set threshold level for the start trigger, use the **olDaGetTriggerThresholdLevel** function. To return the currently set threshold level for the reference trigger, use the **olDaGetReferenceTriggerThresholdLevel** function.

### *Sync Bus Trigger Source*

For devices that support connecting multiple devices together in a master/slave relationship using Sync Bus (RJ45) connectors, the slave device may support the ability to configure a Sync Bus trigger source as the reference trigger.

To determine if the subsystem supports a Sync Bus trigger source as the reference trigger, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_SYNCBUS_ REFERENCE_TRIG. If this function returns a nonzero value, the capability is supported.

Use the Sync Bus trigger source as the reference trigger if you want the slave device to receive a Sync Bus trigger from one of the other devices to stop pre-trigger acquisition and start post-trigger acquisition.

If you want to set the slave module to receive a Sync Bus trigger as the start trigger source, set the synchronization mode of the device to Slave using the **olDaSetSyncMode** function, described on page 86; the Sync Bus trigger is used by the slave module as the start trigger source by default.

### Analog Event Trigger Source

For this trigger source, a trigger is generated when an analog event occurs. To determine if the subsystem supports an analog event trigger, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_ANALOGEVENTTRIG. If this function returns a nonzero value, the capability is supported.

### Digital Event Trigger Source

For this trigger source, a trigger is generated when a digital event occurs. To determine if the subsystem supports a digital event trigger, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_DIGITALEVENTTRIG. If this function returns a nonzero value, the capability is supported.

### Timer Event Trigger Source

For this trigger source, a trigger is generated when a counter/timer event occurs. To determine if the subsystem supports a timer event trigger, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_TIMEREVENTTRIG. If this function returns a nonzero value, the capability is supported.

### Extra Trigger Source

Extra trigger sources may be defined by your device driver. To determine how many extra triggers are supported by the subsystem, use the **olDaGetSSCaps** function, specifying the capability OLSSC_NUMEXTRATRIGGERS. Refer to your device/driver documentation for a description of these triggers.

The extra trigger sources may be internal or external. Refer to the previous sections for information on how to specify internal and external triggers.

## Post-Trigger Scan Count

On devices that support a reference trigger for performing continuous pre- and post-trigger analog input operations, you can specify how many samples to acquire after the reference trigger occurs using the **olDaSetReferenceTriggerPostTriggerScanCount** function.

To determine if your device supports the ability to specify the number of post-trigger samples to acquire, use the use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_POST_REFERENCE_TRIG_SCANCOUNT.

To return the currently set number of samples to acquire after the reference trigger, use the **olDaGetReferenceTriggerPostTriggerScanCount** function.

## Synchronization Mode

Some devices support one or more synchronization connectors (such as an LVDS RJ45 or Sync Bus connector) that allows you to synchronize operations on multiple devices. In this configuration, the subsystem on one device is configured as the master and the subsystem on the other device is configured as a slave. When the specified subystem of the master module is triggered, the subsystem on both the master device and the slave device start operating at the same time.

To determine if your subsystem supports the ability to program the synchronization mode, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_SYNCHRONIZATION capability.

If the subsystem supports programmable synchronization modes, use the **olDaSetSyncMode** function to set the synchronization mode to one of the following values:

- OL_SYNC_MODE_MASTER – Sets the subsystem as a master; the synchronization connector on the device is configured to output a synchronization signal.
- OL_SYNC_MODE_SLAVE – Sets the subsystem as a slave; the synchronization connector on the device is configured to accept a synchronization signal as an input.
- OL_SYNC_MODE_NONE – The subsystem is configured to ignore the synchronization circuit.

Refer to your hardware documentation to determine how synchronizing multiple devices works on for your device.

## Buffers

The buffering capability usually applies to A/D and D/A subsystems only. Note that you cannot use a buffer with single-value operations.

A data buffer is a memory location that you allocate in host memory. This memory location is used to store data for continuous input and output operations.

To determine if the subsystem supports buffers, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_BUFFERING. If this function returns a nonzero value, the capability is supported.

Buffers are stored on one of three queues: the ready queue, the inprocess queue, or the done queue. These queues are described in more detail in the following subsections.

### Ready Queue

For input operations, the ready queue holds buffers that are empty and ready for input. For output operations, the ready queue holds buffers that you have filled with data and that are ready for output.

Allocate the buffers using the **olDmMallocBuffer**, **olDmAllocBuffer**, or **olDmCallocBuffer** function. **olDmAllocBuffer** allocates a buffer of samples, where each sample is 2 bytes; **olDmCallocBuffer** allocates a buffer of samples of a specified size; **olDmMallocBuffer** allocates a buffer in bytes.

**Note:** If you use the **olDaSetReturnCjcTemperatureInStream** function, described on page 60, to return CJC values in the data stream, ensure that you allocate a buffer with **olDmCallocBuffer** that is twice as large to accommodate the returned CJC values for each channel (buffer size = number of channels x 2 x the number of samples).

For analog input operations, it is recommended that you allocate a minimum of three buffers; for analog output operations, you can allocate one or more buffers. The size of the buffers should be at least as large as the sampling or output rate; for example, if you are using a sampling rate of 100 ksamples/s (100 kHz), specify a buffer size of 100,000 samples.

Once you have allocated the buffers (and, for output operations, filled them with data), put the buffers on the ready queue using the **olDaPutBuffer** function.

For example, assume that you are performing an analog input operation, that you allocated three buffers, and that you put these buffers on the ready queue. The queues appear on the ready queue as shown in Figure 5.

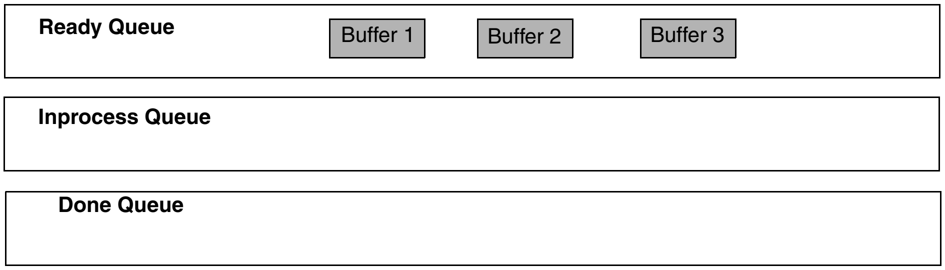


**Figure 5: Example of the Ready Queue**

## Inprocess Queue

When you start a continuous (post-trigger, pre-trigger, or about-trigger) operation, the data acquisition device takes the first available buffer from the ready queue and places it on the inprocess queue.

The inprocess queue holds the buffer that the specified data acquisition device is currently filling (for input operations) or outputting (for output operations). The buffer is filled or emptied at the specified clock rate.

Continuing with the previous example, when you start the analog input operation, the driver takes the first available buffer (Buffer 1, in this case), puts it on the inprocess queue, and starts filling it with data. The queues appear as shown in Figure 6.

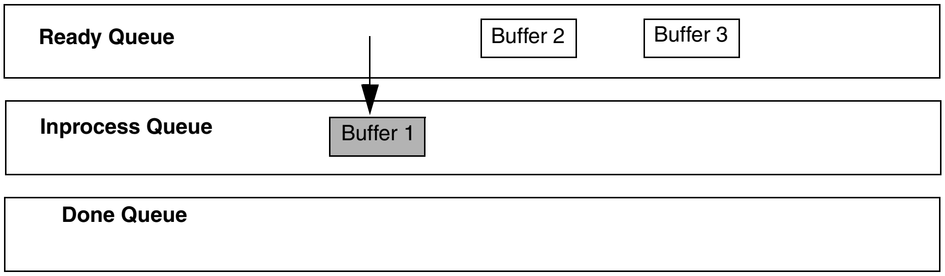


**Figure 6: Example of the Inprocess Queue**

If required, you can use the **olDaFlushFromBufferInprocess** function to transfer data from a partially-filled buffer on an inprocess queue to a buffer you create (if this capability is supported). Typically, you would use this function when your data acquisition operation is running slowly.

To determine if the subsystem supports transferring data from a buffer on the inprocess queue, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_INPROCESSFLUSH capability. If this function returns a nonzero value, this capability is supported.

**Note:** Some devices transfer data to the host in segments instead of one sample at a time. For example, data from the DT3010 device is transferred to the host in 64 byte segments; the number of valid samples is always a multiple of 64 depending on the number of samples transferred to the host when **olDaFlushFromBufferInprocess** was called. It is up to your application to take this into account when flushing an inprocess buffer. Refer to your device documentation for more information.

### Done Queue

Once the data acquisition device has filled the buffer (for input operations) or emptied the buffer (for output operations), the buffer is moved from the inprocess queue to the done queue. Then, either the OLDA_WM_BUFFER_DONE message is generated when the buffer contains post-trigger data, or in the case of pre-trigger and about-trigger acquisitions, an OLDA_WM_PRETRIGGER_BUFFER_DONE message is generated when the buffer contains pre-trigger data.

**Note:** For analog input operations that use a reference trigger whose trigger type is something other than software (none), the OLDA_WM_IO_COMPLETE message is generated when the last post-trigger sample is copied into the user buffer. This message includes the total number of samples per channel that were acquired from the time acquisition was started (with the start trigger) to the last post-trigger sample. For example, a value of 100 indicates that a total of 100 samples (samples 0 to 99) were acquired. In some cases, this message is generated well before the OLDA_WM_BUFFER_DONE messages are generated. You can determine when the reference trigger occurred and the number of pre-trigger samples that were acquired by subtracting the post trigger scan count, described on page 85, from the total number of samples that were acquired. Devices that do not support a reference trigger will never receive the OLDA_WM_IO_COMPLETE message for analog input operations.

For pre-trigger acquisitions that do not use a reference trigger, the OLDA_WM_QUEUE_STOPPED message is also generated when the operation completes or you stop a pre-trigger acquisition.

For analog output operations only, the OLDA_WM_IO_COMPLETE message is generated when the last data point has been output from the analog output channel. In some cases, this message is generated well after the data is transferred from the buffer (when the OLDA_WM_BUFFER_DONE and OLDA_WM_QUEUE_DONE messages are generated.

Continuing with the previous example, the queues appear as shown in Figure 7 when you get the first OLDA_WM_BUFFER_DONE message.

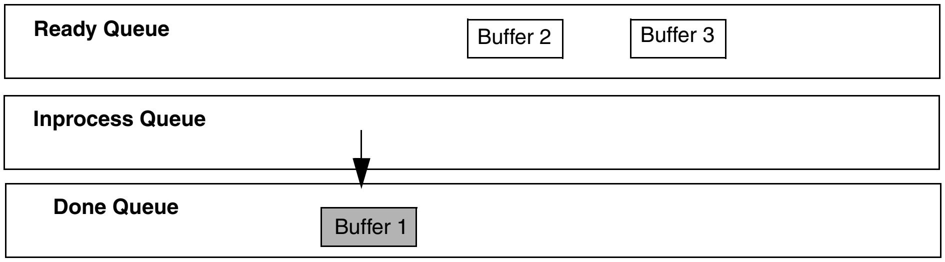


**Figure 7: Example of the Done Queue**

Then, the driver moves Buffer 2 from the ready queue to the inprocess queue and starts filling it with data. When Buffer 2 is filled, Buffer 2 is moved to the done queue and another OLDA_WM_BUFFER_DONE message is generated.

The driver then moves Buffer 3 from the ready queue to the inprocess queue and starts filling it with data. When Buffer 3 is filled, Buffer 3 is moved to the done queue and another OLDA_WM_BUFFER_DONE message is generated. Figure 8 shows how the buffers are moved.

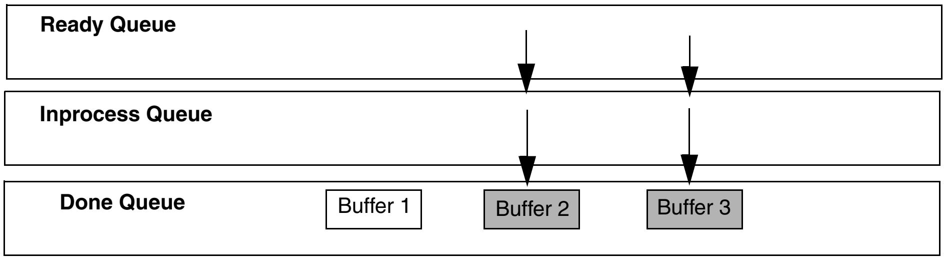


**Figure 8: How Buffers are Moved to the Done Queue**

If you transferred data from an inprocess queue to a new buffer using **olDaFlushFromBufferInprocess**, the new buffer is put on the done queue for your application to process. When the buffer on the inprocess queue finishes being filled, this buffer is also put on the done queue; the buffer contains only the samples that were not previously transferred.

## *Buffer and Queue Management*

Each time it gets an OLDA_WM_BUFFER_DONE message, your application program should remove the buffers from the done queue using the **olDaGetBuffer** buffer management function.

Your application program can then process the data in the buffer. For an input operation, you can copy the data from the buffer to an array in your application program using the **olDmGetBufferPtr** function. For continuously paced analog output operations, you can fill the buffer with new output data using the **olDaGetBufferPtr** function.

If you want to convert the count value to engineering units, you can use the **olDaCodeToVolts** function. Similarly, if you want to convert the engineering units to counts, you can use the **olDaVoltsToCode** function.

For channels that support strain gage inputs, you can convert the value in voltage to a strain value by using the **olDaVoltsToStrain** function or to a value for a bridge-based sensor using the **olDaVoltsToBridgeBasedSensor** function.

When you are finished processing the data, you can put the buffer back on the ready queue using the **olDaPutBuffer** function if you want your operation to continue.

For example, assume that you processed the data from Buffer 1 and put it back on the ready queue. The queues would appear as shown in Figure 9.

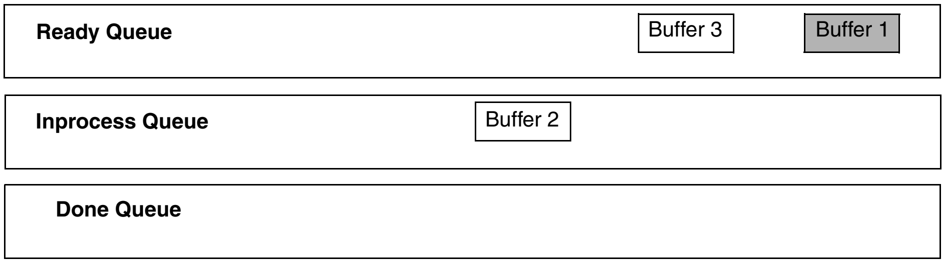


**Figure 9: Putting Buffers Back on the Ready Queue**

When the data acquisition operation is finished, use the **olDaFlushBuffers** function to transfer any data buffers left on the subsystem's ready queue to the done queue.

Once you have processed the data in the buffers, remove the buffers from the done queue using the **olDaFreeBuffer** function.

### Buffer Wrap Modes

Most Data Translation data acquisition devices can provide gap-free data, meaning no samples are missed when data is acquired or output. You can acquire gap-free data by manipulating data buffers so that no gaps exist between the last sample of the current buffer and the first sample of the next buffer.

**Note:** The number of DMA channels, number of buffers, and buffer size are critical to the device's ability to provide gap-free data. It is also critical that the application process the data in a timely fashion.

If you want to acquire gap-free input data, we recommend that you specify a buffer wrap mode of *none* using the **olDaSetWrapMode** buffer management function. When a buffer wrap mode of none is selected, the operation continues indefinitely if you process the buffers and put them back on the ready queue in a timely manner. When no buffers are available on the ready queue, the operation stops, and an OLDA_WM_QUEUE_DONE message is generated.

If you want to continuously reuse the buffers in the queues and you are not concerned with gap-free data, specify *multiple* buffer wrap mode using **olDaSetWrapMode**. When multiple wrap mode is selected and no buffers are available on the ready queue, the driver overwrites the data in the current buffer. This process continues indefinitely until you stop it. When it reuses a buffer on the done queue, the driver generates an OLDA_WM_BUFFER_REUSED message.

If you want to output gap-free waveforms from your analog output channels, specify *single* wrap mode using **olDaSetWrapMode.** When single wrap mode is specified, a single buffer is used.

If the device has a FIFO and the buffer fits into the FIFO, the buffer is downloaded to the FIFO on the device. The driver (or device) outputs the data starting from the first location in the buffer. When it reaches the end of the buffer, the driver (or device) continues outputting data from the first location of the buffer, and the process continues indefinitely until you stop it. Typically, no messages are posted in this mode until you stop the operation.

**Note:** If the size of your buffer is less than the FIFO size and you stop the analog output operation, the operation stops after the current buffer and the next buffer have been output.

If you query the subsystem with the OLSSC_SUP_WRPWAVEFORM_ONLY capability and the **olDaGetSSCaps** function returns a nonzero value, the subsystem supports waveform-based operations using the onboard FIFO only. In this case, the buffer wrap mode must be set to single. In addition, the buffer size must be less than or equal to the FIFO size. You can determine whether the subsystem supports a FIFO using the **olDaGetSSCaps** function with the capability OLSSC_SUP_FIFO. If this function returns a nonzero value, a FIFO is supported. You can determine the size of the FIFO using the capability OLSSC_FIFO_SIZE_IN_K. This query returns the actual FIFO size in kilobytes.

To determine the buffer wrap modes available for the subsystem, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_WRPSINGLE (for single wrap mode) or OLSSC_SUP_WRPMULTIPLE (for multiple wrap mode). If this function returns a nonzero value, the capability is supported.

## DMA Resources

You cannot use DMA resources for single-value operations.

To determine if gap-free data acquisition is supported, use the **olDaGetSSCaps** function, specifying OLSSC_SUP_GAPFREE_NODMA (for gap free data using no DMA channels), OLSSC_SUP_GAPFREE_SINGLEDMA (for gap free data using one DMA channel), or OLSSC_SUP_GAPFREE_DUALDMA (for gap free data using two DMA channels). If this function returns a nonzero value, the capability is supported.

To determine how many DMA channels are supported, use the **olDaGetSSCaps** function, specifying the capability OLSSC_NUMDMACHANS.

Use the **olDaSetDmaUsage** function to specify the number of DMA channels to use. These channels must also be specified in the driver configuration dialog.

**Note:** DMA channels are a limited resource and the request may not be honored if the requested number of channels is unavailable. For example, suppose that a device that supports both A/D and
D/A subsystems provides hardware for two DMA channels, and that one DMA channel is currently allocated to the A/D subsystem. In this case, a request to the D/A subsystem to use two DMA channels will fail.

# Counter/Timer Operations

The counter/timer subsystem supports general-purpose user counter/timers and may support measure counters and quadrature decoders. Refer to page 123 for more information on measure counters. Refer to page 123 for more information on quadrature decoders. The rest of this section describes the operation of general-purpose counter/timers.

## User Counter/Timers

Each user counter/timer channel accepts a clock input signal and gate input signal and outputs a clock output signal (also called a pulse output signal), as shown in Figure 10.

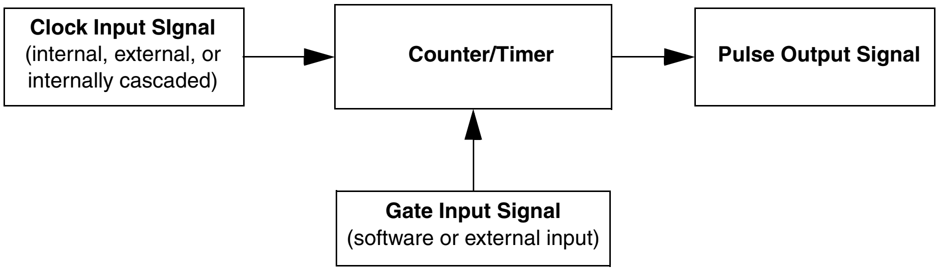

Clock Input SIgnal
(internal, external, or internally cascaded)
Counter/Timer
Pulse Output Signal
Gate Input Signal
(software or external input)

**Figure 10: Counter/Timer Channel**

Each counter/timer channel corresponds to a counter/timer (C/T) subsystem. To specify the counter to use in software, specify the appropriate C/T subsystem. For example, counter 0 corresponds to C/T subsystem element 0; counter 3 corresponds to C/T subsystem element 3.

The DataAcq SDK defines the following capabilities that you can query and/or configure for user counter/timer operations:

- Counter/timer operation mode
- Clock source
- Gate source
- Pulse output type
- Pulse output duty cycle

The following sections describe these capabilities in more detail.

## Counter/Timer Operation Mode

The DataAcq SDK supports the following counter/timer operations:

- Event counting
- Up/down counting
- Frequency measurement

- Edge-to-edge measurement
- Continuous edge-to-edge measurement
- Rate generation (continuous pulse output)
- One-shot
- Repetitive one-shot

The following subsections describe these counter/timer operations.

### Event Counting

Use event counting mode to count events from the counter's associated clock input source.

To determine if the subsystem supports event counting, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_CTMODE_COUNT. If this function returns a nonzero value, the capability is supported.

To specify an event counting operation, use the **olDaSetCTMode** function, specifying the OL_CTMODE_COUNT parameter.

Specify the C/T clock source for the operation. In event counting mode, an external C/T clock source is more useful than the internal C/T clock source; refer to page 112 for more information on specifying the C/T clock source.

Also specify the gate type that enables the operation; refer to page 114 for more information on specifying the gate type.

Start an event counting operation using the **olDaStart** function. To read the current number of events counted, use the **olDaReadEvents** function.

To stop the event counting operation, call **olDaStop**, **olDaAbort**, or **olDaReset**; **olDaReset** function stops the operation and reinitializes the subsystem after stopping it.

Figure 11 shows an example of an event counting operation. In this example the gate type is low level.

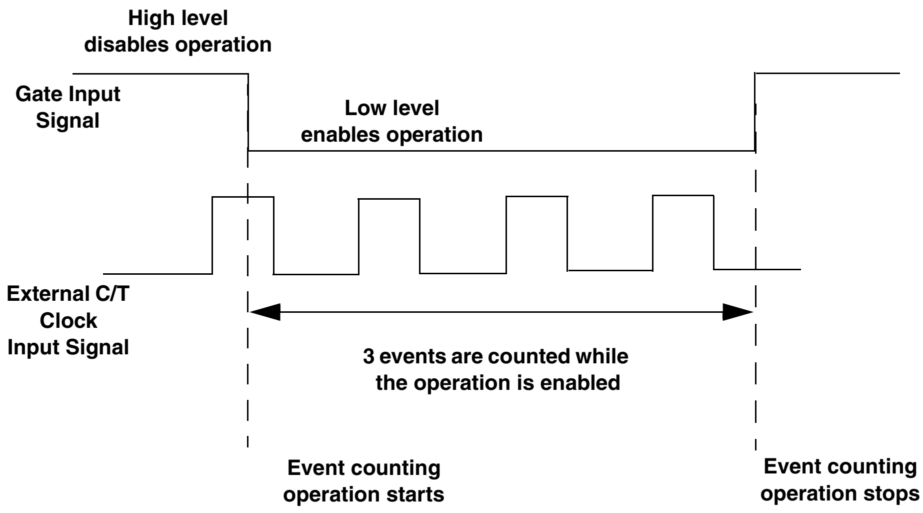


**Figure 11: Example of Event Counting**

### *Up/Down Counting*

Use up/down counting mode to increment or decrement the number of rising edges that occur on the counter's associated clock input, depending on the level of the counter's associated gate signal. If the gate signal is high, the C/T increments; if the gate signal is low, the C/T decrements.

To determine if the subsystem supports up/down counting, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_CTMODE_UP_DOWN. If this function returns a nonzero value, the capability is supported.

To specify an up/down counting operation, use the **olDaSetCTMode** function, specifying the OL_CTMODE_UP_DOWN parameter.

Specify the C/T clock source for the operation as external. Note that you do not specify the gate type in software.

Start an up/down counting operation using the **olDaStart** function. To read the current number of rising edges counted, use the **olDaReadEvents** function.

To stop the event counting operation, call **olDaStop**, **olDaAbort**, or **olDaReset**; **olDaReset** function stops the operation and reinitializes the subsystem after stopping it.

Figure 12 shows an example of an up/down counting operation. The counter increments when the gate signal is high and decrements when the gate signal is low.

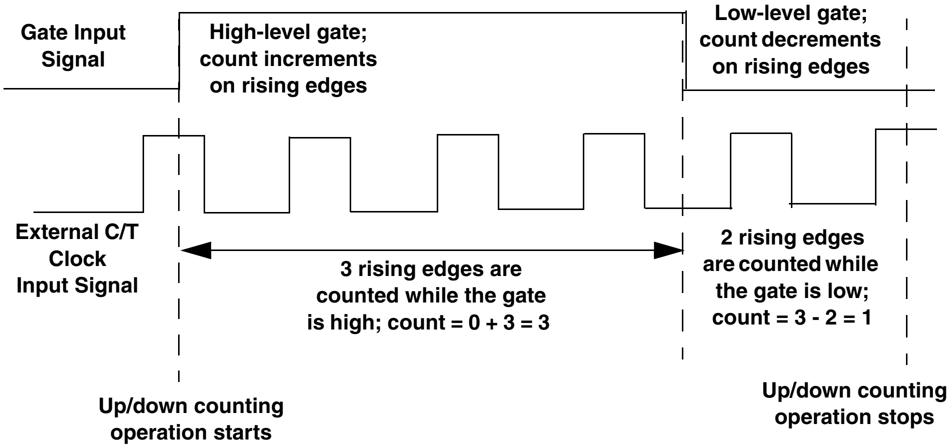

Gate Input Signal
High-level gate; count increments on rising edges
Low-level gate; count decrements on rising edges
External C/T Clock Input Signal
3 rising edges are counted while the gate is high; count = 0 + 3 = 3
2 rising edges are counted while the gate is low; count = 3 - 2 = 1
Up/down counting operation starts
Up/down counting operation stops

Figure 12: Example of Up/Down Counting

## Frequency Measurement

You can also use event counting mode to measure the frequency of the clock input signal for the counter, since frequency is the number of events divided by a specified duration.

To determine if the subsystem supports event counting (and therefore, frequency measurement), use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_CTMODE_COUNT. If this function returns a nonzero value, the capability is supported.

You can perform a frequency measurement operation in one of two ways: using the Windows timer to specify the duration or using a pulse of a known duration as the gate input signal to a counter/timer configured for event counting mode. The following subsections describe these ways of measuring frequency.

### Using the Windows Timer

To perform a frequency measurement operation on a single C/T subsystem using the Windows timer to specify the duration, do the following:

1. Use the **olDaSetCTMode** function, specifying the OL_CTMODE_COUNT parameter.
2. Specify the input clock source using **olDaSetClockSource**. In frequency measurement mode, an external C/T clock source is more useful than the internal C/T clock source; refer to page 112 for more information on the external C/T clock source.
3. Use the **olDaSetGateType** function, specifying the OL_GATE_NONE parameter, to set the gate type to software.
4. Use the **olDaMeasureFrequency** function to specify the duration of the Windows timer (which has a resolution of 1 ms) and to start the frequency measurement operation.

Frequency is determined using the following equation:

$$\text{Frequency} = \frac{\text{Number of Events}}{\text{Duration of the Windows Timer}}$$

When the operation is complete, the OLDA_WM_MEASURE_DONE message is generated. Use the LongtoFreq (lParam) macro, described in the DataAcq SDK online help, to return the measured frequency value.

Figure 13 shows an example of a frequency measurement operation. Three events are counted from the clock input signals during a duration of 300 ms. The frequency is 10 Hz (3/.3).

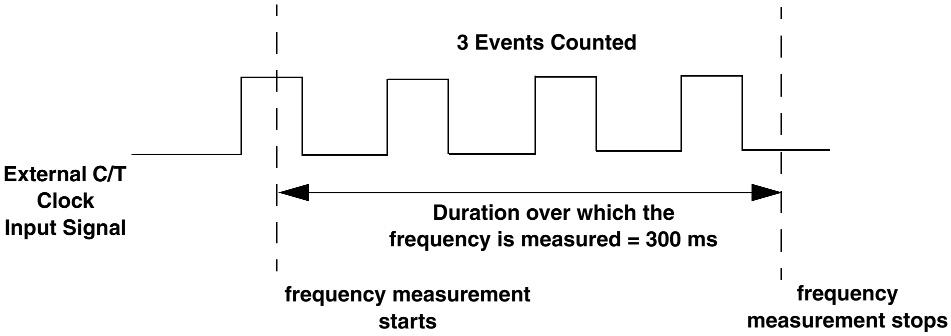

3 Events Counted
External C/T Clock Input Signal
Duration over which the frequency is measured = 300 ms
frequency measurement starts
frequency measurement stops

**Figure 13: Example of Frequency Measurement**

### Using a Pulse of a Known Duration

If you need more accuracy than the Windows timer provides, you can connect a pulse of a known duration to the external gate input of a counter/timer configured for event counting; refer to the device user manual for wiring details.

The following example describes how to use the DataAcq SDK to measure frequency using two C/T subsystems: one that generates a variable-width one-shot pulse as the gate input to a second C/T subsystem configured for event counting mode:

1. Set up one C/T subsystem for one-shot mode as follows:
   a. Use the **olDaSetCTMode** function, specifying the OL_CTMODE_ONESHOT parameter.
   b. For this C/T subsystem, specify the clock source (with **olDaSetClockSource**), the clock frequency (with **olDaSetClockFrequency** if using an internal clock source, or **olDaSetExternalClockDivider** if using an external clock source), the gate type (with **olDaSetGateType**), the type of output pulse (with **olDaSetPulseType**), and the pulse width (with **olDaSetPulseWidth**). The pulse width and period are used to determine the time that the gate is active.
   c. Configure this C/T subsystem with **olDaConfig**.

**d.** Get the actual clock frequency used by this C/T subsystem with **olDaGetClockFrequency** or **olDaGetExternalClockDivider**. You will use this value in the measurement period calculation.

**e.** Get the actual pulse width used by this C/T subsystem with **olDaGetPulseWidth**. You will use this value in the measurement period calculation.

**2.** Set up another C/T subsystem for event counting mode:

**a.** Use the **olDaSetCTMode** function, specifying the OL_CTMODE_COUNT parameter, to set up this C/T subsystem for event counting mode (and, therefore, a frequency measurement operation).

**b.** For this C/T subsystem, use **olDaSetClockSource** to specify the clock source you want to measure. For frequency measurement operations, an external C/T clock source is more useful than the internal C/T clock source; refer to page 112 for more information on the external C/T clock source.

**c.** For this C/T subsystem, use the **olDaSetGateType** function to specify the gate type; ensure that the gate type for this C/T subsystem matches the active period of the output pulse from the C/T subsystem configured for one-shot mode.

**d.** Configure this C/T subsystem with **olDaConfig**.

**3.** Start the counter/timer configured for event counting mode with **olDaStart**.

**4.** Start the counter/timer configured for one-shot mode with **olDaStart.**

**5.** Allow a delay approximately equal to the measurement period to allow the one-shot to finish; events are counted only during the active period of the one-shot pulse.

**6.** For the event-counting C/T subsystem, read the number of events counted with **olDaReadEvents**.

**7.** Determine the measurement period using the following equation:

$$\text{Measurement Period} = \frac{1}{\text{Actual Clock Frequency}} * \text{Active Pulse Width of One-Shot C/T}$$

**8.** Determine the frequency of the clock input signal using the following equation:

$$\text{Frequency Measurement} = \frac{\text{Number of Events}}{\text{Measurement Period}}$$

## Edge-to-Edge Measurement

Use edge-to-edge measurement to measure the time interval between a specified start edge and a specified stop edge. The start edge and the stop edge can occur on the rising edge of the counter's associated gate input, the falling edge of the counter's associated gate input, the rising edge of the counter's associated clock input, or the falling edge of the counter's associated clock input. When the start edge is detected, the counter starts incrementing, and continues incrementing until the stop edge is detected.

To determine if the subsystem supports edge-to-edge measurement, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_CTMODE_MEASURE. This function returns a bit value indicating how edge-to-edge measurement mode is supported for the specified device. For example, if edge-to-edge measurements are supported on the gate signal only (using both rising and falling edges), a bit value of 3 is returned. Table 12 lists the possible bit values.

**Table 12: Values for OLSCC_SUP_CTMODE_MEASURE**

| Value | Name | Description |
|---|---|---|
| 0x00 | – | Edge-to-edge measurements are not supported. |
| 0x01 | SUP_GATE_RISING_BIT | Rising edge of the gate signal is supported for edge-to-edge measurement mode. |
| 0x02 | SUP_GATE_FALLING_BIT | Falling edge of the gate signal is supported for edge-to-edge measurement mode. |
| 0x04 | SUP_CLOCK_RISING_BIT | Rising edge of the clock signal is supported for edge-to-edge measurement mode. |
| 0x08 | SUP_CLOCK_FALLING_BIT | Falling edge of the clock signal is supported for edge-to-edge measurement mode. |
| 0x10 | SUP_ADC_CONVERSION_COMPLETE_BIT | A/D conversion is complete is supported as an edge type for edge-to-edge measurement mode. |
| 0x20 | SUP_TACHOMETER_INPUT_FALLING_BIT | Falling edge of the tachometer input signal is supported for edge-to-edge measurement mode. |
| 0x40 | SUP_TACHOMETER_INPUT_RISING_BIT | Rising edge of the tachometer input signal is supported for edge-to-edge measurement mode. |
| 0x80 | SUP_DIGITAL_INPUT_0_FALLING_BIT | Falling edge of digital input 0 is supported for edge-to-edge measurement mode. |
| 0x100 | SUP_DIGITAL_INPUT_0_RISING_BIT | Rising edge of digital input 0 is supported for edge-to-edge measurement mode. |
| 0X200 | SUP_DIGITAL_INPUT_1_FALLING_BIT | Falling edge of digital input 1 is supported for edge-to-edge measurement mode. |
| 0X400 | SUP_DIGITAL_INPUT_1_RISING_BIT | Rising edge of digital input 1 is supported for edge-to-edge measurement mode. |

Table 12: Values for OLSCC_SUP_CTMODE_MEASURE

| Value | Name | Description |
|---|---|---|
| 0X800 | SUP_DIGITAL_INPUT_2_FALLING_BIT | Falling edge of digital input 2 is supported for edge-to-edge measurement mode. |
| 0X1000 | SUP_DIGITAL_INPUT_2_RISING_BIT | Rising edge of digital input 2 is supported for edge-to-edge measurement mode. |
| 0X2000 | SUP_DIGITAL_INPUT_3_FALLING_BIT | Falling edge of digital input 3 is supported for edge-to-edge measurement mode. |
| 0X4000 | SUP_DIGITAL_INPUT_3_RISING_BIT | Rising edge of digital input 3 is supported for edge-to-edge measurement mode. |
| 0X8000 | SUP_DIGITAL_INPUT_4_FALLING_BIT | Falling edge of digital input 4 is supported for edge-to-edge measurement mode. |
| 0X10000 | SUP_DIGITAL_INPUT_4_RISING_BIT | Rising edge of digital input 4 is supported for edge-to-edge measurement mode. |
| 0X20000 | SUP_DIGITAL_INPUT_5_FALLING_BIT | Falling edge of digital input 5 is supported for edge-to-edge measurement mode. |
| 0X40000 | SUP_DIGITAL_INPUT_5_RISING_BIT | Rising edge of digital input 5 is supported for edge-to-edge measurement mode. |
| 0X80000 | SUP_DIGITAL_INPUT_6_FALLING_BIT | Falling edge of digital input 6 is supported for edge-to-edge measurement mode. |
| 0X100000 | SUP_DIGITAL_INPUT_6_RISING_BIT | Rising edge of digital input 6 is supported for edge-to-edge measurement mode. |
| 0X200000 | SUP_DIGITAL_INPUT_7_FALLING_BIT | Falling edge of digital input 7 is supported for edge-to-edge measurement mode. |
| 0X400000 | SUP_DIGITAL_INPUT_7_RISING_BIT | Rising edge of digital input 7 is supported for edge-to-edge measurement mode. |
| 0X800000 | SUP_CT0_CLOCK_INPUT_FALLING_BIT | Falling edge of the clock input signal associated with counter/timer 0 is supported for edge-to-edge measurement mode. |
| 0X1000000 | SUP_CT0_CLOCK_INPUT_RISING_BIT | Rising edge of the clock input signal associated with counter/timer 0 is supported for edge-to-edge measurement mode. |
| 0X2000000 | SUP_CT0_GATE_INPUT_FALLING_BIT | Falling edge of the gate input signal associated with counter/timer 0 is supported for edge-to-edge measurement mode. |
| 0X4000000 | SUP_CT0_GATE_INPUT_RISING_BIT | Rising edge of the gate input signal associated with counter/timer 0 is supported for edge-to-edge measurement mode. |

To specify an edge-to-edge measurement operation, use the **olDaSetCTMode** function, specifying the OL_CTMODE_MEASURE parameter.

Specify the C/T clock source for the operation as internal. Specify the start edge with the **olDaSetMeasureStartEdge** function and the stop edge with **olDaSetMeasureStopEdge** function. Configure the counter/timer with **olDaConfig.**

Start an edge-to-edge measurement operation using the **olDaStart** function. To read the current counter value, use the **olDaReadEvents** function.

To stop the edge-to-edge measurement operation, call **olDaStop**, **olDaAbort**, or **olDaReset**; **olDaReset** function stops the operation and reinitializes the subsystem after stopping it.

Figure 14 shows an example of an edge-to-edge measurement operation. The start edge is a rising edge on the gate signal; the stop edge is a falling edge on the gate signal.

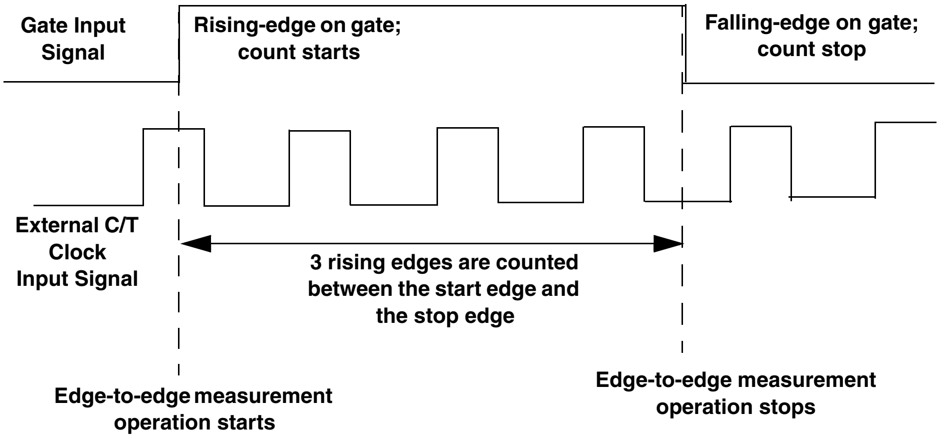

Gate Input Signal
Rising-edge on gate; count starts
Falling-edge on gate; count stop
External C/T Clock Input Signal
3 rising edges are counted between the start edge and the stop edge
Edge-to-edge measurement operation starts
Edge-to-edge measurement operation stops

**Figure 14: Example of Edge-to-Edge Measurement**

You can use edge-to-edge measurement to measure the following:

- Pulse width of a signal pulse (the amount of time that a signal pulse is in a high or a low state, or the amount of time between a rising edge and a falling edge or between a falling edge and a rising edge). You can calculate the pulse width as follows:
  - Pulse width = Number of counts/Internal C/T Clock Freq
- Period of a signal pulse (the time between two occurrences of the same edge - rising edge to rising edge or falling edge to falling edge). You can calculate the period as follows:
  - Period = 1/Frequency
  - Period = Number of counts/Internal C/T Clock Freq
- Frequency of a signal pulse (the number of periods per second). You can calculate the frequency as follows:
  - Frequency = Internal C/T Clock Freq/Number of Counts

### Continuous Edge-to-Edge Measurement

In continuous edge-to-edge measurement mode, the counter automatically performs an edge-to-edge measurement operation, where the counter starts incrementing when it detects the specified start edge and stops incrementing when it detects the specified stop edge. (Refer to the description of edge-to-edge measurement mode on page 100 for more information on start and stop edges.) When the operation completes, the counter remains idle until it is next read. On the next read, the current value of the counter (from the previous edge-to-edge measurement operation) is returned and the next edge-to-edge measurement operation is started automatically.

**Note:** If you read the counter before the measurement is complete, 0 is returned.

To determine if the subsystem supports continuous edge-to-edge measurement, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_CTMODE_CONT_MEASURE. This function returns a bit value indicating how edge-to-edge measurement mode is supported for the specified device. For example, if edge-to-edge measurements are supported on the gate signal only (using both rising and falling edges), a bit value of 3 is returned. Table 13 lists the possible bit values.

**Table 13: Values for OLSCC_SUP_CTMODE_CONT_MEASURE**

| Value | Name | Description |
|---|---|---|
| 0x00 | – | Continuous edge-to-edge measurements are not supported. |
| 0x01 | SUP_GATE_RISING_BIT | Rising edge of the gate signal is supported for continuous edge-to-edge measurement mode. |
| 0x02 | SUP_GATE_FALLING_BIT | Falling edge of the gate signal is supported for continuous edge-to-edge measurement mode. |
| 0x04 | SUP_CLOCK_RISING_BIT | Rising edge of the clock signal is supported for continuous edge-to-edge measurement mode. |
| 0x08 | SUP_CLOCK_FALLING_BIT | Falling edge of the clock signal is supported for continuous edge-to-edge measurement mode. |
| 0x10 | SUP_ADC_CONVERSION_COMPLETE_BIT | A/D conversion is complete is supported as an edge type for continuous edge-to-edge measurement mode. |
| 0x20 | SUP_TACHOMETER_INPUT_FALLING_BIT | Falling edge of the tachometer input signal is supported for continuous edge-to-edge measurement mode. |
| 0x40 | SUP_TACHOMETER_INPUT_RISING_BIT | Rising edge of the tachometer input signal is supported for continuous edge-to-edge measurement mode. |

**Table 13: Values for OLSCC_SUP_CTMODE_CONT_MEASURE**

| Value | Name | Description |
|---|---|---|
| 0x80 | SUP_DIGITAL_INPUT_0_FALLING_BIT | Falling edge of digital input 0 is supported for continuous edge-to-edge measurement mode. |
| 0x100 | SUP_DIGITAL_INPUT_0_RISING_BIT | Rising edge of digital input 0 is supported for continuous edge-to-edge measurement mode. |
| 0X200 | SUP_DIGITAL_INPUT_1_FALLING_BIT | Falling edge of digital input 1 is supported for continuous edge-to-edge measurement mode. |
| 0X400 | SUP_DIGITAL_INPUT_1_RISING_BIT | Rising edge of digital input 1 is supported for continuous edge-to-edge measurement mode. |
| 0X800 | SUP_DIGITAL_INPUT_2_FALLING_BIT | Falling edge of digital input 2 is supported for continuous edge-to-edge measurement mode. |
| 0X1000 | SUP_DIGITAL_INPUT_2_RISING_BIT | Rising edge of digital input 2 is supported for continuous edge-to-edge measurement mode. |
| 0X2000 | SUP_DIGITAL_INPUT_3_FALLING_BIT | Falling edge of digital input 3 is supported for continuous edge-to-edge measurement mode. |
| 0X4000 | SUP_DIGITAL_INPUT_3_RISING_BIT | Rising edge of digital input 3 is supported for continuous edge-to-edge measurement mode. |
| 0X8000 | SUP_DIGITAL_INPUT_4_FALLING_BIT | Falling edge of digital input 4 is supported for continuous edge-to-edge measurement mode. |
| 0X10000 | SUP_DIGITAL_INPUT_4_RISING_BIT | Rising edge of digital input 4 is supported for continuous edge-to-edge measurement mode. |
| 0X20000 | SUP_DIGITAL_INPUT_5_FALLING_BIT | Falling edge of digital input 5 is supported for continuous edge-to-edge measurement mode. |
| 0X40000 | SUP_DIGITAL_INPUT_5_RISING_BIT | Rising edge of digital input 5 is supported for continuous edge-to-edge measurement mode. |
| 0X80000 | SUP_DIGITAL_INPUT_6_FALLING_BIT | Falling edge of digital input 6 is supported for continuous edge-to-edge measurement mode. |
| 0X100000 | SUP_DIGITAL_INPUT_6_RISING_BIT | Rising edge of digital input 6 is supported for continuous edge-to-edge measurement mode. |
| 0X200000 | SUP_DIGITAL_INPUT_7_FALLING_BIT | Falling edge of digital input 7 is supported for continuous edge-to-edge measurement mode. |

Table 13: Values for OLSCC_SUP_CTMODE_CONT_MEASURE

| Value | Name | Description |
|---|---|---|
| 0X400000 | SUP_DIGITAL_INPUT_7_RISING_BIT | Rising edge of digital input 7 is supported for continuous edge-to-edge measurement mode. |
| 0X800000 | SUP_CT0_CLOCK_INPUT_FALLING_BIT | Falling edge of the clock input signal associated with counter/timer 0 is supported for continuous edge-to-edge measurement mode. |
| 0X1000000 | SUP_CT0_CLOCK_INPUT_RISING_BIT | Rising edge of the clock input signal associated with counter/timer 0 is supported for continuous edge-to-edge measurement mode. |
| 0X2000000 | SUP_CT0_GATE_INPUT_FALLING_BIT | Falling edge of the gate input signal associated with counter/timer 0 is supported for continuous edge-to-edge measurement mode. |
| 0X4000000 | SUP_CT0_GATE_INPUT_RISING_BIT | Rising edge of the gate input signal associated with counter/timer 0 is supported for continuous edge-to-edge measurement mode. |

To specify a continuous edge-to-edge measurement operation, use the **olDaSetCTMode** function, specifying the OL_CTMODE_CONT_MEASURE parameter.

Specify the C/T clock source for the operation as internal. Specify the start edge with the **olDaSetMeasureStartEdge** function and the stop edge with **olDaSetMeasureStopEdge** function.

When you configure the counter/timer with **olDaConfig**, the continuous edge-to-edge measurement operation starts immediately.

To read the current counter value, use the **olDaReadEvents** function or read the counter/timer channel as part of the analog input channel-gain list, if the device supports this capability. For example, you might see results similar to the following if you read the counter/timer channel as part of the analog input channel list:

| Time | A/D Value | Counter/Timer Value | Status of Continuous Edge-to-Edge Measurement Mode |
|---|---|---|---|
| 10 | 5002 | 0 | Operation started when the C/T subsystem was configured, but is not complete |
| 20 | 5004 | 0 | Operation not complete |
| 30 | 5003 | 0 | Operation not complete |
| 40 | 5002 | 12373 | Operation complete |
| 50 | 5000 | 0 | Next operation started, but is not complete |
| 60 | 5002 | 0 | Operation not complete |
| 70 | 5004 | 0 | Operation not complete |
| 80 | 5003 | 12403 | Operation complete |
| 90 | 5002 | 0 | Next operation started, but is not complete |

You can use a continuous edge-to-edge measurement to measure the following:

- Pulse width of a signal pulse (the amount of time that a signal pulse is in a high or a low state, or the amount of time between a rising edge and a falling edge or between a falling edge and a rising edge). You can calculate the pulse width as follows:
  - Pulse width = Number of counts/Internal C/T Clock Freq
- Period of a signal pulse (the time between two occurrences of the same edge - rising edge to rising edge or falling edge to falling edge). You can calculate the period as follows:
  - Period = 1/Frequency
  - Period = Number of counts/Internal C/T Clock Freq
- Frequency of a signal pulse (the number of periods per second). You can calculate the frequency as follows:
  - Frequency = Internal C/T Clock Freq/Number of Counts

To stop a continuous edge-to-edge measurement operation, call **olDaStop**, **olDaAbort**, or **olDaReset**; **olDaReset** function stops the operation and reinitializes the subsystem after stopping it.

### Rate Generation

Use rate generation mode to generate a continuous pulse output signal from the counter; this mode is sometimes referred to as continuous pulse output or pulse train output. You can use this pulse output signal as an external clock to pace analog input, analog output, or other counter/timer operations.

To determine if the subsystem supports rate generation, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_CTMODE_RATE. If this function returns a nonzero value, the capability is supported.

To specify a rate generation mode, use the **olDaSetCTMode** function, specifying the OL_CTMODE_RATE parameter.

Specify the C/T clock source for the operation. In rate generation mode, either the internal or external C/T clock input source is appropriate depending on your application; refer to page 112 for information on specifying the C/T clock source.

Specify the frequency of the C/T clock output signal. For an internal C/T, the **olDaSetClockFrequency** function determines the frequency of the output pulse. For an external C/T clock source, the frequency of the clock input source divided by the clock divider (specified with the **olDaSetExternalClockDivider** function) determines the frequency of the output pulse.

Specify the polarity of the output pulses (high-to-low transitions or low-to-high transitions) and the duty cycle of the output pulses; refer to page 117 for more information.

Also specify the gate type that enables the operation; refer to page 114 for more information on specifying the gate type.

Start rate generation mode using the **olDaStart** function. While rate generation mode is enabled, the counter outputs a pulse of the specified type and frequency continuously. As soon as the operation is disabled, the pulse output operation stops.

To stop rate generation if it is in progress, call **olDaStop**, **olDaAbort**, or **olDaReset**; **olDaReset** stops the operation and reinitializes the subsystem after stopping it.

Figure 15 shows an example of an enabled rate generation operation using an external C/T clock source with an input frequency of 4 kHz, a clock divider of 4, a low-to-high pulse type, and a duty cycle of 50%. (The gate type does not matter for this example.) A 1 kHz square wave is the generated output.

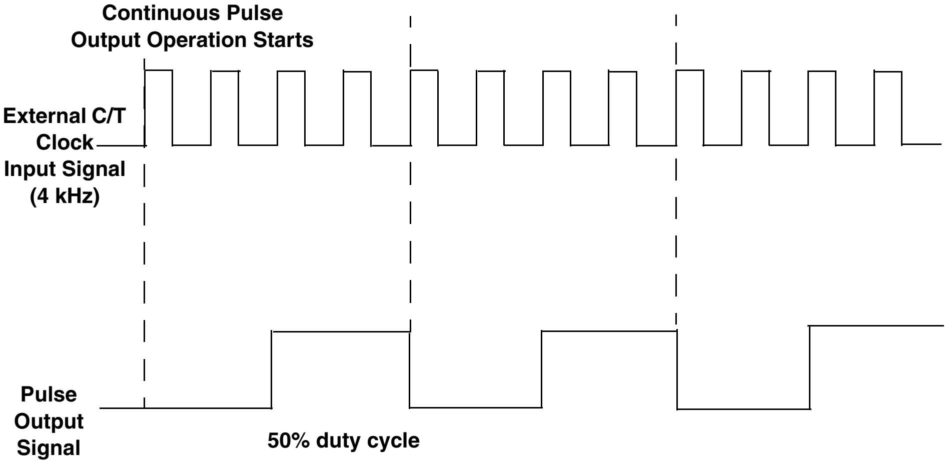


**Figure 15: Example of Rate Generation Mode with a 50% Duty Cycle**

Figure 16 shows the same example using a duty cycle of 75%.

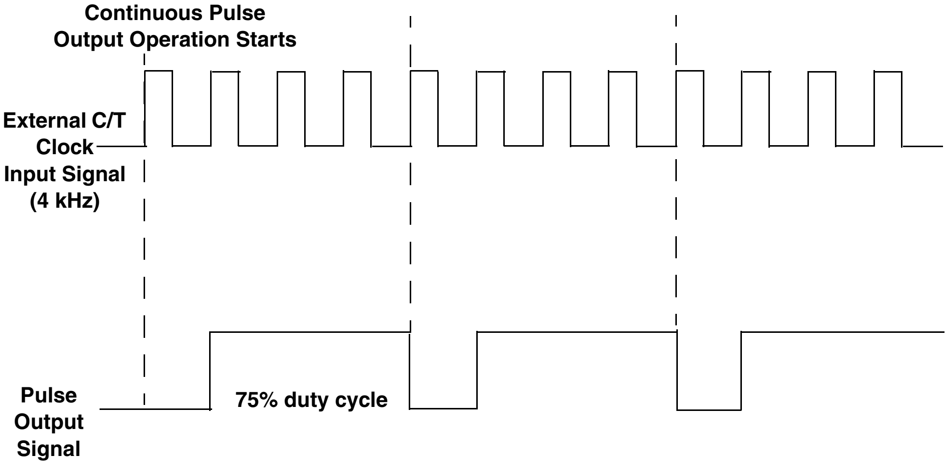


**Figure 16: Example of Rate Generation Mode with a 75% Duty Cycle**

Figure 17 shows the same example using a duty cycle of 25%.

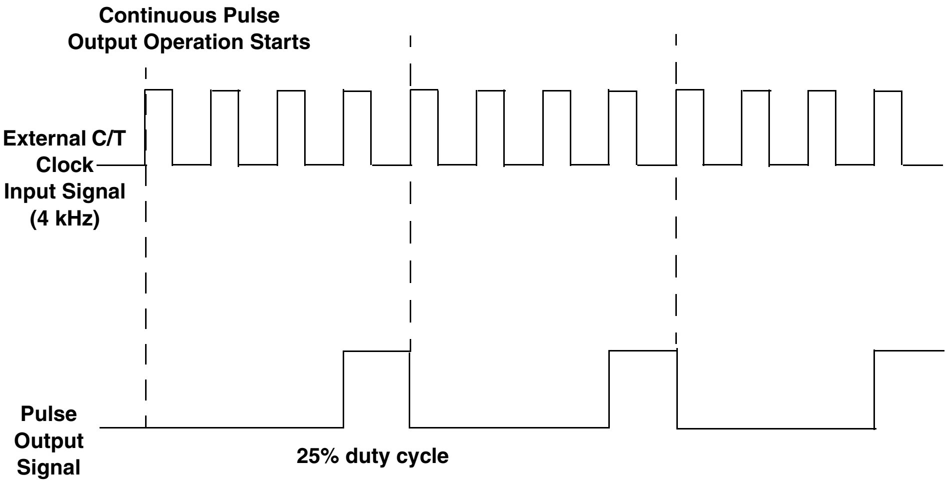


**Figure 17: Example of Rate Generation Mode with a 25% Duty Cycle**

## One-Shot

Use one-shot mode to generate a single pulse output signal from the counter when the operation is triggered (determined by the gate input signal). You can use this pulse output signal as an external digital (TTL) trigger to start analog input, analog output, or other operations.

To determine if the subsystem supports one-shot mode, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_CTMODE_ONESHOT. If this function returns a nonzero value, the capability is supported.

To specify a one-shot operation, use the **olDaSetCTMode** function, specifying the OL_CTMODE_ONESHOT parameter.

Specify the C/T clock source for the operation. Refer to page 112 for more information on specifying the C/T clock source.

Specify the polarity of the output pulse (high-to-low transition or low-to-high transition) and the duty cycle of the output pulse; refer to page 117 for more information.

**Note:** In the case of a one-shot operation, set the duty cycle to 100% to output a pulse immediately. Using a duty cycle less then 100% acts as a pulse output delay.

Also specify the gate type that triggers the operation; refer to page 114 for more information.

Configure the operation with the **olDaConfig** function.

To start a one-shot pulse output operation, use the **olDaStart** function. When the one-shot operation is triggered (determined by the gate input signal), a single pulse is output; then, the one-shot operation stops. All subsequent clock input signals and gate input signals are ignored.

Use software to specify the counter/timer mode as one-shot and wire the signals appropriately.

Figure 18 shows an example of a one-shot operation using an external gate input (rising edge), a clock output frequency of 1 kHz (one pulse every 1 ms), a low-to-high pulse type, and a duty cycle of 100%. Figure 19 shows the same example using a duty cycle of less than or equal to 1%.

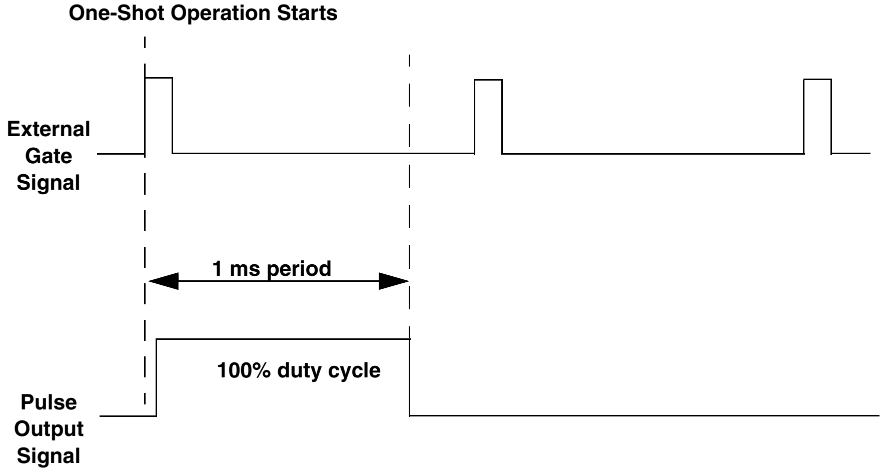


Figure 18: Example of One-Shot Mode Using a Duty Cycle of 100%

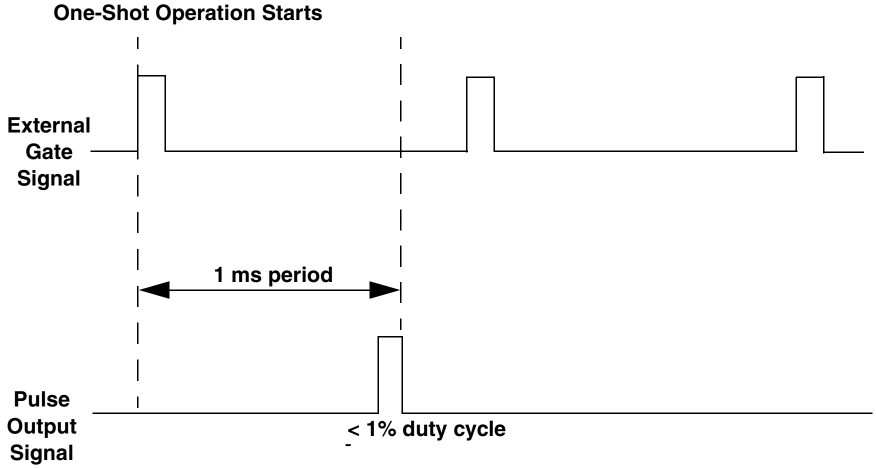


Figure 19: Example of One-Shot Mode Using a Duty Cycle Less Than or Equal to 1%

### Repetitive One-Shot

Use repetitive one-shot mode to generate a pulse output signal each time the device detects a trigger (determined by the gate input signal). You can use this mode to clean up a poor clock input signal by changing its pulse width, then outputting it.

To determine if the subsystem supports repetitive one-shot mode, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_CTMODE_ONESHOT_RPT. If this function returns a nonzero value, the capability is supported.

To specify a repetitive one-shot operation, use the **olDaSetCTMode** function, specifying the OL_CTMODE_ONESHOT_RPT parameter.

Specify the C/T clock source for the operation. In repetitive one-shot mode, the internal C/T clock source is more useful than an external C/T clock source; refer to page 112 for more information on specifying the C/T clock source.

Specify the polarity of the output pulses (high-to-low transitions or low-to-high transitions) and the duty cycle of the output pulses; refer to page 117 for more information. Also specify the gate type that triggers the operation; refer to page 114 for more information.

Configure the operation with the **olDaConfig** function.

To start a repetitive one-shot pulse output operation, use the **olDaStart** function. When the one-shot operation is triggered (determined by the gate input signal), a pulse is output. When the device detects the next trigger, another pulse is output.

This operation continues until you stop the operation using **olDaStop**, **olDaAbort**, or **olDaReset**; **olDaReset** stops the operation and reinitializes the subsystem after stopping it.

**Note:** Triggers that occur while the pulse is being output are not detected by the device.

Figure 20 shows an example of a repetitive one-shot operation using an external gate (rising edge); a clock output frequency of 1 kHz (one pulse every 1 ms), a low-to-high pulse type, and a duty cycle of 100%.

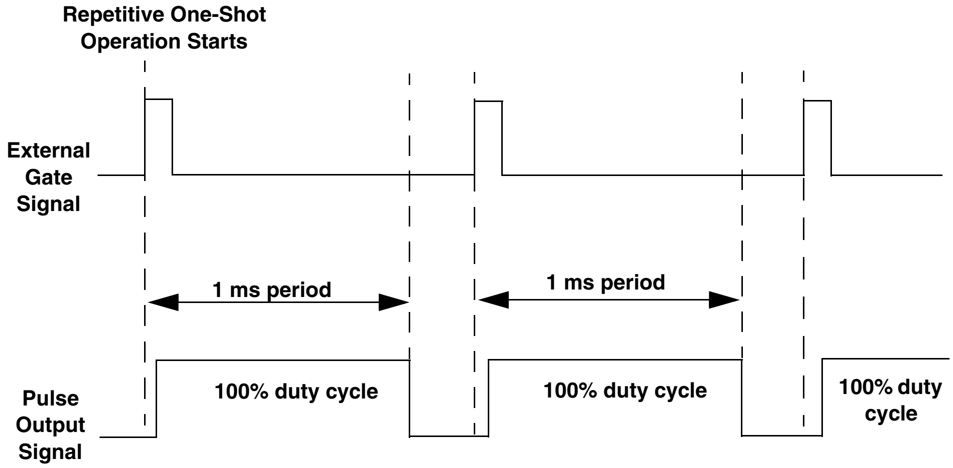


Figure 20: Example of Repetitive One-Shot Mode Using a Duty Cycle of 100%

Figure 21 shows the same example using a duty cycle of 50%.

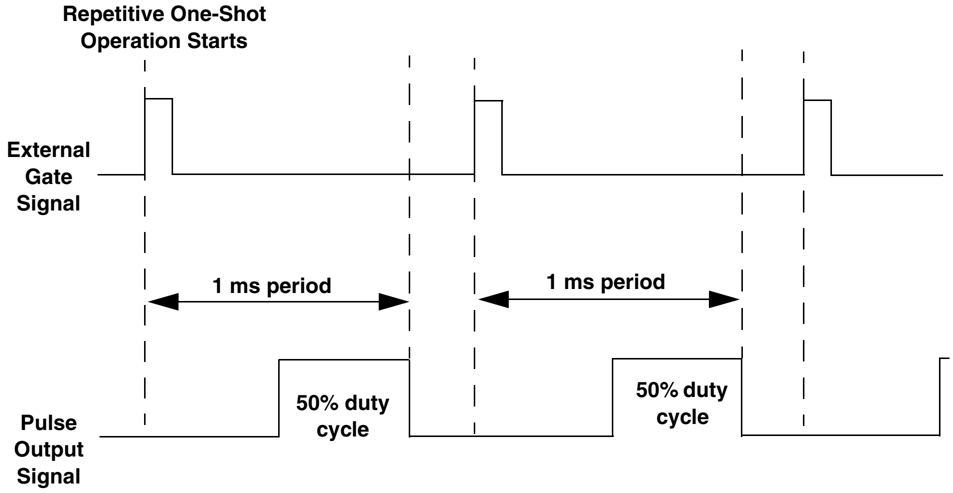


Figure 21: Example of Repetitive One-Shot Mode Using a Duty Cycle of 50%

## C/T Clock Sources

The DataAcq SDK defines the following clock sources for counter/timers:

- Internal C/T clock
- External C/T clock
- Internally cascaded clock
- Extra C/T clocks

The following subsections describe these clock sources.

### Internal C/T Clock

The internal C/T clock is the clock source on the device that paces a counter/timer operation for a C/T subsystem.

To determine if the subsystem supports an internal C/T clock, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_INTCLOCK capability. If this function returns a nonzero value, the capability is supported.

To specify the clock source, use the **olDaSetClockSource** function.

Using the **olDaSetClockFrequency** function, specify the frequency of the clock output signal.

To determine the maximum frequency that the subsystem supports, use the **olDaGetSSCapsEx** function, specifying the OLSSCE_MAXTHROUGHPUT capability. To determine the minimum frequency that the subsystem supports, use the **olDaGetSSCapsEx** function, specifying the OLSSCE_MINTHROUGHPUT capability.

### External C/T Clock

The external C/T clock is a clock source attached to the device that paces counter/timer operations for a C/T subsystem. The external C/T clock is useful when you want to pace at rates not available with the internal clock or if you want to pace at uneven intervals.

To determine if the subsystem supports an external C/T clock, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_EXTCLOCK capability. If this function returns a nonzero value, the capability is supported.

Specify the clock source using the **olDaSetClockSource** function. Specify the clock divider using the **olDaSetExternalClockDivider** function; the clock input signal divided by the clock divider determines the frequency of the clock output signal.

To determine the maximum clock divider that the subsystem supports, use the **olDaGetSSCapsEx** function, specifying the OLSSCE_MAXCLOCKDIVIDER capability. To determine the minimum clock divider that the subsystem supports, use the **olDaGetSSCapsEx** function, specifying the OLSSCE_MINCLOCKDIVIDER capability.

### Internally Cascaded Clock

You can also internally connect or cascade the clock output signal from one counter/timer to the clock input signal of the next counter/timer in software. In this way, you can create a 32-bit counter out of two 16-bit counters.

To determine if the subsystem supports internal cascading, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_CASCADING capability. If this function returns a nonzero value, the capability is supported.

Specify whether the subsystem is internally cascaded or not (single) using the **olDaSetCascadeMode** function.

**Note:** If a counter/timer is cascaded, you specify the clock input and gate input for the first counter in the cascaded pair. For example, if counters 1 and 2 are cascaded, specify the clock input and gate input for counter 1.

### Extra C/T Clock Source

Extra C/T clock sources may be defined by your device driver.

To determine how many extra clock sources are supported by your subsystem, use the **olDaGetSSCaps** function, specifying the OLSSC_NUMEXTRACLOCKS capability. Refer to your device/driver documentation for a description of these clocks.

To specify internal or external extra clock sources and their frequencies and/or clock dividers, refer to the previous subsections.

## Gate Types

The active edge or level of the gate input to the counter enables or triggers counter/timer operations. The DataAcq SDK defines the following gate input types:

- Software
- High level
- Low level
- High edge
- Low edge
- Any level
- High level debounced
- Low level debounced
- High edge debounced
- Low edge debounced
- Any level debounced

To specify the gate type, use the **olDaSetGateType** function. The following subsections describe these gate types.

### Software Gate Type

A software gate type enables any specified counter/timer operation immediately when the **olDaSetGateType** function is executed.

To determine if the subsystem supports a software gate, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_GATE_NONE capability. If this function returns a nonzero value, the capability is supported.

### High-Level Gate Type

A high-level external gate type enables a counter/timer operation when the external gate signal is high, and disables a counter/timer operation when the external gate signal is low. Note that this gate type is used only for event counting, frequency measurement, and rate generation; refer to page 94 for more information on these modes.

To determine if the subsystem supports a high-level external gate input, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_GATE_HIGH_LEVEL capability. If this function returns a nonzero value, the capability is supported.

### Low-Level Gate Type

A low-level external gate type enables a counter/timer operation when the external gate signal is low, and disables the counter/timer operation when the external gate signal is high. Note that this gate type is used only for event counting, frequency measurement, and rate generation; refer to page 94 for more information on these modes.

To determine if the subsystem supports a low-level external gate input, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_GATE_LOW_LEVEL capability. If this function returns a nonzero value, the capability is supported.

### Low-Edge Gate Type

A low-edge external gate type triggers a counter/timer operation on the transition from the high edge to the low edge (falling edge). Note that this gate type is used only for one-shot and repetitive one-shot mode; refer to page 111 for more information on these modes.

To determine if the subsystem supports a low-edge external gate input, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_GATE_LOW_EDGE capability. If this function returns a nonzero value, the capability is supported.

### High-Edge Gate Type

A high-edge external gate type triggers a counter/timer operation on the transition from the low edge to the high edge (rising edge). Note that this gate type is used only for one-shot and repetitive one-shot mode; refer to page 94 for more information on these modes.

To determine if the subsystem supports a high-edge external gate input, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_GATE_HIGH_EDGE capability. If this function returns a nonzero value, the capability is supported.

### Any Level Gate Type

A level gate type enables a counter/timer operation on the transition from any level. Note that this gate type is used only for event counting, frequency measurement, and rate generation; refer to page 94 for more information on these modes.

To determine if the subsystem supports a level external gate input, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_GATE_LEVEL capability. If this function returns a nonzero value, the capability is supported.

### High-Level, Debounced Gate Type

A high-level, debounced gate type enables a counter/timer operation when the external gate signal is high and debounced. Note that this gate type is used only for event counting, frequency measurement, and rate generation; refer to page 94 for more information on these modes.

To determine if the subsystem supports a high-level debounced external gate input, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_GATE_HIGH_LEVEL_DEBOUNCE capability. If this function returns a nonzero value, the capability is supported.

### Low-Level, Debounced Gate Type

A low-level, debounced gate type enables a counter/timer operation when the external gate signal is low and debounced. Note that this gate type is used only for event counting, frequency measurement, and rate generation; refer to page 94 for more information on these modes.

To determine if the subsystem supports a low-level debounced external gate input, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_GATE_LOW_LEVEL_DEBOUNCE capability. If this function returns a nonzero value, the capability is supported.

### High-Edge, Debounced Gate Type

A high-edge, debounced gate type triggers a counter/timer operation on the rising edge of the external gate signal; the signal is debounced. Note that this gate type is used only for one-shot and repetitive one-shot mode; refer to page 94 for more information on these modes.

To determine if the subsystem supports a high-edge debounced external gate input, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_GATE_HIGH_EDGE_DEBOUNCE capability. If this function returns a nonzero value, the capability is supported.

### Low-Edge, Debounced Gate Type

A low-edge, debounced gate type triggers a counter/timer operation on the falling edge of the external gate signal; the signal is debounced. Note that this gate type is used only for one-shot and repetitive one-shot mode; refer to page 94 for more information on these modes.

To determine if the subsystem supports a low-edge debounced external gate input, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_GATE_LOW_EDGE_DEBOUNCE capability. If this function returns a nonzero value, the capability is supported.

### Level, Debounced Gate Type

A level, debounced gate type enables a counter/timer operation on the transition of any level of the external gate signal; the signal is debounced. Note that this gate type is used only for event counting, frequency measurement, and rate generation; refer to page 94 for more information on these modes.

To determine if the subsystem supports a high-edge debounced external gate input, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_GATE_LEVEL_DEBOUNCE capability. If this function returns a nonzero value, the capability is supported.

## Pulse Output Types and Duty Cycles

The DataAcq SDK defines the following pulse output types:

- **High-to-low transitions** – The low portion of the total pulse output period is the active portion of the counter/timer clock output signal.

  To determine if the subsystem supports high-to-low transitions on the pulse output signal, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_PLS_HIGH2LOW capability. If this function returns a nonzero value, the capability is supported.

- **Low-to-high transitions** – The high portion of the total pulse output period is the active portion of the counter/timer pulse output signal.

  To determine if the subsystem supports low-to-high transitions on the pulse output signal, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_PLS_LOW2HIGH capability. If this function returns a nonzero value, the capability is supported.

Specify the pulse output type using the **olDaSetPulseType** function.

The duty cycle (or pulse width) indicates the percentage of the total pulse output period that is active. A duty cycle of 50, then, indicates that half of the total pulse is low and half of the total pulse output is high.

You can determine whether the pulse width is programmable by querying the OLSSC_FIXED_PULSE_ WIDTH capability. In a non-zero result is returned, the pulse width is fixed and cannot be programmed. If 0 is returned, the device supports a programmable pulse width.

Specify the pulse width using the **olDaSetPulseWidth** function.

Figure 22 illustrates a low-to-high pulse with a duty cycle of approximately 30%.

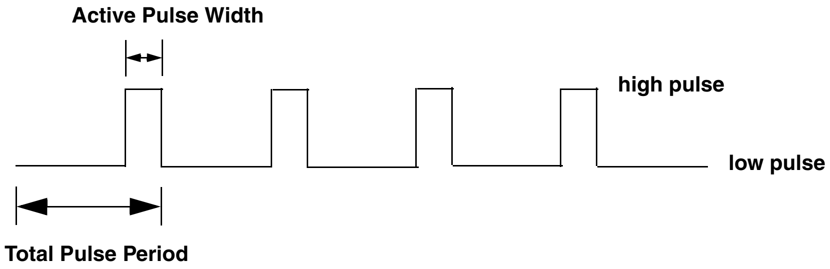


**Figure 22: Example of a Low-to-High Pulse Output Type**

# Measure Counter Operations

On some devices, measure counters may be supported by the counter/timer subsystem.

A measure counter starts incrementing when it detects a specified start edge and stops incrementing when it detects a specified stop edge. When the operation completes, the counter remains idle until it is next read. On the next read, the current value of the counter (from the previous measurement) is returned and the next measurement operation is started automatically.

To determine which edges are supported for the measurement operation, use the **olDaGetSSCaps** function, specifying the capability OLSSC_SUP_CTMODE_CONT_MEASURE. This function returns a bit value indicating which edges are supported. For example, if measure operations are supported on the rising and falling edges of the gate signal only, a bit value of 3 is returned. Table 13 lists the possible bit values.

**Table 14: Values for OLSCC_SUP_CTMODE_CONT_MEASURE**

| Value | Name | Description |
|---|---|---|
| 0x00 | – | Continuous edge-to-edge measurements are not supported. |
| 0x01 | SUP_GATE_RISING_BIT | Rising edge of the gate signal is supported for continuous edge-to-edge measurement mode. |
| 0x02 | SUP_GATE_FALLING_BIT | Falling edge of the gate signal is supported for continuous edge-to-edge measurement mode. |
| 0x04 | SUP_CLOCK_RISING_BIT | Rising edge of the clock signal is supported for continuous edge-to-edge measurement mode. |
| 0x08 | SUP_CLOCK_FALLING_BIT | Falling edge of the clock signal is supported for continuous edge-to-edge measurement mode. |
| 0x10 | SUP_ADC_CONVERSION_COMPLETE_BIT | A/D conversion is complete is supported as an edge type for continuous edge-to-edge measurement mode. |
| 0x20 | SUP_TACHOMETER_INPUT_FALLING_BIT | Falling edge of the tachometer input signal is supported for continuous edge-to-edge measurement mode. |
| 0x40 | SUP_TACHOMETER_INPUT_RISING_BIT | Rising edge of the tachometer input signal is supported for continuous edge-to-edge measurement mode. |
| 0x80 | SUP_DIGITAL_INPUT_0_FALLING_BIT | Falling edge of digital input 0 is supported for continuous edge-to-edge measurement mode. |

Table 14: Values for OLSCC_SUP_CTMODE_CONT_MEASURE

| Value | Name | Description |
|---|---|---|
| 0x100 | SUP_DIGITAL_INPUT_0_RISING_BIT | Rising edge of digital input 0 is supported for continuous edge-to-edge measurement mode. |
| 0X200 | SUP_DIGITAL_INPUT_1_FALLING_BIT | Falling edge of digital input 1 is supported for continuous edge-to-edge measurement mode. |
| 0X400 | SUP_DIGITAL_INPUT_1_RISING_BIT | Rising edge of digital input 1 is supported for continuous edge-to-edge measurement mode. |
| 0X800 | SUP_DIGITAL_INPUT_2_FALLING_BIT | Falling edge of digital input 2 is supported for continuous edge-to-edge measurement mode. |
| 0X1000 | SUP_DIGITAL_INPUT_2_RISING_BIT | Rising edge of digital input 2 is supported for continuous edge-to-edge measurement mode. |
| 0X2000 | SUP_DIGITAL_INPUT_3_FALLING_BIT | Falling edge of digital input 3 is supported for continuous edge-to-edge measurement mode. |
| 0X4000 | SUP_DIGITAL_INPUT_3_RISING_BIT | Rising edge of digital input 3 is supported for continuous edge-to-edge measurement mode. |
| 0X8000 | SUP_DIGITAL_INPUT_4_FALLING_BIT | Falling edge of digital input 4 is supported for continuous edge-to-edge measurement mode. |
| 0X10000 | SUP_DIGITAL_INPUT_4_RISING_BIT | Rising edge of digital input 4 is supported for continuous edge-to-edge measurement mode. |
| 0X20000 | SUP_DIGITAL_INPUT_5_FALLING_BIT | Falling edge of digital input 5 is supported for continuous edge-to-edge measurement mode. |
| 0X40000 | SUP_DIGITAL_INPUT_5_RISING_BIT | Rising edge of digital input 5 is supported for continuous edge-to-edge measurement mode. |
| 0X80000 | SUP_DIGITAL_INPUT_6_FALLING_BIT | Falling edge of digital input 6 is supported for continuous edge-to-edge measurement mode. |
| 0X100000 | SUP_DIGITAL_INPUT_6_RISING_BIT | Rising edge of digital input 6 is supported for continuous edge-to-edge measurement mode. |
| 0X200000 | SUP_DIGITAL_INPUT_7_FALLING_BIT | Falling edge of digital input 7 is supported for continuous edge-to-edge measurement mode. |
| 0X400000 | SUP_DIGITAL_INPUT_7_RISING_BIT | Rising edge of digital input 7 is supported for continuous edge-to-edge measurement mode. |

**Table 14: Values for OLSCC_SUP_CTMODE_CONT_MEASURE**

| Value | Name | Description |
|---|---|---|
| 0X800000 | SUP_CT0_CLOCK_INPUT_FALLING_BIT | Falling edge of the clock input signal associated with counter/timer 0 is supported for continuous edge-to-edge measurement mode. |
| 0X1000000 | SUP_CT0_CLOCK_INPUT_RISING_BIT | Rising edge of the clock input signal associated with counter/timer 0 is supported for continuous edge-to-edge measurement mode. |
| 0X2000000 | SUP_CT0_GATE_INPUT_FALLING_BIT | Falling edge of the gate input signal associated with counter/timer 0 is supported for continuous edge-to-edge measurement mode. |
| 0X4000000 | SUP_CT0_GATE_INPUT_RISING_BIT | Rising edge of the gate input signal associated with counter/timer 0 is supported for continuous edge-to-edge measurement mode. |

Specify the start edge with the **olDaSetMeasureStartEdge** function and the stop edge with **olDaSetMeasureStopEdge** function. When you configure the counter/timer with **olDaConfig**, the measure counter starts the measurement immediately.

To read the current counter value, read the counter/timer channel as part of the analog input channel-gain list. You might see results similar to the following:

**Table 15: An Example of Reading the Measure Counter as Part of the Analog Input Data Stream**

| Time | A/D Value | Measure Counter Value | Status of Operation |
|---|---|---|---|
| 10 | 5002 | 0 | Operation started, but is not complete |
| 20 | 5004 | 0 | Operation not complete |
| 30 | 5003 | 0 | Operation not complete |
| 40 | 5002 | 12373 | Operation complete |
| 50 | 5000 | 12373 | Next operation started, but is not complete |
| 60 | 5002 | 12373 | Operation not complete |
| 70 | 5004 | 12373 | Operation not complete |
| 80 | 5003 | 14503 | Operation complete |
| 90 | 5002 | 14503 | Next operation started, but is not complete |

Using the count that is returned from the measure counter, you can determine the following:

- Frequency of a signal pulse (the number of periods per second). You can calculate the frequency as follows:
  - Frequency = Frequency of the internal counter/(Number of counts – 1)

    For example, if the frequency of the internal counter on the device is 48 MHz and the count is 201, the measured frequency is 240 kHz (48 MHz/200).
- Period of a signal pulse. You can calculate the period as follows:
  - Period = 1/Frequency
  - Period = (Number of counts – 1)/Frequency of the internal counter

# Quadrature Decoder Operations

On some devices, quadrature decoders may be supported by the counter/timer subsystem.

Quadrature decoders let you accept inputs (A, B, and Index) from a quadrature encoder device and determine relative or absolute position of the inputs and/or rotational speed.

Using the **olDaSetQuadDecoder** function, you can specify the following parameters for a quadrature decoder operation:

- The pre-scale value that is used to filter the onboard clock. Using a pre-scale value can remove ringing edges and unwanted noise for more accurate results.
- The mode of operation (X1 or X4 mode) that matches the quadrature encoder mode.
- The index mode, which either enables the Index signal or disables the Index signal. If enabled, the value of the decoder is reset to 0 whenever a selected edge (high or low) of the Index signal goes high or low. If disabled, the Index signal has no effect.

You can read the value of the quadrature decoder using the **olDaReadEvents** function to determine relative or absolute position.

To determine the rotation of a quadrature encoder, use the following formula:

$$\textit{Rotation degrees} = \frac{\text{Count}}{4 * \text{N}} \text{ x 360 degrees}$$

where *N* is the number of pulses generated by the quadrature encoder per rotation. For example, if every rotation of the quadrature encoder generated 10 pulses, and the value read from the quadrature decoder is 20, the rotation of the quadrature encoder is 180 degrees (20/40 x 360 degrees).

# Tachometer Operations

Some devices allow you to connect a tachometer signal to the device to measure the frequency or period of the tachometer input signal. You can read the value of the tachometer channel through the analog input channel list. Refer to the documentation for your device to determine the channel number to use.

In a tachometer operation, the internal counter starts incrementing when it detects the first specified edge of the tachometer input and stops incrementing when it detects the next specified edge of the tachometer input. You specify the edge of the tachometer signal that is used for the measurement (Falling or Rising) using the **olDaSetEdgeType** function. To query the value of this capability, use the **olDaGetEdgeType** function.

To determine if the subsystem supports high-to-low (falling) edges on the tachometer signal, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_PLS_HIGH2LOW capability. If this function returns a nonzero value, the capability is supported. To determine if the subsystem supports low-to-high (rising) edges on the tachometer signal, use the **olDaGetSSCaps** function, specifying the OLSSC_SUP_PLS_LOW2HIGH capability. If this function returns a nonzero value, the capability is supported.

You can determine whether the tachometer value is old or not by using the **olDaSetStaleDataFlagEnabled** function. If this flag is True, the most significant bit (MSB) of the value is set to 0 to indicate new data; reading the value before the measurement is complete returns an MSB of 1. If this flag is False, the MSB is always set to 0. To query the value of this capability, use the **olDaGetStaleDataFlagEnabled** function.

When you read the value of the tachometer input as part of the analog input data stream, you might see results similar to the following:

**Table 16: An Example of Reading the Tachometer Input as Part of the Analog Input Data Stream**

| Time | A/D Value | Tachometer Input Value | Status of Operation |
|---|---|---|---|
| 10 | 5002 | 0 | Operation started, but is not complete |
| 20 | 5004 | 0 | Operation not complete |
| 30 | 5003 | 0 | Operation not complete |
| 40 | 5002 | 12373 | Operation complete |
| 50 | 5000 | 12373 | Next operation started, but is not complete |
| 60 | 5002 | 12373 | Operation not complete |
| 70 | 5004 | 12373 | Operation not complete |
| 80 | 5003 | 14503 | Operation complete |
| 90 | 5002 | 14503 | Next operation started, but is not complete |

Using the count that is returned from the tachometer input, you can determine the following:

- Frequency of a signal pulse (the number of periods per second). You can calculate the frequency as follows:
  - Frequency = Frequency of the internal counter/(Number of counts – 1)

    For example, if the frequency of the internal counter on the device is 12 MHz and the count is 21, the measured frequency is 600 kHz (12 MHz/20).
- Period of a signal pulse. You can calculate the period as follows:
  - Period = 1/Frequency
  - Period = (Number of counts – 1)/Frequency of the internal counter

## Simultaneous Startup

If supported, you can synchronize subsystems to perform simultaneous startup. Note that you cannot perform simultaneous startup on subsystems configured for single-value operations unless you are using a simultaneous sampling module.

To determine if the subsystems support simultaneous startup, use the **olDaGetSSCaps** function for each subsystem, specifying the OLSSC_SUP_SIMULTANEOUS_START capability. If this function returns a nonzero value, the capability is supported.

You can synchronize the triggers of subsystems by specifying the same trigger source for each of the subsystems that you want to start simultaneously and wiring them to the device, if appropriate.

Use the **olDaGetSSList** function to allocate a simultaneous start list. Then, use the **olDaPutDassToSSList** function to put the subsystems that you want to start simultaneously on the start list.

To determine the device handles given to each subsystem on the simultaneous start list, use the **olDaEnumSSList** function.

Pre-start the subsystems using the **olDaSimultaneousPreStart** function. Pre-starting a subsystem ensures a minimal delay once the subsystems are started. Once you call the **olDaSimultaneousPreStart** function, do not alter the settings of the subsystems on the simultaneous start list.

Start the subsystems using the **olDaSimultaneousStart** function. When started, both subsystems are triggered simultaneously.

**Note:** Do not call **olDaStart** when using simultaneous start lists, since the subsystems are already started.

When you are finished with the operations, call the **olDaReleaseSSList** function to free the simultaneous start list. Then, call the **olDaReleaseDASS** function for each subsystem to free it before calling **olDaTerminate**.

To stop the simultaneous operations, call **olDaStop** (for an orderly stop), **olDaAbort** (for an abrupt stop) or **olDaReset** (for an abrupt stop that reinitializes the subsystem).

4

# Programming Flowcharts

If you are unfamiliar with the capabilities of your device and/or subsystem, query the device as follows:

- To determine the number and types of DT-Open Layers devices and drivers installed, use the **olDaEnumBoards** function.
- To determine the subsystems supported by the device, use the **olDaEnumSubSystems** or **olDaGetDevCaps** function.
- To determine the capabilities of a subsystem, use the **olDaGetSSCaps** or **olDaGetSSCapsEx** function, specifying one of the capabilities listed in Table 2 on page 22.
- To determine the gains, filters, ranges, and resolutions if more than one is available, use the **olDaEnumSSCaps** function.

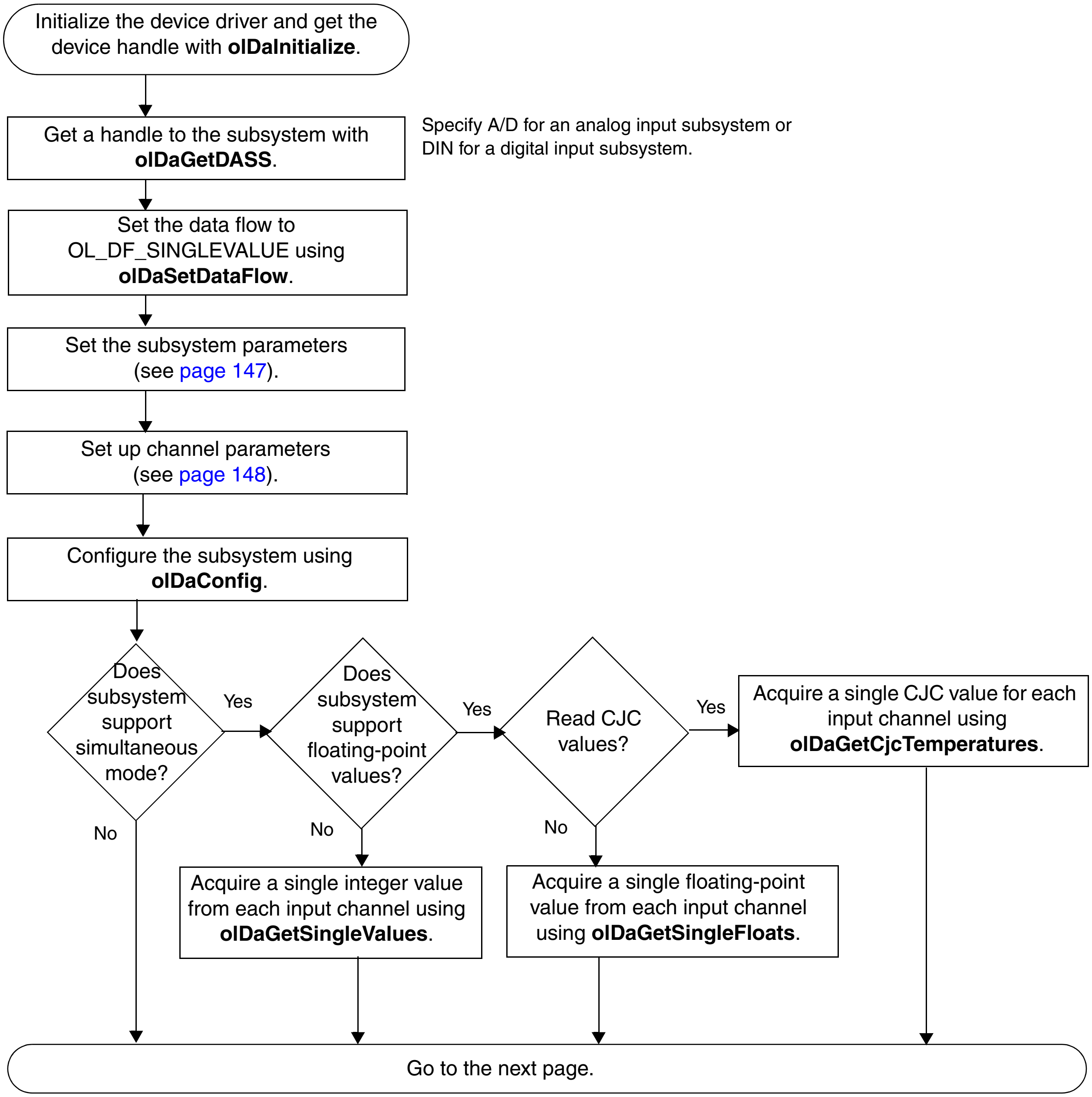
Then, follow the flowcharts presented in the remainder of this chapter to perform the desired operation.

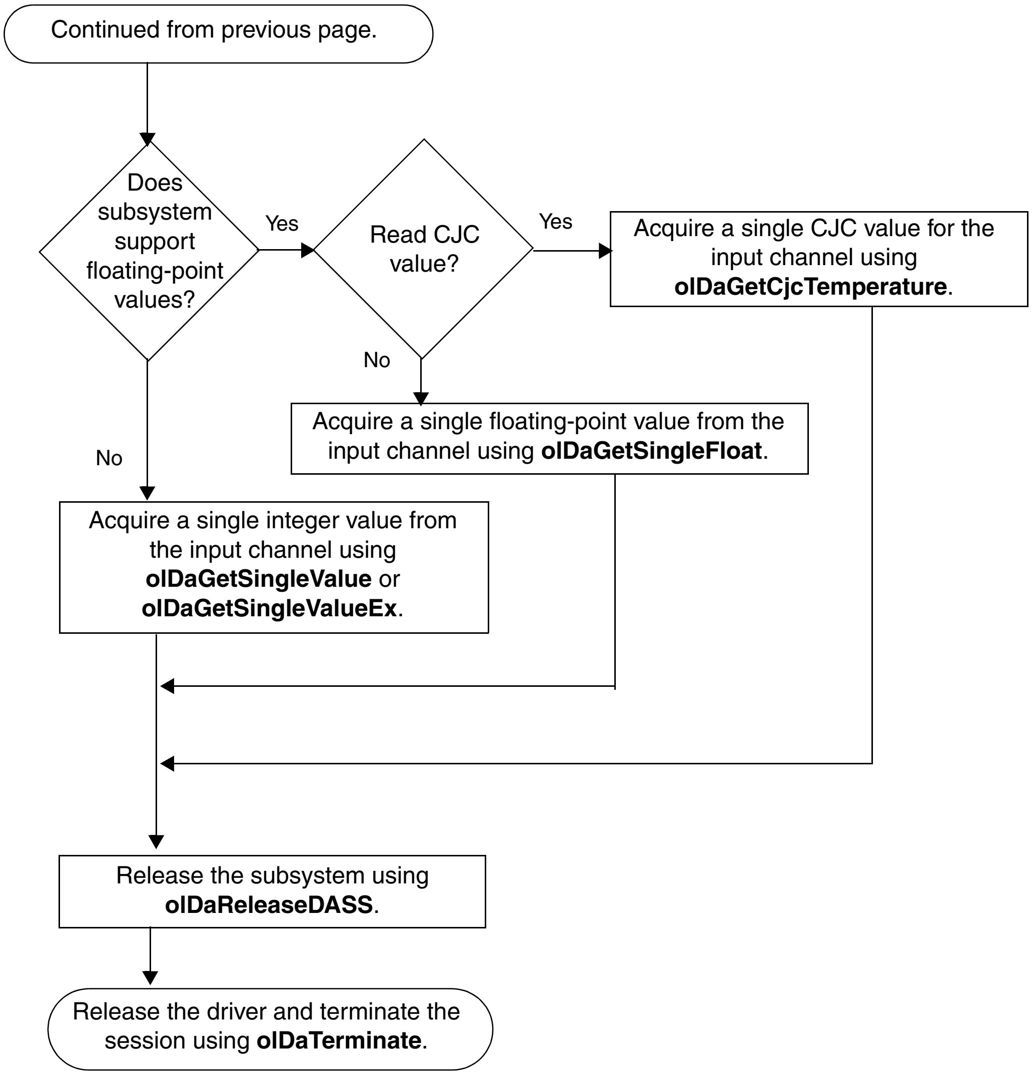
**Notes:** Depending on your device, some of the settings may not be programmable. Refer to your device driver documentation for details.

Although the flowcharts do not show error checking, it is recommended that you check for errors after each function call.

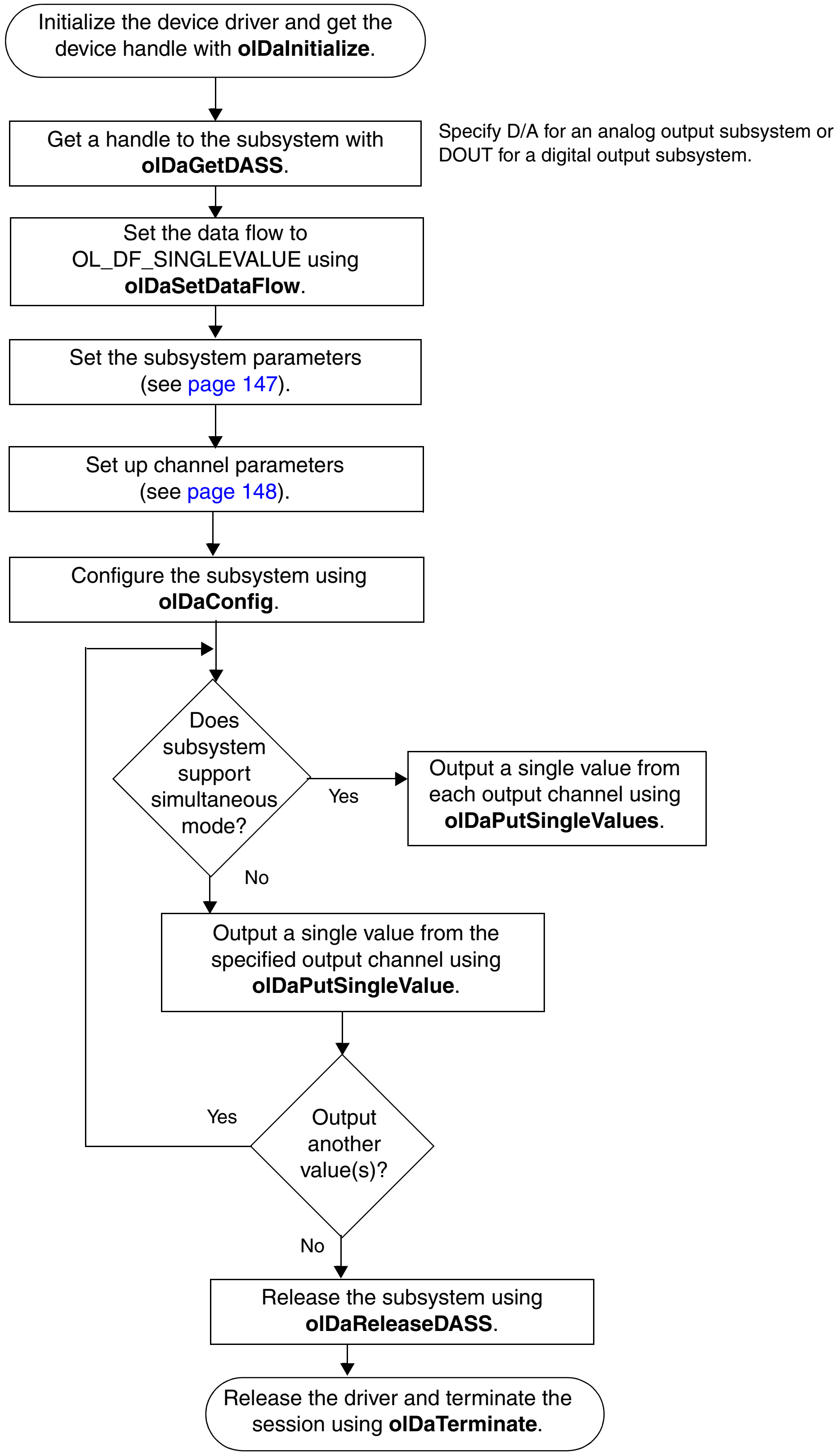
Some steps represent several substeps; if you are unfamiliar with the detailed operations involved with any one step, refer to the indicated page for detailed information. Optional steps appear in shaded boxes.

# Single-Value Input Operations

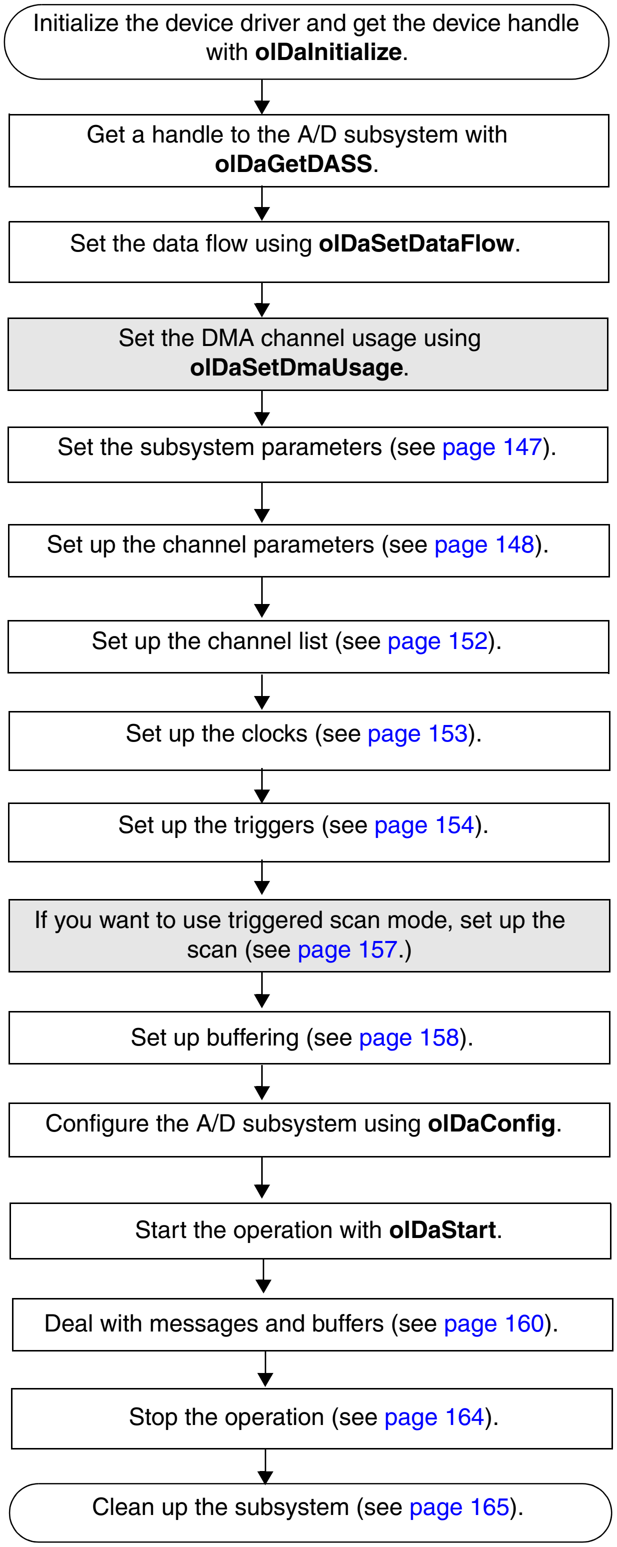

Initialize the device driver and get the device handle with **olDaInitialize**.
Get a handle to the subsystem with **olDaGetDASS**.
Specify A/D for an analog input subsystem or DIN for a digital input subsystem.
Set the data flow to OL_DF_SINGLEVALUE using **olDaSetDataFlow**.
Set the subsystem parameters (see page 147).
Set up channel parameters (see page 148).
Configure the subsystem using **olDaConfig**.
Does subsystem support simultaneous mode?
Yes
No
Does subsystem support floating-point values?
Yes
No
Read CJC values?
Yes
No
Acquire a single CJC value for each input channel using **olDaGetCjcTemperatures**.
Acquire a single integer value from each input channel using **olDaGetSingleValues**.
Acquire a single floating-point value from each input channel using **olDaGetSingleFloats**.
Go to the next page.


Continued from previous page.
Does subsystem support floating-point values?
Yes
Read CJC value?
Yes
Acquire a single CJC value for the input channel using **olDaGetCjcTemperature**.
No
Acquire a single floating-point value from the input channel using **olDaGetSingleFloat**.
No
Acquire a single integer value from the input channel using **olDaGetSingleValue** or **olDaGetSingleValueEx**.
Release the subsystem using **olDaReleaseDASS**.
Release the driver and terminate the session using **olDaTerminate**.

# Single-Value Output Operations


Initialize the device driver and get the device handle with **olDaInitialize**.
Get a handle to the subsystem with **olDaGetDASS**.
Specify D/A for an analog output subsystem or DOUT for a digital output subsystem.
Set the data flow to OL_DF_SINGLEVALUE using **olDaSetDataFlow**.
Set the subsystem parameters (see page 147).
Set up channel parameters (see page 148).
Configure the subsystem using **olDaConfig**.
Does subsystem support simultaneous mode?
Yes
Output a single value from each output channel using **olDaPutSingleValues**.
No
Output a single value from the specified output channel using **olDaPutSingleValue**.
Yes
Output another value(s)?
No
Release the subsystem using **olDaReleaseDASS**.
Release the driver and terminate the session using **olDaTerminate**.

# Continuous Analog Input Operations



Initialize the device driver and get the device handle with **olDaInitialize**.

Get a handle to the A/D subsystem with **olDaGetDASS**.

Set the data flow using **olDaSetDataFlow**.

Set the DMA channel usage using **olDaSetDmaUsage**.

Set the subsystem parameters (see page 147).

Set up the channel parameters (see page 148).

Set up the channel list (see page 152).

Set up the clocks (see page 153).

Set up the triggers (see page 154).

If you want to use triggered scan mode, set up the scan (see page 157.)

Set up buffering (see page 158).

Configure the A/D subsystem using **olDaConfig**.

Start the operation with **olDaStart**.

Deal with messages and buffers (see page 160).

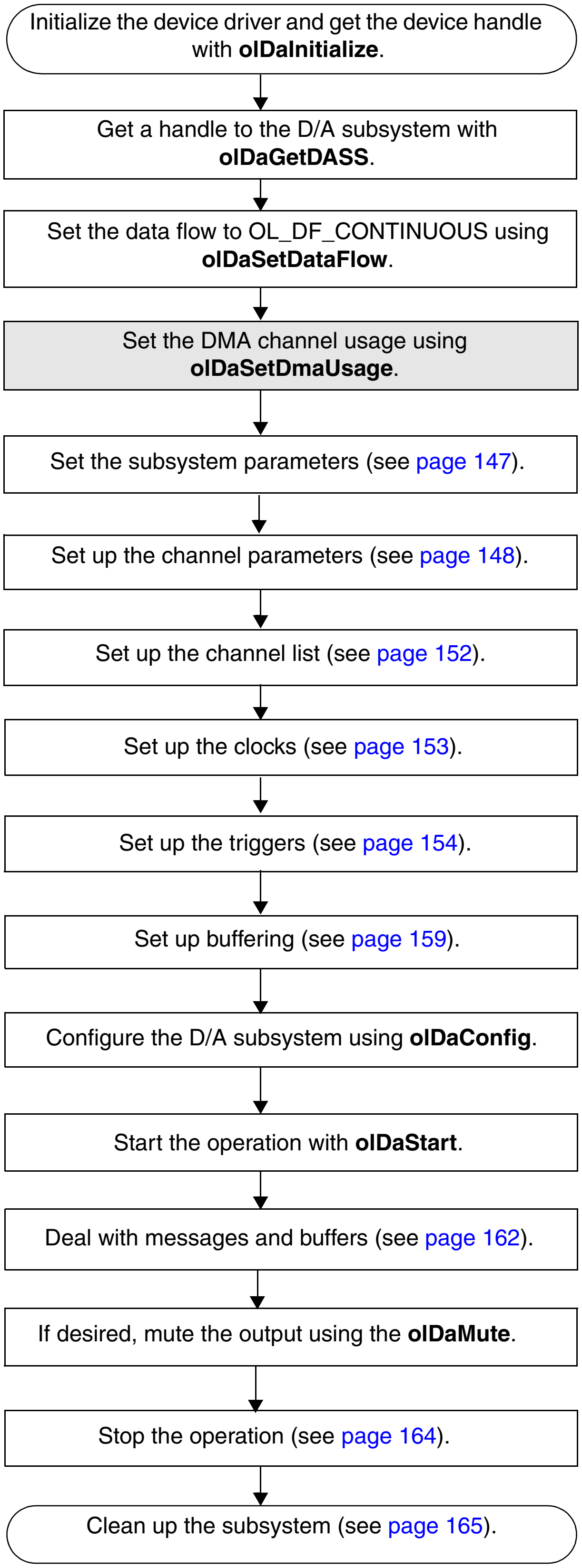
Stop the operation (see page 164).

Clean up the subsystem (see page 165).

Specify OL_DF_CONTINUOUS (the default value) for post-trigger operations, OL_DF_CONTINUOUS_PRETRIG for continuous pre-trigger operations, or OL_DF_CONTINUOUS_ABOUTTRIG for continuous about-trigger operations).

After configuration, if using an internal clock, you can use **olDaGetClockFrequency** to get the actual frequency that the internal sample clock can achieve; if using an external clock, you can use **olDaGetExternalClockDivider** to get the actual clock divider that the device can achieve; if using internal retrigger mode, you can use **olDaGetRetriggerFrequency** to get the actual frequency that the internal retrigger clock can achieve.

# Continuous Analog Output Operations



Initialize the device driver and get the device handle with **olDaInitialize**.

Get a handle to the D/A subsystem with **olDaGetDASS**.

Set the data flow to OL_DF_CONTINUOUS using **olDaSetDataFlow**.

Set the DMA channel usage using **olDaSetDmaUsage**.

Set the subsystem parameters (see page 147).

Set up the channel parameters (see page 148).

Set up the channel list (see page 152).

Set up the clocks (see page 153).

Set up the triggers (see page 154).

Set up buffering (see page 159).

Configure the D/A subsystem using **olDaConfig**.

Start the operation with **olDaStart**.

Deal with messages and buffers (see page 162).

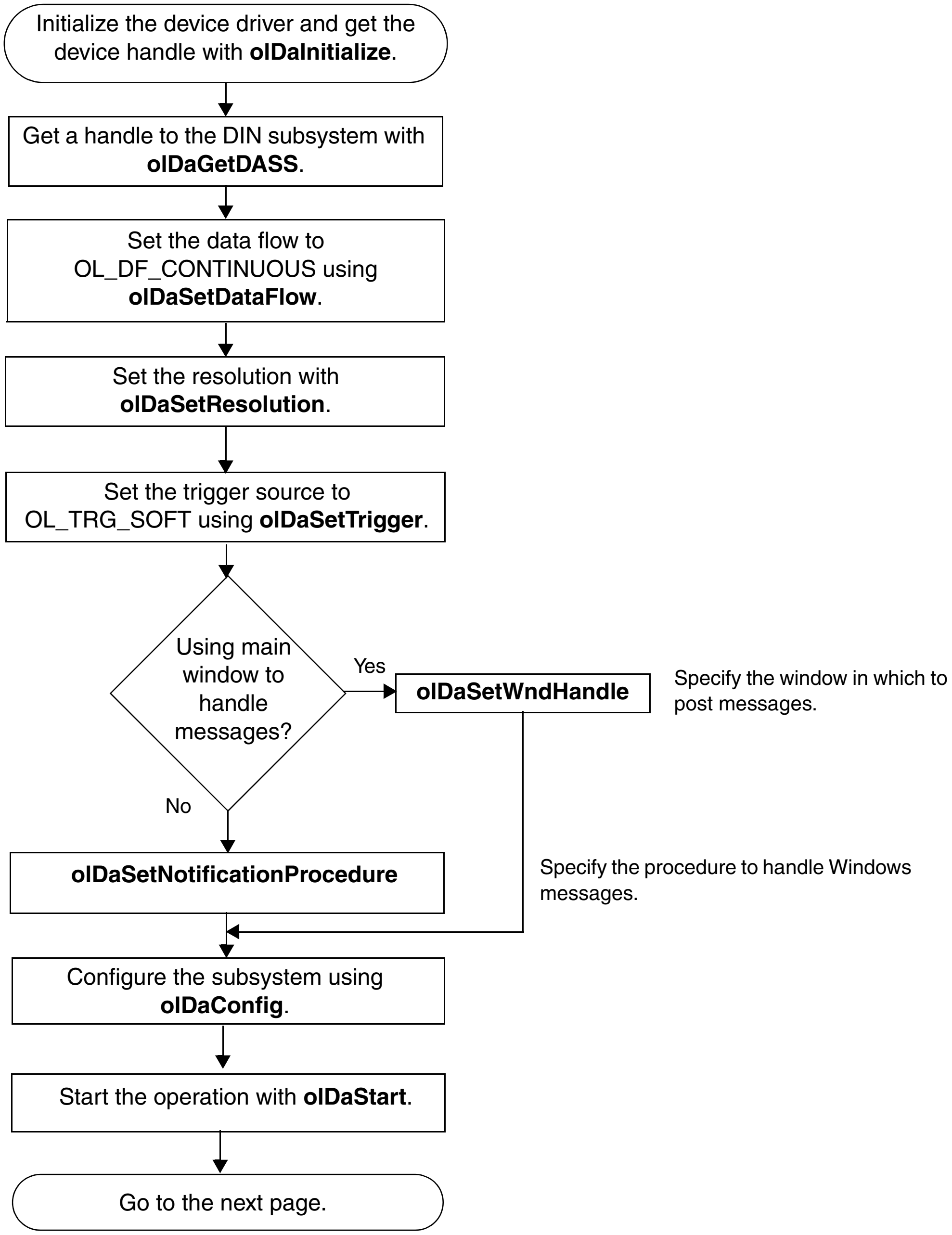
If desired, mute the output using the **olDaMute**.

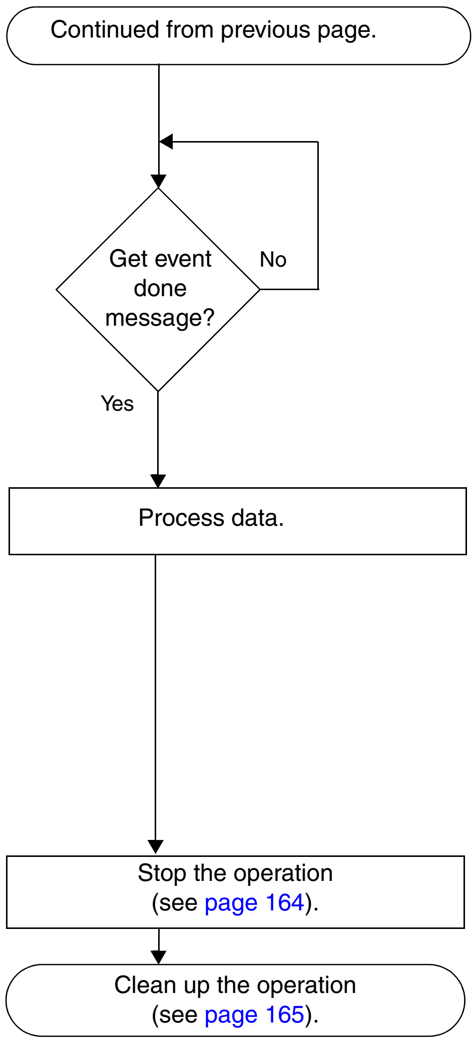
Stop the operation (see page 164).

Clean up the subsystem (see page 165).

After configuration, if using an internal clock, you can use **olDaGetClockFrequency** to get the actual frequency that the internal output clock can achieve; or if using an external clock, you can use **olDaGetExternalClockDivider** to get the actual clock divider that the device can achieve.

# Continuous Digital Input Operations


Initialize the device driver and get the device handle with **olDaInitialize**.
Get a handle to the DIN subsystem with **olDaGetDASS**.
Set the data flow to OL_DF_CONTINUOUS using **olDaSetDataFlow**.
Set the resolution with **olDaSetResolution**.
Set the trigger source to OL_TRG_SOFT using **olDaSetTrigger**.
Using main window to handle messages?
Yes
**olDaSetWndHandle**
Specify the window in which to post messages.
No
**olDaSetNotificationProcedure**
Specify the procedure to handle Windows messages.
Configure the subsystem using **olDaConfig**.
Start the operation with **olDaStart**.
Go to the next page.


Continued from previous page.
Get event done message?
No
Yes
Process data.
Stop the operation (see page 164).
Clean up the operation (see page 165).

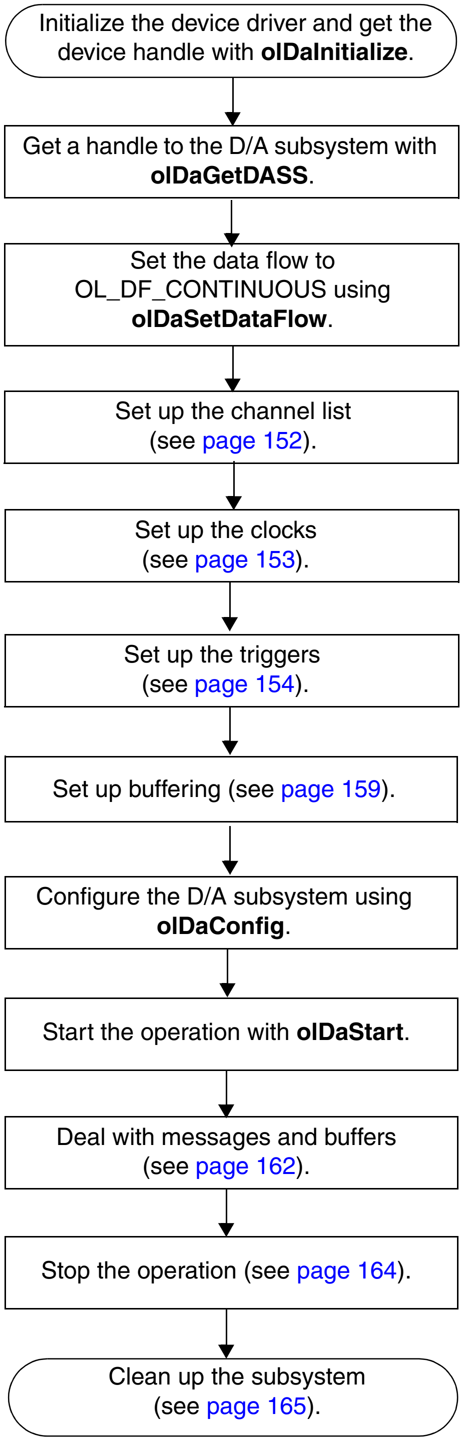
The event done message is OLDA_WM_EVENT_DONE. In **olDaSetWndHandle** or **olDaSetNotificationProcedure**, the subsystem handle, HDASS, is returned in the *wParam* *p*arameter; this allows one window to handle messages from all subsystems. The subsystem status is returned in the *IParam* parameter.

For Data Translation PCI boards that support interrupt-on-change, the low word of *IParam* contains the DIO lines (bits) that caused the event and the high word of *IParam* contains the status of the digital input port when the interrupt occurred.

For Data Translation USB modules that support interrupt-on-change, the meaning of *IParam* depends on the module you are using.

Refer to your device documentation for more information.

# Continuous Digital Output Operations



Initialize the device driver and get the device handle with **olDaInitialize**.

Get a handle to the D/A subsystem with **olDaGetDASS**.

Set the data flow to OL_DF_CONTINUOUS using **olDaSetDataFlow**.

Set up the channel list (see page 152).

Set up the clocks (see page 153).

Set up the triggers (see page 154).

Set up buffering (see page 159).

Configure the D/A subsystem using **olDaConfig**.

Start the operation with **olDaStart**.

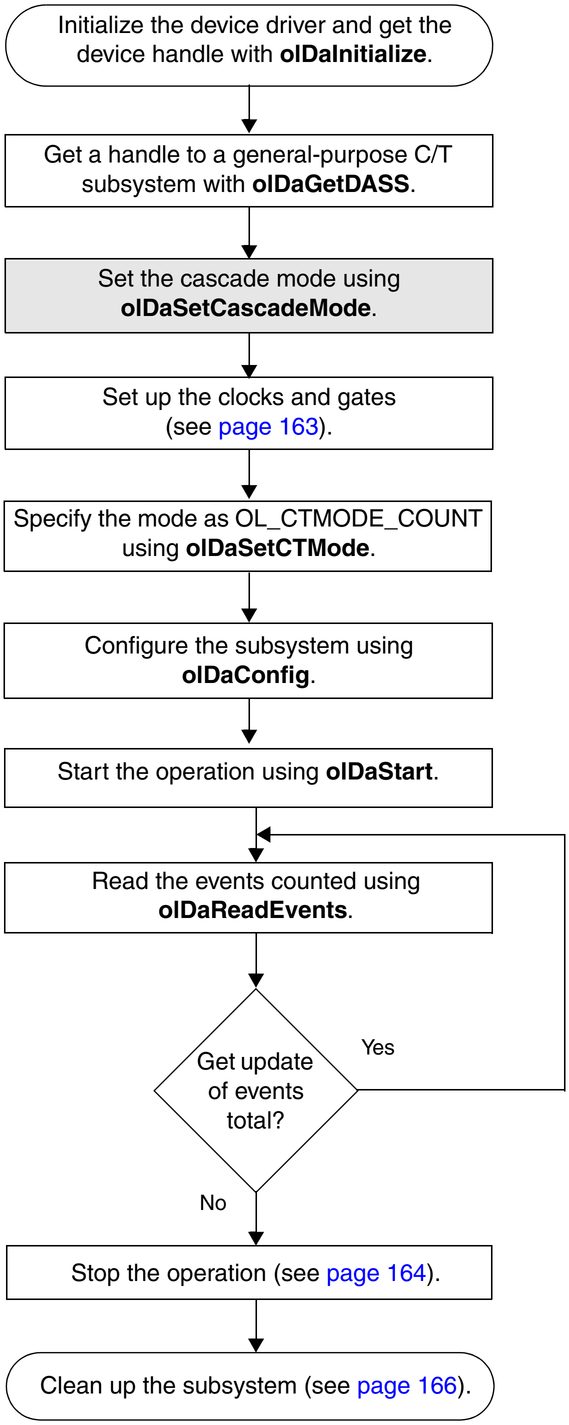
Deal with messages and buffers (see page 162).

Stop the operation (see page 164).

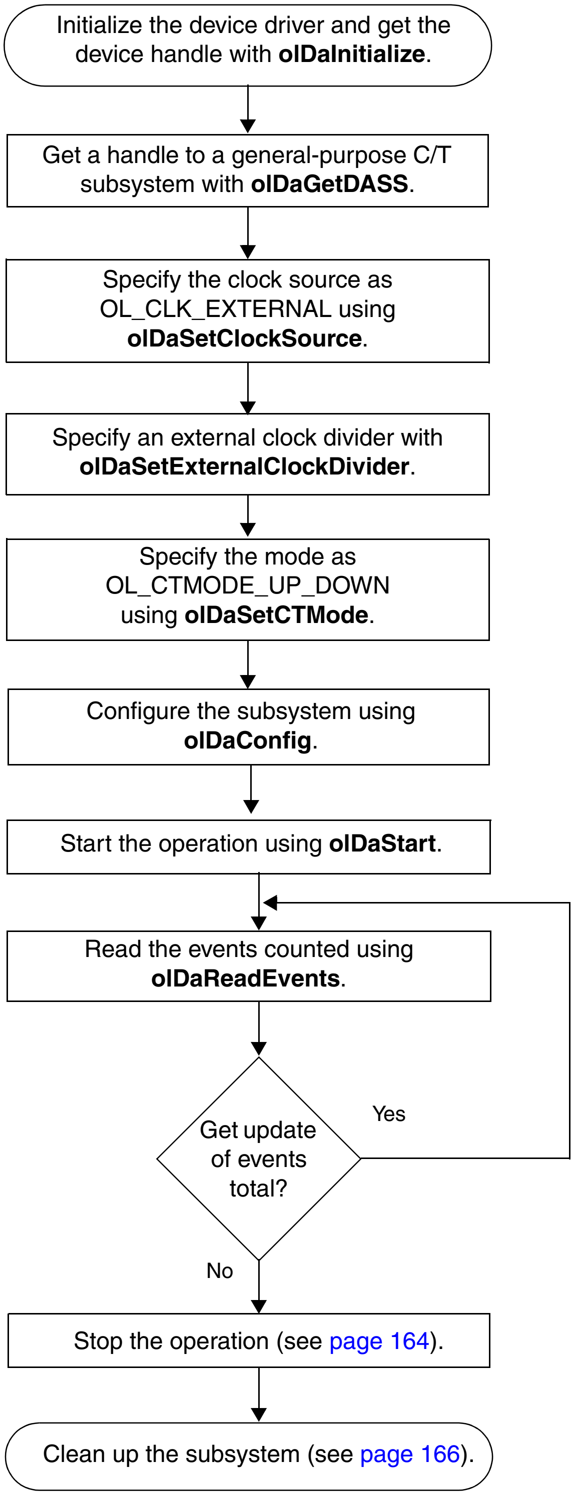
Clean up the subsystem (see page 165).

After configuration, if using an internal clock, you can use **olDaGetClockFrequency** to get the actual frequency that the internal output clock can achieve; or if using an external clock, you can use **olDaGetExternalClockDivider** to get the actual clock divider that the device can achieve.

# Event Counting Operations

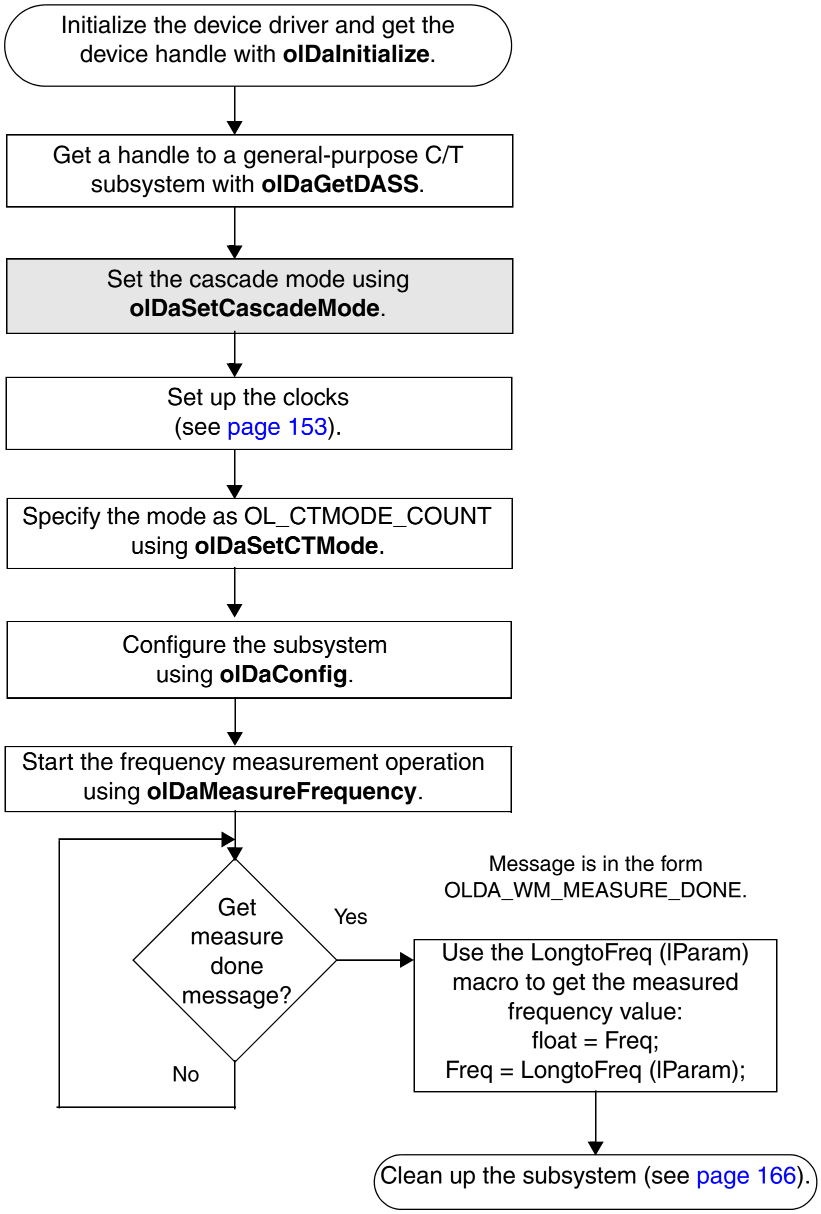

Initialize the device driver and get the device handle with **olDaInitialize**.
Get a handle to a general-purpose C/T subsystem with **olDaGetDASS**.
Set the cascade mode using **olDaSetCascadeMode**.
Set up the clocks and gates (see page 163).
Specify the mode as OL_CTMODE_COUNT using **olDaSetCTMode**.
Configure the subsystem using **olDaConfig**.
Start the operation using **olDaStart**.
Read the events counted using **olDaReadEvents**.
Get update of events total?
Yes
No
Stop the operation (see page 164).
Clean up the subsystem (see page 166).

# Up/Down Counting Operations

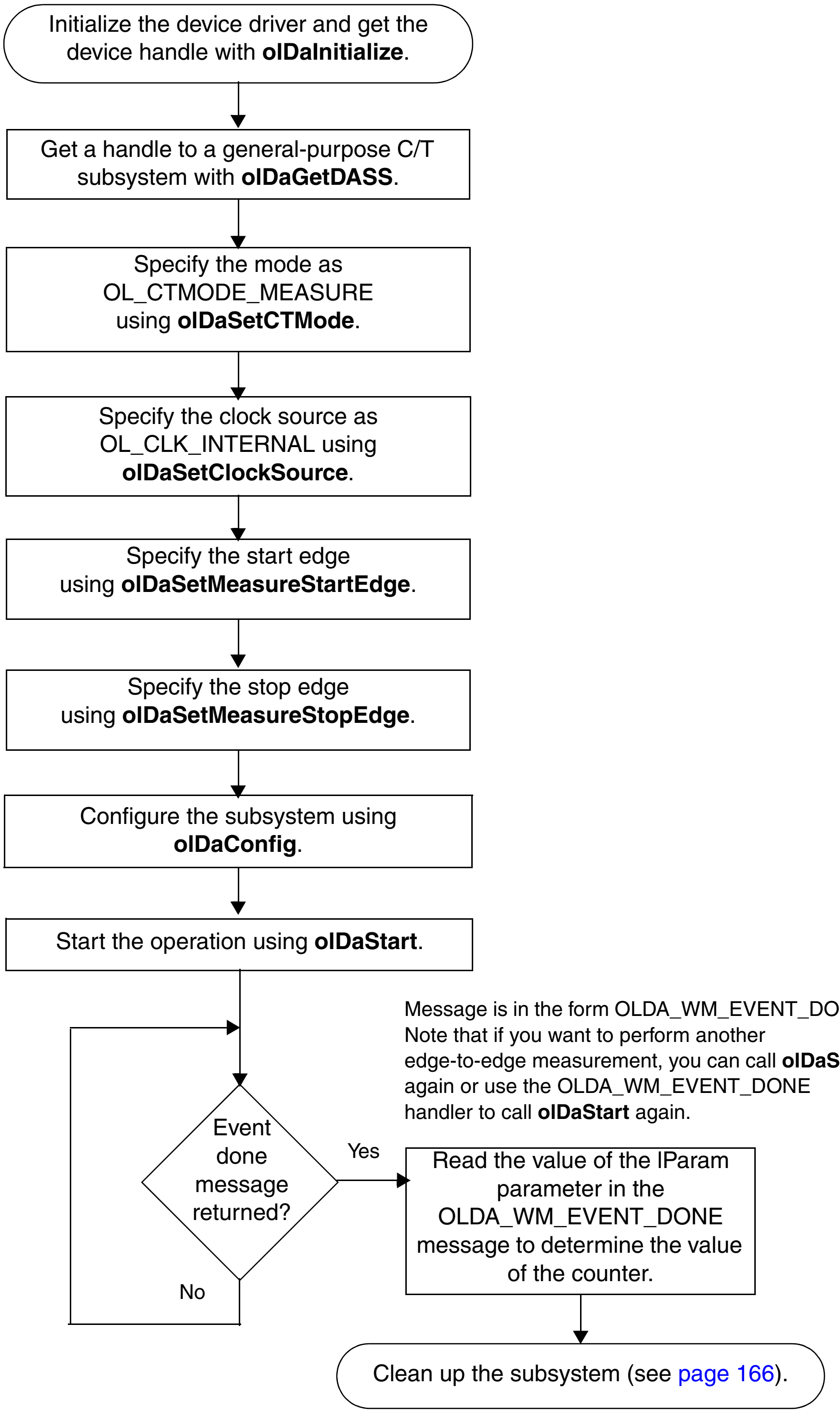

Initialize the device driver and get the device handle with **olDaInitialize**.
Get a handle to a general-purpose C/T subsystem with **olDaGetDASS**.
Specify the clock source as OL_CLK_EXTERNAL using **olDaSetClockSource**.
Specify an external clock divider with **olDaSetExternalClockDivider**.
Specify the mode as OL_CTMODE_UP_DOWN using **olDaSetCTMode**.
Configure the subsystem using **olDaConfig**.
Start the operation using **olDaStart**.
Read the events counted using **olDaReadEvents**.
Get update of events total?
Yes
No
Stop the operation (see page 164).
Clean up the subsystem (see page 166).

# Frequency Measurement Operations

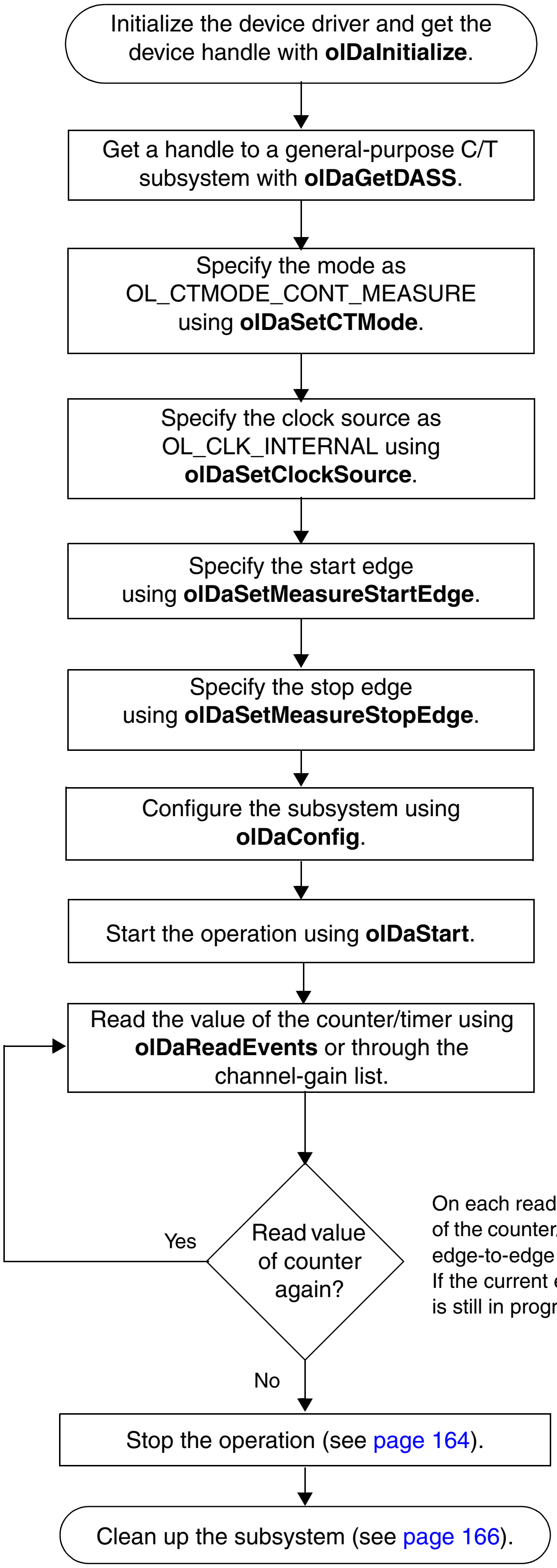
**Note:** If you need more accuracy than the system timer provides, refer to page 97.


Initialize the device driver and get the device handle with **olDaInitialize**.
Get a handle to a general-purpose C/T subsystem with **olDaGetDASS**.
Set the cascade mode using **olDaSetCascadeMode**.
Set up the clocks (see page 153).
Specify the mode as OL_CTMODE_COUNT using **olDaSetCTMode**.
Configure the subsystem using **olDaConfig**.
Start the frequency measurement operation using **olDaMeasureFrequency**.
Get measure done message?
Yes
No
Message is in the form OLDA_WM_MEASURE_DONE.
Use the LongtoFreq (lParam) macro to get the measured frequency value:
float = Freq;
Freq = LongtoFreq (lParam);
Clean up the subsystem (see page 166).

# Edge-to-Edge Measurement Operations

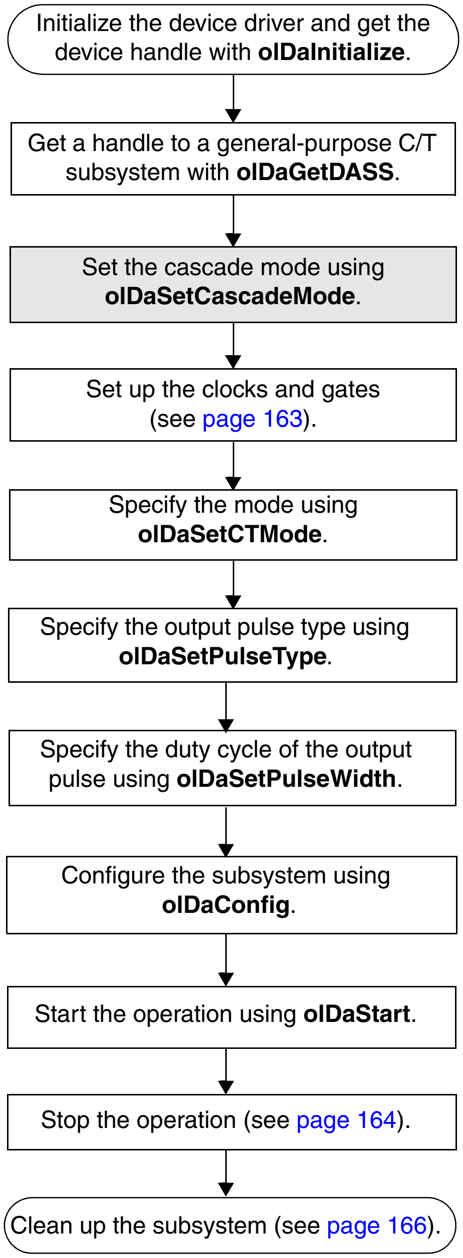

Initialize the device driver and get the device handle with **olDaInitialize**.
Get a handle to a general-purpose C/T subsystem with **olDaGetDASS**.
Specify the mode as OL_CTMODE_MEASURE using **olDaSetCTMode**.
Specify the clock source as OL_CLK_INTERNAL using **olDaSetClockSource**.
Specify the start edge using **olDaSetMeasureStartEdge**.
Specify the stop edge using **olDaSetMeasureStopEdge**.
Configure the subsystem using **olDaConfig**.
Start the operation using **olDaStart**.
Event done message returned?
Yes
No
Message is in the form OLDA_WM_EVENT_DONE. Note that if you want to perform another edge-to-edge measurement, you can call **olDaStart** again or use the OLDA_WM_EVENT_DONE handler to call **olDaStart** again.
Read the value of the lParam parameter in the OLDA_WM_EVENT_DONE message to determine the value of the counter.
Clean up the subsystem (see page 166).

# Continuous Edge-to-Edge Measurement Operations


Initialize the device driver and get the device handle with **olDaInitialize**.
Get a handle to a general-purpose C/T subsystem with **olDaGetDASS**.
Specify the mode as OL_CTMODE_CONT_MEASURE using **olDaSetCTMode**.
Specify the clock source as OL_CLK_INTERNAL using **olDaSetClockSource**.
Specify the start edge using **olDaSetMeasureStartEdge**.
Specify the stop edge using **olDaSetMeasureStopEdge**.
Configure the subsystem using **olDaConfig**.
Start the operation using **olDaStart**.
Read the value of the counter/timer using **olDaReadEvents** or through the channel-gain list.
Read value of counter again?
Yes
No
Stop the operation (see page 164).
Clean up the subsystem (see page 166).

On each read of the counter/timer, the current value of the counter/timer channel is returned and the next edge-to-edge measurement mode operation starts. If the current edge-to-edge measurement operation is still in progress, 0 is returned.

# Pulse Output Operations



Initialize the device driver and get the device handle with **olDaInitialize**.

Get a handle to a general-purpose C/T subsystem with **olDaGetDASS**.

Set the cascade mode using **olDaSetCascadeMode**.

Set up the clocks and gates (see page 163).

Specify the mode using **olDaSetCTMode**.

Specify OL_CTMODE_RATE for rate generation (continuous pulse output), OL_CTMODE_ONESHOT for single one-shot, or OL_CTMODE_ONESHOT_RPT for repetitive one-shot.

Specify the output pulse type using **olDaSetPulseType**.

Specify the duty cycle of the output pulse using **olDaSetPulseWidth**.

Configure the subsystem using **olDaConfig**.

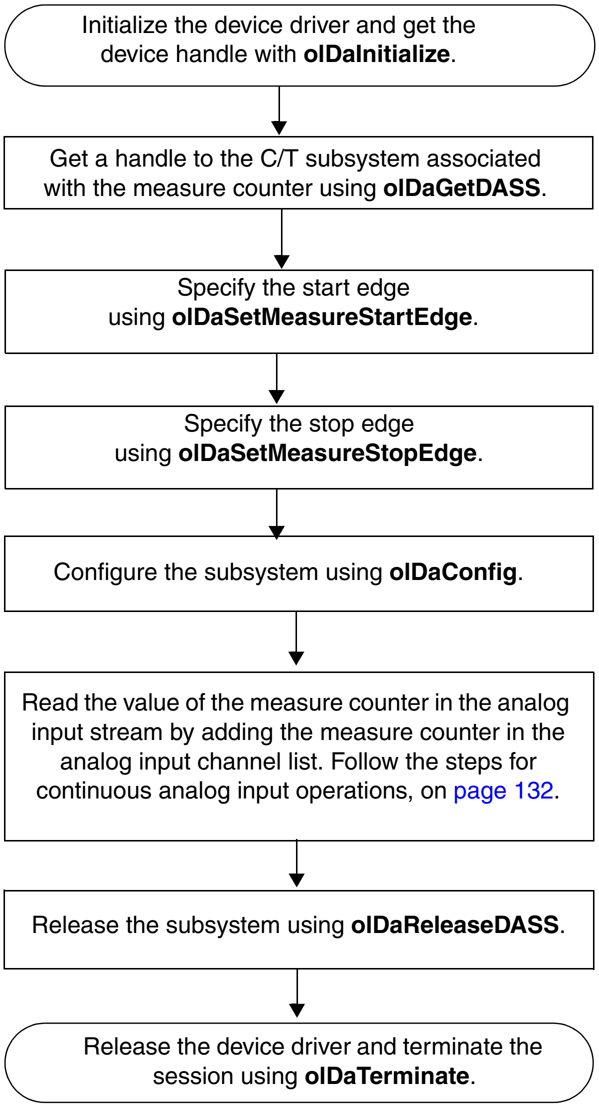
Start the operation using **olDaStart**.

Stop the operation (see page 164).

This step is not needed for single one-shot operations.

Clean up the subsystem (see page 166).

# Measure Counter Operations



Initialize the device driver and get the device handle with **olDaInitialize**.

Get a handle to the C/T subsystem associated with the measure counter using **olDaGetDASS**.

Specify the start edge using **olDaSetMeasureStartEdge**.

Specify the stop edge using **olDaSetMeasureStopEdge**.

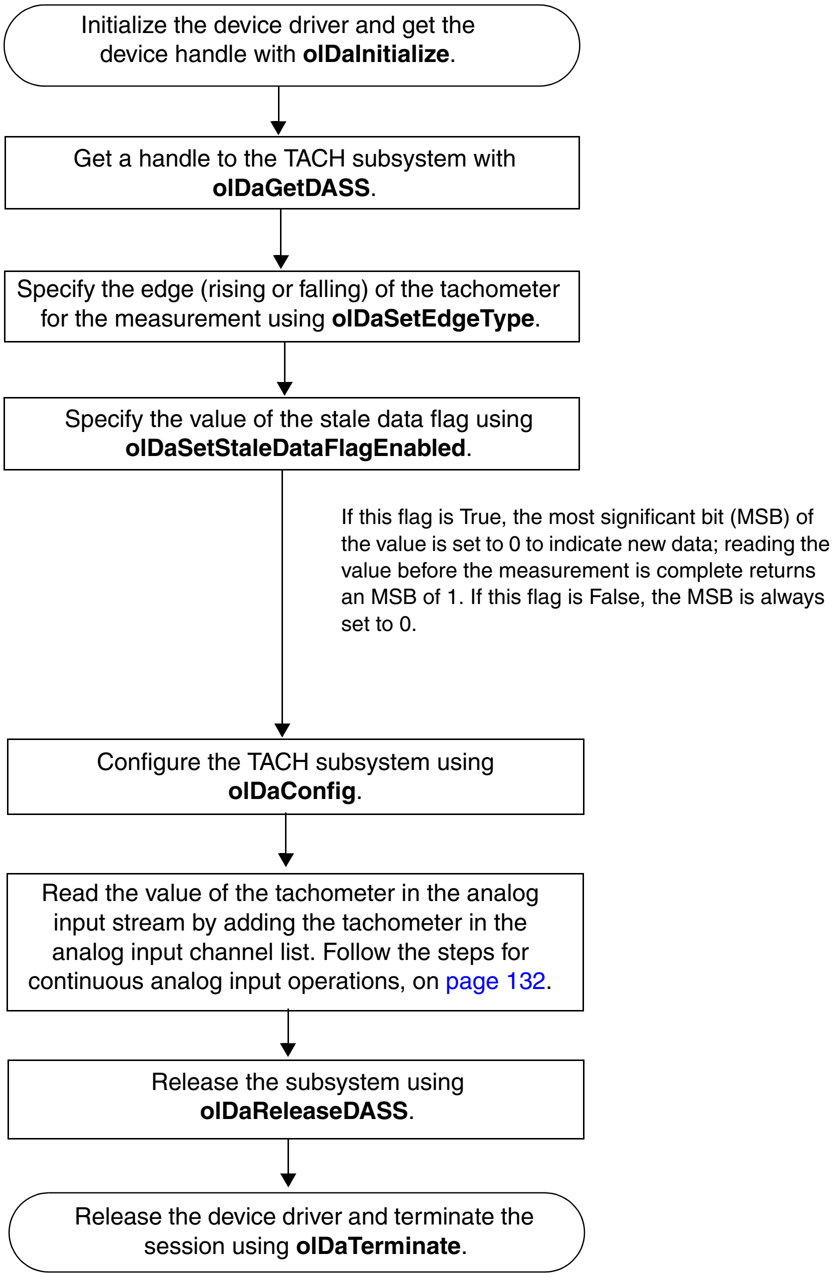
Configure the subsystem using **olDaConfig**.

Read the value of the measure counter in the analog input stream by adding the measure counter in the analog input channel list. Follow the steps for continuous analog input operations, on page 132.

Release the subsystem using **olDaReleaseDASS**.

Release the device driver and terminate the session using **olDaTerminate**.

# Tachometer Operations



Initialize the device driver and get the device handle with **olDaInitialize**.

Get a handle to the TACH subsystem with **olDaGetDASS**.

Specify the edge (rising or falling) of the tachometer for the measurement using **olDaSetEdgeType**.

Specify the value of the stale data flag using **olDaSetStaleDataFlagEnabled**.

If this flag is True, the most significant bit (MSB) of the value is set to 0 to indicate new data; reading the value before the measurement is complete returns an MSB of 1. If this flag is False, the MSB is always set to 0.

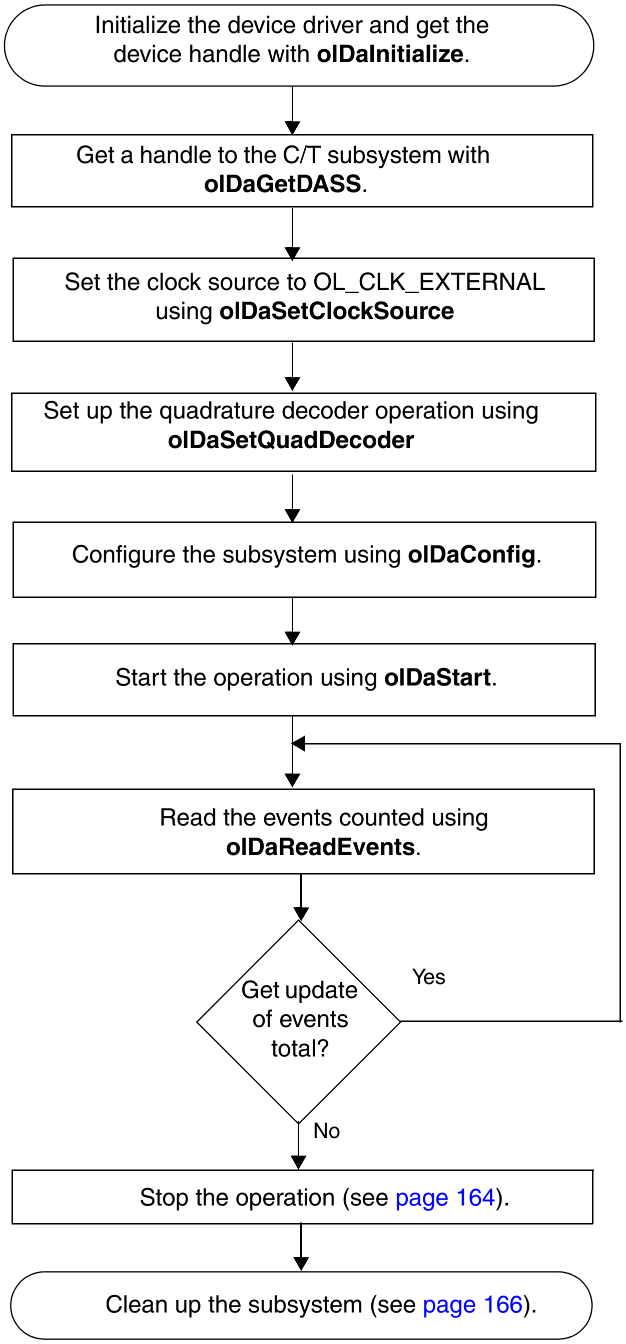
Configure the TACH subsystem using **olDaConfig**.

Read the value of the tachometer in the analog input stream by adding the tachometer in the analog input channel list. Follow the steps for continuous analog input operations, on page 132.

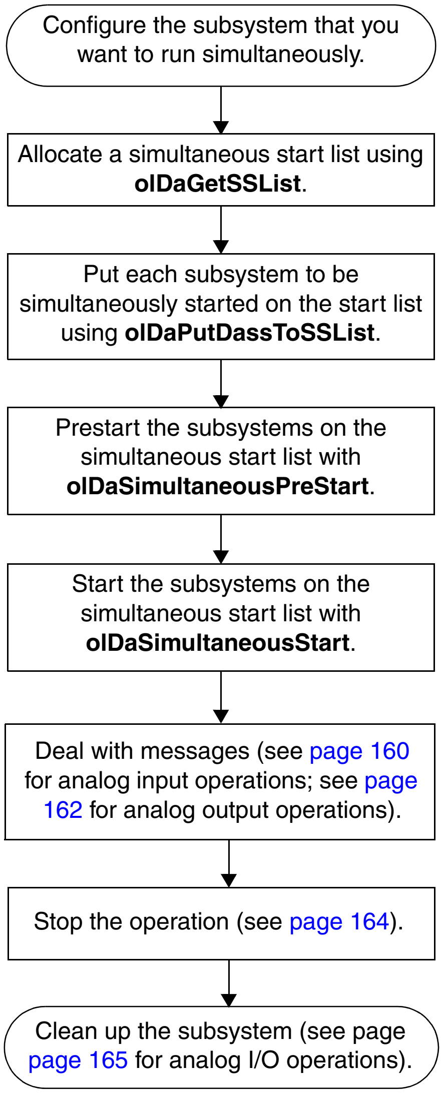
Release the subsystem using **olDaReleaseDASS**.

Release the device driver and terminate the session using **olDaTerminate**.

# Quadrature Decoder Operations

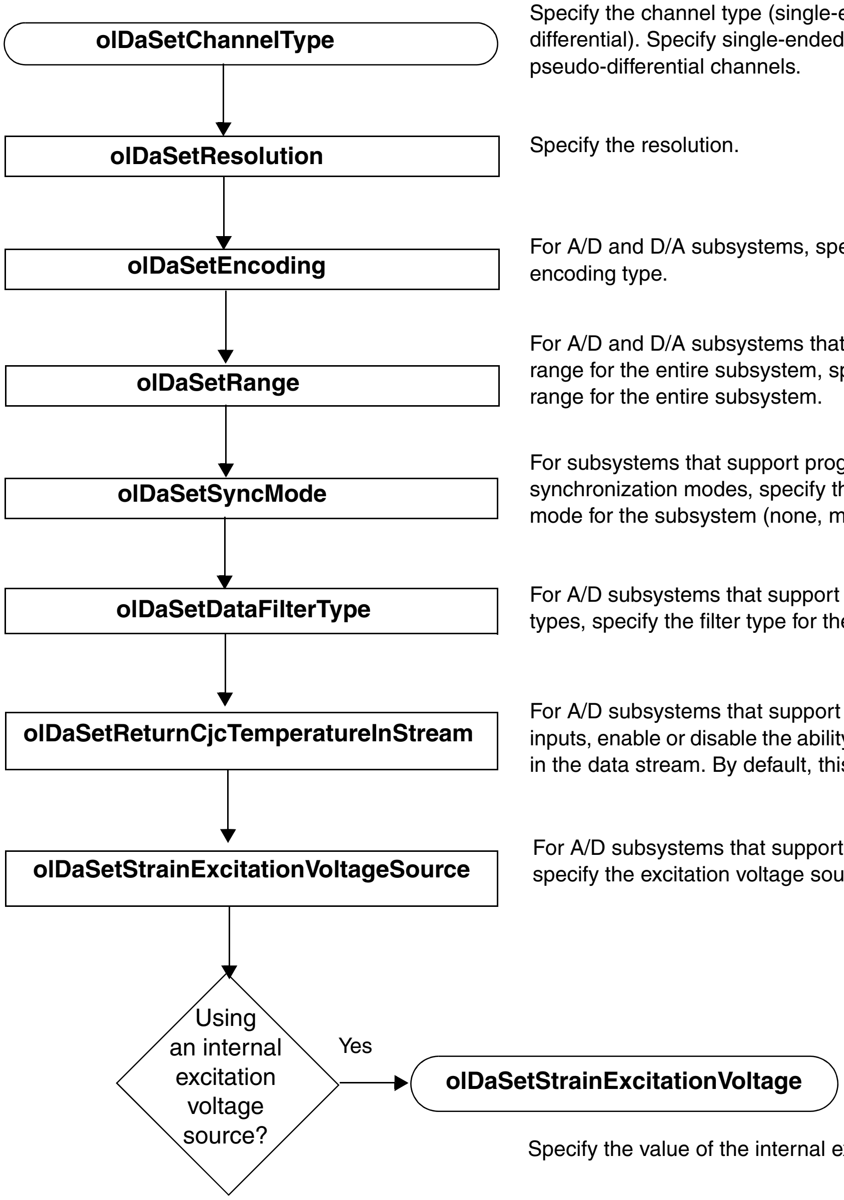

Initialize the device driver and get the device handle with **olDaInitialize**.
Get a handle to the C/T subsystem with **olDaGetDASS**.
Set the clock source to OL_CLK_EXTERNAL using **olDaSetClockSource**
Set up the quadrature decoder operation using **olDaSetQuadDecoder**
Configure the subsystem using **olDaConfig**.
Start the operation using **olDaStart**.
Read the events counted using **olDaReadEvents**.
Get update of events total?
Yes
No
Stop the operation (see page 164).
Clean up the subsystem (see page 166).

# Simultaneous Operations


Configure the subsystem that you want to run simultaneously.
Allocate a simultaneous start list using **olDaGetSSList**.
Put each subsystem to be simultaneously started on the start list using **olDaPutDassToSSList**.
Prestart the subsystems on the simultaneous start list with **olDaSimultaneousPreStart**.
Start the subsystems on the simultaneous start list with **olDaSimultaneousStart**.
Deal with messages (see page 160 for analog input operations; see page 162 for analog output operations).
Stop the operation (see page 164).
Clean up the subsystem (see page page 165 for analog I/O operations).

See the previous flow diagrams in this chapter; you cannot perform single-value operations simultaneously on multiplexed A/D modules.

## Set Subsystem Parameters


olDaSetChannelType
olDaSetResolution
olDaSetEncoding
olDaSetRange
olDaSetSyncMode
olDaSetDataFilterType
olDaSetReturnCjcTemperatureInStream
olDaSetStrainExcitationVoltageSource
Using an internal excitation voltage source?
Yes
olDaSetStrainExcitationVoltage

Specify the channel type (single-ended or differential). Specify single-ended if you are using pseudo-differential channels.

Specify the resolution.

For A/D and D/A subsystems, specify the data encoding type.

For A/D and D/A subsystems that support a single range for the entire subsystem, specify the voltage range for the entire subsystem.

For subsystems that support programmable synchronization modes, specify the synchronization mode for the subsystem (none, master, or slave).

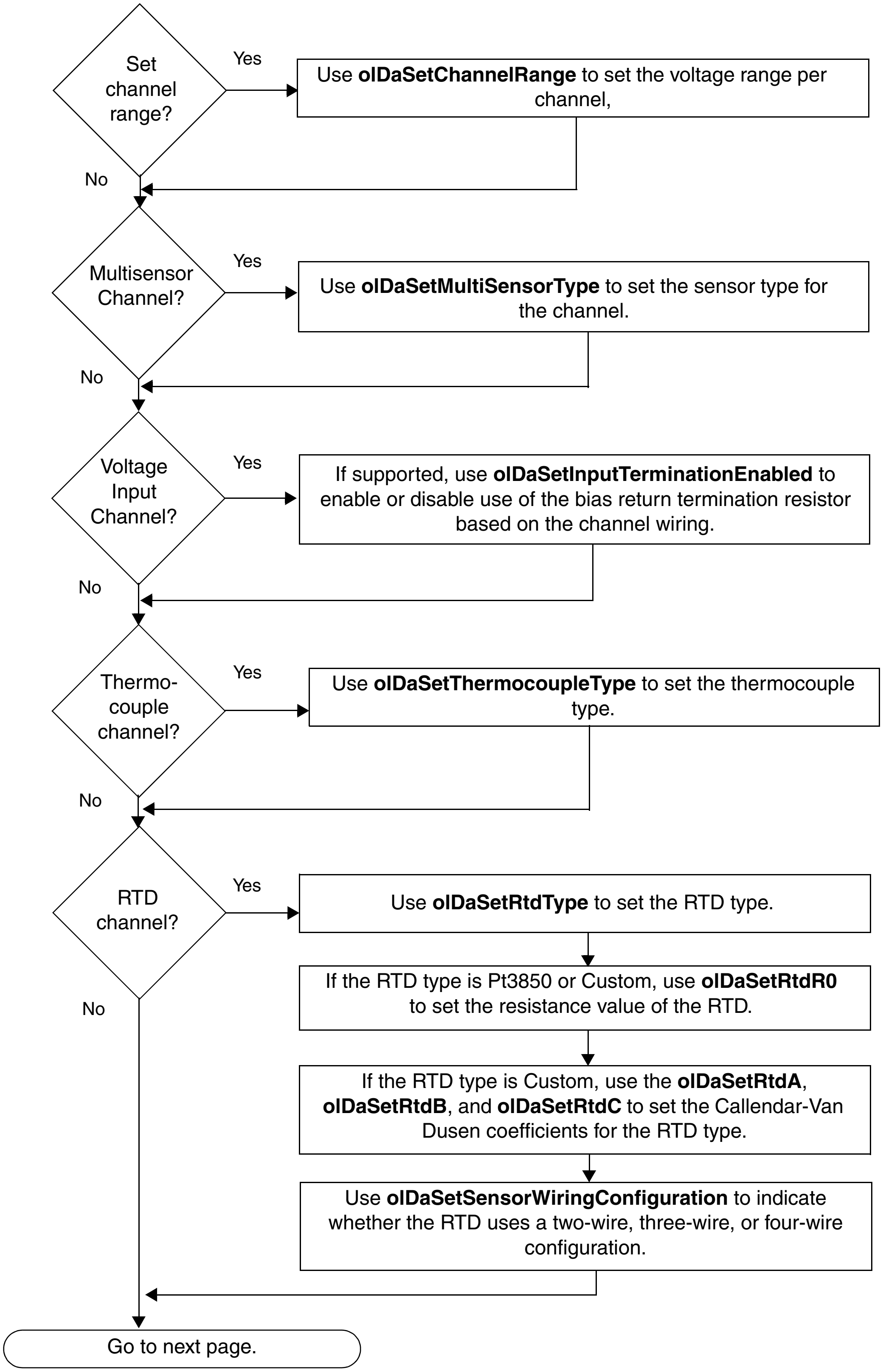
For A/D subsystems that support programmable filter types, specify the filter type for the subsystem.

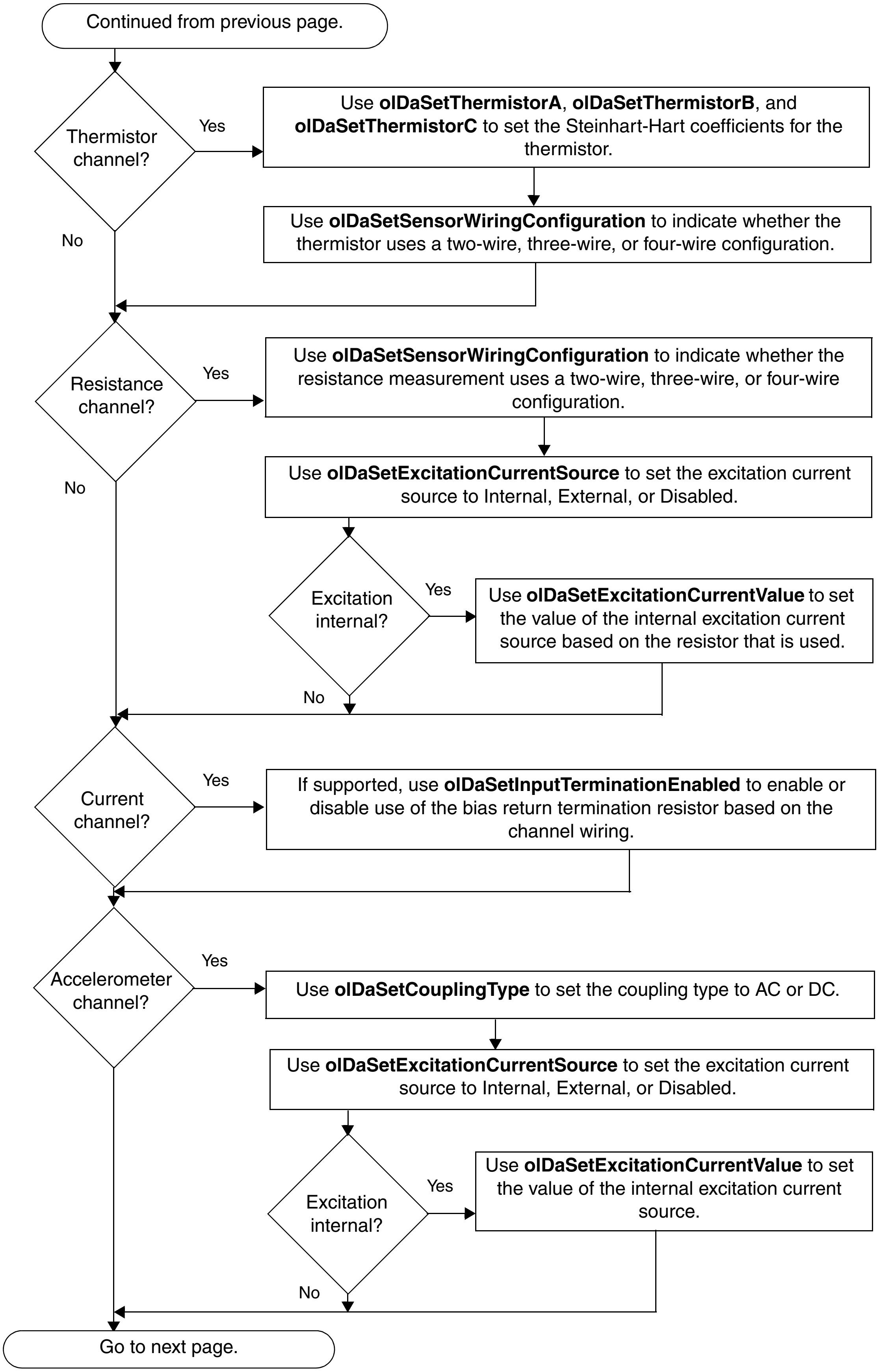
For A/D subsystems that support thermocouple inputs, enable or disable the ability to return CJC data in the data stream. By default, this ability is disabled.

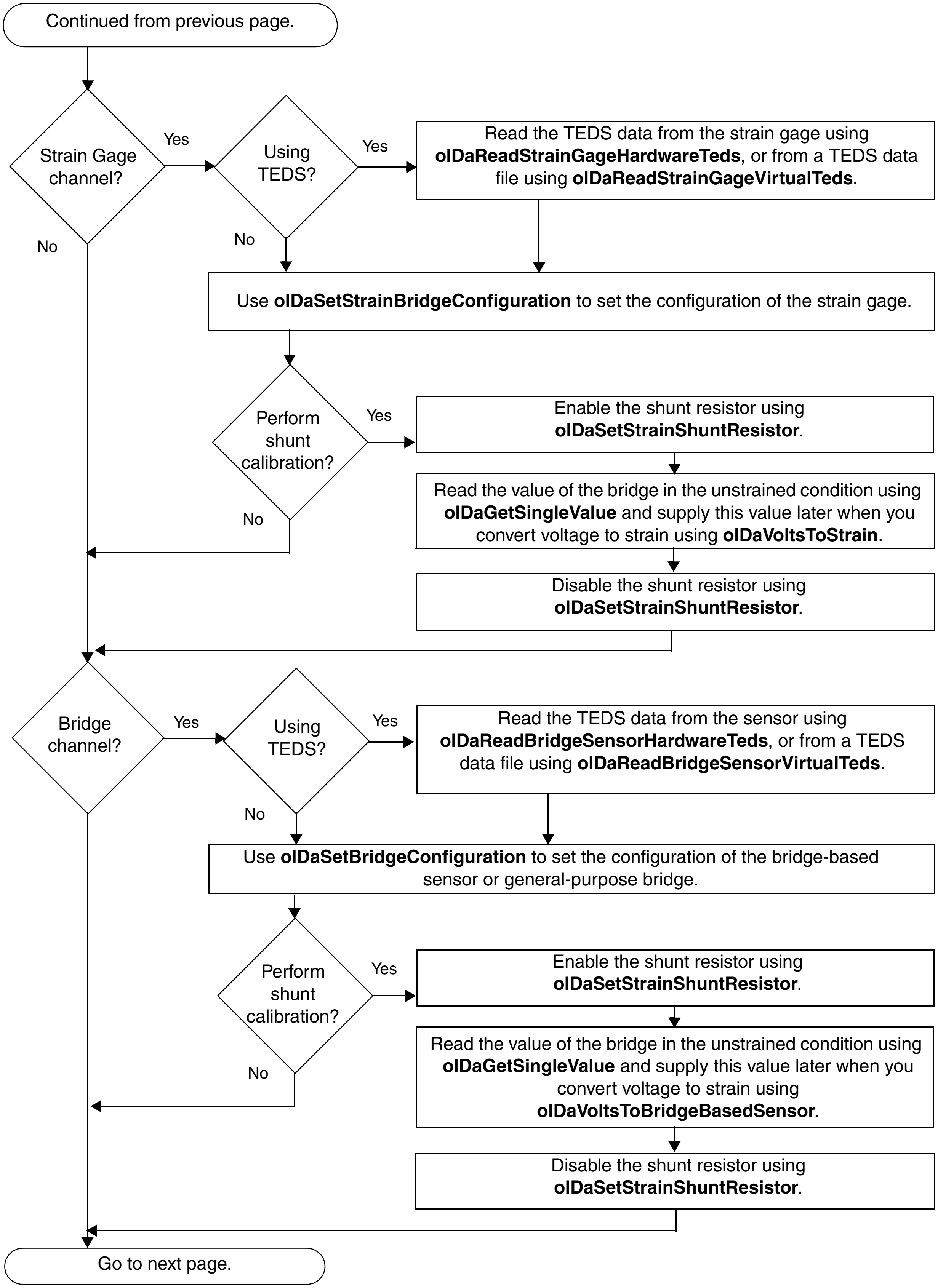
For A/D subsystems that support strain gage inputs, specify the excitation voltage source

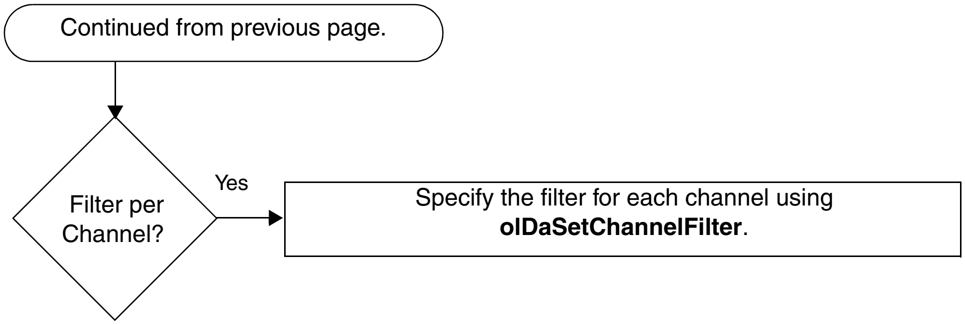
Specify the value of the internal excitation voltage source.

### Set up Channel Parameters

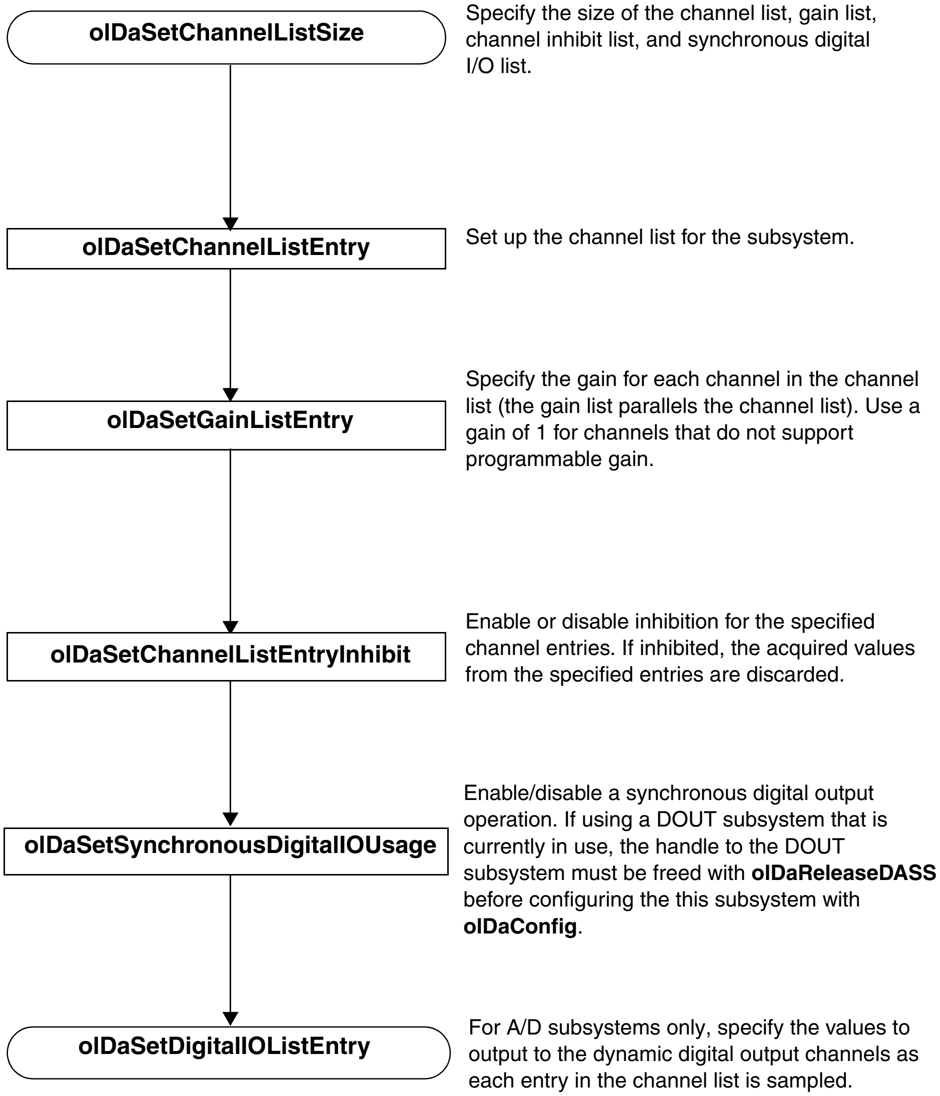

Set channel range?
Yes
Use olDaSetChannelRange to set the voltage range per channel,
No
Multisensor Channel?
Yes
Use olDaSetMultiSensorType to set the sensor type for the channel.
No
Voltage Input Channel?
Yes
If supported, use olDaSetInputTerminationEnabled to enable or disable use of the bias return termination resistor based on the channel wiring.
No
Thermo-couple channel?
Yes
Use olDaSetThermocoupleType to set the thermocouple type.
No
RTD channel?
Yes
Use olDaSetRtdType to set the RTD type.
If the RTD type is Pt3850 or Custom, use olDaSetRtdR0 to set the resistance value of the RTD.
If the RTD type is Custom, use the olDaSetRtdA, olDaSetRtdB, and olDaSetRtdC to set the Callendar-Van Dusen coefficients for the RTD type.
Use olDaSetSensorWiringConfiguration to indicate whether the RTD uses a two-wire, three-wire, or four-wire configuration.
No
Go to next page.


Continued from previous page.
Thermistor channel?
Yes
Use **olDaSetThermistorA**, **olDaSetThermistorB**, and **olDaSetThermistorC** to set the Steinhart-Hart coefficients for the thermistor.
Use **olDaSetSensorWiringConfiguration** to indicate whether the thermistor uses a two-wire, three-wire, or four-wire configuration.
No
Resistance channel?
Yes
Use **olDaSetSensorWiringConfiguration** to indicate whether the resistance measurement uses a two-wire, three-wire, or four-wire configuration.
Use **olDaSetExcitationCurrentSource** to set the excitation current source to Internal, External, or Disabled.
No
Excitation internal?
Yes
Use **olDaSetExcitationCurrentValue** to set the value of the internal excitation current source based on the resistor that is used.
No
Current channel?
Yes
If supported, use **olDaSetInputTerminationEnabled** to enable or disable use of the bias return termination resistor based on the channel wiring.
Accelerometer channel?
Yes
Use **olDaSetCouplingType** to set the coupling type to AC or DC.
Use **olDaSetExcitationCurrentSource** to set the excitation current source to Internal, External, or Disabled.
Excitation internal?
Yes
Use **olDaSetExcitationCurrentValue** to set the value of the internal excitation current source.
No
Go to next page.


Continued from previous page.
Strain Gage channel?
Yes
Using TEDS?
Yes
Read the TEDS data from the strain gage using **olDaReadStrainGageHardwareTeds**, or from a TEDS data file using **olDaReadStrainGageVirtualTeds**.
No
No
Use **olDaSetStrainBridgeConfiguration** to set the configuration of the strain gage.
Perform shunt calibration?
Yes
Enable the shunt resistor using **olDaSetStrainShuntResistor**.
Read the value of the bridge in the unstrained condition using **olDaGetSingleValue** and supply this value later when you convert voltage to strain using **olDaVoltsToStrain**.
No
Disable the shunt resistor using **olDaSetStrainShuntResistor**.
Bridge channel?
Yes
Using TEDS?
Yes
Read the TEDS data from the sensor using **olDaReadBridgeSensorHardwareTeds**, or from a TEDS data file using **olDaReadBridgeSensorVirtualTeds**.
No
Use **olDaSetBridgeConfiguration** to set the configuration of the bridge-based sensor or general-purpose bridge.
Perform shunt calibration?
Yes
Enable the shunt resistor using **olDaSetStrainShuntResistor**.
Read the value of the bridge in the unstrained condition using **olDaGetSingleValue** and supply this value later when you convert voltage to strain using **olDaVoltsToBridgeBasedSensor**.
No
Disable the shunt resistor using **olDaSetStrainShuntResistor**.
Go to next page.


Continued from previous page.
Filter per Channel?
Yes
Specify the filter for each channel using **olDaSetChannelFilter**.

## Set Up Channel List Parameters



**olDaSetChannelListSize**

Specify the size of the channel list, gain list, channel inhibit list, and synchronous digital I/O list.

**olDaSetChannelListEntry**

Set up the channel list for the subsystem.

**olDaSetGainListEntry**

Specify the gain for each channel in the channel list (the gain list parallels the channel list). Use a gain of 1 for channels that do not support programmable gain.

**olDaSetChannelListEntryInhibit**

Enable or disable inhibition for the specified channel entries. If inhibited, the acquired values from the specified entries are discarded.

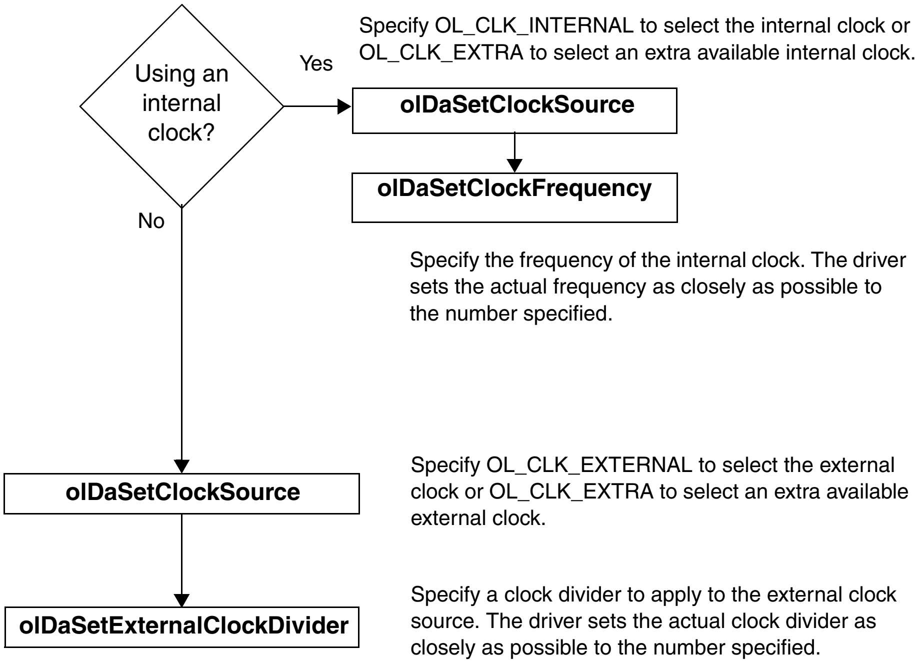
**olDaSetSynchronousDigitalIOUsage**

Enable/disable a synchronous digital output operation. If using a DOUT subsystem that is currently in use, the handle to the DOUT subsystem must be freed with **olDaReleaseDASS** before configuring the this subsystem with **olDaConfig**.

**olDaSetDigitalIOListEntry**

For A/D subsystems only, specify the values to output to the dynamic digital output channels as each entry in the channel list is sampled.

## Set Up Clocks



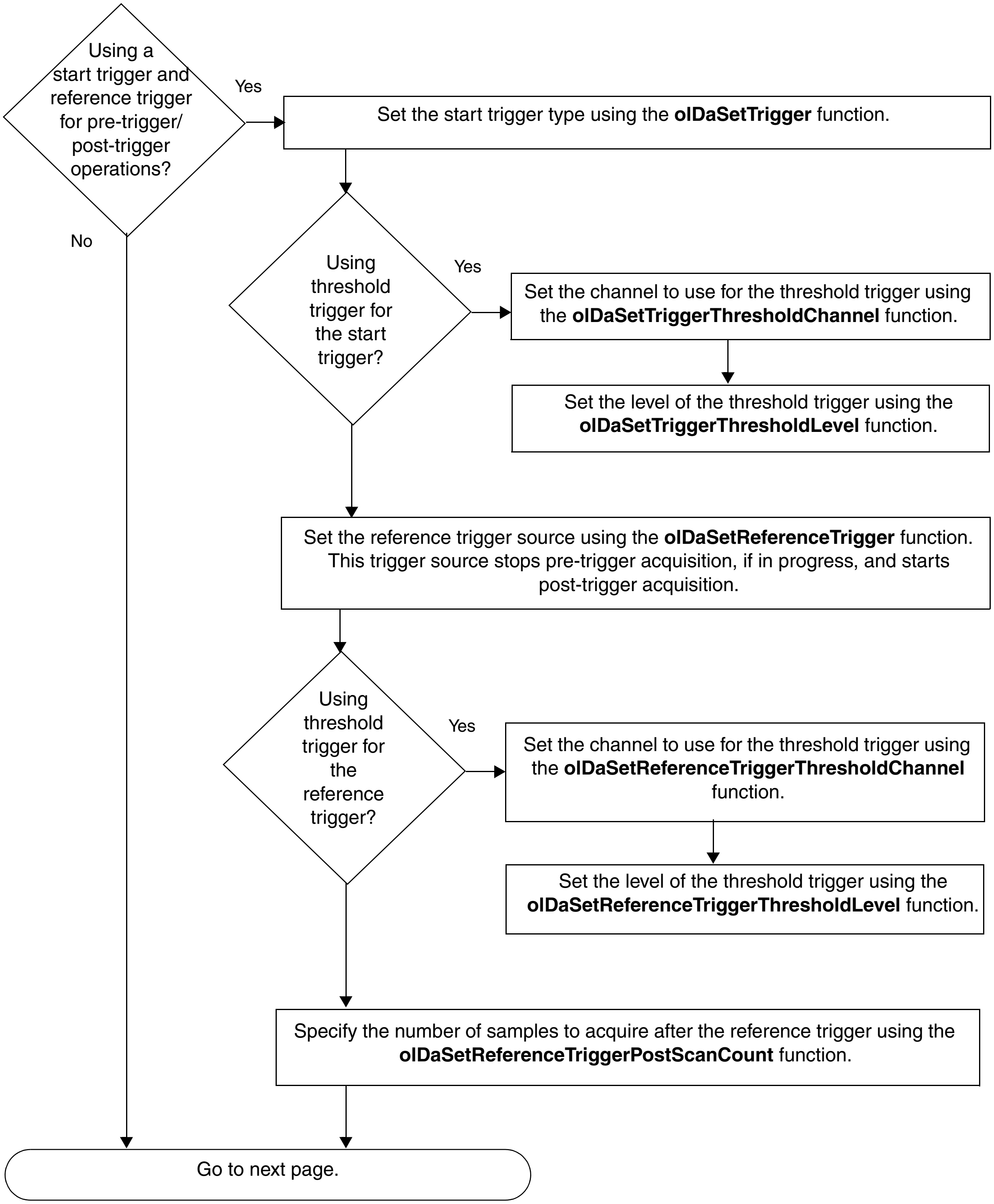
Specify OL_CLK_INTERNAL to select the internal clock or OL_CLK_EXTRA to select an extra available internal clock.

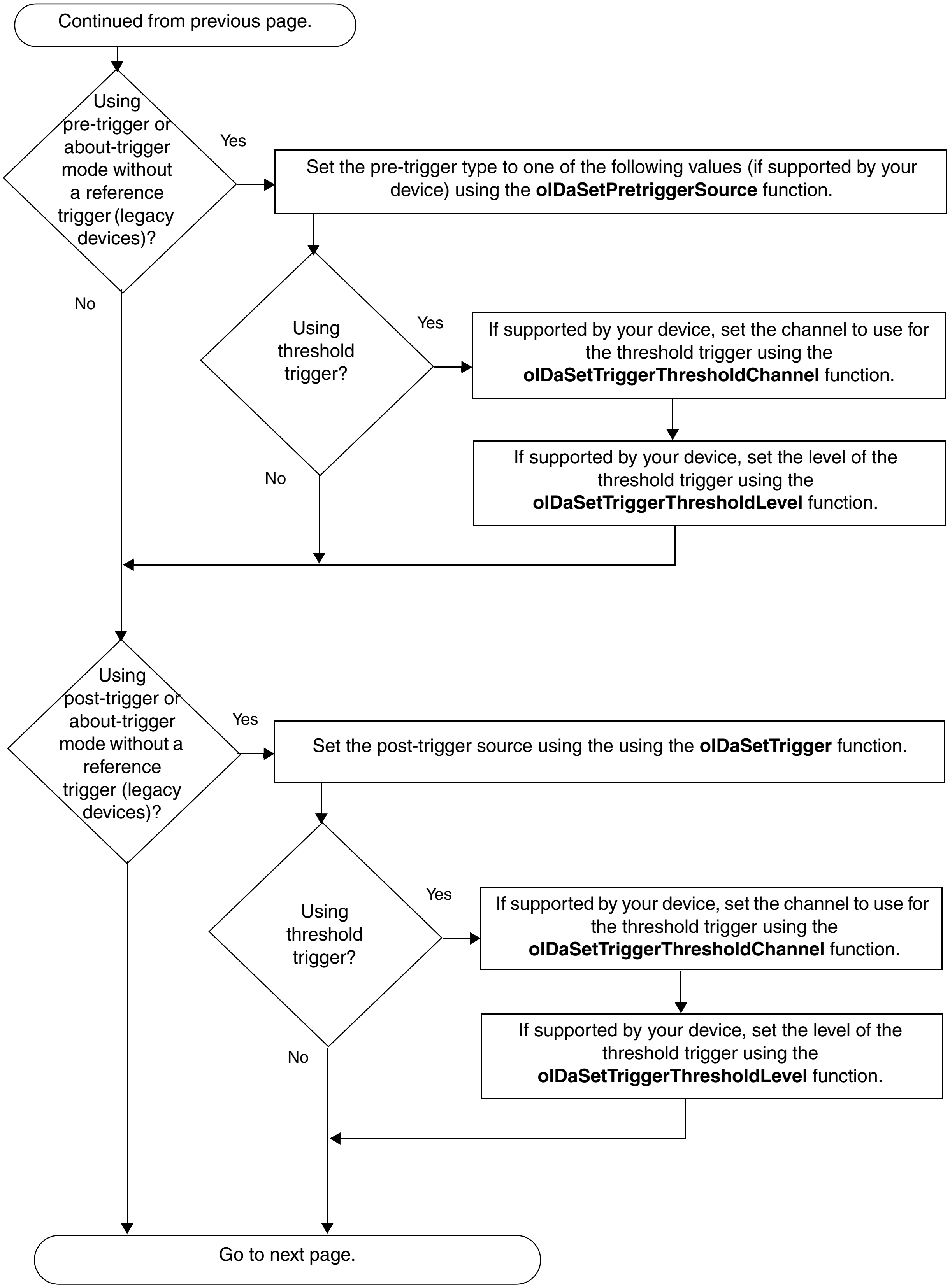
Specify the frequency of the internal clock. The driver sets the actual frequency as closely as possible to the number specified.

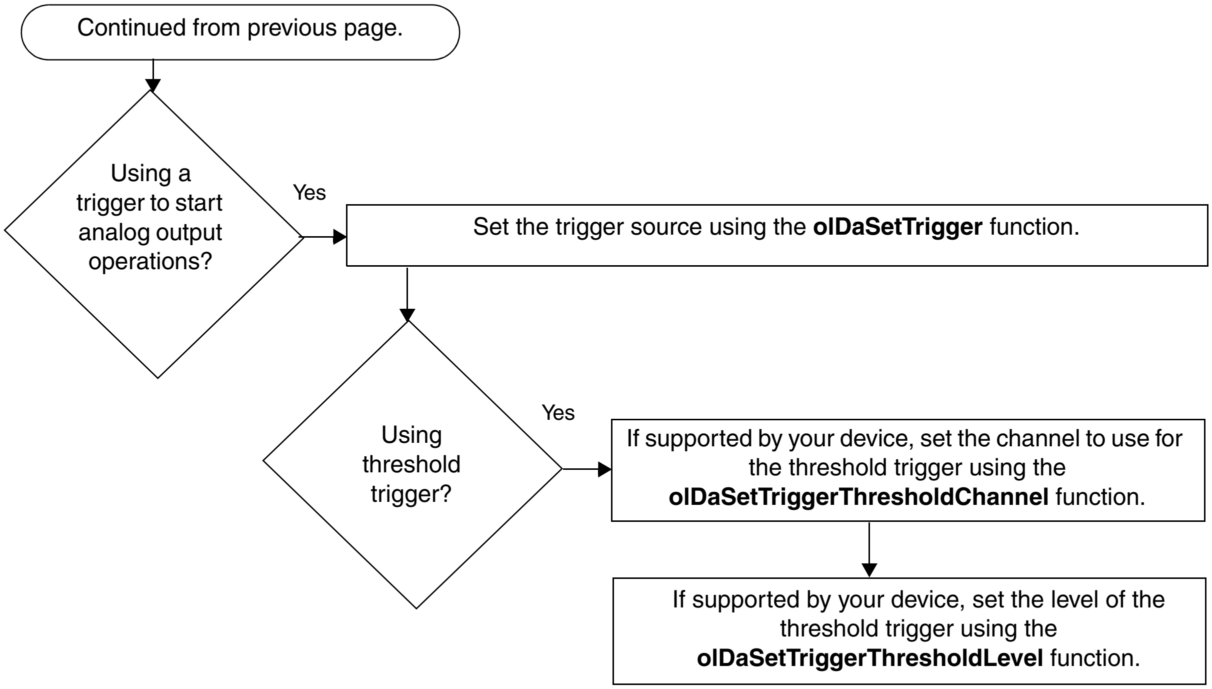
Specify OL_CLK_EXTERNAL to select the external clock or OL_CLK_EXTRA to select an extra available external clock.

Specify a clock divider to apply to the external clock source. The driver sets the actual clock divider as closely as possible to the number specified.

### Set Up Triggers

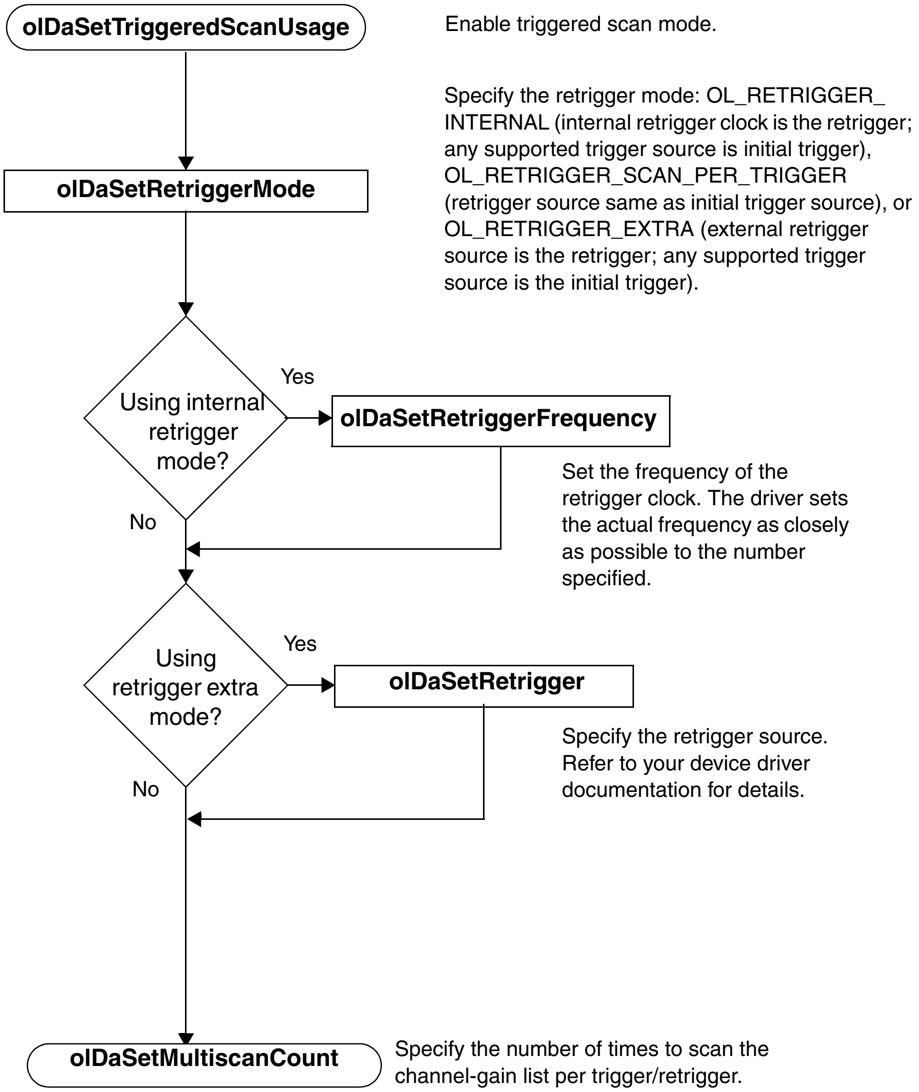

Using a start trigger and reference trigger for pre-trigger/ post-trigger operations?
Yes
No
Set the start trigger type using the **olDaSetTrigger** function.
Using threshold trigger for the start trigger?
Yes
Set the channel to use for the threshold trigger using the **olDaSetTriggerThresholdChannel** function.
Set the level of the threshold trigger using the **olDaSetTriggerThresholdLevel** function.
Set the reference trigger source using the **olDaSetReferenceTrigger** function. This trigger source stops pre-trigger acquisition, if in progress, and starts post-trigger acquisition.
Using threshold trigger for the reference trigger?
Yes
Set the channel to use for the threshold trigger using the **olDaSetReferenceTriggerThresholdChannel** function.
Set the level of the threshold trigger using the **olDaSetReferenceTriggerThresholdLevel** function.
Specify the number of samples to acquire after the reference trigger using the **olDaSetReferenceTriggerPostScanCount** function.
Go to next page.


Continued from previous page.
Using pre-trigger or about-trigger mode without a reference trigger (legacy devices)?
Yes
No
Set the pre-trigger type to one of the following values (if supported by your device) using the **olDaSetPretriggerSource** function.
Using threshold trigger?
Yes
No
If supported by your device, set the channel to use for the threshold trigger using the **olDaSetTriggerThresholdChannel** function.
If supported by your device, set the level of the threshold trigger using the **olDaSetTriggerThresholdLevel** function.
Using post-trigger or about-trigger mode without a reference trigger (legacy devices)?
Yes
No
Set the post-trigger source using the using the **olDaSetTrigger** function.
Using threshold trigger?
Yes
No
If supported by your device, set the channel to use for the threshold trigger using the **olDaSetTriggerThresholdChannel** function.
If supported by your device, set the level of the threshold trigger using the **olDaSetTriggerThresholdLevel** function.
Go to next page.



Continued from previous page.
Using a trigger to start analog output operations?
Yes
Set the trigger source using the **olDaSetTrigger** function.
Using threshold trigger?
Yes
If supported by your device, set the channel to use for the threshold trigger using the **olDaSetTriggerThresholdChannel** function.
If supported by your device, set the level of the threshold trigger using the **olDaSetTriggerThresholdLevel** function.

## Set Up Triggered Scan


olDaSetTriggeredScanUsage
olDaSetRetriggerMode
Using internal retrigger mode?
Yes
No
olDaSetRetriggerFrequency
Using retrigger extra mode?
Yes
No
olDaSetRetrigger
olDaSetMultiscanCount

Enable triggered scan mode.

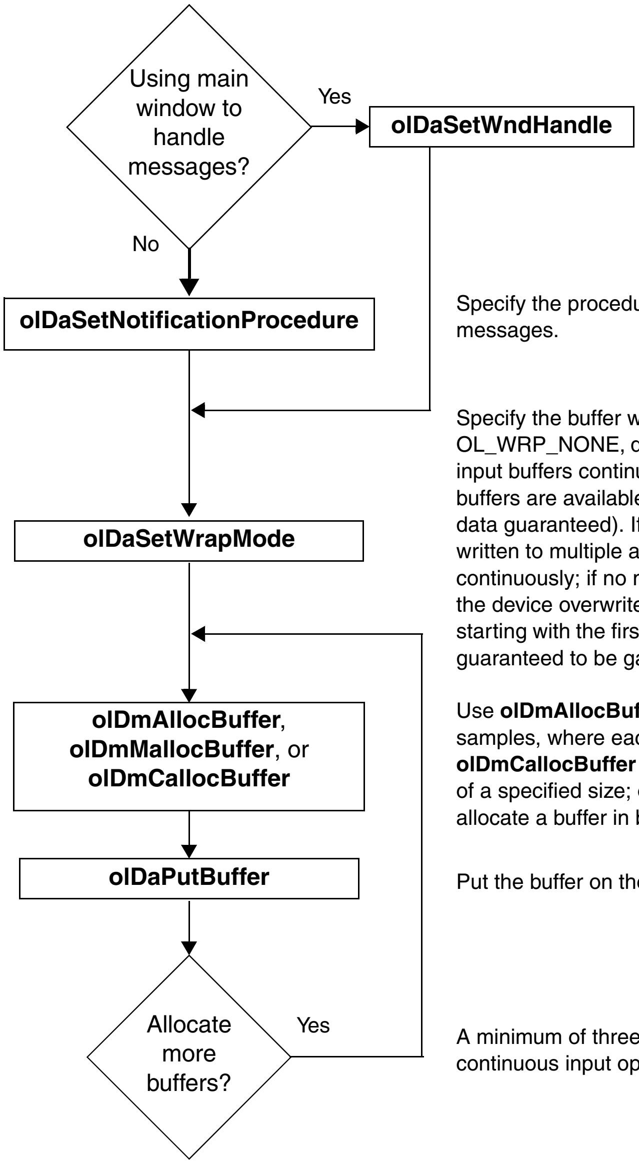
Specify the retrigger mode: OL_RETRIGGER_INTERNAL (internal retrigger clock is the retrigger; any supported trigger source is initial trigger), OL_RETRIGGER_SCAN_PER_TRIGGER (retrigger source same as initial trigger source), or OL_RETRIGGER_EXTRA (external retrigger source is the retrigger; any supported trigger source is the initial trigger).

Set the frequency of the retrigger clock. The driver sets the actual frequency as closely as possible to the number specified.

Specify the retrigger source. Refer to your device driver documentation for details.

Specify the number of times to scan the channel-gain list per trigger/retrigger.

## Set Up Input Buffering


Using main window to handle messages?
Yes
oIDaSetWndHandle
No
oIDaSetNotificationProcedure
oIDaSetWrapMode
oIDmAllocBuffer, oIDmMallocBuffer, or oIDmCallocBuffer
oIDaPutBuffer
Allocate more buffers?
Yes

Specify the window in which to post messages.

Specify the procedure to handle Windows messages.

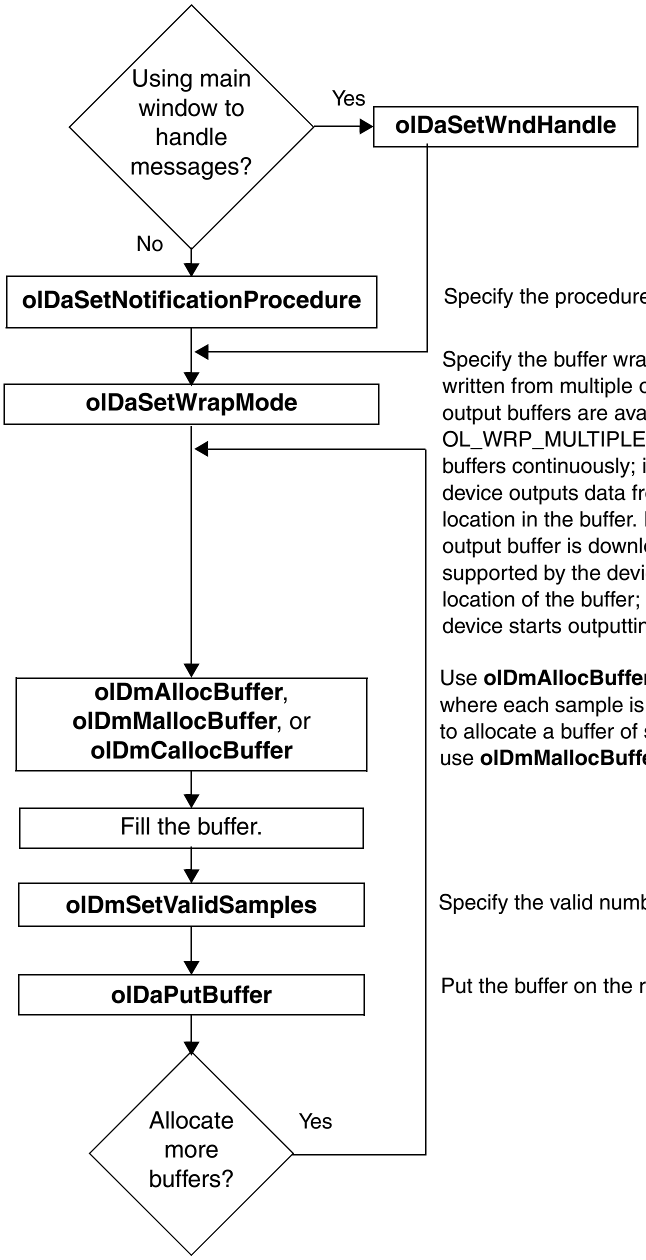
Specify the buffer wrapping mode. If OL_WRP_NONE, data is written to multiple allocated input buffers continuously; when no more empty buffers are available, the operation stops (gap-free data guaranteed). If OL_WRP_MULTIPLE, data is written to multiple allocated input buffers continuously; if no more empty buffers are available, the device overwrites the data in the current buffer, starting with the first location in the buffer (data is not guaranteed to be gap-free).

Use **olDmAllocBuffer** to allocate a buffer of samples, where each sample is 2 bytes; use **olDmCallocBuffer** to allocate a buffer of samples of a specified size; or use **olDmMallocBuffer** to allocate a buffer in bytes.

Put the buffer on the ready queue.

A minimum of three buffers is recommended for continuous input operations.

## Set Up Output Buffering


Using main window to handle messages?
Yes
olDaSetWndHandle
No
olDaSetNotificationProcedure
olDaSetWrapMode
olDmAllocBuffer, olDmMallocBuffer, or olDmCallocBuffer
Fill the buffer.
olDmSetValidSamples
olDaPutBuffer
Allocate more buffers?
Yes

Specify the window in which to post messages.

Specify the procedure to handle Windows messages.

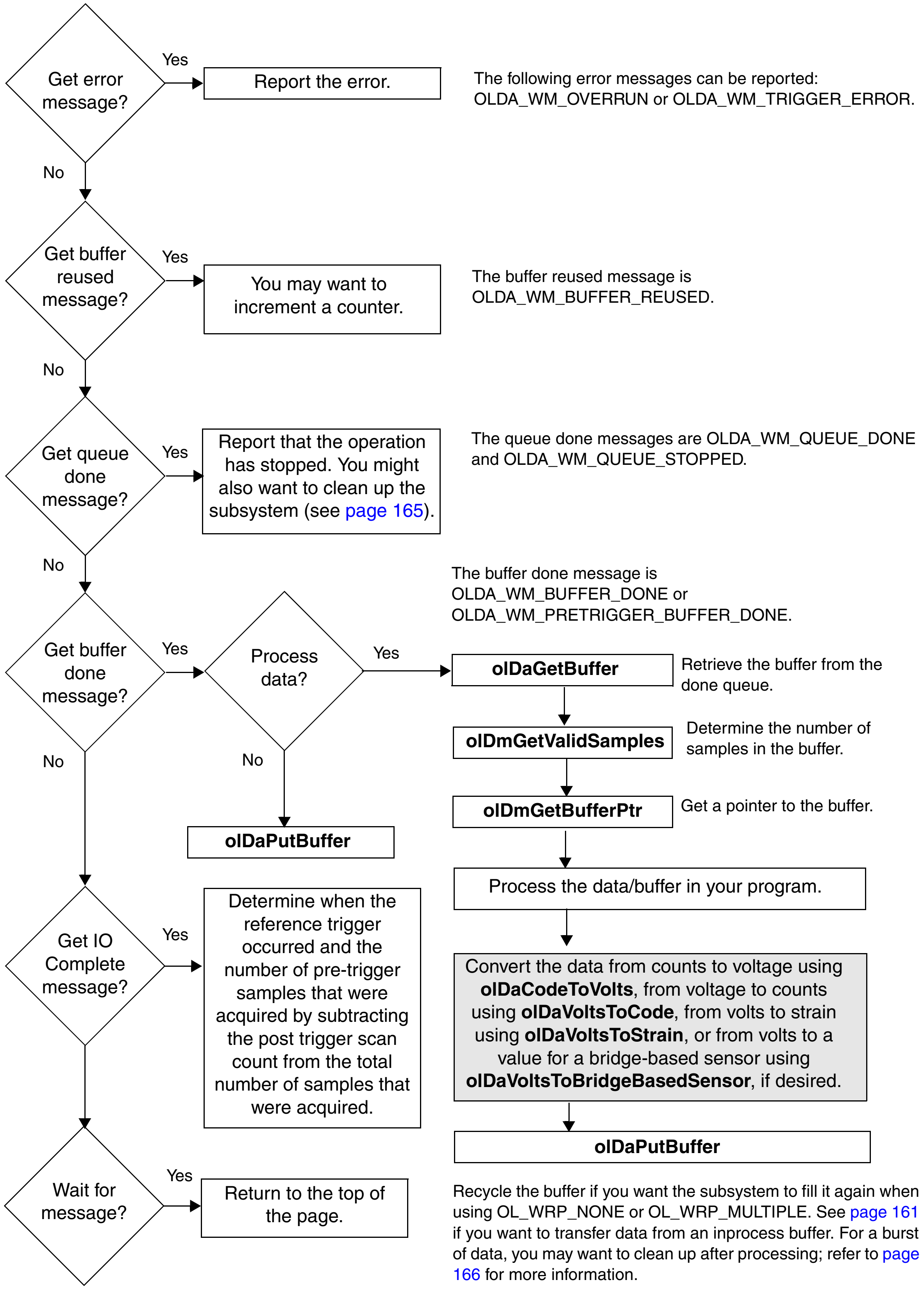
Specify the buffer wrapping mode. If OL_WRP_NONE, data is written from multiple output buffers continuously; when no more output buffers are available, the operation stops. If OL_WRP_MULTIPLE, data is output from multiple output buffers continuously; if no more output buffers are available, the device outputs data from the current buffer, starting with the first location in the buffer. If OL_WRP_SINGLE, data from a single output buffer is downloaded to the FIFO of the device (if supported by the device) and is written out starting from the first location of the buffer; when the end of the buffer is reached, the device starts outputting data from the first location of the buffer.

Use **olDmAllocBuffer** to allocate a buffer of samples, where each sample is 2 bytes; use **olDmCallocBuffer** to allocate a buffer of samples of a specified size; or use **olDmMallocBuffer** to allocate a buffer in bytes.

Specify the valid number of data points in the buffer.

Put the buffer on the ready queue.

## Deal with Messages and Buffers for Input Operations


Get error message?
Yes
Report the error.
No
Get buffer reused message?
Yes
You may want to increment a counter.
No
Get queue done message?
Yes
Report that the operation has stopped. You might also want to clean up the subsystem (see page 165).
No
Get buffer done message?
Yes
Process data?
Yes
olDaGetBuffer
olDmGetValidSamples
olDmGetBufferPtr
Process the data/buffer in your program.
Convert the data from counts to voltage using olDaCodeToVolts, from voltage to counts using olDaVoltsToCode, from volts to strain using olDaVoltsToStrain, or from volts to a value for a bridge-based sensor using olDaVoltsToBridgeBasedSensor, if desired.
olDaPutBuffer
No
olDaPutBuffer
No
Get IO Complete message?
Yes
Determine when the reference trigger occurred and the number of pre-trigger samples that were acquired by subtracting the post trigger scan count from the total number of samples that were acquired.
Wait for message?
Yes
Return to the top of the page.

The following error messages can be reported: OLDA_WM_OVERRUN or OLDA_WM_TRIGGER_ERROR.

The buffer reused message is OLDA_WM_BUFFER_REUSED.

The queue done messages are OLDA_WM_QUEUE_DONE and OLDA_WM_QUEUE_STOPPED.

The buffer done message is OLDA_WM_BUFFER_DONE or OLDA_WM_PRETRIGGER_BUFFER_DONE.

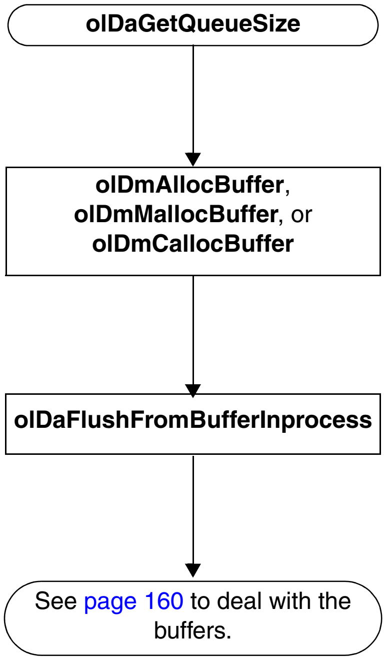
Retrieve the buffer from the done queue.

Determine the number of samples in the buffer.

Get a pointer to the buffer.

Recycle the buffer if you want the subsystem to fill it again when using OL_WRP_NONE or OL_WRP_MULTIPLE. See page 161 if you want to transfer data from an inprocess buffer. For a burst of data, you may want to clean up after processing; refer to page 166 for more information.

## Transfer Data from an Inprocess Buffer

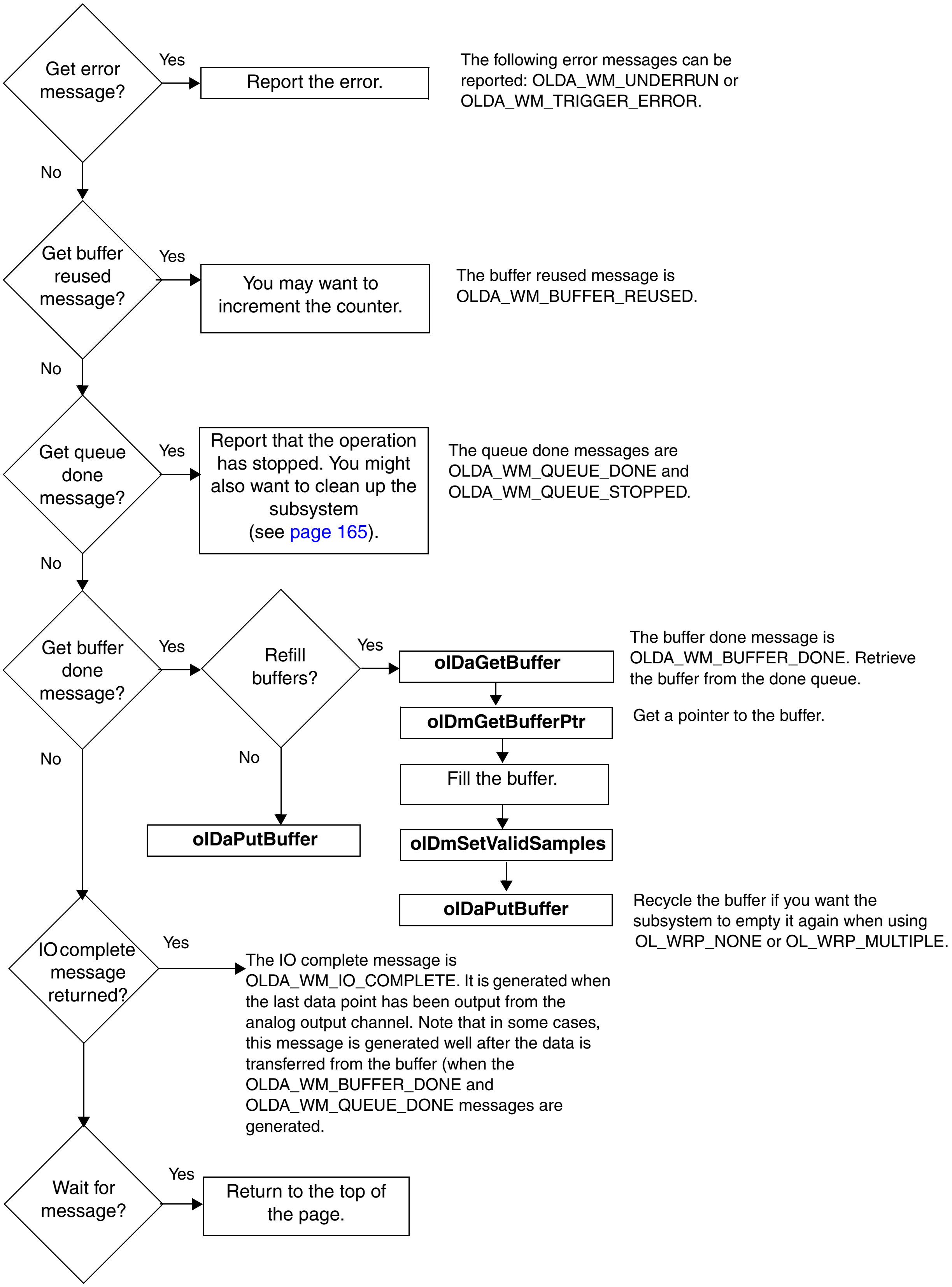

olDaGetQueueSize
olDmAllocBuffer, olDmMallocBuffer, or olDmCallocBuffer
olDaFlushFromBufferInprocess
See page 160 to deal with the buffers.

Determine the number of buffers on the inprocess queue (at least one buffer must be on the inprocess queue to perform this operation).

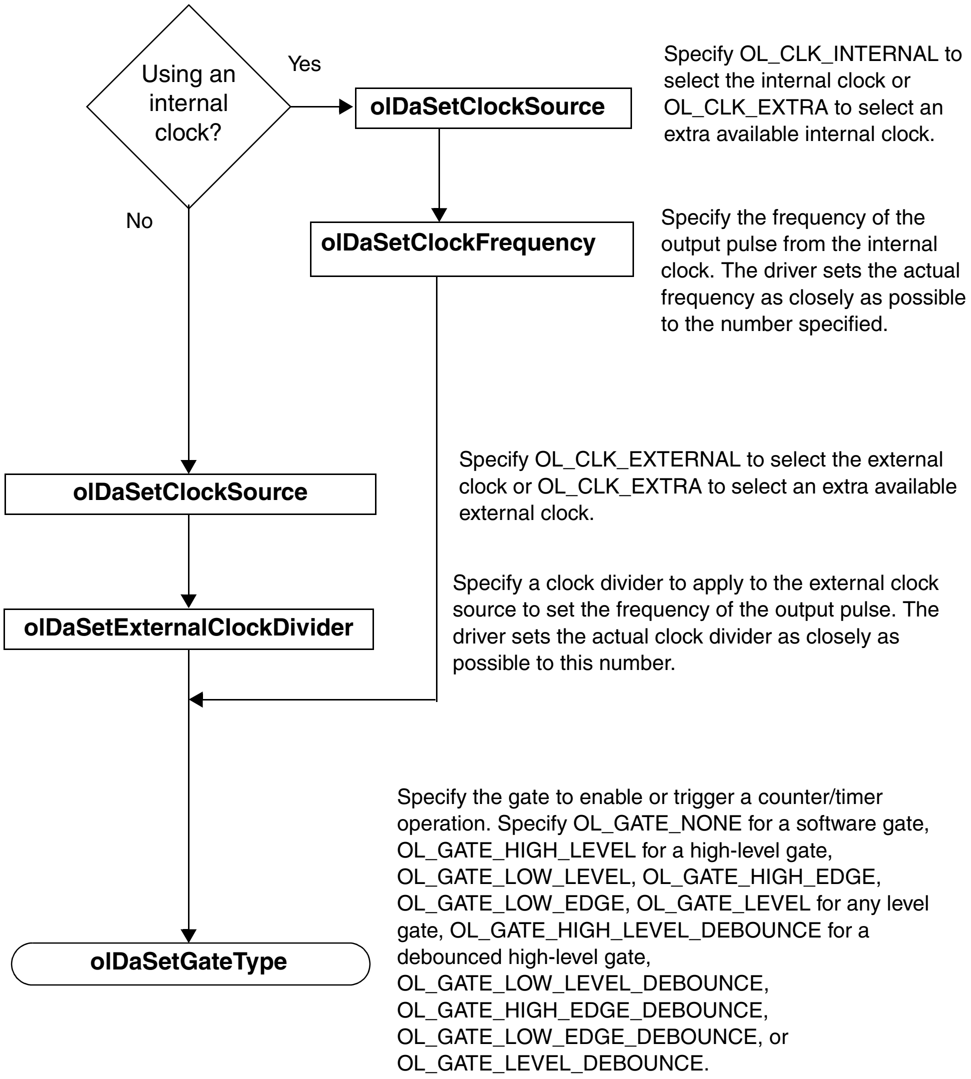
Use **olDmAllocBuffer** to allocate a buffer of samples, where each sample is 2 bytes; use **olDmCallocBuffer** to allocate a buffer of samples of a specified size; or use **olDmMallocBuffer** to allocate a buffer in bytes.

Copy the data from the inprocess buffer to the allocated buffer for immediate processing. An OLDA_WM_BUFFER_DONE message is generated when the operation completes.

### Deal with Messages and Buffers for Output Operations


Get error message?
Yes
Report the error.
The following error messages can be reported: OLDA_WM_UNDERRUN or OLDA_WM_TRIGGER_ERROR.
No
Get buffer reused message?
Yes
You may want to increment the counter.
The buffer reused message is OLDA_WM_BUFFER_REUSED.
No
Get queue done message?
Yes
Report that the operation has stopped. You might also want to clean up the subsystem (see page 165).
The queue done messages are OLDA_WM_QUEUE_DONE and OLDA_WM_QUEUE_STOPPED.
No
Get buffer done message?
Yes
Refill buffers?
Yes
olDaGetBuffer
The buffer done message is OLDA_WM_BUFFER_DONE. Retrieve the buffer from the done queue.
olDmGetBufferPtr
Get a pointer to the buffer.
Fill the buffer.
olDmSetValidSamples
olDaPutBuffer
Recycle the buffer if you want the subsystem to empty it again when using OL_WRP_NONE or OL_WRP_MULTIPLE.
No
olDaPutBuffer
No
IO complete message returned?
Yes
The IO complete message is OLDA_WM_IO_COMPLETE. It is generated when the last data point has been output from the analog output channel. Note that in some cases, this message is generated well after the data is transferred from the buffer (when the OLDA_WM_BUFFER_DONE and OLDA_WM_QUEUE_DONE messages are generated.
Wait for message?
Yes
Return to the top of the page.

## Set Clocks and Gates for Counter/Timer Operations



Specify OL_CLK_INTERNAL to select the internal clock or OL_CLK_EXTRA to select an extra available internal clock.

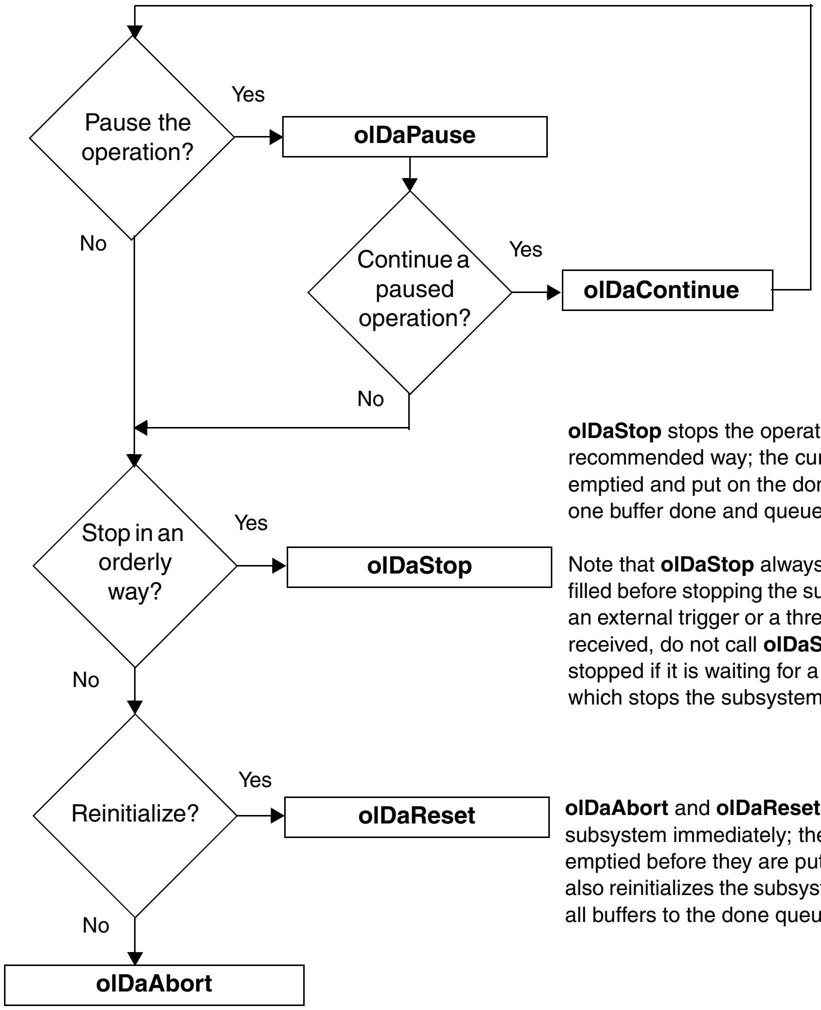
Specify the frequency of the output pulse from the internal clock. The driver sets the actual frequency as closely as possible to the number specified.

Specify OL_CLK_EXTERNAL to select the external clock or OL_CLK_EXTRA to select an extra available external clock.

Specify a clock divider to apply to the external clock source to set the frequency of the output pulse. The driver sets the actual clock divider as closely as possible to this number.

Specify the gate to enable or trigger a counter/timer operation. Specify OL_GATE_NONE for a software gate, OL_GATE_HIGH_LEVEL for a high-level gate, OL_GATE_LOW_LEVEL, OL_GATE_HIGH_EDGE, OL_GATE_LOW_EDGE, OL_GATE_LEVEL for any level gate, OL_GATE_HIGH_LEVEL_DEBOUNCE for a debounced high-level gate, OL_GATE_LOW_LEVEL_DEBOUNCE, OL_GATE_HIGH_EDGE_DEBOUNCE, OL_GATE_LOW_EDGE_DEBOUNCE, or OL_GATE_LEVEL_DEBOUNCE.

## Stop the Operation

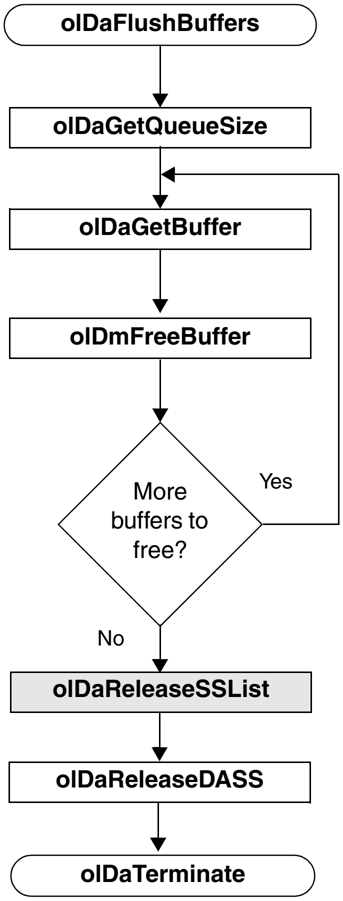


**olDaStop** stops the operation on the subsystem in the recommended way; the current inprocess buffers are filled or emptied and put on the done queue. The driver posts at least one buffer done and queue stopped message.

Note that **olDaStop** always waits for the current buffer to be filled before stopping the subsystem. Therefore, if you are using an external trigger or a threshold trigger and the trigger is never received, do not call **olDaStop** as the subsystem will not be stopped if it is waiting for a trigger. Instead, call **olDaAbort**, which stops the subsystem immediately.

**olDaAbort** and **olDaReset** stop the operation on the subsystem immediately; the current buffers are not filled or emptied before they are put on the done queue. **olDaReset** also reinitializes the subsystem to a known state and flushes all buffers to the done queue.

## Clean Up Buffered I/O Operations



Flush all buffers on the ready and/or inprocess queues to the done queue.

Determine the number of buffers on the done queue.

Retrieve each buffer on the done queue.

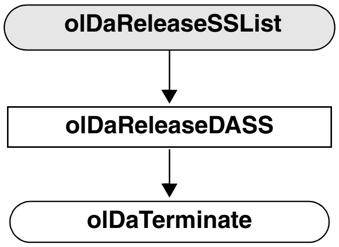
Free each buffer retrieved from the done queue.

For simultaneous operations only, release the simultaneous start list.

Release each subsystem.

Release the device driver and terminate the session.

## Clean Up Counter/Timer Operations



For simultaneous operations only, release the simultaneous start list.

Release each subsystem.

Release the device driver and terminate the session.

5

# *Product Support*

Should you experience problems using the DataAcq SDK, follow these steps:

1. Read all the appropriate sections of this manual. Make sure that you have added any "Read This First" information to your manual and that you have used this information.
2. Check for a README file on the Data Acquisition OMNI CD. If present, read this file for the latest installation and usage information.
3. Check that you have installed your hardware devices properly. For information, refer to the documentation supplied with your devices.
4. Check that you have installed the device drivers for your hardware devices properly. For information, refer to the documentation supplied with your devices.
5. Check that you have installed your software properly. For information, refer to Chapter 2 starting on page 19.

If you are still having problems, Data Translation's Technical Support Department is available to provide technical assistance. To request technical support, go to our web site at hwww.mccdaq.com and click on the Support link.

When requesting technical support, be prepared to provide the following information:

- Your product serial number
- The hardware/software product you need help on
- The version of the CD you are using
- Your contract number, if applicable

If you are located outside the USA, contact your local distributor; see our web site (www.mccdaq.com) for the name and telephone number of your nearest distributor.

# A

# Sample Code

# Single-Value Analog Input

The following code fragments illustrate the steps required to perform a single-value analog input operation. Refer to the example program svadc.c in the directory C:\Program Files\Data Translation\Win32\SDK\Examples\ for the entire program.

This program calls a user-defined function called GetDriver(), which enumerates the devices installed in the system.

## Declare Variables and User Functions

This code fragment defines the variables used and the user-defined **GetDriver()** function; note that this program uses the device's default values for channel type, resolution, data encoding, range, and channel filter.

```
typedef struct tag_board {
   HDRVR hdrvr;        /* driver handle          */
   HDASS hdass;        /* subsystem handle       */
   ECODE status;       /* board error status     */
   char name[STRLEN];  /* string for board name  */
   char entry[STRLEN]; /* string for board name  */
   } BOARD;

typedef BOARD FAR* LPBOARD;

static BOARD board;

BOOL __export FAR PASCAL GetDriver(lpszName,lpszEntry,lParam)

   LPSTR  lpszName;    /* board name              */
   LPSTR  lpszEntry;   /* system.ini entry        */
   LPARAM lParam;      /* optional user data      */
   UINT channel = 0;
   DBL gain = 1.0;
   DBL min,max;
   float volts;
   long value;
   UINT encoding,resolution;
```

## Initialize the Driver

The following code fragment, in **WinMain ()**, calls the CHECKERROR error handler macro and the **olDaEnumBoards** function, which initializes the first available DT-Open Layers device. **olDaEnumBoards** calls **GetDriver()**, which lists the name of the device:

```
board.hdrvr = NULL;
CHECKERROR(olDaEnumBoards(GetDriver, (LPARAM) (LPBOARD) &board));
```

This code fragment is in **GetDriver()** and gets the device name:

```
{
LPBOARD lpboard = (LPBOARD)(LPVOID)lParam;
/* fill in board strings */
lstrcpyn(lpboard->name,lpszName,STRLEN);
lstrcpyn(lpboard->entry,lpszEntry,STRLEN);
```

This code is in **WinMain()** and checks for errors within the callback function:

```
CHECKERROR (board.status);
/* check for NULL driver handle - means no boards */
if (board.hdrvr == NULL){
   MessageBox(HWND_DESKTOP, "No DT-Open Layer boards!!!", "Error",
      MB_ICONEXCLAMATION | MB_OK);
return ((UINT)NULL);
}
```

This code fragment is in **WinMain()** and initializes the device:

```
lpboard->status = olDaInitialize(lpszName,
      &lpboard->hdrvr);
if   (lpboard->hdrvr != NULL)
      return FALSE;
/* false to stop enumerating */
         else
      return TRUE;           /* true to continue */
}
```

## Get a Handle to the Subsystem

The following code fragment gets a handle to the A/D subsystem and checks for errors:

```
CHECKERROR(olDaGetDASS(board.hdrvr,OLSS_AD,0, &board.hdass));
```

## Set the DataFlow to Single Value

The following code fragment sets the dataflow mode of the A/D subsystem to single value and checks for errors.

```
CHECKERROR (olDaSetDataFlow(board.hdass,OL_DF_SINGLEVALUE));
```

## Configure the Subsystem

The following code fragment configures the A/D subsystem and checks for errors.

```
CHECKERROR (olDaConfig(board.hdass));
```

## Acquire a Single Value

The following code fragment acquires a single analog input value from channel 0 of the A/D subsystem (using a gain of 1) and checks for errors.

```
CHECKERROR (olDaGetSingleValue(board.hdass, &value, channel, gain));
```

## Convert the Value to Voltage

The following code fragment uses the default range, encoding, and resolution of the A/D subsystem to convert the acquired value into voltage and to check for errors. Note that this step is optional.

```
CHECKERROR (olDaGetRange(board.hdass,&max,&min));
CHECKERROR (olDaGetEncoding(board.hdass, &encoding));
CHECKERROR (olDaGetResolution(board.hdass, &resolution));

/* Convert value to volts */
if (encoding != OL_ENC_BINARY)

{
/* convert to offset binary by inverting the */
/* sign bit */
    value ^= 1L << (resolution-1);

      /* zero upper bits */
      value &= (1L << resolution) - 1;
}
volts=(float)max-(float)min)/(1L<<resolution)* value+float)min;

/* display value with message box */
sprintf(str,"Single Value AD Op.\nADC Input = %.3f V", volts);
MessageBox(HWND_DESKTOP, str, board.name,
      MB_ICONINFORMATION | MB_OK);
```

## Release the Subsystem and Terminate the Session

The following code fragment releases the A/D subsystem, terminates the session, and checks for errors:

```
CHECKERROR (olDaReleaseDASS(board.hdass));
CHECKERROR (olDaTerminate(board.hdrvr));
```

## Handle Errors

The following code fragment handles the errors from the DataAcq SDK and displays the error codes. Note that this step is optional but recommended.

```
#define STRLEN 80 /* String size for general text*/
               /* manipulation. */
```

```
char str[STRLEN]; /* Global string for general */
                  /* text manipulation       */

#define SHOW_ERROR(ecode)
MessageBox(HWND_DESKTOP,olDaGetErrorString(ecode, str,STRLEN),
      "Error", MB_ICONEXCLAMATION|MB_OK);

#define CHECKERROR(ecode) \
if ((board.status = (ecode)) != OLNOERROR)\
   {\
      SHOW_ERROR(board.status);\
      olDaReleaseDASS(board.hdass);\
      olDaTerminate(board.hdrvr);\
      return ((UINT)NULL);
}
```

# Continuous Analog Input

The following code fragments illustrate the steps required to perform a continuous (post-trigger) analog input operation. Refer to the example program contadc.c in the directory C:\Program Files\Data Translation\Win32\SDK\Examples\ for the entire program.

This program calls two user-defined functions: **GetDriver()**, which enumerates the devices installed in the system, and **OutputBox()**, which creates a dialog box to handle information and error window messages from the A/D subsystem.

## Declare Variables and User Functions

This code fragment defines the variables used and the user-defined **GetDriver()** function; note that this program uses the device's default values for channel type, resolution, data encoding, range, and channel filter.

```
typedef struct tag_board {
   HDRVR hdrvr;         /* driver handle           */
   HDASS hdass;         /* subsystem handle        */
   ECODE status;        /* board error status      */
   HBUF  hbuf;          /* subsystem buffer handle */
   WORD FAR* lpbuf;     /* buffer pointer          */
   char name[STRLEN];   /* string for board name   */
   char entry[STRLEN];  /* string for board name   */

} BOARD;

typedef BOARD FAR* LPBOARD;

static BOARD board;
static ULNG count = 0;
BOOL __export FAR PASCAL GetDriver(lpszName, pszEntry, lParam)

   LPSTR  lpszName;      /* board name         */
   LPSTR  lpszEntry;     /* system.ini entry   */
   LPARAM lParam;        /* optional user data */

BOOL __export FAR PASCAL InputBox(hDlg, message, wParam, lParam)

HWND   hDlg;
/* window handle of the dialog box */
UINT   message;
/* type of message */
WPARAM wParam;
/* message-specific information    */
LPARAM lParam;

DBL min,max;
float volts;
long value;
ULNG samples;
```

```
UINT encoding,resolution;

DBL  freq;
UINT size,dma,gainsup;
int i;

UINT channel = 0;
DBL gain = 1.0;
```

## Initialize the Driver

The following code fragment, in **WinMain()**, calls the CHECKERROR error handler macro and the **olDaEnumBoards** function, which initializes the first available DT-Open Layers device. **olDaEnumBoards** calls **GetDriver()**, which lists the name of the device:

```
board.hdrvr = NULL;
CHECKERROR(olDaEnumBoards(GetDriver,(LPARAM)(LPBOARD)&board));
CHECKERROR (board.status);

/* check for NULL driver handle - means no boards */
if (board.hdrvr == NULL){
   MessageBox(HWND_DESKTOP, " No Open Layer boards!!!", "Error",
    MB_ICONEXCLAMATION | MB_OK);
return ((UINT)NULL);
}
```

This code is in **GetDriver()** and gets the device name:

```
{
LPBOARD lpboard = (LPBOARD)(LPVOID)lParam;

/* fill in board strings */
lstrcpyn(lpboard->name,lpszName,STRLEN);
lstrcpyn(lpboard->entry,lpszEntry,STRLEN);
}
```

This code is in **WinMain()** and initializes the device:

```
lpboard->status = olDaInitialize(lpszName,
   &lpboard->hdrvr);
if   (lpboard->hdrvr != NULL)
      return FALSE; /* false to stop enumerating */
         else
      return TRUE; /* true to continue */
}
```

## Get a Handle to the Subsystem

The following code fragment gets a handle to the A/D subsystem and checks for errors:

```
CHECKERROR (olDaGetDASS(board.hdrvr,OLSS_AD,0,&board.hdass));
```

## Set the DataFlow to Continuous

The following code fragment sets the dataflow mode of the A/D subsystem to single value and checks for errors:

```
CHECKERROR (olDaSetDataFlow(board.hdass,OL_DF_CONTINUOUS));
```

## Specify the Channel List and Channel Parameters

The following code fragment specifies a channel-gain list size of 1; specifies channel 0 in the channel-gain list; if the subsystem supports programmable gain, specifies a gain of 1 for this entry; and checks for errors:

```
/* Specify a channel-list size of 1.*/
CHECKERROR (olDaSetChannelListSize(board.hdass,1));

/* Specify a channel 0 in the channel list.*/
CHECKERROR (olDaSetChannelListEntry(board.hdass,0,channel));

/* Check if the subsystem supports programmable gain. */
CHECKERROR (olDaGetSSCaps(board.hdass,OLSSC_SUP_PROGRAMGAIN,
  gainsup));
/* Set the gain for entry 0 in the channel list */
/* if the board supports it. */
if (gainsup)
CHECKERROR (olDaSetGainListEntry(board.hdass, 0,gain));
```

## Specify the Clocks

The following code fragment specifies the frequency of the internal A/D sample clock and checks for errors:

```
/* Check the maximum frequency for the internal clock */
CHECKERROR(olDaGetSSCapsEx(board.hdass,OLSSCE_MAXTHROUGHPUT, &freq));

/* set 1000 Hz frequency */
freq = min (1000.0, freq);
CHECKERROR (olDaSetClockFrequency(board.hdass, freq));
```

## Specify DMA Usage

The following code fragment specifies one DMA channel for the A/D subsystem and checks for errors:

```
/* Check the number of DMA channels supported. */
CHECKERROR(olDaGetSSCaps(board.hdass, OLSSC_NUMDMACHANS, &dma));

/* Set one dma channel.*/
dma  = min (1, dma);
CHECKERROR (olDaSetDmaUsage(board.hdass,dma));
```

## Set Up Window Handle and Buffering

The following code fragment specifies a handle to the message window, set up buffers, and check for errors:

```
/* Specify window handle. */
CLOSEONERROR (olDaSetWndHandle(board.hdass, hDlg,(UINT)NULL));

/*Specify the buffer wrap mode as multiple */
CHECKERROR (olDaSetWrapMode(board.hdass, OL_WRP_MULTIPLE));

/*Specify the buffers and put them on the ready queue. */
size = (UINT)freq/10;
/* Specify the buffer size. */

/* Allocate three input buffers and put the buffers on the
/* ready queue. */
for (i=0;i<3;i++)
{
   CHECKERROR (olDmCallocBuffer(0,0,(ULNG) size, 2,&board.hbuf));
   CHECKERROR (olDmGetBufferPtr(board.hbuf,(LPVOID FAR*)
      &board.lpbuf));
   CHECKERROR (olDaPutBuffer(board.hdass, board.hbuf));
}
```

## Configure the Subsystem

The following code fragment configures the A/D subsystem and checks for errors.

```
CHECKERROR (olDaConfig(board.hdass));
```

## Start the Continuous Analog Input Operation

The following code fragment acquires a single analog input value from channel 0 of the A/D subsystem (using a gain of 1) and checks for errors:

```
CLOSEONERROR (olDaStart(board.hdass));
```

## Deal with Messages and Buffers

The following code fragment deals with messages and buffers for the A/D subsystem:

```
/* Use a dialog box to collect information */
/* and error messages from the subsystem. */
DialogBox(hInstance, (LPCSTR)INPUTBOX, HWND_DESKTOP, InputBox);

/* This function processes messages for the input dialog box. */
switch (message) {

   case WM_INITDIALOG:
   /* message: initialize dialog box*/
   /* set the title to the board name */
   SetWindowText(hDlg,board.name);
   return (TRUE);   /* A message was returned. */

   case OLDA_WM_BUFFER_REUSED:
   /* message: buffer reused*/
   break;
   case OLDA_WM_BUFFER_DONE:
   /* message: buffer done*/

   /* Get buffer off the done queue. */
   CHECKERROR (olDaGetBuffer(board.hdass, &board.hbuf));
      /*If there is a buffer, get subsystem */
      /*information for code to volts conversion */
      if (board.hbuf != NULL){
      CLOSEONERROR (olDaGetRange(board.hdass,&max,&min));
      CLOSEONERROR (olDaGetEncoding(board.hdass,&encoding));
      CLOSEONERROR (olDaGetResolution (board.hdass,&resolution));

      /* get max samples in input buffer */
      CLOSEONERROR (olDmGetMaxSamples(board.hbuf,&samples));

      /* get last sample in buffer */
      value = board.lpbuf[samples-1];

      /* Get pointer to buffer data */
      CHECKERROR (olDmGetBufferPtr (board.hbuf, (LPVOID FAR*)
        &board.lpbuf));
      /* Put buffer back on the ready queue. */
      CHECKERROR (olDaPutBuffer(board.hdass,board.hbuf));

      case OLDA_WM_QUEUE_DONE:
      /* using wrap multiple or none */
      /* if this message is received, */
      /* acquisition has stopped.    */
      EndDialog(hDlg, TRUE);
      case OLDA_WM_QUEUE_STOPPED:
      /* using wrap multiple or none */
      /* if this message is received, */
      /* acquisition has stopped. */
      EndDialog(hDlg, TRUE);

      case OLDA_WM_TRIGGER_ERROR:

      /* Process trigger error message */
      MessageBox(hDlg,"Trigger error: acquisition stopped",
         "Error", MB_ICONEXCLAMATION |MB_OK);
      EndDialog(hDlg, TRUE);

      case OLDA_WM_OVERRUN_ERROR:
      /* Process underrun error message */
      MessageBox(hDlg,"Input overrun error: acquisition stopped",
         "Error", MB_ICONEXCLAMATION | MB_OK);
      EndDialog(hDlg, TRUE);

      case WM_COMMAND:
      /* message: received a command */
      #ifdef WIN32
      switch ( LOWORD(wParam) )  {
      #else
      switch (wParam) {
      #endif
      case IDOK:
      case IDCANCEL:
         CLOSEONERROR (olDaAbort(board.hdass));
         EndDialog(hDlg, TRUE);
      return (TRUE);  /* Did process a message. */
   }
   break;
    }
   return (FALSE);       /* Didn't get a message */
}
```

## Convert Values to Voltage

The following code fragment uses the default range, encoding, and resolution of the A/D subsystem to convert the acquired values into voltages and to check for errors. Note that this step is optional.

```
/*  convert value to volts */
if (encoding != OL_ENC_BINARY) {

/* convert to offset binary by inverting sign bit */
value ^= 1L << (resolution-1);

/* zero upper bits */
value &= (1L << resolution) - 1;
}
volts = ((float)max-(float)min)/(1L<<resolution) *
    value + (float)min;

/* display value */
sprintf(str,"%.3f Volts",volts);
SetDlgItemText (hDlg, IDD_VALUE, str);
}
```

## Clean Up

The following code fragment flushes the buffers, releases the subsystem, and terminates the program when the continuous A/D operation is complete:

```
/* Get the input buffers from the done queue and free the
/* input buffers */
CHECKERROR (olDaFlushBuffers(board.hdass));

for (i=0;i<3;i++)
{
   CHECKERROR (olDaGetBuffer(board.hdass, &board.hbuf));
   CHECKERROR (olDmFreeBuffer(board.hbuf));
}

/* release the subsystem and terminate the session */
CHECKERROR (olDaReleaseDASS(board.hdass));
CHECKERROR (olDaTerminate(board.hdrvr));
```

## Handle Errors

The following code fragment handles the errors from the DataAcq SDK and displays the error codes. Note that this step is optional but recommended.

```
/* Error handling macros */

#define STRLEN 80 /* String size for general text manipulation */
char str[STRLEN]; /* Global string for general text manipulation. */

#define SHOW_ERROR(ecode)
MessageBox(HWND_DESKTOP,olDaGetErrorString(ecode,(str,STRLEN),
   "Error", MB_ICONEXCLAMATION |MB_OK);
#define CHECKERROR(ecode)
      if ((board.status = (ecode))!= OLNOERROR)\
      {\
         SHOW_ERROR(board.status);\
         olDaReleaseDASS(board.hdass);\
         olDaTerminate(board.hdrvr);\
      return ((UINT)NULL);}
```

```
#define CLOSEONERROR(ecode)
      if ((board.status = (ecode)) != OLNOERROR)\
      {\
      SHOW_ERROR(board.status);\
      olDaReleaseDASS(board.hdass);\
      olDaTerminate(board.hdrvr);\
      EndDialog(hDlg, TRUE);\
      return (TRUE);}
```

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